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Forder Application

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Abstract

In Portugal eating out is a part of the lifestyle. People meet in coffee shops and restaurants, creating business opportunities for the owners of the places. In the summer season there are many bars that open their terrace service. Like many business, there are some 'quiet times' during the day – moments, when the place doesn't receive so many clients.

This project proposes an idea on how to maintain the efficiency of the outdoor service with possibly lower costs for the company. The application presented in the given project enables clients to make their requests directly from the table using a cellphone. In the next step the employee receives a notification with the request and he can prepare and deliver the order. Combining Proximity Communication Technologies and a web and mobile application, the communication between a client and an employee may turn out to be fast and comfortable. This solution can have an impact on the number of employees during a calmer time. It is also expected that the client will be able to receive his order in the faster way, through the implemented innovation.

Keywords: Quick Response Code (QR Code), Near Field Communication (NFC), Bluetooth Low Energy (BLE), Angular, Ionic, Firebase.

Resumo

Em Portugal comer fora faz parte do estilo de vida. As pessoas encontram-se em cafés e restaurantes, dando oportunidade de negócio aos proprietários desses estabelecimentos. Na altura do verão existem muitos bares e restaurantes que abrem o seu serviço de esplanada e, como em qualquer negócio, existem períodos calmos ao longo do dia.

Este projeto propõe uma solução que procura garantir um serviço de esplanada eficiente. A solução proposta permitirá ao utilizador fazer os pedidos diretamente da mesa onde se encontra, utilizando o seu telemóvel. Na próxima etapa o funcionário recebe uma notificação com o pedido e pode então preparar e entregar a ordem. Combinando tecnologias de comunicação por proximidade e uma aplicação *mobile* e *web*, a comunicação entre o cliente e o funcionário será rápida e confortável. A integração deste sistema poderá ter impacto no número de funcionários do estabelecimento em períodos de menor afluência de clientes. Também é expectável que o cliente receba o seu pedido de uma forma rápida, através da inovação implementada.

Keywords: QR Code, NFC, BLE, Angular, Ionic, Firebase.

Contents

List of Figures

List of Tables

Listings

List of Acronyms

2D: Two Dimensional
API: Application Programming Interface
ATT: Attribute Protocol
AWS: Amazon Web Services
BE: Back-End
BLE: Bluetooth Low Energy
CDN: Content Delivery Network
CLIS: Command Line Interface
CSS: Cascading Style Sheets
DOM: Document Object Model
EDR: Enhanced Data Rate
FE: Front-End
GAP: Generic Access Profile
HCI: Host Controller Interface
HTML: Hypertext Markup Language
HTTP: Hypertext Transfer Protocol
HTTPS: Hypertext Transfer Protocol Secure
iOS: iPhone Operational System
IoT: Internet of Things
ISO: International Organization for Standardization
IT: Information Technology
JS: JavaScript
JSON: JavaScript Object Notation
L2CAP: Logical Link Control and Adaptation Protocol
LL: Link Layer
MAC: Media Access Control
NFC: Near Field Communication
NoSQL: Not only SQL
PCT: Proximity Communication Technologies
PDA: Personal Digital Assistant
PHY: Physical Layer
POS: Point of Sale
PWA: Progressive Web Applications

QR Code: Quick Response Code
QSR: Quick Service Restaurants
RF: Radio Frequency
RFID: Radio Frequency Identification
RSSI: Received Signal Strength
RUP: Rational Unified Process
S3: Simple Storage Service
SDK: Software Development Kit
SIG: Bluetooth Special Interest Group
SMP: Security Manager Protocol
SPA: Single Page Applications
UI: User Interface
ULP: Ultra Low Power
URL: Uniform Resource Locator
WWW: World Wide Web

Chapter 1

Introduction

Among European countries, Portugal is the nation that chooses eating outside the house the most often. Almost a quarter (23%) of Portuguese population consumes a meal in a restaurant at least one time each week [1]. This phenomenon is the proof that the catering area is an essential part of industry, worth paying attention. Nowadays, even the Information Technology (IT) sector can benefit from such an occurrence. Catering service is not skipped in the process of modernization. Restaurants offer various amenities, for instance card payment, interactive displays for the employees and online orders. However, there is still a chance for IT area to become even more associated with restaurants. During summer coffee shops, bars and restaurants take the advantage of sunny weather and a bigger interest by people in eating out. These places start their outdoor service and throughout the day they can experience some periods of a lower attendance.

Since mobile devices have started to appear on the market, developers have launched thousands of applications and created technologies to make life easier, while convincing people to use mobile phones and tablets more frequently. Providing Internet was a crucial moment for the industry that led to the appearance of technologies that do not require a cable to work. In this work, the aspect of near proximity will be particularly important. In wireless networks, communication between devices take place at a distance that does not exceed some meters. Proximity communication, instead of wires, use capacitive coupling and offer a speed increase when exchanging information between chips, with receiver and transmitter pads, placed in an electronic system. Proximity Communication Technologies (PCT) enable sending of data at a low cost and requiring less power, which is a significant point nowadays [2].

In order to use such technologies, developers work on various programming languages. Among the most popular ones we can find: Java, JS, Python and C# [3, 4]. These languages have different features and apply to various fields. For instance, Java is considered to be the language that would run an application everywhere, on the other hand there is JS that is used in programming for web browsers [5]. This variety in combination with modern technologies gives an expanded and diverse base for all of the sectors and areas of life. People use modern technologies in all of the services, for example: sales, medicine, in the offices and restaurants [6].

We live in times where communication is a click away. In a perfect world a client arrives at the terrace, sits at the table and he is served immediately. However this does not always happen. In this scenario the ideal solution would be to communicate to the employee the presence of the client, in a simple and comfortable way and this is where the proximity communication will start. These technologies are within reach of the majority of smartphones. These systems are the main basis of this project.

Due to the occurrence of variable traffic in these places, there appears to be a need to optimize the labor resources. In the scenario introduced in this work, there are some assumptions in the mode of operation for these businesses. Coffee shops, bars and restaurants always need to have two employees - one for the conventional service and one for the terrace service. Otherwise, when there is only one employee, the terrace service will be neglected.

The proposed solution helps to mitigate the problems caused by the lack of employees in the 'quiet periods'. This system will also help clients to quickly make their requests, with the code describing his table and without needing immediate assistance of the employee. In extreme situations, the application may reduce the number of vacancies during the rush hours and improve the process of making an order.

Figure 1.1 shows the reference scenario adapted in this work. There are two outdoor tables and the system, which includes a way to identify them, through a code. The unique code identifies a table (the place where the request is made). A client having the application can read the code through his mobile devices, sitting at the table. Therefore, he can order a meal when he is ready for it, without waiting for the employee or rushing with decision about what to eat. This will then enable an employee to attend the client, serving the ready dish and provide the client with the product menu and place the order directly.

Figure 1.1: Reference scenario

This process seems to be more convenient for the client since it allows them to order a product without having to wait for the employee. The employee can then see the requests made through the clients device. Having this said, it is expected for the whole process to take less time. It can also exclude some unnecessary actions. As a result, it is predicted that the company may be able to decrease the number of employees working during lower traffic periods, as well as it can support employees during high-traffic time.

1.1 Objectives

The project aims to meet the needs of catering companies that provide terrace service, with small number of employees in times of greater business volume. It also should be an innovative and attractive way to attend to the client. The implementation of this system should also aim to allow the employee to respond to client's requests in a shorter period. Once he or she knows what orders have been made, by what order and by whom, the employee should end up saving time and effort. For its part, the client will be able to make a comfortable and practical request. The project should contain two applications that can meet the needs of both sides of the transaction – the restaurant and the client.

1.2 Expected results

By the end of this project, the expected results are:

- Evaluation of the PCT best suited to the reference scenario adopted.
- Specification of a solution that meets the project requirements. Within various solutions there must be chosen the most effective one, that will be simple to use.
- Mobile application for registering orders of products and services, containing information about products and being as intuitive as possible.
- Web application to support the mobile application operation.
- The system must be secure. There cannot be any way for clients to access data of another client through the application (except for the content of the order needed by the employee).

This document is organized in chapters. Chapter 2 discusses and analyses PCT deemed appropriate to the project herein. Chapter 3 presents the environment surrounding the project – current competitors, which use similar technologies in their services. Chapter 4 describes the proposed solution. It reveals the design and technical details of the created systems, as well as, describes the practical usage of the various options available. Chapter 5 shows an assessment of the project and the methodology used for the evaluation. Finally, Chapter 6 concludes the work and presents future work.

Chapter 2

Technologies, tools and frameworks

In XXI century technological news appear in such a frequency, that it does not surprise the world anymore. Especially information and communication technology take an important part in creating and developing a variety of software. The base here is transmission and integration of information in order to perform specific tasks. By using the wireless communication technologies of modern smartphones, such as Bluetooth, NFC, and Wi-Fi, a solid ground to transmit and receive information from various sources can be established [7].

In this work, the main concern is PCT, that will be featured in the first part of this chapter. These being: QR Code, NFC and BLE. These technologies are remarkably used in mobile applications. The wide use of them is recognizable for instance in the culture centers as theaters or operas. More modern places almost do not use the paper tickets anymore. Clients can simply show their mobile devices with QR Code in it [8, 9].

There are multiple programming languages available today. All of them have advantages and disadvantages, nevertheless, only a few of them seem to be the most preferable ones among users. In this work the main focus is put on HTML and JS. At the end of this chapter, some frameworks will be described. The particular elements worth considering are: Firebase, Ionic, Angular and JSON. These are the components which transform the data between initial and final stages of the process - Front-End (FE) and Back-End (BE).

2.1 Proximity Communication Technologies

In this section it will be presented the analysis of three PCT. They can be called this way because of the common feature – short distance between different sources of communication. First, it will be defined QR Code. Next, it will be introduced the concept of NFC. The last part will be related to BLE. At the end of the section a comparative benchmarking of the three technologies analyzed will be showed.

2.1.1 QR Code

QR Codes are a way of representing information in Two Dimensional (2D) codes, according to Kikuchi, Yoshikawa, Jayaraman, Zheng & Maekawa (2018)[10]. As mentioned in the above article, the inventor of these 2D, black-and-white matrix barcodes was Denso – automotive company from Japan, which is a Toyota's subsidiary. First QR Codes appeared in 1994. The firm saw the big advantage of the inventory

– the capability of storing more data than it is done by 1D barcode.

QR Code has gained the interest of different applications in daily life by allowing to encode more information than a simple number, in a smaller space. A smartphone can simply play a role of the scanner. Thanks to that, the client after scanning is redirected to a website – the warehouse with all the information displayed. In the article written by Zhou et al. (2018) this technology is described as a tool to dealing with real-time data [11]. QR Code is also called an optical encryption.

From the technical point of view, there are some distinctive features of this kind of barcodes. First, it is capable of adopting only four kinds of input data. There is also a restriction in the quantity of bytes that can be located. Next, the dimensions of QR Code depend on the version of the code. However, it must be at least 21 x 21. The biggest possible size is 177 x 177. Finally, the number of elements in the code is in a proportion to the complexity of data that it contains. These limitations can make the conversion from a picture to a code more complicated [11].

This 2D code is detected by a scanner and after it is examined by a processor, which finds the location of the three big squares placed at the corners and uses one or more smaller squares in order to form the size and the correct viewing angle of the graphics, as well as the right direction of it [12]. Final step, according to Liu, Du & Xu (2018), is a moment when: "small dots in the QR Code are converted to binary numbers and verified by using an error correction algorithm". Then the process is completed, and the result is displayed.

Zhou (2018) depicts: "With the further popularization of Android smartphones, QR Code has growingly numerous applications in manufacturing, sales, logistics, storage, transportation and consumer product industry." Therefore, this kind of technology is said to be widespread. As Shin, Jung & Chang (2012) present, it is common to use QR Codes to encode web addresses Uniform Resource Locator (URL)s [13]. The small square, which resembles an indecipherable hieroglyph, holds in itself a panoply of information that can be accessed via the use of a smartphone or Personal Digital Assistant (PDA) device with a camera and a reader of such codes.

In considerations contained in the work of Mostafa (2014) there are QR Codes pictured a useful in digital marketing, since they aim to facilitate communication with clients who are adept at new technologies [14]. From the perspective of marketing, QR Code can play an important role in promoting brands and attracting clients. "Adding a QR Code to an advertisement increases visual design complexity, yet there remains little research on its impact on clients" (Okazaki, Navarro, Mukherji & Plangger, 2017), which means that QR Code as an element of an advertisement probably seems to be a luxurious looking supplement. The ongoing research may prove this argument in the future. QR Codes are also used in other cases, such as a Norwegian Museum of Telecommunications project that developed an application for students aged 11-14. This application invites students to answer puzzles using the mobile phone to read QR Codes present in strategic points of the museum. The results of this application were considered very positive and helped to stimulate students' interest in the museum exhibition [15, 16].

2.1.2 NFC

Another example of PCT is NFC. This standard was developed within cooperation of Nokia, Sony and Philips. The base of the standard are principles and association between electricity and magnetism [17, 18].

According to Alexiou, Basagiannis & Petridou (2016) it is a short-range wireless technology that

allows communication between objects with the same technology. It was created to assist a huge number of applications. For instance, NFC supports areas which operate with tickets, as well as payments, not necessarily related to those tickets [19]. It is a technology developed for communication over short distances, which cannot exceed 20 centimeters [20].

As mentioned by Pesonen & Horster (2012), NFC is based on Radio Frequency Identification (RFID) standards. Supports two communication modes: active and passive [19]:

1. In active mode, also called peer-to-peer mode, both devices generate their own Radio Frequency (RF) fields. Both of them turn on their RF field while transferring data in Initiator mode (active device dispatching data) and send the medium for the RF field of the other piece of equipment when they are in a Target mode (receiving data). Both devices change their nature from Initiator to Target and back again. NFC in active peer-to-peer mode may aid application in terms of connecting devices in pairs.

2. In the passive mode, that can be also named Reader/Writer mode, one of the devices generates a RF field (Initiator) and the other device uses this field to communicate (Target). It responds with a so-called load modulation scheme. The active device is usually called a reader, since the passive device is usually called the tag. NFC technology is at the base of e.g. Google's Wallet service and mobile payment systems.

Some sources provide the third type of communication modes – emulation card mode [20, 17, 21]. It means that data is transferred from mobile-device to NFC-Reader. In other words, in this kind of mode a device emulates a passive element, for example a contactless card.

The RF of NFC equals 13,65 MHz. This technology gives a set of protocols in a passive mode in the base of International Organization for Standardization (ISO)-14443 [19].

1. RF collision avoidance – prevents conflicts between Readers nearby, in the same time having their RF's enabled.

2. Device detection – empowers a Reader to find NFC-enabled devices. A reader may support up to sixteen Targets simultaneously.

3. Transport protocol – when a Reader selects a Target, it begins a transfer of data. During this activation, both sides negotiate parameters related to their communication, for example the anticipated timeouts during the data transfer. When exchanging data, the Target accepts each successfully received packet and responds to the Reader with its own packets. To conclude the protocol, it is used a deactivation of the Target.

NFC standard became more popular with support of huge corporations related to technology like for example Google, but also companies from banking sector as MasterCard. Nowadays, mobile payment is said to have the biggest potential in the area [17]. Although NFC technology continues to be closely associated with payment services, it is also being explored in other areas such as tourism and catering. An example of this is a prototype application implemented at the Stanford University canteen where the client uses NFC technology to initiate communication with the server. This application was able to enhance the experience of clients and restaurant staff Tourism App [20].

2.1.3 BLE

When speaking about proximity communication, there is another type of technology that must be mentioned – Bluetooth. Bluetooth is a standard for small size wireless coverage network, that has been widespread for about twenty years. It allows devices to build a dynamic multi-hop network, which is called Scatternet. It is based on lower-power radio with two-ways communication [22, 23]. Data can be transferred between two Bluetooth-enabled elements and some devices can be controlled from a distance by other devices through Bluetooth network. These operations demand an agreement between devices. There are certain rules during the communication, that ensure a high privacy level:

1. Bluetooth option must be turned on in the related devices. Thanks to that they can detect each other.

2. An agreement between devices must be made.

3. The Media Access Control (MAC) addresses of the detected devices are not specified (used anonymously) and not related to specific individuals.

There is also possible a multiple detection over a range of specified devices. Still, the specific addresses of elements stay unknown.

Nowadays, Bluetooth connects a big number of devices, like laptops, smartphones, keyboards, headphones and smart watches. It also produces special data sources and bring up with technological cases, as well as application-related features [24].

As showed in the work delivered by Castillo-Cara et al. (2016), Bluetooth is able to perform in two modes: BLE and Enhanced Data Rate (EDR). The difference between them is the power consumption (the first one uses less power), as well as the range of data transmission. Common feature from both modes is performing the same tasks: digital transmission, data acquisition and tele-control [25].

The BLE is a technology developed by Bluetooth Special Interest Group (SIG) for short distance communications, consuming very little energy Ultra Low Power (ULP) [26]. It is frequently compared to Wi-Fi or just basic Bluetooth versions and it is discussed to be the best alternative to these technologies. It contains a light protocol stack and allows integration with Bluetooth, for example in a mobile phone and tablet. Due to the fact that Bluetooth technology is practically omnipresent, and it is considered as a legacy technology, it could provide the rapid adoption of BLE. The implementation of BLE can take advantage of the similarities with the classic Bluetooth. BLE is expected to be used on millions of devices in the near future.

Examples of the use of BLE in everyday life are several. In health care, where for instance, it allows the communication between a scale and the mobile phone enabling the user to check their weighing history. In sport, where an athlete through a wristband can measure the heart rate or in situations as simple as opening the car door through a remote control or to understand crowd dynamic.

BLE (known also as Bluetooth 4.0) has been used for finding position and distance measurement thanks to beacon communication. Different elements programmed in a specific way and provided with interface and with defined location in the environment can send broadcast messages [27].

Moreover, BLE has been applied in Internet of Things (IoT) technologies [28]. Its low power consumption and ability to work in various disciplines and areas led to a successful transmission of Protocol

Version 6 packets over low power Wireless Personal Area Networks in health monitoring application [29].

Characteristic for BLE is an advantage of low power consumption which enables this standard to be used in small devices with low-charge and small batteries, which may last certain number of years [30].

BLE enables devices to communicate through two ways. Firstly, broadcasting, that is the fastest way to transfer data to few devices simultaneously. One device can dispatch advertising packets to any receiving or scanning element in the same range. It lacks certain security controls, that is why data transferred should be selected carefully. The second type of communication are connections – cyclical, fixed and private exchange of packets between two pieces of equipment. This kind of communication is characterized by higher level of security.

A BLE main network is called piconet and consists of a 'master' and a 'slave'. Devices are able to play both roles in the same time, in different piconets. This model of network is called, as mentioned before, Scatternet.

The BLE protocol stack is composed of the following framework [26, 31]:

- The Application – it illustrates the direct interface with the user. It is the highest block of the stack. It enables various applications reusing common functionality to implement operations between them. Since App set special profiles, it encourages competing manufacturers to conduct consistent operations.
- The Host – it comprises the layers:

  Generic Access Profile (GAP)

  Logical Link Control and Adaptation Protocol (L2CAP)

  Attribute Protocol (ATT)

  Security Manager Protocol (SMP)

  Host Controller Interface (HCI), Host side
- The Controller – structured in the layers:

  HCI, Controller side

  Link Layer (LL)

  Physical Layer (PHY)

Each of these layers includes its lower layer.

2.1.4 Comparison of the technologies

Table 2.1 compares three PCT (QR Code, NFC and BLE) according to the type of interaction, requirements, reach and cost. QR Codes are the less expensive, in the same time the most mature, and those available for a larger segment of mobile devices, since such technology needs only a camera to interact with the device. The NFC has advantages in terms of simplicity of interaction. On the other hand, its unavailability in the majority of Apple equipments and in some Android devices. NFC technology on iOS systems is reserved for use in the Apple Pay payment system. However, Apple has been working on improvements and some of the NFC options are already available. Finally, BLE technology can be

	BLE	NFC	QR Code
Interaction	Client accepts connection	Client approaches phone to the tag	Client initiates reading application
Requirements	Bluetooth 4.0 Android $\geq$ 4.3 iOS $\geq$ 7	Chip NFC	Camera
Reach	20m	20cm	N/A
Cost	4 to 19€ per beacon	1 to 2€ per tag	Cost of impression

Table 2.1: Comparison between Proximity Communication Technologies

seen as a more expensive solution than the previous ones. Nevertheless, it is a technology that allows a simpler interaction than the QR Codes. BLE is still available on a wide range of devices and does not have the limitation of NFC [32].

2.2 Programming languages

Implementing any application would not be possible without following certain established rules. Programmers use codes which are sort of patterns. Thanks to these guidelines the technology can grow, because of knowledge shared in the IT environment. For this reason, programming languages play such an essential role in creating applications. For the purposes of this project there has been chosen two languages: HTML and JS. These sets of grammatical rules exist in the market for many years, what means an accessible support when struggling with issues. In addition, the frameworks of HTML and JS feed all the technical needs of the project.

2.2.1 HTML

When speaking about creating websites or applications, one of the most frequently appearing names is HTML. HTML was created in Geneva in early 90s' [33] and belongs to periphrastic group of languages composed of elements representing each part of the content website. Each puzzle of this set is connected to the other one by being placed inside it. The structure of this system resembles a tree [34]. At first, the format appeared for describing scientific documents. Over time this system evolved to finally become adapted for a variety of different documents [35].

Web application User Interface (UI) bases on elements, that are indicated by HTML tags, included in angled brackets. After the opening angled bracket there must be inserted the element type label. The order of the remaining features does not matter. To each given attribute, there must be value assigned [36]. HTML is basically said to be a document formatting or tagging language. Those tags recommend the viewer the way to display chunks of text or pictures [37].

In 2014 there was released the last version of the format – HTML5. One of the main features of HTML5 is parsing algorithm, which makes Document Object Model (DOM) of each website look the same in each browser. In this standard user have a free access to a platform with possibility of developing and modifying web pages there. The content of the software is diverse and universal, including the source code possible to reuse and redistribute [38].

HTML markup is composed of few particular key components, including tags and their attributes,

character-based data types, character references, entity references and document type declaration. Tags generally come in pairs, except for the start tag and end tag, that come that represent empty elements and come unpaired.

It is important to mention that HTML is a basic format. The application, which was created for the purpose of this project, could not appear with HTML support only. This language is poor in terms of modularization, even when speaking about the latest version [39].

2.2.2 JS

JS is an extremely competitive language, which has been considered the most well-paid programming format of 2016 and one of ten the most well-paid languages of 2017. The standard appeared in 1995 and started gaining the market in the area of web programming, compilers, as well as web operating systems [40]. The majority of websites launched nowadays uses JS. Not only that, but also browsers comprise JS interpreters. This format together with HTML and Cascading Style Sheets (CSS) is the correct set of standards to create content, style of presentation and behavior of web pages. All of these standards are fundaments for a significant percentage of modern web pages [41, 42].

There are several features which benefit from dynamic style of this languages. The format is able to generate code at runtime and insert object properties dynamically. It can also delete those properties while program execution. Moreover, JS programs are many times settled in HTML documents and other formats. Generally, it happens in web applications, it supports user interactions [43].

JS can be used for the modelling and the implementation of synthesis tools. It is well adapted to object-oriented and functional types of programming. It draws its principles for coding from Java. Moreover, some of the main functions come from Scheme and Self.

Since all languages must have either a standard library, a platform or Application Programming Interface (API) of functions so as they can present input, output and other fundamental parts. JS is settled within 'host environment', that is usually a browser and is responsible for those input, outputs, but also elements like graphics and networking.

JS is generally used to fulfill following tasks:

- Interactions with users (e.g. input fields, buttons).
- Displaying small data bases in a well-organized and esthetic way.
- Preprocessing data bases.
- Controlling multiple-frame navigation in HTML document.
- Modifying content and styles, especially in modern browsers and as a dynamic or instant response to user interaction.

JS is not free from limitations. The majority of the restrictions were created to protect users from others' undesirable activities. Thus, JS standard is not able to:

- Setting or restoring preferences settings of the browser, action buttons, main window appearance features.
- Starting an application on the client's computer.

- Reading or writing files on the client's computer.
- Gaining live data streams for retransmission [37].

JS solely represents general-purpose programming language that is an element of the suite of standards determining the technology of the World Wide Web (WWW) content. It indicates that when the rules of the language are modified, it may have an impact on the websites which often passively store JS codes [44].

2.2.3 JSON

JSON is a standard characterized by lightweight data-interchange. This language is used for various and complex data exchange. A unit of data introduced in JSON is called a document [45, 46]. It is one of the simpler languages in terms of reading and writing, but also for be generated by devices. The language is based on JS, which means full support of this standard. As its base, JSON also uses the elements of C formats (C++, C#), as well as Perl, Python and many more. It is composed of three universal data structures:

- A collection of pairs between names and values; In certain languages, it can be achieved as an object or record.
- An ordered values list (array) [47].
- Value (A value may be a primitive sort of value, e.g. numeric, or a structured type like objects, or null) [45, 48].

This kind of framework is sometimes said to be implicit [49]. According to Canovas Izquierdo & Cabot (2016), 'this poses a serious problem when consuming and integrating Web APIs from different sources since it forces us to manually analyze each individual API in detail'. Due to presented opinion, the structure of JSON can cause delays in projects, because of some parts must be developed element by element. In some kind of works it can appear as a real disadvantage.

Transmitting JSON data as a process taking place between the browser and the server contains following order:

1. On the client side: An object is created by the client and then JS data structures are serialized into JSON text, through JSON stringifier. Next, the client uses methods called GET or POST to trigger an Hypertext Transfer Protocol (HTTP) request, which is composed by the encoded JSON string.
2. On the server side: server receives the request and using a JSON parser for the language deserializes the JSON string into one object [50].

JSON is used to protect data when it comes to trust boundaries. Semi-structured data embeds an individual message or an individual element in a key-value store, allowing for flexibility and extensibility. Within an application relational data can be control in detail and well-formed [51].

JSON documents tend to raise as a common standard for representation of data because of growing popularity of Not only SQL (NoSQL) document-oriented databases. The big advantage of this format is ability to manage big volumes of data when explicit data schema is not available. On the other hand, data schema is sometimes necessary for applications, when it is needed to retrieve or integrate data [45].

2.3 Frameworks

An application framework is a software library that ensures a primary structure to assist the development of applications directed to specific environment. It plays a role of a skeletal support when building application. The purpose of designing frameworks of applications is to reduce the appearance of general problems occurring when developing applications. Developers, while creating mobile applications, must remember about differences between operational systems. Technically speaking, mobile applications in Android, iPhone Operational System (iOS) and Windows Phone are created using different programming languages. On the other hand, when forming a web application, programmers must adapt it to conditions of displaying in various devices like computers, mobile phones or tablets. For these reasons choosing the right environment for designing an application is significant.

2.3.1 Angular

Angular is a framework maintained by Google, which allows to create reactive Single Page Applications (SPA). SPA are applications or websites created using only one HTML [52] file and a bunch of JS code gotten from the server and each change is rendered in the browser. This solution gives the user an extremely reactive and dynamic user experience. This works much faster than having to reach out to a server for every page change and for every new piece of data needed to be displayed [53]. When necessary, data is load in the background and user does not see it. Besides from basing on JS, this framework may be developed in Dart, or TypeScript. Angular in a simple way enables creating custom components, that are possible to be added to HTML documents, as well as to implement application logic. This standard employs an extensive data binding, offering dependency injection module, also supporting modularization and finally includes a routing mechanism [42].

NGModules are the fundamental building blocks of an Angular application. They ensure a compilation context for all the components. This structure gathers related code into functional sets. Set of NgModules creates an Angular application. This structure is different and completes JS. A compilation context for a set of components intended for is declared by NGModule. This set of components is related to a domain of the application, a workflow or may refer to capabilities. An NGModule can form functional units through combining its components and related code.

An Angular application always has at least a module which provides bootstrapping – launching the application. It is called a root module. There are also some more feature modules:

- Components define views – suites of screen elements that Angular may choose among and change according to given program logic and data.
- Components use services – enable particular kind of functionality, which is not directly related to views. Service developers can be injected into components as dependencies, making the code modular, extremely efficient and possible to use again.

Both components are classes with decorators that indicate their type and supply metadata that guides Angular how to use them:

- The metadata for a component class connects it with a template that determines a view. A template associates HTML with Angular directives and binding markup that enable Angular to change the HTML until it is rendered for display.

- The metadata for a service class supplies the information Angular requires to share it with components through dependency injection.

Every Angular application contains at least one component – the root component. The root component connects a component hierarchy with the page DOM. Each of them determines a class that contains application data and logic. It is also linked to HTML template that defines a view that will be presented in a target environment. The decorator of the component identifies the class immediately below it as a component and supplies the template and component-specific metadata related to it.

A template associates HTML to Angular markup that is able to change elements of HTML before they are presented. Program logic is provided by template directives. Application data is connected to DOM through binding markup. There exist two types of data binding:

- Even binding – lets the application reply to input from a user in the target environment by updating application data.
- Property binding – allows to interpolate (insert) values computed from application data into the HTML.

If data or logic is not associated with a specific view, but is dedicated to being displayed, it must have a service class created. It is preceded by the special decorator that provides the metadata allowing one's service to be injected into client components as a dependency. Dependency Injection allows to store the component classes concise and efficient. It deputes various tasks to services.

The Angular Router NGModule supplies a service enables to find a navigation path among various states of application and view hierarchies. The router maps URL-like paths to views instead of pages. When an action, such as clicking a link loading a new page in the browser, is performed, the router takes over the browser's behavior and depending on the need shows or hides view hierarchies [54].

2.3.2 Ionic

Next platform worth to be mentioned when creating an application is called Ionic. According to the official website of the format, Ionic is "The developer-friendly application platform for building cross-platform applications with one codebase, for any device, with the web" [55]. Ionic provides the FE UI framework that managess all the design and enables user to interact in a hybrid application [56]. It is a versatile program which as a purpose has offering a clear and simple environment for developing high-performance mobile and web applications. Progressive Web Applications (PWA) that suit every device or platform. This open source framework with many tools and services available features an abundant collection of FE building blocks and UI components. Ionic uses some of the most popular technologies, e.g. HTML, CSS and JS. The platform is appreciated by world's well-known brands: Sworkit, Untappd and Dow Jones MarketWatch.

Ionic was launched in 2012. The mission of the company was to form a better way for web developers to take advantage of their existing skills to design applications. Nowadays, it is one of the most popular cross-platform mobile development technology stack.

Ionic recently requires Angular for using its full potential. It is still possible to use CSS part of the framework, however much more innovation has been provided for the usage of AngularJS and Angular. The platform is preparing for Cordova/PhoneGap plugins release that will be an extension for the standard.

In terms of the browser support, Ionic offers two versions:

- Ionic 1 – used in order to build native/hybrid mobile apps. This concept does not focus on mobile websites.
- Ionic 2 – created to build native/hybrid applications through Cordova with the possibility of working on PWA and Electron. It is compatible with iOS 8+, Windows 10 Universal App and Android 4.4+.

Ionic also provides Command Line Interface (CLIS) that is a tool containing useful commands to its developers. It comes with a built-in server for developers, as well as build and debugging tools [55].

This modern standard can be divided into three main components: the HTML5 that provides realization of original components in website, a native style interface provided by framework and the native wrapper platform like Cordova [57, 56].

What matters when speaking about Ionic is that it is a framework for hybrid mobile applications which are very popular due to its practicality. Most of the people spend plenty of time in the browser. Browsers exist on desktop, laptop, but also on smartphone and tablet. Ionic manages cross-platforms and thanks to that created application can run on lower level browser and have interface with native platform layer shell. The other advantage is the fact that using Ionic the code can be written once and be run anywhere. There is also possible an access to the third-party code. It distinguishes Ionic from other platforms.

Ionic with its popularity may lead developers to give up creating native applications, starting a domination of hybrid formats.

2.3.3 Firebase

The last framework that is an essential assistance for creating applications is Firebase. It is a mobile and web platform for application development launched in 2011, then acquired by Google in 2014. It offers a variety of services characterized by cloud-computing solution for developers in mobile and web areas. The services contain user authentication and a real-time NoSQL system performing database management (e.g. storing, hosting) that allows fast queries execution. Each database is consolidated in an individual JSON file. There, instead of using traditional relational databases, tabular relations are preferably chosen. It enables highly-responsive synchronization of data between system modules that reach latency in the range of milliseconds [58].

Unfortunately, the use of Firebase does not guarantee connection reliability. It focuses on real-time data transmission/retrieval and works with a stable WiFi connection [59, 60].

Firebase developed few options of services for different needs and profiles of users:

1. Analytics – new solution for developing reports for even 500 individual events possible to define using the Firebase Software Development Kit (SDK) – set of tools used by a programmer to create application programs.
2. Develop – Firebase's core suit of services. The standard is composed of:
    - Authentication – standard launched to prevent security issues. It saves user's data in the cloud and delivers the same personalized service across all the devices that the user works

on. Authentication is characterized by BE services and ready-made UI libraries used for authentication. It uses passwords, phone numbers, but also popular identity providers like Google and Facebook.

- Realtime Database – supplies an API allowing application data to be synchronized across clients and using the cloud for storing this data in the form of JSON. It is useful especially in building a cross-platform application where all the clients share one database instance updated automatically. Applications containing this kind of database remain responsive even in offline mode. Additionally, the platform offers a support for application's data needs at scale by dividing data and spreading it across multiple data instances located in the same Firebase project.
- Cloud Firestore – flexible database, similar to Realtime Database, but offering also integration with other Firebase products, as well as Google Cloud Platform formats, including Cloud Functions.
- Storage – executes secure and cost-effective uploads and downloads in Firebase applications, irrespective of network quality. Created to store and manage user-generated content, like images, video and audio. Firebase Storage is supported by Google Cloud Storage which scales to petabytes.
- Hosting – production-grade hosting of web content. It provides hosting static files (e.g. HTML, JS) and dynamic content through Cloud Functions. The service is delivered over a Content Delivery Network (CDN).
- Cloud Functions – enables to automatically run BE code as a response to events triggered by features of Firebase and Hypertext Transfer Protocol Secure (HTTPS) requests.
- ML kit - a mobile SDK that delivers Google's machine learning system to Android and iOS applications in an easy-to-use package. ML Kit contains API with various features, such as text recognition, scanning barcodes, labelling images, detecting faces and recognizing landmarks. The APIs can be used on-device or in cloud.
- Ionic 2 – created to build native/hybrid applications through Cordova with the possibility of working on PWA and Electron. It is compatible with iOS 8+, Windows 10 Universal App and Android 4.4+.

3. Quality – these tools provide users with the support necessary to improve a standard of the application. A user can find there: Crashlytics (crash reporting solution), Performance Monitoring and Test Lab

4. Grow – special formats for predicting increasing future growth. In this section Firebase offers: Predictions, A/B Testing, Cloud Messaging, In-App Messaging, Remote Confrig, Dynamic Links, App Indexing, Invites Google Ads and Google AdMob [61].

2.4 Conclusion

In summary, the world of technology recently gives people more and more tools for improving information and communication process. One of the main concerns is to complete the tasks faster and in an

effortless way. PCT as QR Code, NFC and BLE give opportunities to build even more interactive applications. In addition, there exist a variety of languages for writing codes for those applications. Thanks to that developers can choose the language according to their needs. On the top of the list of popular languages are HTML, JS and JSON. Those languages must operate in frameworks that enable to store data, build applications and manage them. Nowadays, developers mostly use frameworks such as Angular, Ionic and Firebase.

Chapter 3

Related work

Catering services industry exist for over a century. That is why restaurants were also taking a part in testing new technologies in practice. Recent research points out that restaurants and the technology they base on are changing quickly. Over 80% of restaurants have an electronic register system or a Point of Sale (POS), as showed in the research carried out by the National Restaurant Association [62]. Those systems are particularly based on card processing, labor and inventory management, as well as include accounting tools. Such solutions impact productivity, grow sales and ensure a competitive edge. It can also decrease the level of costs, leading to a better pricing method. Apart from quality of the meals that is significant, this all helps the entrepreneur achieve the goal of attaining high efficiency that is not possible using manual systems. According to a recent study, nearly 80% of clients admit technology in restaurants, since normally it makes service faster [63].

3.1 Restaurant Technology Trends

There are multiple ways that restaurants make use IT systems. Starting with the cash register and finishing with the kitchen, technology is an essential part of all operations in restaurants and coffee shops. New digital answers to business needs constantly appear and make the service simpler to use, faster in terms of acting and making more profit. The current trends used by restaurants to grow the entrepreneurship and make it more appealing to clients is shown next [64].

- Technology decreasing food waste. There exists a predictive order management software that helps estimate demand among clients, reduce waste, but also increase profits. Making this task automate, the restaurateur receives a result eliminating spreadsheets and inaccuracies happening during realizing the process in the manual way. Eruza is a developer offering a system based on a cloud that supports quick-serve restaurants and coffee shops order the correct amount of product at the correct moment. The company ensure optimization of the supply and improves margins by keeping the inventory filled with the right number of ingredients [65].
- Technology simplifying loyalty programs. It is not news that clients spend more money when they are about to receive a loyalty reward. As it happens Toast's Restaurant Loyalty Programs, modern technologies involve POS systems and clients' smartphones to enable clients to sign up whenever they want and check their account status (owned points) anytime. Research confirms that restaurant guests using these loyalty programs spend about 39% more money than non-loyalty

clients. The program is easy to use in terms of earning and spending points. Each account includes a card number that ensures simple and fast identification of the user. Restaurants can choose the milestones enabling clients to get rewarded [66].

- Technology improving guest's data. As mentioned in the previous paragraph, various technologies help discover clients' identities. It frequently goes with collecting information about each user: his preferences, choices and other features. This, in turn, leads to indicators for the best ways to attract the client which is willing to come back more often. Those technologies in a smart way suggest the client ordering the beverage which was repeatedly ordered before. For the client it normally means shorter time of requesting and for the restaurateur it is a way to create a client demand. A proper example can be GuestBridge that offers a leverage for scalability of the hospitality industry's most robust guest database in order to capture the information about the guests and creating highly personalized guest experience. All of this leads to building and sustaining a strong company-client relationship [67].

- Technology keeping clients updated on meal delivery progress. Nowadays, people suffer from lack of time in their lives. That is why they often choose service providers which are able to satisfy their needs quickly and in a simple way. Tracking presents a solution for this issue. The system empowers clients to track the progress of the order in real time and in each step of the preparation. It is said to reduce frustration related to the waiting time and increase engagement [68].

- Technology allowing guests to split the bills and pay them at the table. Well-known example of developer in this area is Split. Thanks to this application clients can have an insight into the value of their bills, divide the amount among members and pay all sitting at the table. This system also adds some surveys and text messaging, all to make the service more pleasant for the client [69].

- Bluetooth temperature sensors. Food safety has a great significance to the owners of restaurants. A system monitoring the state of products ensure they can last longer and be as efficient as possible. Equipment uses handheld probes, as well as fixed sensors, thus, the control can be executed manually or automatically. Thanks to this service, restaurateurs make sure that the temperature of the products is correct, and it can be programmed with limits settled for each kind of food and equipment. They can also be alerted in case of any changes. Such a solution prevents from falsifying daily reports and eliminates paper records.

- Optimized schedule makers. Scheduling software is useful in many different areas, however, in restaurants it is particularly desirable. This system enables to generate and distribute digitally formed schedule to all employees for each week. It bases on historical staffing patterns, as well as employees' availability and time off requests and forecasted sales levels and creates a plan avoiding over or under-staffing. There is one additional feature – it is possible to monitor sales and staff budgets which gives an opportunity to reduce overtime and increase profitability. All of this are components for the functional application which is said to reduce up to 2% in restaurant's labor cost.

- Virtual reality on boarding. One of the pioneers in the area is Honeygrow. This system gives new employee a chance to experience a tour of the facility in a simulated environment. It is a new form

of training sessions. The new user can watch other employees in action and try their skills. It has a 360-degree format and decreases pressure since the new employee does not need to act in front of others. It prepares new employees for their jobs in better and faster way. It helps avoid mistakes in the future and saves managers' time, because they do not have to organize a training.

- Automated purchasing tool. This is a solution for restaurants that make food quantity a priority and cannot imagine a situation when some kind of orders must be neglected. This digital tool alerts managers to low product levels and proposes purchasing recommendations, basing on vendor product lead times, sales forecasts and custom par levels. This innovative application enables to make optional automatic orders whenever inventory reaches established threshold. An additional option for this solution is verifying invoices. Not only that, but also there is available a comparison of vendor bid prices.

- Kiosks/tabletop tablets. This is one of POS technology. It focuses on placing free-standing screens at some local restaurant chains. Those screens display a menu, enables to create customized orders and even manage the transactions. The system provides recommendations for upsells and cross-sells, that encourage clients to order more. Thanks to this all, employees can focus on back-of-house operations and serving clients, instead of having to run from one task to a different one. In the future, the system will be able to recognize client's verbal and visual signals, that can make the service more intuitive and faster.

- Digital table/reservation manager. This software takes an initiative in leading the whole order – starting with reservations booking and ending suggestions about optimal seating arrangements, according to time and party size. It is particularly useful when the client can receive information about estimated waiting time and notifications via text when a place is ready. Moreover, restaurants' staff has access to information about the reservation and dining history, for instance favorite dishes and important dates (birthdays and anniversaries). In addition, employees are able to update clients on the status of ordered meals at any point during the preparation process [70].

3.2 Recent changes in restaurants caused by technology

As mentioned in the previous section, there exist a variety of technologies dedicated to help restaurateurs and over the years there have appeared more and more different digital tools to attract clients. Nowadays, restaurants and coffee shops need to be willing to embrace the changes. They evolve quickly, and those transformations appear in few different dimensions of their entrepreneurship. In this section will be presented few fields of operation that have changed due to providing some improvements in the form of digital technologies.

In XXI century the way marketing is driven requires collecting information in order to give the clients a more personalized experience. Companies gather data about clients, products, services and processes. Each operation must be registered. This strategy turned out to be a success, because entrepreneurs predict what action can satisfy someone's needs in a given moment. They use information to find trends, create specific needs in society and search for actionable insights. There are particular IT systems focused on seeking correlations between contented clients and ideal turn time.

One of the factors that cause decrease of the cost of operations in restaurants and other companies is moving on and searching for streams of revenues out of the business. For instance, some companies diversify their services to generate two sources of income: from Quick Service Restaurants (QSR) and private events. Thanks to the opportunities given by growing variety of different technologies, restaurants can manage also a third revenue channel. An example describing the phenomenon can be Union Square Hospitality Group which, apart from the regular service and particular events, decided to open a sort of coffee shops chain called Daily Provisions. This and other similar businesses benefit from the technological progress. They launch fully embraced deliveries through applications, such as Uber Eats and Postmates. It is usually related to some significant costs, however, it is still profitable and yields great renown to the firm. In the market there is also a place for software that offer ticketing and events services. This type of solutions enables to leverage big mailing lists into steady, innovative in-restaurants revenue lines, for instance recurring event series. In the future, it is expected that every larger member of the market will need at least three essential revenue streams. Technology is going to ensure such conditions.

Nowadays, conducting measurable user testing plays an important role for the performance of entrepreneurship. Companies take a deeper look at the comments and grades given by the clients, especially because there are a lot of different components to evaluate: menu, music, lighting, level of service and prices. Restaurants seek a better feedback loop, so they invest purposefully in good quality software ensuring surveys, but also systems of consulting and support. This context-complete, customizable feedback is becoming more and more popular.

Modern restaurants have already found a way to be precise about the source of origin of their clients. Businesses determine that, for example, allocating a part of their tables for the card holders, and paying more attention to letting them show the demand, boosts profitability. There exist digital methods for building connectivity out towards independent demand channels, unbundling them, but also allowing restaurants to target them a la carte.

There are few factors causing decrease in cash operations. At first, cashless method is safer, because it is harder to steal money that does not have a physical form. Moreover, it is ‘cleaner’ – not requiring organization of the space. The companies responsible for credit cards claim to provide financial incentives to bars and restaurants that do not make cash transactions.

It is said that first-time dinners and the impression it makes have a great impact on the efficiency of the business. Firstly, because restaurants benefit the most from the first orders. Not only that, but also satisfied client can appreciate the place in the future, coming back more frequently. The main conclusion is that the owners focus should be on having clients back. This approach leads to the statement that the longer a place can retain a client, the lower the per meal cost related to acquiring that client becomes, more beneficial that client becomes to the restaurant. As a result, and taking into consideration modern software, restaurants have managed and enhanced each milestone along the client journey, since the place is discovered until given feedback and rebooking. This way the process of turning new clients into regulars is scalable [71].

3.3 QR Codes in catering

According to Mind Commerce, the redemption of mobile barcode and QR Code in the whole world was worth near $50 billion by 2017 [72]. In spite of playing an essential role in catering, this technology is widely used in other areas for various purposes. Nowadays, extremely popular online shopping platforms use this kind of innovation. Moreover, paying for in-store purchases can also take place in the level of an application which uses this form of codes. The client only needs the PayPal application on his smartphone, then the system prompts the client with QR Code (sometimes it is just a four-digit short code) and in the end the merchant scans the code (or the client enters the four-digit number into card swiping terminal) in order to complete the purchase. Furthermore, a new feature implemented in ATM system allows money withdrawal from a machine by just presenting a code [73].

Predominantly, restaurants use QR Codes in a all sorts of advertising that will lead clients to a landing page or to a mobile application store, but also to a secure site prepared for monetary transactions to be completed. Notwithstanding, restaurants have discovered many other creative uses for the codes. In the field of gastronomy, there are several methods available for improving businesses using QR Codes:

- Client Loyalty Rewards, where each client has his own code that contains personal details.
- Mobile ordering directly from the smartphone and the use of coded takeout menus so that the client does not need to ask for a paper one.
- Manage links to photos and Social Media, where the client can see the name of the dish, the price and has access to restaurant's Yelp listing.
- Differentiating restaurants, from fine dining to casual, between fast food, food trucks, but also exclusive places. A modern solution is utilizing QR Code for the city guide advertising, which leads even to online reservations systems and pictures of the interior.
- Design art. Usually, the appearance of the codes are discussed not to be appealing, however, designers have already found a way to improve on this and create a marketing strategy hiding in it. It gives a restaurant an occasion to express its style and emphasize beauty of the various patterns [74].

Thus, restaurants, coffee shops and bars may utilize QR Codes for the marketing and branding purposes. There is a plenty of businesses that deal with those tasks at a high level. Next, some examples of companies that benefit from implementing QR Codes is presented.

McDonald's uses codes on its product packaging. It provides nutritional information on every single item from the menu. It enables health-conscious clients to knowingly choose their meals, as well as allow the restaurant to counter an obsolete fast food image. McDonald's claims the QR Code campaign is dedicated to 'engaging with clients'. It enables them to choose the healthier alternatives when they come back to the restaurant in the future. Consequently, this campaign does not instill a sense of urgency to return to McDonald'. For those purposes the restaurant launched other campaigns. This campaign is only informational. Nevertheless, this action was not a success, because it did not lead users to an interactive experience which could engage them. On the other hand, this solution helped its branding – it showed that McDonald's takes care of its clients' health [75, 76].

Starbucks, in association with Scanbuy, decided to engage in the mobile initiative. Starbucks had already used traditional solutions, for instance print an outdoor to drive downloads of the mobile application. Next, it turned out that QR Code can lead to those services with just one click. Scanbuy is an expert in providing services related to barcode products and software. Starbucks placed the codes in its locations, also in newspapers and magazines such as People. It is possible to see them on outdoor advertisements in major cities. After scanning the code, users are redirected to a mobile landing web page that enables to see a video on Starbucks' Caffe Verona blend. Moreover, it is possible to find the nearest and find out about the company's variety of products, its flavors and what food fits each kind of coffee. Not only that, but also clients can browse the menu, check their card balance and buy the brand's products [77]. To create an opportunity for users to interact more, Starbucks thought about a code that can present a sample of music listened to, in the region where the product was picked or a experts' opinion about what makes that coffee unique [78].

As part of its ESPN College Football campaign around the Bowl Championship Series, Taco Bell, that is the fast food chain, printed the codes on boxes and cups with drinks in 2013. Clients could watch exclusive videos of Mark May - ESPN college football analyst which was previewing upcoming games [79]. As another client of Scanbuy, but also with association with Snipp, this American company generated more than 225,000 scans that can be a sign of high engagement of the clients [80].

Front Flip is a company in Kansas providing QR Codes for restaurants loyal clients to reward them. Each client has a unique code that is placed on the back of his receipt. The loyalty program creates profitable and long-term relationships through variety of instant promotions and fun experiences. It offers complex analytics and mobile campaigns targeted to specific groups of users [81].

On the market there already exists a specific model that aims to provide a complete ordering without a necessity to engage a employee. According to Mohammad and Azam (2015), one of The Japanese restaurants in Canada issues a barcode for each client who comes in and it links to the company's website that gives access to the menu with picture and price and food ingredients. The code generated is available to use one time. Client can order the products after reviewing the menu and submit his order. Even for the users of smartphones that which do not have QR Code scan software, next to the code there is a four-digit number which gives possibility to order without code. This code is single also can be used once and is reissued for each client [82].

3.4 NFC in catering

There have appeared a variety of methods for NFC technology to be leveraged in order to decrease restaurant operating costs, improve client loyalty and manage restaurants operations at a high level; all of which have a big and positive influence on the bottom line. The catering industry is noticing the emergence of new NFC solutions developers, also the implementation of mobile applications created to streamline the experience gained in restaurants [83]. Taking a deeper look at IoT, a world comprised of sensors and touch points throughout a restaurant, connecting clients and NFC-enabled devices belonging to them. When placing NFC tags throughout establishments, in storefront windows, on smart posters and finally on menus, it may enable clients to connect via smartphone, to receive notifications about availability of the tables, to receive personalized coupons, to request any additional product while waiting all given by mobile application. Once seated at the table, clients are able to tap an NFC tag, that is

an alternative for QR Code, placed on the menu or on the table. Clients can then, for instance, receive specific promotional information, request the assistance of an employee or learn some nutritional content and, in the future, make contactless payments. Moreover, all given mean a plenty of benefits from the restaurateur's perspective. Entrepreneurs can expect decreased make order times, simpler transactions, enhanced client analytics, as well as ability to make decisions in real time, depending on seating, dishes and staffing. In addition, NFC can provide restaurant managers and marketers the ability to combine mobile technology with their social media marketing projects. For example, it can be responsible for real-time Facebook likes and shares, also interactive reviews and personalized promotions and sweepstakes. In this section there will be presented varied visions of NFC technology in restaurants and coffee shops [84].

3.4.1 Benefits of implementing NFC in restaurants

NFC can be used for mobile payments. Such solution have nowadays a more regular occurance. By 2017, NFC retail payments market is estimated to surpass $180 billion globally, according to Juniper Research's report [84].

Usage of loyalty schemes is not only popular in the QR Code area, but also NFC can be significant when improving the services. Apart from the advantages of contactless payments, NFC proposes the opportunity for these businesses to augment the client-restaurant relationship. NFC ensures efficient distribution and redemption of essential and timely mobile promotions and discounts, streamlined integration of social media, and real-time data storage. Popular service is NFC-based coupon system that ensures a loyalty 'stamp' for the clients with each visit. Clients with NFC-equipped devices can place their handset near to the NFC touchpad in order to receive instant coupons enabling to order a coffee for free at the next visit. Additionally to numerous client benefits, this technology provides business with a modern and efficient method of tracking of the client base.

NFC means also a better access to client reviews. There exist an opportunity to affix NFC tags to the storefront windows and entryways, also on client receipt folders, to convince users to either read added or post new online reviews, ratings or have access to other relevant client content.

In 2010, McDonald's was at the forefront of using new mobile technology to extend experience of its clients. It began providing clients with supported mobile coupons throughout Japan. There, on the week basis, the restaurant could send registered members of its promotional program a set of coupons directly to about 18 million clients' mobile devices. Recipients would then open the coupon via browser on their smartphones and present this alpha-numeric code to the cashier or only add it to a digital wallet. It turned out to be only the beginning for this sort of innovative solutions that are extremely popular all over the world lately [85].

Starbucks enabled the convenience of mobile payments proceeding their partnership with Sqaure in over 7000 coffee houses in United States. Thanks to their service, clients are able to use the iOS and Android application to process a contactless payment, build their own drink, acquire reward points and locate a Starbucks shops within the directory. Despite the mobile service, Pay with Square, does not enable to use NFC, it has exhibited the integral role of mobile payments for the world of quick service in restaurants. Almost two years after its deployment, the Starbucks mobile application is still undisputed leader in terms of mobile payments, regarding user experience, volume and frequency [86].

As Starbucks' rival, Dunkin' Donuts also decided to start mobile payment service, as well as loyalty

bandwagon. In 2013, the company debuted its mobile application in almost all of it locations throughout America. The application enabled their patrons to pay via iOS or Android system device. As it happened in other businesses, clients can now make a purchase with QR Code, while also transferring money from existing gift cards to other people via Facebook, email, as well as sms [87].

3.5 Bluetooth

The last type of technology mentioned in this chapter that should be utilized by restaurants is Bluetooth. By ensuring Bluetooth POS, entrepreneurs can take their client's experience to the next level by designing a smoother workflow for waiters and other employees. Restaurateurs, as mentioned in the case of QR Code and NFC, can also offer a convenient method for clients to order and pay. Due to the fact that bluetooth exist on the market for a longer time, there are some traditional systems, as well as more innovative ones.

One of the biggest benefits of implementing Bluetooth POS system in a restaurant is the Simple set-up. With Bluetooth ensured receipt printers, there is no need for messy cables and connecting various devices is not complicated. Restaurateurs can also rely on Table-side service. It is necessary to pair tablet or other mobile device with a receipt or printer and this allows for servers to receive the orders from clients directly from the table and send the orders directly to the printer. Here again a relevant fact is that all is happening and saved in real-time. Temperature monitoring and control is another benefit of using Bluetooth-based technology. Special sensors can be placed in the machines in order to log the temperature.

Bluetooth-based systems have been widespread in such a scale all over the world, that it could be difficult to present an example of a normal size company that does not use this technology. Applications based on Bluetooth frequently support other systems using sensors and localization, that is why it can play a plenty of roles in restaurants industry [88].

3.6 Portuguese case of success

Another company which proposed a concept focusing on satiating client's needs is PsstMenu. The application developed by MeshPorto enables users to stay in touch with restaurants to avoid long-time waiting for the meal. The originators of the solution - João Neiva, with knowledge in computer science, and Pedro Adrião, with training in web design, which were then joined by interns of the School of Technology and Management of Felgueiras and some employees - looked at the issue from the perspective of a client. They were waiting at a restaurant table and spent long time making the lunch request. Then, they began designing a way to streamline the process, making it operating almost instantly and in the same time more efficiently. It is based on two applications: one for clients, which can be downloaded from the App Store or Google Play Store, and one for the owners, which can be purchased under license. The key idea of PsstMenu is an application that allows clients in restaurants and hotels to place their order from a smartphone, using a simple and intuitive interface. Research shows that the system is able to reduce by 40% the number of times an employee has to go to the table [89]. In addition to this functionality, it is also possible to order take-away from home. Moreover, restaurants can offer their own loyalty programs. This method leads to satisfying both sides of the transaction. The system allows restaurants to increase

sales and reduce staff costs [90].

3.7 Conclusion

Despite it may be years until the market notice full-blown deployments, it is expected to witness the rise of new NFC and QR Codes systems throughout the quick service catering and restaurant industry. Also bluetooth is not going to become less popular and helpful for the market. In few years handheld wireless applications are disputed to produce additional paperless processing of data from remote localizations, through abbreviated processes and procedures, across the landscape of the industry. Restaurant managers are able to estimate the feasibility of PDAs across the foodservice environment. Potential of these technologies is extremely promising.

Chapter 4

Forder

There are plenty of benefits that the restaurant industry can draw from implementing Near Proximity Communication-based applications. Those systems should not focus solely on satisfying the various needs of the client. It ought to deal with daily problems of the company, manage its organization and structure, as well as make the business generate more profit. These lead to the developing of a system focusing on making orders in restaurant by leveraging QR Code, NFC and BLE. These technologies do not require the presence of a employee at the table. The project described below supports the key process of taking orders at a restaurant, bar or coffee shop.

4.1 Requirements

There are a few relevant features that the system should have in its characteristics. At the end, each side of the transaction, the client and the company, ought to be content with the results. Both functional and nonfunctional requirements were identified and realized, as they are necessary for the application to run flawlessly and to satisfy the conditions to which it is referred. On the market there are some specialized applications that help with orders in restaurants, however, either they are designed only to view the menu, not to make a purchase, or they are primarily based on QR Codes and NFC technology, without using BLE. The proposed solution, named Forder, allow the client to submit the request using three PCT options and is simple and intuitive to use.

Functional requirements describe intended behaviors for the proposed solution, its outputs and inputs. These characteristics will be available to all users. The functional requirements identified for presented application are:

- Mobile application: It is necessary to design mobile application that will be suitable to needs of the clients. It has to exhibit food ingredients, picture and price of each product.
- Informative function: The applications must be supported with sort of data: clients must be able to display the menu and select products and employees must able to view each order with all the notes given by the clients.
- Portability: The client should be able to run application on Android and iOS platforms. The web application should run in any device with internet connection and a browser. The system should be also available in the latest versions of most popular web browsers.

- Confidentiality: The client information, under any circumstances, should not be shared with other clients or with other applications. The client information should be private and well-secured.

- Identity: The mobile application must be able to recognize each client of the transaction. It leads to the point that every client must have an identity for the system.

Nonfunctional requirements describe constraints on the implementation of functional requirements and are usually related to the general aspects of the system. The nonfunctional requirements present in the application are:

- Data minimization: The client's application should allow the clients to share the minimum amount of personal information. To do so, the application will set as required only client's email and password, in order to to work properly. The client will be able to share more personal information, for instance photo, name or NIF, however this information will be optional.

- Usability: The client's application should have a simple and intuitive UI.

- Availability: Products must be available to select by the client, add to the card and confirm the order in the end.

- Appealing interface: The applications should have attractive appearance, encouraging clients to use it.

4.2 Work methodology

In order to realize this project, there was a Rational Unified Process (RUP) system implemented. This development methodology provides a framework for companies to envision design software programs. It delivers a specific plan for every step of the development process and thanks to that it supports prevention of resources from becoming wasted. It also decreases unexpected development costs. RUP in this work was composed of the following stages: Business model, Requirements gathering, System analysis and design, Project implementation, Test and Deployment [91].

The first stage of the project aimed to build a business model that would meet the needs of the market. It had to be a solution presenting a new and original idea that could ensure reduction of costs of the business and lead to more profit.

Subsequently, the project needed to be covered by the list of functional and nonfunctional requirements. Use-case diagrams were also constructed to obtain a better understanding of all functional requirements.

The following step was to carry out the system analysis, in order to be able to provide the design of the software. There were some difficulties related to development and the business rules to be applied, according to the list of nonfunctional requirements elaborated previously. At this stage, all the architecture, technologies, languages and protocols were defined. Some specific diagrams were elaborated, namely the entity relationship diagrams and the class diagrams, describing activities and sequences of processes in the project. These were useful for understanding the workflow of the proposed solution and for developing it.

Next, each part of the system was implemented. Firstly, it was necessary to create a database containing all the information to make the application functional. Also, at this stage, the code was developed. At the end of this phase all the components were placed together and set up. Testing of the proposed solution took place afterwards. Testing was composed of carrying out functional tests. This was followed by deployment, the final step of the project.

4.3 Proposed architecture

This project aims to allow any company based on serving of meals to operate with reduced number of employee during the calmer periods of the day. Also, when there is a traffic at the place, the project should help employees with collecting orders. This all would be possible with the use of a tool that could enable clients to make orders without attendance of an employee. The solution proposal is based on the client / server model. The server application is made to be available on the Internet in the form of a web application. The client application will be a accessible on a smartphone that makes use of the server application. From the point of view of requirements of the application, it is possible to divide the problem into groups: requirements from the point of view of the client and perspective of the employee. From the client's point of view, the application should enable it to create a client profile, provide some tax data and access the product list and pricing. To the employee, the application should help the employee review the current orders, see the date and time the orders were placed, launch new products, check current accounts, and change product prices.

4.4 Solution specification

Figure 4.1 shows the architecture of the proposed solution. The server application will communicate with the database and the storage, the mobile application and the web application. All data will be stored in a NoSQL database. In possession of a mobile device, the client will be able to download the application. With the mobile application installed, the client can access the list of products available for the place. After, the client can use a QR Code, a NFC tag or the BLE beacon to obtain the code present at the table. The code will be scanned by the mobile application to identify the table where the request was made. With the code scanned, the request can be sent to the server. The server will retrieve the list of requests from the client. The client can still access other features of the application. The employee will have access to the list of client requests by accessing the web application from the POS or from other equipment - represented as a tablet in the Figure 4.1. Integration with existing billing software is out of scope of the present work, but should remains as possible.

4.4.1 Mobile application

Figure 4.2 comprises a use case diagram that presents the actions to take through the mobile application. First of all, each new client has to register in the system. In order to do so, the client enters his email address and establishes his password. The client's application starts with the login, where it is necessary for the client to enter his login credentials (username and password). If the username and password are valid, it allows to access the other features. After the client is allowed to start selecting the products from the automatically displayed menu or typing its name in a search box. Each product from the list has a

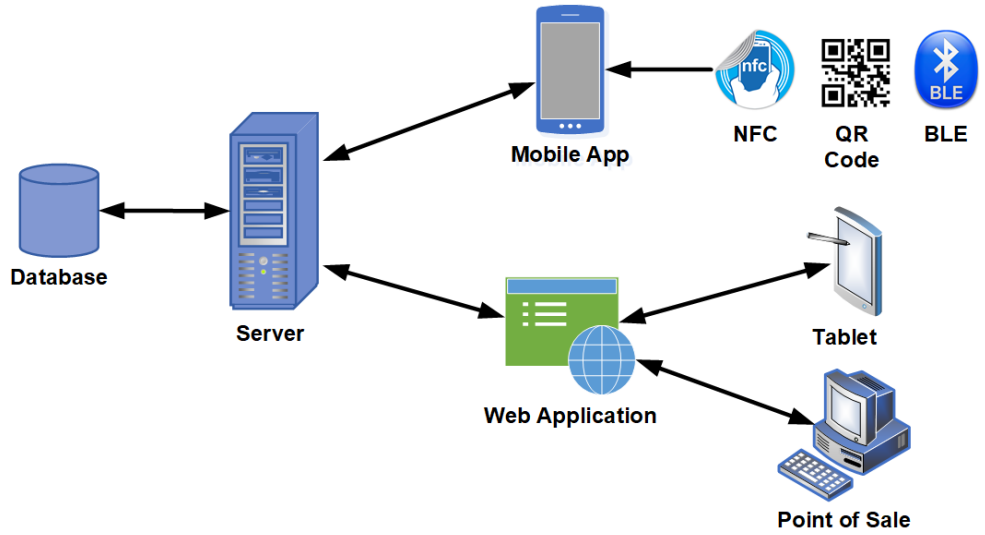


Figure 4.1: Architecture of the proposed solution

picture and a brief description that should dispel doubts and enable to make decision faster. Choosing products, clients can add a note for the employee - special request. Selected products are then placed in the shopping list section. Client can change the number of chosen products or even remove them from his shopping list. Subsequently, client goes to shopping list and view his order. The client can see the order summary with total amount to pay, then clear the list or submit it, selecting QR Code, NFC or BLE icon to read the code, tag or beacon from the table.

In the side navigation menu, there are several options. Client is able to view his shopping list, as well as made requests. He can also submit suggestions and complaints. Moreover, each client having his profile can update it. Not only that, but also there is information about the application and a change application settings bar. At the end of this vertical menu, there is a log out option.

4.4.2 Web application

Figure 4.3 comprises another use case diagram, this one showing the system from the perspective of the employee. It is a web application, part of the project. Through the browser, employees are able to use a variety of options. Firstly, they are obliged to log in. In this case, as in the previous one, he needs to enter its email and password. In the next step, he can view each submitted request and consult it. Employees are able to access the orders anytime, opening and closing each order, depending on the needs. When the client makes a mistake in his order and wants to modify it, he can report it and employees can make a modification manually and delete the request. There is also a possibility to consult closed requests and delete a request when it is not needed anymore. Each employee can also modify the list of the products, depending on what is currently available in the stock: he can add products, edit them or delete, if necessary. Additional options are consult suggestions and complaints and consult application information. The first one allows to read feedback from the clients, in order to be able to monitor the quality of the service and improve operations taking place in the restaurant. The second option was implemented to ensure changing information about the system when there are any modifications to inform about. After finishing all the operations, client can do log out.

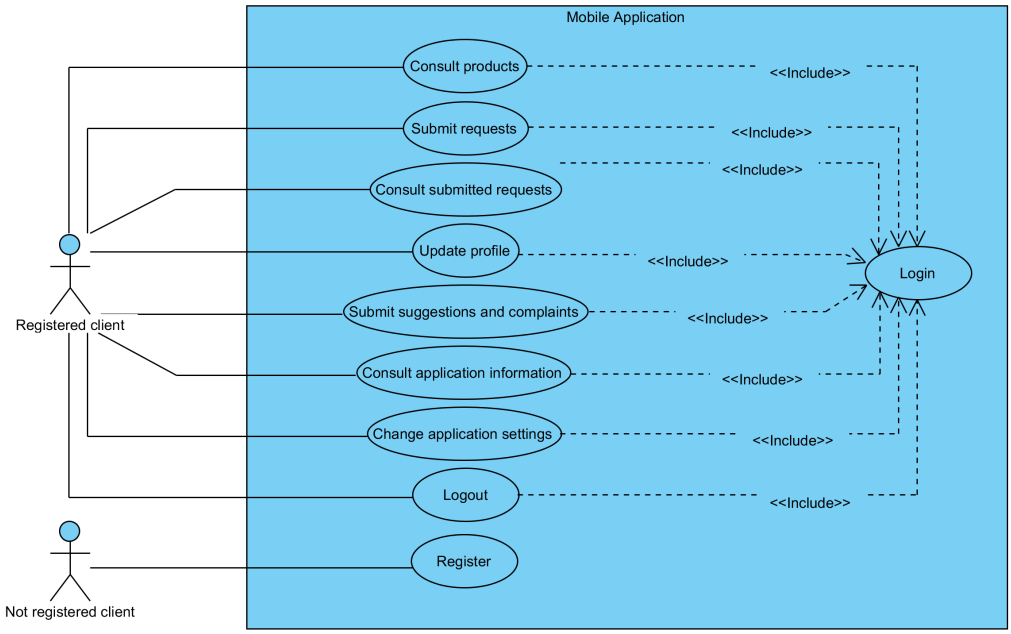


Figure 4.2: Mobile application use case diagram

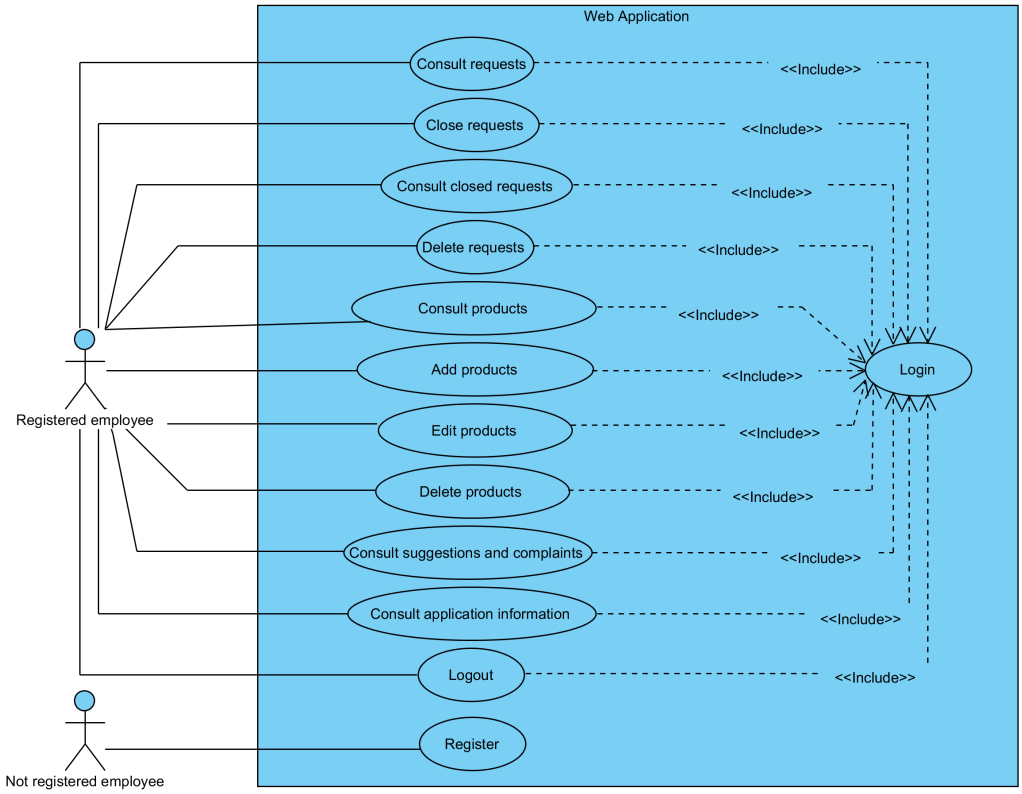


Figure 4.3: Web application use case diagram

4.4.3 Database design

The logical schema of the database that is shown the Figure 4.4 is the schema used by the firebase server. The application database schema consists of 8 entities: user, session, product, selected_products, requests, complaints_and_suggestions, about and developers. Double card signify a collection, while single card is a document. The User entity represents the registered users in the application. This entity includes the user identifier (ordinal number), the email, the password as well as optional data: user's name, nif and photo. The session part is composed of entities: user_id number and the token necessary for establish communication between the mobile and web application with the firebase BE server. Product includes: the name of the product, its description, also given price and photo. Selcted_products represents the exact content from what client submitted to the shopping list. Entities here are: product and its amount and additional_request which is not mandatory. Requests portrays selected_products, table that was chosen by scanning the table code - QR Code NFC tag or BLE beacon. It also shows total which means the sum of the prices, user_email, status of the order (open or closed), as well as open_date and close_date. To complaints_and_suggestions belong: title of the text, description (content), the date of the message and information about its author - email address. About describes app_name, app_version and app_info, having developers as the last type of information. Among developers section it is possible to find name of each developer and his photo, placed as an url address.

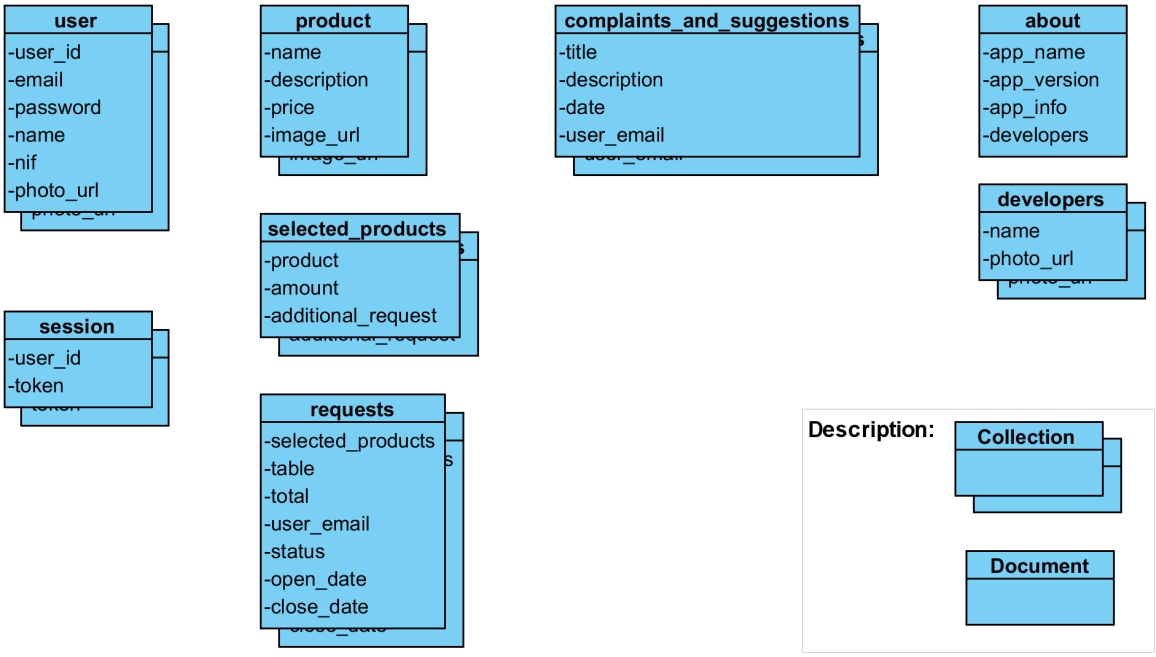


Figure 4.4: Database diagram

Since for the purposes of the project, a NoSQL database was used, data is saved as collections of documents and each document can be used in the application as a JS Object. Thanks to that, in the application it is possible to, for instance, create a class called Request and use this class in the mobile and web application. The class is presented in the Listing 4.1. There is also a possibility of storing this request in the firebase database as a JSON object in the Requests collection as shown in the Listing 4.2. The second piece of code is the representation of one completed request in the database. Apart from that,

in the Listing 4.2 attribute image_url it is displayed an URL and here is where we are saving our images using the features from firebase storage.

Listing 4.1: Requests model - part of the mobile application code

```
import {SelectedProduct} from "./selected-product";

export class Requests {
  constructor(public selected_products: SelectedProduct[],
              public table: string,
              public total: number,
              public user_email: string,
              public status: 'open' | 'closed',
              public closed_date: Date,
              public open_date: Date) { }
}
```

Listing 4.2: Requests collection - example of a database document

```
{
  "selected_products" : [ {
    "product" : {
      "name" : "Ice Cream",
      "description" : "Chocolate and vanilla flavor",
      "price" : 3,
      "image_url" :
         "https://firebasestorage.googleapis.com/v0/b/fast-order
        -app.appspot.com/o/products%2FIce%20Cream?alt=media"
    },
    "amount" : 1,
    "additional_request" : ""
  }, {
    "product" : {
      "name" : "Tea",
      "description" : "Irish tea",
      "price" : 1,
      "image_url" :
         "https://firebasestorage.googleapis.com/v0/b/fast-order
        -app.appspot.com/o/products%2FTea?alt=media"
    },
    "amount" : 1,
    "additional_request" : ""
  } ],
  "table" : "10",
  "total" : 4,
```

```
25    "user_email" : "test@test.com",
26    "status" : "closed",
27    "open_date" : "2018-11-13T23:41:53.044Z",
28    "close_date" : "2018-11-13T23:42:15.500Z"
29  }
```

4.4.4 Solution development

The mobile application of the proposed solution was implement with the Ionic framework, which is based on Angular. The mobile application was developed following a hybrid approach, that empowers a greater adaptation to the different platforms. It is assumed to be a simple and objective application. The system will be developed using the Ionic framework based on Angular since Ionic is a framework that allows the developer to develop mobile apps using web technologies - HTML, CSS and JS. The web application was implemented using Angular and the Bootstrap FE framework because both feed the needs of the project, these frameworks are mature solutions that include detailed documentation.

4.4.5 Activities diagram

Figure 4.5 shows the activity diagram of the proposed solution. the purpose of the activities diagram is to present the flow of activities in the process. The diagram shows the interdependence between activities, but also the relationship between the various use cases and the components of the solution proposal.

4.5 Conclusion

In this chapter, the proposed solution was specified and detailed. Identifying all functional and non-functional requirements related to the essential features of the system. All technologies used in the applications, such as QR Code, NFC and BLE, as well as the language necessary for coding - JS, were presented. The proposed solution aims to support the management of a restaurant in its daily operations. With a correctly implemented system, places can work faster and with less labor. The system, accessing database, is able to return the appropriate information about several aspects, for instance, the menu in the client's application and the order list in the employee's application.

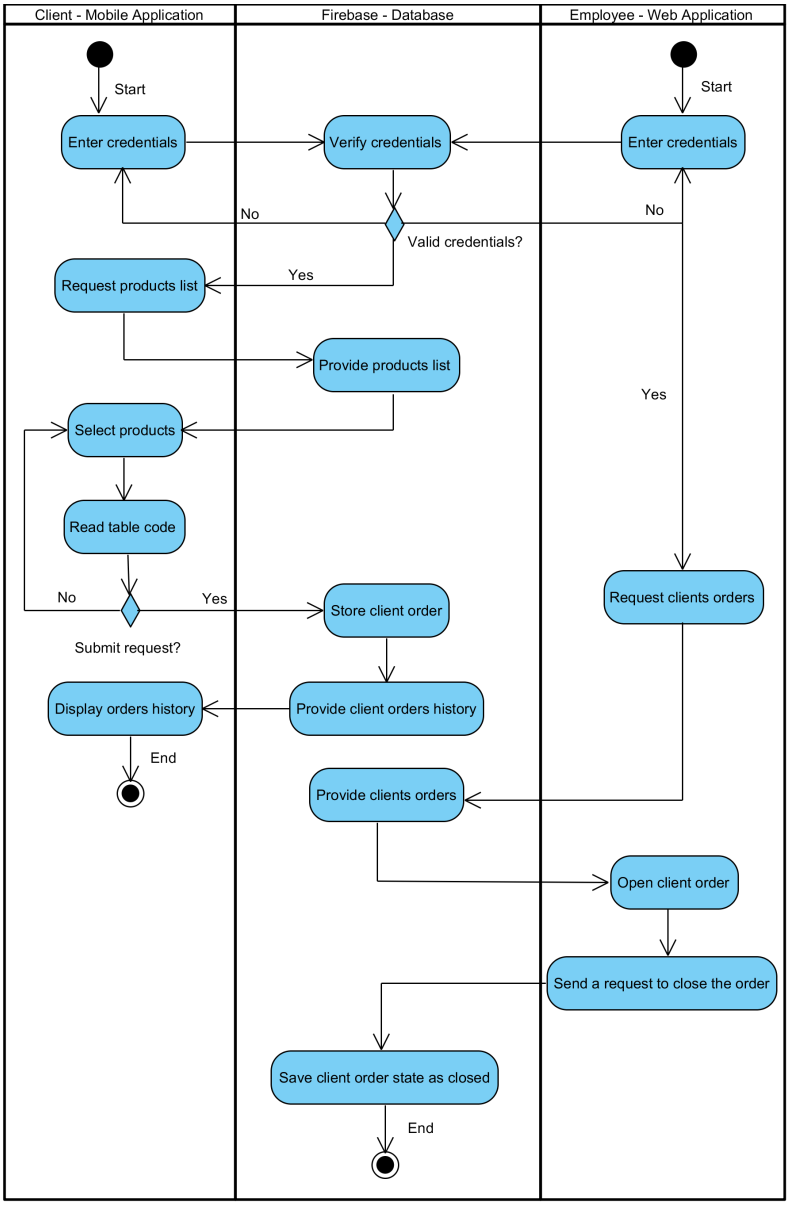


Figure 4.5: Activity diagram

Chapter 5

Evaluation

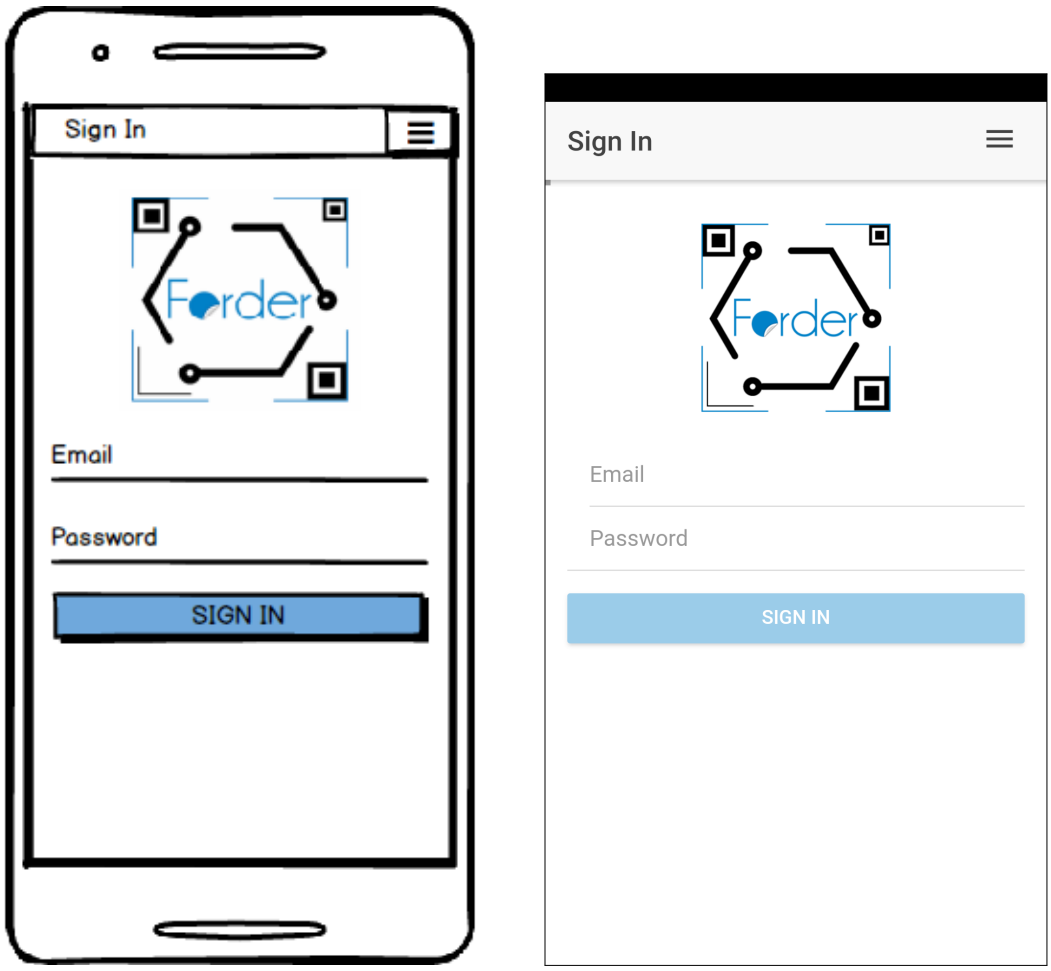
The evaluation of the proposed solution is an essential step. Developers must ensure that the number of possible errors is reduced as much as possible, that clients will obtain a guarantee of data protection and that they will be satisfied while using the system. The evaluation of the proposed solution consisted of two major tasks. The first task comprised the usability evaluation and the second the functional evaluation. In this chapter, the satisfaction of the requirements initially identified is also evaluated. The developed prototype is composed of two main applications. The mobile application can be installed on an smartphone equipped with Android or iOS system. The web application is available on the web and was implemented with the Angular framework.

5.1 Usability evaluation

The usability evaluation consisted of testing client's access to specific options of the solution proposal, validating the satisfaction of the requirements previously identified. Starting with the most essential, the first step was to check how the application would behave realizing the first task - logging in.

5.1.1 Log in from a mobile device

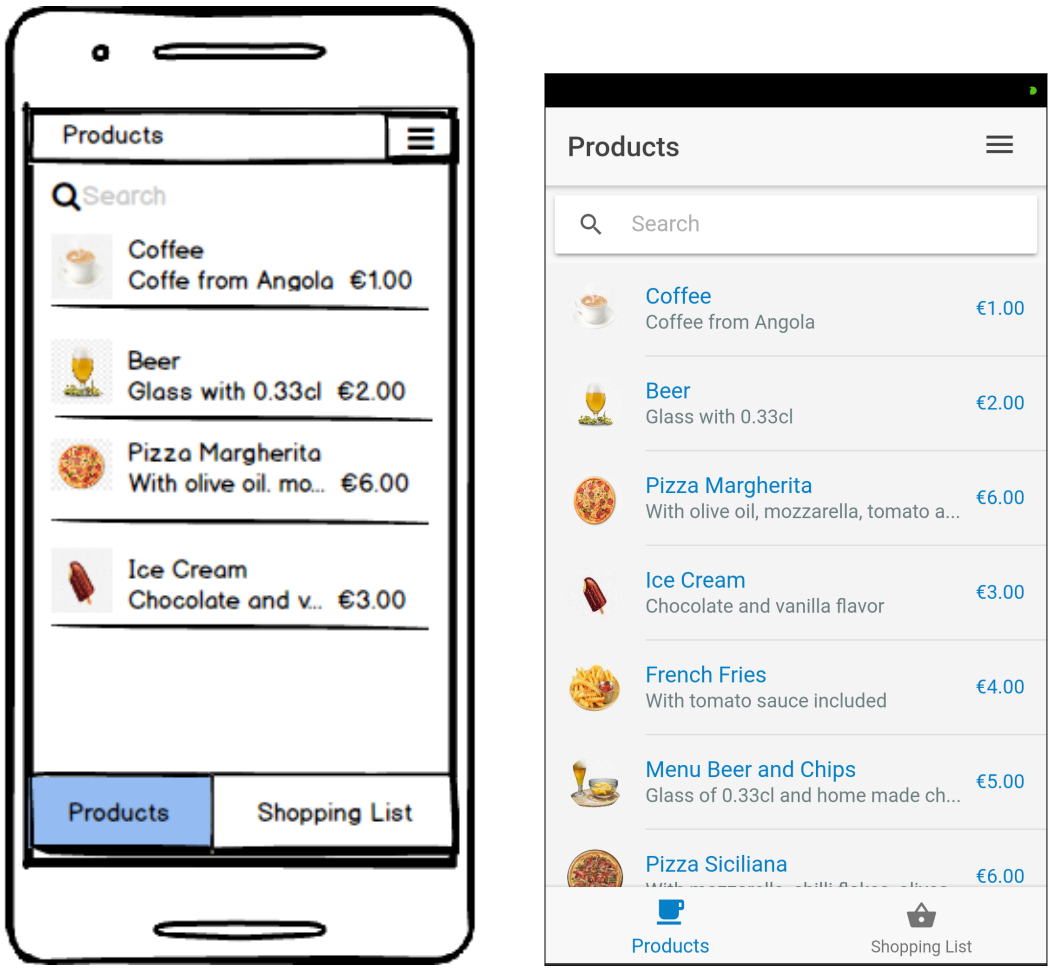
Figure 5.1 a) presents the mockup of the login page of the mobile application. In the foreground there is logo of the company – Forder – which relates to fast order service.



(a) (b)

Figure 5.1: Login screen - mobile application

Figure 5.1 b) shows the real version of the page. It is possible to see that the development looks similar, so the task was conducted according to the plan. The client enters his credentials to two text boxes: one represents client's email and the other one for the password. Afterwards, client is redirected to the home page in the form of the menu. This solution saves time, skipping some steps. It makes the application more intuitive. Figure 5.2 a) shows what happens when credentials are correct. After a few seconds, the home page with the menu appears.



(a) (b)

Figure 5.2: Products list screen - mobile application

In the Figure 5.2 b) the real appearance of the list is presented. Here the difference is that the realization turned out to be even more intuitive: to choose the sections with products or shopping list, the client has to tap the icon of a mug or shopping bag respectively.

Going back to the login option, if the client fails in filling his username or password, as presented in the Figure 5.3, the client receives a notification with the content: 'Sign is failed! The password is invalid or the user does not have a password.' It gives the client an opportunity to click 'OK' and try to enter the credentials again, while not having access to the system.

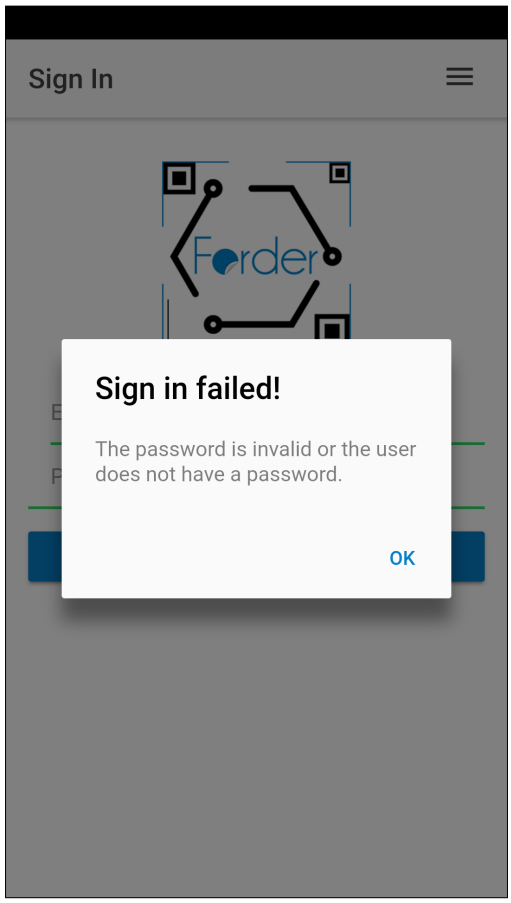
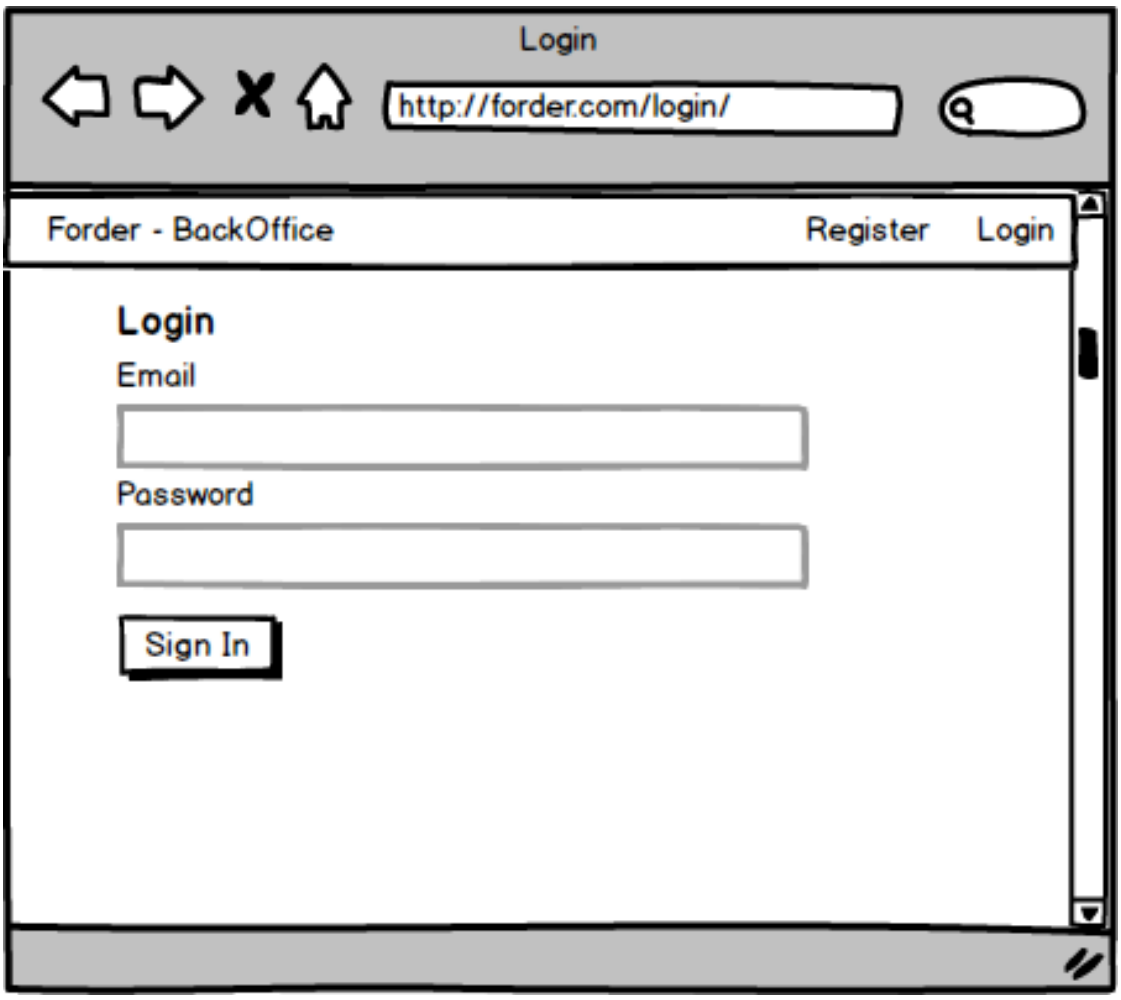


Figure 5.3: Login failed - mobile application

5.1.2 Log in from a web application

The part of the system prepared for the browsers was published on a Simple Storage Service (S3) bucket. This is a public cloud storage resource available in Amazon Web Services (AWS). In the Figure 5.4 a) it is displayed the mockup of web application. Here, user also has to fill two text boxes: an email and a password.



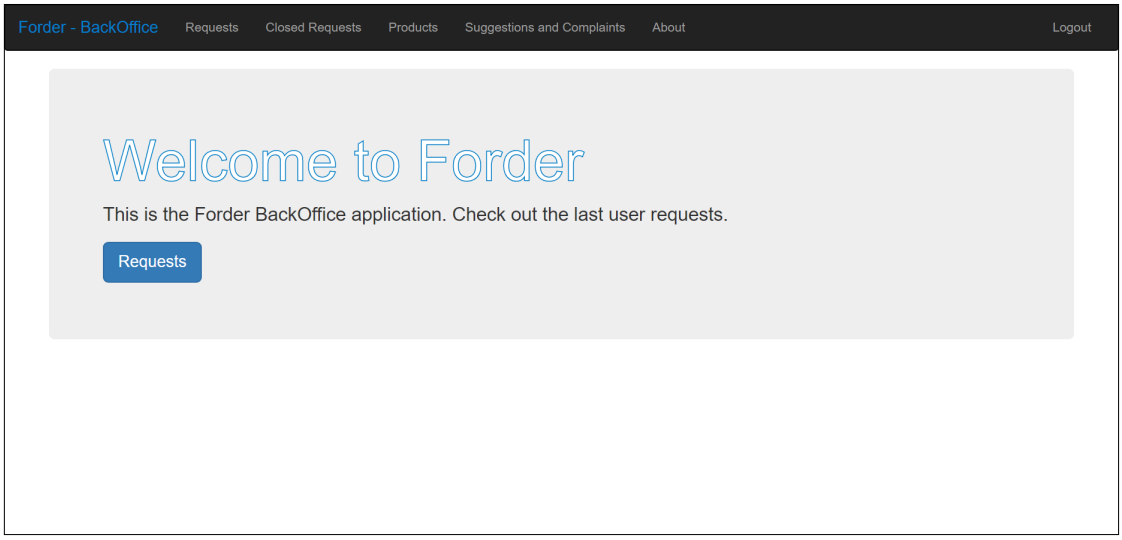
(a)

(b)

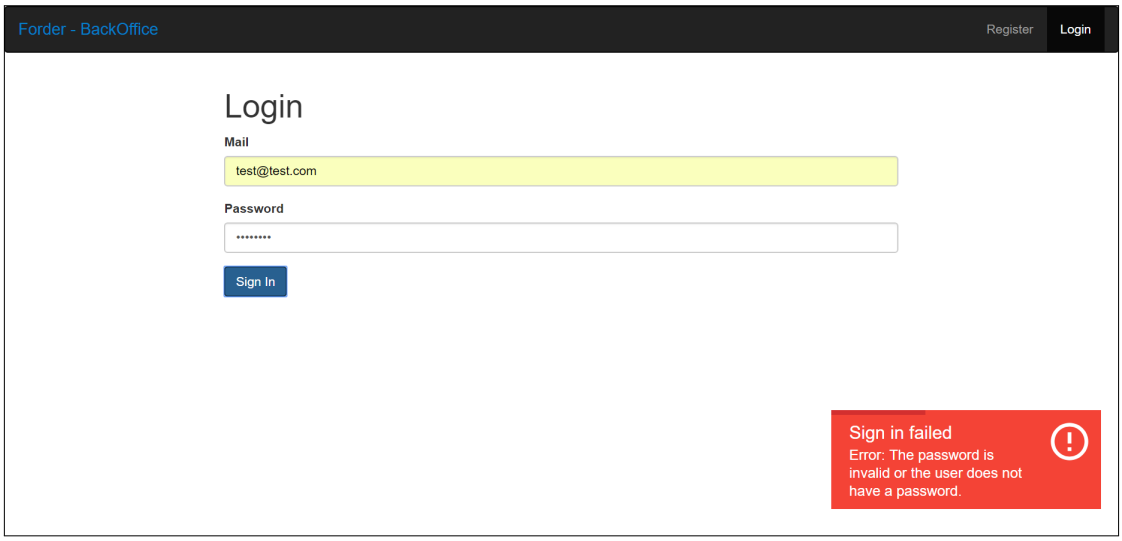
Figure 5.4: Login screen - web application

The realization of the task went without problems once more. Login page has an appearance recalling the mockup. The result of the login page is shown in Figure 5.4 b).

After the submission of the correct credentials, an employee can see a welcome page with a title: 'Welcome to Forder! This is the Forder BackOffice application. Check out the last client requests.' Below the text, there was placed a button redirecting to all the requests. Figure 5.5 a) shows the web application logged in home page.



(a)



(b)

Figure 5.5: Login result screen - web application

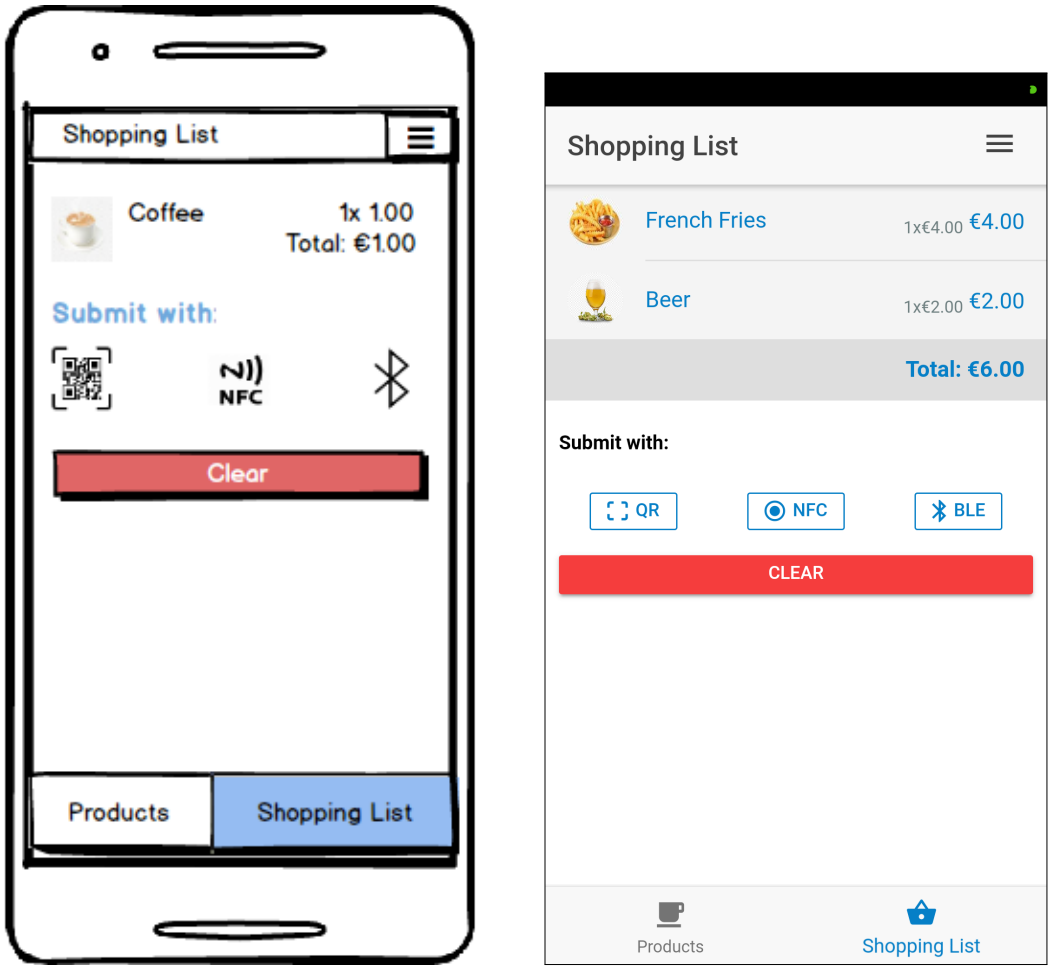
Figure Figure 5.5 b) exhibits the reaction of the applications when the enter data is invalid. The application denies entry. In this case the application also conducted that unauthorized person is not permitted to use the software.

5.2 Functional evaluation

Functional testing analyzes the various functionalities of the application. It checks if the implemented components work well. It ensures the high quality of the system and originality of proposed solutions.

5.2.1 Submit order

To send an order, a client at first has to select products displayed in the menu (presented in the previous section). Next, it is necessary to submit the order with one of the methods: QR Code, NFC or BLE.



(a) (b)

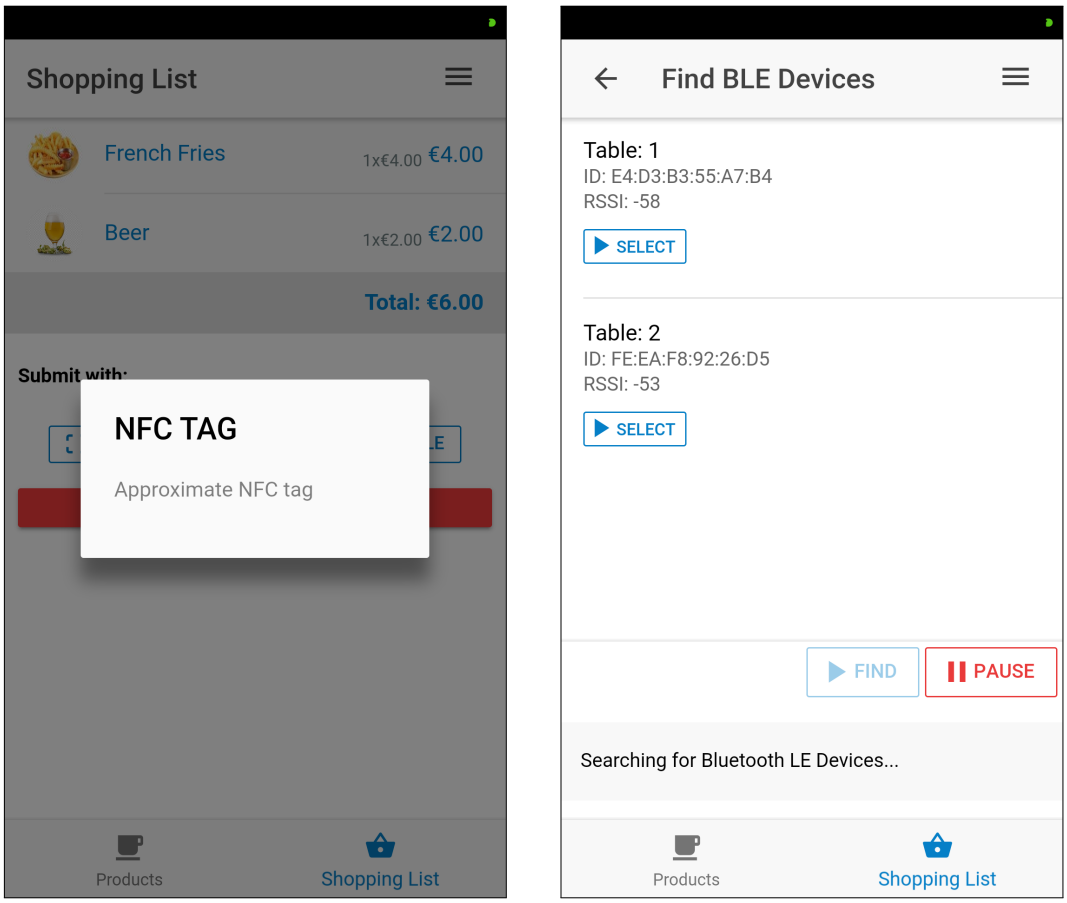
Figure 5.6: Shopping list screen - mobile application

The Figure 5.6 a) presents a mockup of the making of the order when the client is almost about to submit it. The client can still clear his order t this point. He can also choose one of three options for the submission: with QR Code, NFC or BLE. On the top there is shown the selected product, as well as total amount to pay. The client can come back to Products or Shopping list, which is enabled by the icons below the order.

The Figure Figure 5.6 b) shows that the task turned out to be realized in the same way as the mockup.

Merely the submission buttons (QR Code, NFC and BLE) changed it design, what made them more readable.

In order to submit the request with QR Code, the client has to enable the device to use its camera to scan the code. After scanning the code present at the table, the application send the client request to the server.



(a) (b)

Figure 5.7: Submit order screen - mobile application

For the purposes of submission using NFC, the client has to enable the device to use NFC. With the NFC technology enabled, the client taps the button and there appears a message: 'Approximate NFC tag' as shown in Figure 5.7 a). The client has to approach, or even touch, the tag placed on the table with the smartphone. It is an interactive method of getting the client involved.

If the client chooses submission with BLE, as presented in the Figure Figure 5.7 b), a new page is presented. By default the find button is selected and it start searchin. There are displayed the available beacons. The beacons near to the smartphone emit a signal - Received Signal Strength (RSSI). The client should after tap the correct beacon with the table that he is sitting at.

For the demonstration of the order submission, all the requests were sent from the table 1 (5.8).

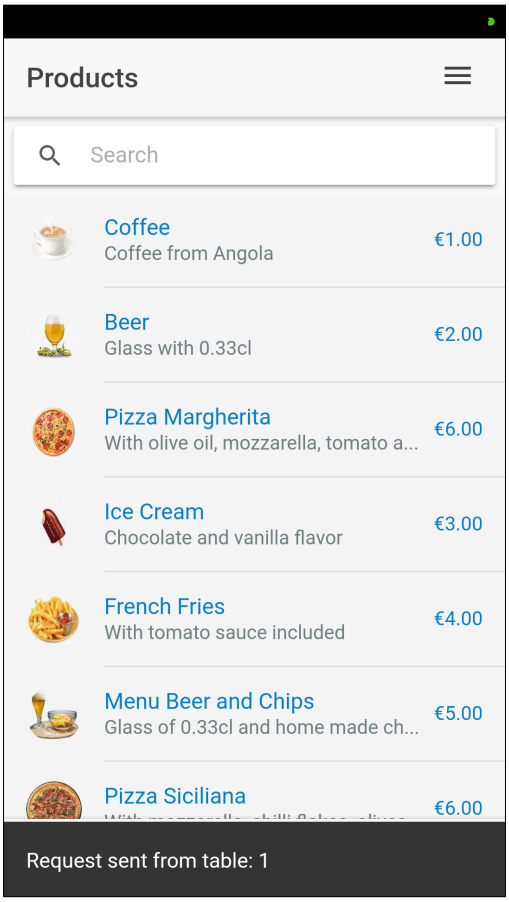


Figure 5.8: Submitted order result - mobile application

Figure 5.9 shows a similar test done in the application operating in iOS system. It is possible to see that after clicking clear option, the client can see a request for acceptance of the decision. He can choose either yes, go ahead, or no, I changed my mind. This option prevents from deleting orders that were not meant to.

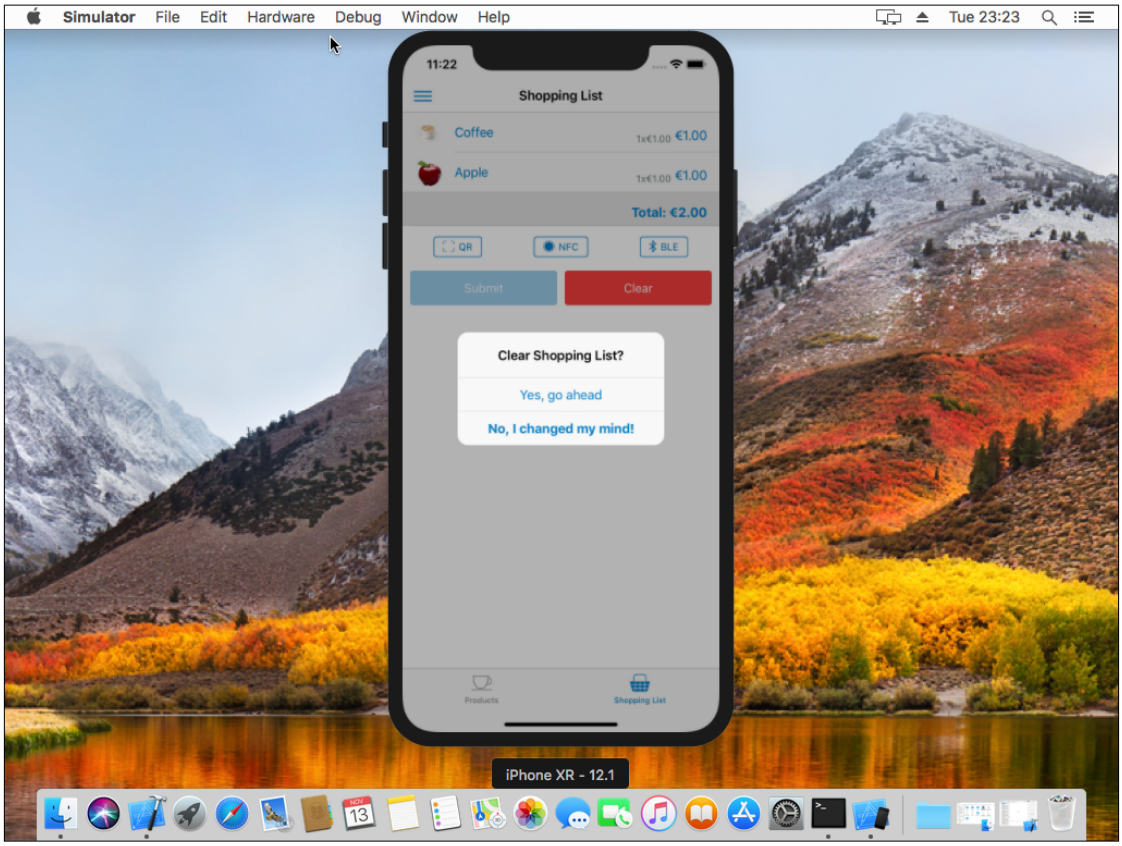
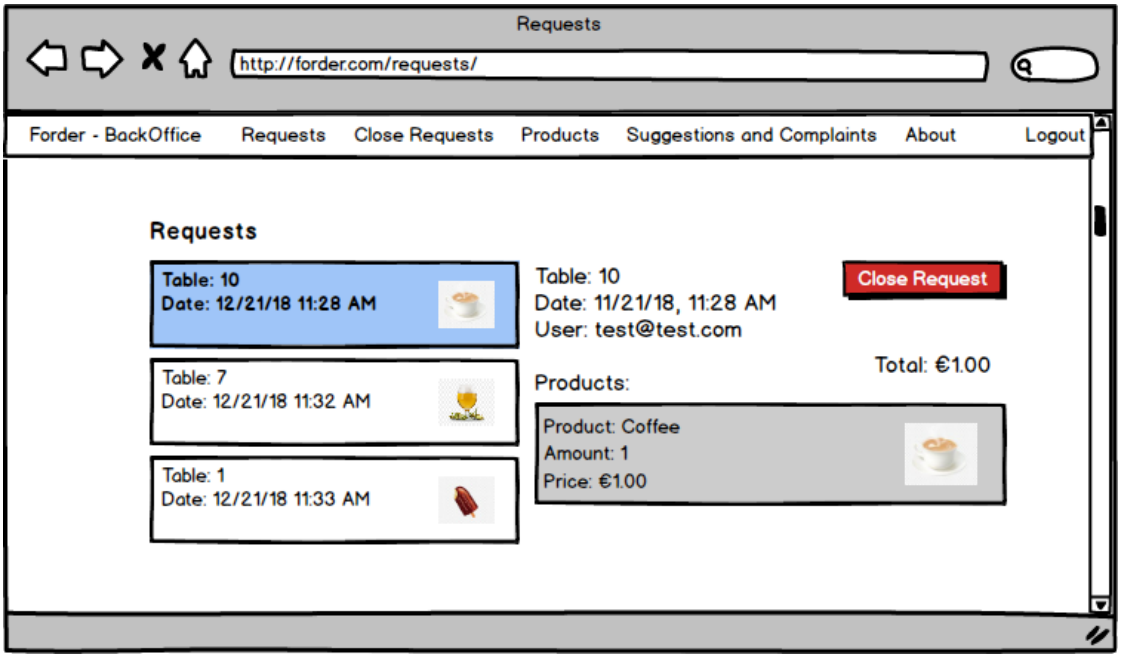


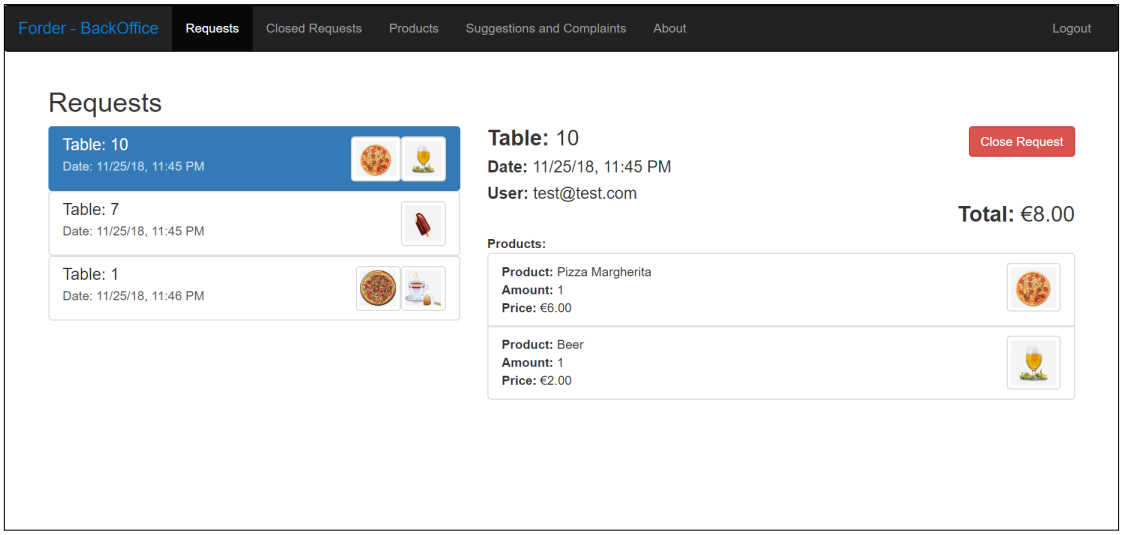
Figure 5.9: Clear order - mobile application

5.2.2 Close request

Another test carried out is dedicated to web users. Close request option can be used when the order is done or it is not needed anymore. The Figure 5.10 a) shows the mockup of the open requests. There is an organized list of the products from the order, including pictures and prices. Each table contains a different list of products (different orders). When one table is selected, the employee can see the total amount to pay, the exact time when the order was made, but also email of the user. In the right corner is a red button allowing to close the request.



(a)



(b)

Figure 5.10: Open requests screen - web application

The real view of the page, presented in the Figure 5.10 b), does not differ from the mockup version present at the Figure 5.10 a). The employee has to select request and then click at close request.

5.3 Conclusion

In this chapter the process of testing the system was presented. There were conducted the usability evaluation and functional evaluation. The following tests were carried out: log in test for both mobile and web application, submission test and close request test. In the developing evaluation there was

also included a functional test using a virtual machine. With the macOS Sierra installed on the virtual machine and using the Xcode integrated development environment, it was possible to compile and test the application through the iOS simulator.

Chapter 6

Conclusion

Technology has an enormous impact on development of many various industries. For years it has been said to be one of the most desired sectors. Similar conclusion can be drawn from observing the restaurant industry – it is a universal area, still desired and characterized by huge demand. What arises from the connection of both? It can be a source of a business idea for many different entrepreneurships. Seeking inconveniences caused by lack of innovation in companies' operations is a way to succeed. During different moments of the day, companies suffer from mismatching a number of employees with the amount of work. There are some calmer periods when there is not so much need to have a lot of employees working. On the other hand, on other periods, coffee shops and bars cannot deal with a great number of clients and orders. The proposed solution aims to mitigate such a phenomenon by increasing a restaurant's performance.

The proposed solution is based on PCT. There are three principal standards belonging to this area: QR Code, NFC and BLE. Each of those are different in terms of specification, for instance the range and functional requirements. It also uses the Ionic framework, which supports primarily multi-platform mobile applications. Moreover, Angular and Boostrap were the basis to implement the application for browsers. A mobile development framework called Cordova was responsible for implementation of HTML, CSS and JS for cross-platform development. Finally, to improve performance of the software, Firebase was used for storing data. The applications are prepared to run in Android and iOS.

6.1 Further work

The selection of the problem to solve and the methods used in the project caused creating an open space for providing changes and improvements. At this moment, the software is able to operate from the moment of attendance of the client, until completing the order. There is still space for providing refinement, which would allow clients to receive and pay their bills directly through their mobile devices. Also, this solution could be integrated with the software present at the restaurant.

To work more efficiently and achieve even higher level of security, the system should have an option for administrator. It is always a part of big and important IT projects and turns out to be extremely useful in the moments of incidents or breakdowns. Not only that, but also in the daily operations the software should have an entity to rely on and be monitored by. The system should allow the administrator to create and configure tables, but it should also ensure configuration of products and management of clients.

The web part of the system could also be improved, for instance, by displaying not only the current

requests, but also the history of closed requests. This may occur necessary when explaining mistakes in billing and many other issues. It could be useful if the clients could also be able to reuse a previous request. He could reuse an additional comment for a specific product or recommend this product to other clients. Last, but not least, the option that would improve the adoption of the system could be the possibility of evaluating dishes and issuing of review rates.

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