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Kaalsy Domotics

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KAALISY DOMOTICS: IMPLEMENTATION OF A USER FRIENDLY INTERFACE COMPLYING WITH A NEW BUSINESS MODEL

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Kaalisy domotics: implementation of a user friendly interface complying with a new business model

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Davide Angelici

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December 2014
The undersigned hereby certify that they recommend an acceptance to the School of Computer Science at Reykjavík University of this experimental thesis entitled, "Kaalisy Domotics: Implementation of a User Friendly Interface Complying with a New Business Model" submitted by Davide Angelici in partial fulfilment of the requirements for the degree of Master of Science in Computer Science.

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27-01-2015
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Abstract
This thesis has two main goals. The first goal is to present the phases involved during the realization of the business plan for a home automation system called Kaalisy Domotics. The presentation include market analysis, competitors analysis, product production and financial plan, which are explained in details. An overview of how the idea started is introduced and how it will be transformed into a real product. The second goal of this thesis is to explain the development of a user interface, used by the customers to interact with the Kaalisy Domotics system. The interface must respect specific requirements according to the end user characteristics, in order to provide a friendly interaction between the user and the system. This report ends with few observations regarding the technique adopted to implement the user-interface, and possible future works.
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Chapter 1

Introduction

Today, we can observe a large offer of domotic installation available on the market. Be connected, be updated and control the energy consumption became the three big concerns of our time. Domotics allows us to be connected to our house, control our devices, be updated in real time in case of intrusion and control our energy consumption through the regulation of the thermostat according to scenarios or through the plugging or unplugging of unused devices. The offer of the market is quite large and domotics has an aspect of luxury, because of the price of its installation and also because of the gadget image that it has. The motivation for the project is to reinvent domotics in order to enable everybody to have access to it and to break with this image of luxury and time consuming installation. The main ideas were to create a system with a low cost, possible to install by the users, possible to control from everywhere and removable. These ideas that would allow the consumer to have a complete power of control on his house gave birth to Kaalisy Domotics.

1.1 Contributions

The whole project Kaalsy Domotics has been done in collaboration between me and Claudio Tesei. We created a system that enables the user to control all the devices that he wants, thanks to several packages available, changeable as much as he wants, configurable as much as he wants. The user has all the freedom possible to control his house. This thesis will study the market of domotics to ensure us that we are on the correct business track. Then we will describe our experimentation: first with the software requirement and then with all the implementation of the user interface. Of course one man is not enough to reinvent the domotic system, that is why it is recommended to read the other part of this team work: Rule Based Control System for Home Automation (Claudio Tesei).
aim of the project is to illustrate all the phases that contributed to transform an initial idea into a final product that we would like to launch on the market. The idea was to provide to the final customer an alternative solution in the field of Home Automation. The project starts with a business plan documentation, in order to provide a general overview of the product. Then the software requirements and software design specifications are explained in details, allowing the reader to understand better how the product/system will look like. After the implementation phase of the product started, we started to implement the beginning the logic of the system and then implemented the layout of interface. Basically what we are implementing is a wireless home automation system which allows the user to transform a normal end-device (light, thermostat, wall plug, ...) into a smart end-device.
Due to Camerino University policy we were forced to split the work into two different theses. For this reason the documentation of the business plan, the software requirements specification and the software design specification are divided between the two theses, even if they were done by both of us.

Finally we decided to divide the work as follows:

**Davide Angelici**
- Business plan
- Software Requirements Specifications
- Implementation of the user interface

**Claudio Tesei**
- Business plan
- Software Design Specifications
- Rule Based Control System for Home Automation

In order to do not confuse the reader it was decide to show business plan documentation in both of the paper, which can be used to have a general overview of the entire project. Finally due to the complexity of the project I suggest to read before the software implementation done by my colleague Claudio Tesei and after that he can proceed to read the implementation of the user interface present at the Chapter 4 of this thesis.

### 1.2 Goal

This thesis has two main goals. The first goal is to present the phases involved during the realization of the business plan for a home automation system called Kaalisy Domotics.
The presentation includes market analysis, competitors analysis, product production and financial plan, which are explained in details. An overview of how the idea started is introduced and how it will be transformed into a real product. The second goal of this thesis is to explain the development of a user interface, used by the customers to interact with the Kaalisy Domotics system. The interface must respect specific requirements according to the end user characteristics, in order to provide a friendly interaction between the user and the system.
Chapter 2

Business Plan

2.1 Overview

2.1.1 The opportunity: home automation easy and low-cost

The home automation systems are capable of controlling lighting, heating, shutters and windows of houses. Kaalisy Domotics[15] aims to bring home automation systems in Italian homes, allowing anyone to be able to realize a customized home automation system at an affordable price. It is not present on the market a solution that offers a service easy to install yet, which does not require work on the electrical system and it also allows you to interact with devices "not smart". Kaalisy Domotics offers an easy to install system which can be purchased at an affordable price and does not require the intervention of specialized technicians. Moreover, with this system is possible to interact with devices "not smart".

2.1.2 The product

Kaalisy Domotics is an innovative home automation system. Thanks to its own communication protocol over wifi, it allows to control easily and intuitively the devices using an app on your smartphone or via an user friendly web interface, which allow the end user to create scenario, for example (" if this happens then do this "). Among the products on sale it is possible to find switches, light adapters, wall plug adapters, thermostat, door opening and sensors.
2.1.3 The team

The entrepreneurial team is both skilled and experienced in Information Technology, Electronics, business development and management.

2.1.4 The business model

The business model adopted is an e-commerce model. The products purchased online will be sent to the buyer by express delivery service carried out by partner curriers company.

2.1.5 Roadmap and economic projections

Before the start of the commercialization of the products, a phase of industrialization and standardization of six months is necessary. Moreover, each product must obtain the CE certification. The economic projections, show that the break-even point is reached during the second year and is followed by a rapid growth in both revenues and profit with ROI and ROE in double digit from the second year.

2.2 The market and the competitive environment

2.2.1 Home Automation: the smart home

Enter at home and turn on the lights, open the blinds, select your favourite music and turn on the TV automatically through a computer when it recognize your presence, it is no longer a futuristic idea but is now a reality (Figure 2.1). Nowadays, home automation systems are able to control lighting, heating, blinds and windows, also acting independently. However, these systems should work together, collaboratively, communicate between each other to make life easier for those who use them, increasing comfort and safety, leading to an energy saving and providing modularity and flexibility. The first home automation systems were fairly rudimentary and the final result was really unattractive. Current systems use innovative technologies and provide to the end user a complete and functional product. This development became possible thanks to the introduction of "smart" domestic components, i.e. circuit breakers, thermostats, bulbs, microwave ovens which are able to communicate with the outside world. The terms "smart home" and "home automation" are now commonly used to refer to devices connected to the internet and house’s equipment able to operate independently. In reality, the full realization of the
smart home needs the integration and collaboration of various technologies and services, all working together.

![Figure 2.1: The smart home](image)

On the market there are various intelligent devices, which use different communication protocols. This constitutes a real obstacle in the realization of a fully integrated smart home. In response to this problem, some companies have developed standard communication protocols, in order to simplify the communication between smart devices available on the market.

### 2.2.2 The standards are numerous

The most common standards of communication protocols are reported in Table 2.1. This are currently used for the communication with automation components.

A home automation system compatible with some of those protocols, definitely offers advantages in terms of flexibility, modularity and expandability compared to systems that use only proprietary communication protocols (i.e. that cannot be used by others). For example, *Revolv*, home automation central unit that is able to communicate with a variety of smart devices, is compatible with a high number of communication protocols (well 7), unlike a product like *Juicy iAX*, that even if it has a good compatibility, is not able to offer the same standards.

### 2.2.3 A great opportunity

The currently available solutions used to transform your home into a smart environment are essentially of two types. The first type requires the installation of the smart devices and the use of a "central unit" (e.g. *Revolv*, *Juicy iAX*) which allows the interaction
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<th>Year</th>
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<td>Z-Wave</td>
<td>Wireless communication protocol, designed for home automation, in particular for control the smart devices in residential and commercial environments.</td>
<td>There are more than 900 different products certified by the Z-Wave Alliance. These products cover all major sectors market for control devices in residential and commercial environments.</td>
<td>2008</td>
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<td>KNX</td>
<td>Communication protocol exclusively used for building automation.</td>
<td>Open standard, which has now connected more than 300 companies around the world.</td>
<td>2002</td>
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<td>ZigBee</td>
<td>Industry standard for wireless networks.</td>
<td>Association of more than 230 companies that are driving the global development of this technology. First ZigBee products came on the market at the beginning of 2005.</td>
<td>2002</td>
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<td>Bluetooth</td>
<td>&quot;Wireless technology standard for exchanging data over short distances&quot;</td>
<td>Technology used in all modern smartphone, often used in systems Home automation systems of small dimensions.</td>
<td>1999</td>
</tr>
<tr>
<td>X-10</td>
<td>Open industry standard for the communication between electronic devices for home automation.</td>
<td>Although there are alternatives with higher bandwidth, including KNX (Konnex), INSTEON, BACnet and LonWorks, X10 remains popular in domestic environment with millions of units in use worldwide.</td>
<td>1975</td>
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Table 2.1: Standards of communication used in home automation

with the devices, usually via a mobile app. The main strengths of this solution are the easy installation and the ability to interact with different devices without the necessity to do any wiring. The disadvantage is the relatively high cost of the smart components, compared with the ordinary appliances findable in most of the homes. The second option allows the use of smart devices and house’s appliance without communication protocols, but it is required the modification of the house’s electric system, changing its structure and performing a complete wiring of the devices that you want to "make smart". This solution allows the use of components such as switches, bulbs, thermostats, blinds and shutters that are not necessarily smart, but the invasive intervention required on the electrical system increases the overall cost. Examples of this solution are those offered by companies such as BTicino, AtHome, HiSystem all characterized by a fairly high price. However, a
solution that tries to combine the advantages of the previous two solutions by removing their disadvantages, is not yet on the market. For example a solution that offers a product that is easy to install, does not require work on the electrical system and at the same time is also addressed to non-intelligent devices. Such a solution would seriously reduce the costs required for the construction of a home automation system and it is precisely this possibility that we intend to achieve with our system.

2.2.4 The customer asks for simplicity and flexibility

From the customer’s point of view, a smart home is much more than a simple high tech gadget. The house is a long-term commitment and a significant investment, and a smart home involves changing the way you live. Previous innovations such as television or personal computer produced significant social changes but the smart home will create even more significant changes. Most of the people are looking for an easy to use system that allows a remote management and the creation of scenarios (e.g. Scenery night: closing the front door, alarm activation, switching off lights). But we observed that there were often too many informations that confuse the buyer. Therefore it is preferable to reduce the amount of information and to reduce its complexity in order to create a more accessible system. Too many interfaces to manage the system also confuse the end user, this is why one prefers simple interfaces such as touch-screens, which enable immediately the user to command and activate different scenarios or series of functions. Solutions based on open standards, flexible and easily programmable systems are required. These solutions provide the ability to the user to change the system or service without the need to modify the electrical system.

2.2.5 Feedback is Important

Feedback is a really powerful "tool" to help people to be updated and improve their lack, it can also be used to know how other people perceive specific performances. We assume extremely important know if our solution could in someway satisfy the needs of future potential customers. Then we decided to retrive these feedbacks through questionnaires.

What to ask?

First of all, in order to get accurate feedbacks, the questions have to be simple and clear to avoid the misunderstanding of the use. Secondly the questionnaire does not have to cover many topics, few questions referred to few concept. Once we were clear regarding
the few main rules, we fixed the goal of the questionnaire, in other words, what the result will emerge after have analyzed it. According to the embrional state of the project it was useless to try to get a feedback about Kaalisy, because we did not have any prototype or examples. Then we decide to try to understand if our solution, which is based on four main aspects (non-invasive, easy-to-install, cheap, reusable), can and answer to the problematic of the potential users. We basically wanted to know if they know about home automation system and if they are interested in it and why they do not have it. At the end of the questionnaire we present a custom home automation configuration and we asked how much they would have spend for it.

We tried to target different category of persons based on their age, in order to have more realistic data. Finally the survey was done by 151 people of different age, 50% of them were people younger than 35 year.

Results

The first information extrapolated from the questionnaire was the number of people that currently have an home automation system installed at their place.

As we expected, almost nobody has an home automation installed at their apartment, then an obvious question to ask was, to see if the would like to have it. As the Figure 2.3 shows that a large number would like to have it.

![Figure 2.2: Do you have an home automation system?](image)
Then we asked why you do not have it if you would like to have it installed at your place? The result coming from this question was really important to understand if Kaalisy was able to answer to their needs. And as we can see from the Figure 2.4 the first reason is because they are expensive, they do not own the apartment and because it is invasive. Moreover we asked how much do they would like to spend for having a system which is able to control all the lights, thermostats, doors and video surveillance. It come out that the are willing to spend around 500 euro.

In conclusion we can be confident with the results obtained from the questionnaire, as we can see the strength of Kaalisy lays on the needs of the users, and this is a really important aspect because it means that we are working in the correct direction. Moreover we are able to present a solution which is non-invasive, reusable and it fits perfectly the budget of the people.
2.2.6 The market trend

The CERP, an organization that gather the research projects of the European Union in the field of Internet of Things [1], shows the home automation and intelligent buildings among the most promising areas of application. The use of wireless communication technologies (ZigBee, 6LoWPAN, etc.) allows you to connect to each other objects within a building providing two-way communication. In the past, home automation technologies were mainly used in offices and luxury homes, but the technological development and the permanent reduction in costs now make these technologies accessible to a growing part of the population. The features offered are varied and constantly evolving. For example, you can use the temperature and humidity sensors to collect the data needed to optimize the use of heating and air conditioning, ensuring comfort and at the same time reducing energy consumption. An important role is also played in helping the people, given that the home automation solutions can be used to monitor the activities of people within the home, providing assistance to elders or individuals with disabilities in the performance of activities of daily living and, in case of need, make alarm. In Italy, the home automation market developed with the growth trend (data Assodomotica) at around 30% per annum. The trend has been to create home automation systems in new homes or renovated. In our country about 300,000 homes per year are built and around 700,000 are restructured with the complete renovation of the electrical system. Home automation systems have grown from 10,000 in 2005 to over 100.00 in 2013 (Figure 2.5). The total value of these implants went from 42 million euro in 2005 to 440 million euro in 2013. These figures include both basic electrical systems (normally included in the offers of new buildings), and advanced systems, with high levels of customization. Assodomotica identifies four market segments. The first referred to "advanced applications" covers housing and extended luxury homes. The advanced systems require a custom project, which involves, in addition to the installer, designer and architect. The second segment of the market concerns the systems made by the installer directly on the final user. The third segment is the one of "Basic systems" provided in the offer by the construction companies and the fourth is the one regarding applications which are intended for the elderly and disabled. The fastest growing segments are the advanced applications and basic systems. As for the last one, a strong pushes has been given by the growing sensibility regarding energy savings.

2.2.7 How will develop the global market

According to ABI Research the global market of home automation is trending upwards with significant growth expected over the next few years[3]. With 9 billion USD in 2014,
the market is expected to reach 14 billion by 2018. The North American market will remain solid over the forecast period, increasing from 5 billion to 7 billion. North America currently holds 64 percent of the market, but its percentage is expected to drop to 50 percent by 2018 (Figure 2.6). Growth is fueled by a constellation of factors, including a recovering economy and new entrants in the market, according to Adarsh Krishnan, senior analyst at ABI Research. Some of the barriers that limited the growth of the market, such as the lagging economy and high costs, have now been removed. The integration of security systems with home automation systems is promoting the wider adoption by user, and technological improvements in general, continues to make the market more attractive to user and suppliers. The constant improvement of wireless chipsets, in addition to their decreasing costs, was also a key factor in promoting their adoption. The automation technologies that should enjoy a pronounced growth during the forecast period include contact sensors, motion sensors, wireless sensors, keypads and control panels.
Some of the features that are added to the home for safety reasons are expected to get substantial gains. "We expect to see the most growth in door locks, thermostats and smart plugs", said Krishan[7]. The demand for a universal solution, easy to install and integrated with several subsystems in a home, led to a phase of explosive growth in the industry.

2.2.8 The main players

To understand better the potential of our product we can compare it with the solutions that are available on the market. After a research made on internet it was possible to create a list of competitors, it was decided to divide that list geographically and by type of service offered, so as to highlight both the potential and the gaps of each proposal on the market.
**Direct Competitor**

**Indirect Competitor**

**In our region**

The table below shows three main competitors, founded looking near by our region, which is called Marche. It was decided to differentiate these three companies from the one listed in the section (Italy), in order to understand if our solution (Kaalisy Domotics) could have any chance to be competitive in this specific region of Italy.

<table>
<thead>
<tr>
<th>Competitor</th>
<th>Product</th>
<th>Strengths</th>
<th>Weaknesses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seav</td>
<td>SEAV DOMUS</td>
<td>- Web interface design, for home automation, system</td>
<td>- Wiring of the system by a qualified technician</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Compatible with Radio, technology 433.92 MHz</td>
<td>- Proprietary communication protocol</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- Invasive modification of the electrical part of the existing</td>
</tr>
<tr>
<td>I.E.T domotica e automazione</td>
<td></td>
<td>- 30 years in the market</td>
<td>- Invasive intervention and modifies electrical system</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Compatibility standard KNX</td>
<td>- Web Page unintuitive</td>
</tr>
<tr>
<td>Domsolution</td>
<td>Smart Solution</td>
<td>- Modularity</td>
<td>- Proprietary communication protocol</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Ability to create dedicated scenarios</td>
<td>- Invasive intervention and modifies electrical system</td>
</tr>
</tbody>
</table>
## In Italy

<table>
<thead>
<tr>
<th>Competitor</th>
<th>Product</th>
<th>Strengths</th>
<th>Weaknesses</th>
</tr>
</thead>
</table>
| atHome     | AtHome@ START | - Modularity  
- Ability to create dedicated scenarios | - Invasive intervention and modifies electrical system  
- It does not support standard as KNX, Z-Wave and ZigBee |
| Auratec    | Auratec System | - User friendly interface  
- Compatible with the KNX standard  
- Ability to create scenarios  
- Web Page very attractive | - Invasive intervention and modifies electrical system  
- Unique system lacks the presence of individual packages |
| Bpt        | HOME SAPIENS | - High design  
- Interactive Web Interface  
- Leader nel settore | - Expensive  
- The need for a total restructuring of the electric system  
- Shortly versatile for electrical installations already exist |
| BTicino    | MyHome  | - BTcino Configurator  
- High design  
- Modularity  
- My Home Web: remote access for configuration and monitoring home automation system  
- Compatibility with all appliances and devices BTcino | - Expensive  
- Shortly versatile for electrical installations already exist. |
| Vimar      | By-me  | - High Design  
- Easy to Use  
- BUS system | - Expensive  
- Invasive intervention and modifies electrical system |
| Feel3      | Vivimat | - Availability of different packages: House, Shops, ...  
- ModBus protocol | - Lack of a Web interface  
- Lack of an app (android, iOS)  
- Invasive, direct intervention in the electrical system |
| HiSystem   | HiControl | - HiVision: Interactive Web interface  
- Compatible with VoIP devices  
- Compatible with standard ModBus, Dmx, Dali, LonTalk, KNX  
- Partnership with RISCO Group and Atec | - Invasive, direct intervention on the electrical system  
- Web Page unintuitive |
| Omnibit    | Juicy iAX | - Modularity  
- Plug play  
- Web Page for monitoring and configuring home  
- Compatible with standard Z-Wave, KNX, MyHome Btcino | - Inability to automate electronic devices without communication protocols |

Table 2.2: List of competitors in Italy
## In the world

<table>
<thead>
<tr>
<th>Competitor</th>
<th>Product</th>
<th>Strengths</th>
<th>Weaknesses</th>
</tr>
</thead>
</table>
| Revolv      | Revolv  | - Plug&play System,  
- Easy to configure,  
- Low cost (299$),  
- Application for Smartphones intuitive,  
- Availability of a Community,  
- Nice Design  | - Compatible with few smart devices |
| SmartThings | Hub     | - Low cost ($99),  
- Plug&Play,  
- Easy to Use,  
- Strong Community,  
- Modularity,  
- Compatible with Z-Wave ZigBee and Wi-Fi devices,  
- Arduino Compatible  | - Compatible with few smart devices |

Table 2.3: List of competitors in the world
The Table 2.3 was made collecting all the information regarding one company, then analyse them and comparing with precise parameters. It was decided to divide all the characteristics founded into two main categories (Strengths, Weaknesses). To list the weaknesses and the Strengths the following parameters were chosen:

- Cost (Is it expensive?)
- Invasive (Does it require the modification of the house’s electrical system?)
- Compatibility (Can it work with other product?)
- User-friendly (Does it provides an intuitive user interface?)
- Easy-to-use (Is it possible to install it by yourself?)

We used these parameters according to the characteristic of our product, in that way it is possible to have a clear vision of what can do kaalisy Domotics.

2.3 The product, process or invention: the value proposition

2.3.1 How has it started

It all started from our personal desire: to control the lights using a smartphone in the house. Unfortunately, there was no possibility to change and modify the structure of the electrical system. As we did not find any easy and accessible way in the market, we decided to solve the problem by creating our own home automation system that uses open-hardware platforms. Taking note of the satisfactory results obtained, we decided not to stop there, but we continued to add new components in our system to increase the control on the house. Also, we decided to work from the software side, and have an overall improvement in terms of "Human-Computer-Interaction". We have made the system customizable, adaptable to every need of the user. Then, gathering feedback from friends, relatives, colleagues and academics, we found that our needs matched with need of many others so the desire to transform our system into a business idea was born.

We have already had the opportunity to concretely demonstrate our technical skills in a previous project, developed as part of our studies at the University of Camerino. "Unicam Solar" Figure2.7 is a hardware/software system for monitoring power control of photovoltaic panels on web and on mobile devices.
2.3.2 The product

Our system, "Kaalisy Domotics", offers several packages that are easy to install and at an affordable price. This will allow users to create a modular system that fully adapts to their needs and grows with their requirements. There will even be the possibility to integrate the packages of other companies into our system, thanks to the use of the Z-Wave protocol. The initial basic product includes a small number of packages, enough to cover the main control requirements of the housing unit. Later the offering will be expanded and diversified, always keeping an eye on the development of the market and technology to avoid ending up with the product becoming obsolete.

The system (Figure 2.8) consists in a central unit connected to the internet, which allows using and programming all packages inside the house through a user-friendly interface on smartphones (app) or web browser. The packages (listed below) are plug & play, easy to install and it does not require any intervention on the electrical system. Once installed in the house, the packages are automatically detected by the system. Then, by accessing to
the user interface configuration, the user will be able to watch a quick tutorial that will explain how to set-up and use the features of the packages.

<table>
<thead>
<tr>
<th>Installation</th>
<th>Communication</th>
<th>Function</th>
<th>Dimension</th>
<th>Alimentation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Central Unit</td>
<td>-Wireless via proprietary protocol (used by our packages), -Z-Wave</td>
<td>-Server -Web to App and configuration page through browser, -Database, -Management And Control Software, -Allows to control</td>
<td>60x10x20 mm</td>
<td>Wall plug</td>
</tr>
<tr>
<td>Bulb adapter</td>
<td>-Wireless via proprietary protocol (used by our packages)</td>
<td>-Remote switch</td>
<td>30x30x50 mm</td>
<td>E27 plug</td>
</tr>
<tr>
<td>Switch</td>
<td>-Wireless via proprietary protocol (used by our packages)</td>
<td>-Switch</td>
<td>110x70x20 mm</td>
<td>Battery</td>
</tr>
<tr>
<td>Wall Plug Adapter</td>
<td>-Wireless via proprietary protocol (used by our packages)</td>
<td>-Monitor appliance consumption, -Remote switch to appliance</td>
<td>40x40x50 mm</td>
<td>Wall plug</td>
</tr>
<tr>
<td>Thermostat</td>
<td>-Adjustment manual / remote / programmed of the temperature</td>
<td></td>
<td>120x60x40 mm</td>
<td>Battery</td>
</tr>
<tr>
<td>Door Opening</td>
<td>-Remote door opening</td>
<td></td>
<td>70x50x20 mm</td>
<td>Battery / Wall plug</td>
</tr>
<tr>
<td>Sensor</td>
<td>-Remote Control of the temperature and humidity, -Detects Gas spill, flood, fire principle</td>
<td></td>
<td>140x40x30 mm</td>
<td>Battery / Wall plug</td>
</tr>
<tr>
<td>Surveillance Camera</td>
<td>-Remote video monitoring, -Motion detection</td>
<td></td>
<td>80x80x80 mm</td>
<td>Wall plug</td>
</tr>
</tbody>
</table>

Table 2.4: Specification of the packages
The packages can be controlled ("Switch", "Shut Down", "Open", "Increase", etc...) Smartphone App (downloadable from the Play Store or the App Store), that also allows to control the system by voice. The scenarios (i.e. "If the camera detects motion then turn on the lights and raise the temperature to 20 °C inside the room") are programmable on the simple web interface through the browser. The interface design is very nice, aimed to be easy-to-use.

2.3.3 Placing on the market

Competitors and our solution have been mapped in the differentiation diagram of Figure 2.10 in which the dimensions considered are the method of communication (ranging from wired solutions into completely wireless solution) and the completeness of the product (offer complete - control + components - or only controller).

Wireless solutions that currently exist are not complete as wired systems because not all switches, light bulbs, and appliances can be operated wirelessly. The wireless solutions available on the market require the purchase of a Central Unit compatible with the most
frequently used wireless communication protocols (Zigbee, Z-Wave, etc...). Therefore the research, from different companies, of the components (switches, bulbs locks, appliances, etc...) able to communicate with the central unit purchased, discourages many buyers because it requires technical competence and a great deal of time to use the "do it yourself" home automation system. Kaalisy Domotics is placed in a segment of the market of home automation still empty, offering a complete solution easy to install and low cost thanks to wireless technology.

2.4 The marketing plan

2.4.1 Product

The product of Kaalisy Domotics is aimed at users that are interested to make their own home "smart" in a simple and economical way. The solution may be purchase completely or partially (one package at a time).
<table>
<thead>
<tr>
<th>Package</th>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Central Unit</td>
<td>Kaalisy</td>
<td>The brain of the whole home automation system, manages all the information from different installed packages and is responsible for the actions taken by the packages.</td>
</tr>
<tr>
<td>Bulb Adapter</td>
<td>Lumus</td>
<td>A device of small dimensions that is connected between the bulb and the lamp holder, allowing to make smart every single light.</td>
</tr>
<tr>
<td>Switch</td>
<td>Lumus Switch Wall</td>
<td>An intelligent switch that, allows to make smart every switch points. It may be inserted in the place of the switch or if you prefer above the breakers themselves.</td>
</tr>
<tr>
<td>Wall Plug Adapter</td>
<td>Wally</td>
<td>It allows you to: - Controlling consumption of each device connected to it - Turn on and off connected devices, Receive notifications when the consumption exceeds a certain threshold</td>
</tr>
<tr>
<td>Thermostat</td>
<td>Ocio</td>
<td>A compact device that in addition to provide all the function of a thermostat is able to interact with the central unit allowing the user to create scenarios increasingly dynamically.</td>
</tr>
<tr>
<td>Door Opening</td>
<td>Locker</td>
<td>Allows the user to make smart key locks in the home (door entrance, gate of the house).</td>
</tr>
<tr>
<td></td>
<td>Sensy</td>
<td>Allows the user to make smart key locks in the home (door entrance, gate of the house).</td>
</tr>
<tr>
<td>Surveillance Camera</td>
<td>Intrusor</td>
<td>It offers the possibility of introducing a Web Cam, allowing the user to monitor in real time what happens in their own home.</td>
</tr>
</tbody>
</table>

Table 2.5: Functions of the packages
Kaalisy is also compatible with all Z-Wave devices, which allow the customer to use in addition to our packages, which use an owner communication protocol, also any other devices already in its possession and based on Z-Wave. When a package fails, the system will note the absence of such package and will inform the user, who may replace it, free of charge if it happens during the warranty period provided by law. In case of failure on the central unit, every package will go in "Single mode" and will work independently from the others. This will cause the loss of management scenarios and remote management; the rest will be like in a not smart house.

2.4.2 Price

The Low Cost strategy chosen by Kaalisy Domotics affects the hardware and plastic components used for assemble the packages. The selected components are not the one with highest quality available, but this decision does not implies the malfunction of the system. Indeed, the system does not need to guarantee a precision of 99.9% during the communication between packages and central unit, even a precision of 90% (which could then lose 1 package communication sent every 10) is reasonable choice because it will be sufficient to resend the information, with an acceptable delay of 0.2 ms.

The Figure 2.11 summarizes the costs in the retail market of electronic components needed to assemble the packages provided in Kaalisy Domotics. The Figure 2.12 summarizes the final price of the packages, based on the production cost and on the fixed costs of the company.
The Figure 2.13 compares the competitive prices of some packages present in the offer of Kaalisy Domotics against the equivalent best solution (based on sales and reviews) on this site www.smarthome.com.

2.4.3 Sales channels (Placement)

The sales channel chosen is the e-commerce. A web site will provide to the customers all the features and the informations about our company and our products. Moreover the web will be used as point of sale and point of care. This choice allows to reduce the final cost of the product to the buyers by eliminating the increases of price which would be caused by distributors and retailers and reducing the costs of management sales and service. It is a strategic choice made by considering the target market, or people, usually in possession of smartphone and/or tablet and with a certain confidence with computers and electronics, used to seek and buy on the Internet. In addition, this eliminates the territorial barriers and makes possible future expansion on the international market. Products purchased on-line will be sent to the buyer by delivery service carried out by couriers.

2.4.4 Promotion

An aggressive advertising campaign is planned starting on internet channels (AdWords and social networks) to attract potential buyers on our website. Around the website, using
the social media, we intend to create a community of customers and fans of Kaalisy Domotics so that they can communicate and exchange information and suggestions as well as provide new ideas, at the same time helping us to understand the real customer needs. As soon as possible we intend to launch advertising campaigns also on the more traditional channels, to reach those who are less informed in technology development and therefore cannot imagine which are the offer became possible thanks to low cost smart solution. We will use radio campaigns, at least on the local radio stations, press campaigns on free press and after local press, in order to increase the visibility of our product. During further growth we would even get to the national press and maybe even to reach the TV channel, initially local and then national. We will not neglect the traditional channels; we intend to participate at the italian fairs about home and home furnishings that are open not only to the industry but especially to the final customers. These occasions can also be used for promotion. We expect partnerships with local companies that are operating in the field of plant and electrical installers/designers who could then offer to its customers a complete solutions very interesting.

2.5 Operational Plan

2.5.1 Roadmap

What has been developed so far is still at the prototype stage. A standardization and industrialization phase of the production of each component is required. Before to insert the packages in the market it will be also compulsory to obtain the CE certification. The main steps expected, with their timing, are illustrated in Figure 2.14 Gantt Overall. The phase of product development is estimated at 6 months. After that the operation phase will begin.

![Figure 2.14: Roadmap of the product’s development](image)

Throughout the start-up phase (first 3 years), we identified the following milestones:

**First 6 months:**
- Product development and CE certification
End of second year:
- Extension the compatibility to other communication standards
- Development of new packages

End of the third year:
- Development of new packages
- Ready to start marketing in Europe . . .

2.5.2 Compliance of the system

The buyer should have the security of buying a product which conforms to the current regulations in the field of electronics. In this regard, it will be necessary to comply with Directive 2006/95/EC on Low-voltage equipment, and then get a CE sign. At this stage, we consider to consult a Notified Body, which will deal with the preparation of the EC Declaration of Conformity, and will assist us in filling the Technical Documentation. The contribution of this organization will allow us to speed up this phase and in about two months we will be able to print the CE mark on our products. The costs are around 1,500 to 2,500€ for the consulting and the certification.

2.5.3 Make or buy?

When the design of our products will be ready we intend to rely on an experienced company, which uses automated systems and is able to assemble at cost and time absolutely unreachable for us. To simplify the simulations, we assumed economic and financial cost of the assembly as an overhead of 10% compared to the cost of materials.

2.5.4 Operation characteristics

Once the production of packages will be standardized, the operations will take place as represented in Figure2.15

Purchase Components
- The electronic components will be purchased from Supplier1 and will be sent directly to the Assembly Company. The cover of each individual packages will be purchased from the Supplier2 and directly shipped to our company.

Components Assembly
- The components are assembled by the Assembly Company and sent to our Company.
Figure 2.15: *Typical operations of Kaalisy Domotics*
Final product

Require the software installation and the application of the cover for every single package assembled.

Storage

The final products are stored in a warehouse and ready to be sold. Then it will be important to take care of the management of the inventory, orders and stocks.

Customer Orders

The orders will be reported by the website to the shipping manager, who picks up the products from the store, prepare and carry out the shipment.

Shipping

It will be provided through couriers to ensure a safe and prompt delivery.

2.5.5 Technical Assistance

We are in a start-up phase and the opinion of buyers is essential for the promotion and development of our product. Beyond the possible interactions via social media, we will offer four dedicated instruments to the customer: three acts to assist him during the pre and post sales phases, and one specific for technical assistance after-sales.

<table>
<thead>
<tr>
<th>Commercial Telephone Assistance</th>
<th>Technical Telephone Assistance</th>
<th>Assistance through E-mail</th>
<th>Forum</th>
</tr>
</thead>
<tbody>
<tr>
<td>8h/5d</td>
<td>24h/7d</td>
<td>24h/7d</td>
<td>24h/7d</td>
</tr>
<tr>
<td>Inform the customer or the possible buyer about the product.</td>
<td>Provide immediate technical assistance to the customer.</td>
<td>Inform the customer or the possible buyer about the product. Provide technical assistance.</td>
<td>Inform the customer or the possible buyer about the product. Provide technical assistance. Complete transparency of strengths and weaknesses of the product.</td>
</tr>
</tbody>
</table>

Figure 2.16: Types of assistance

Interruption on the manufacture of the components

We need to purchase different components with very specific properties, so it is reasonable to take into account a possible interruption in the production line of such components by the producer. This will interfere with our production line since a necessary component to our product is no longer available. Overpass this problem is not always easy and for this reason we will first take it into account in the negotiations phase with
the supplier/manufacturer. If this should be not enough, we will be forced to redesign
the Hardware and Software part involved by that component. In the projecting phase we
will try to mitigate this risk by trying to develop each part quite independently from the
components, especially for the Software part. This will allow us to replace more easily
the involved component, even if it was a voluntary choice, derived from the arrival of
components considered better of that in the market.

Computer security

Security is a delicate aspect especially in the home automation field. With the purpose
of offer to the customers a safe product, Kaalisy Domotic opted for a local solution,
providing at the buyer the full management system in a single device, connected only to
the home router. Such solution allows to avoid the use of an external server (where to
install the entire management system), which are more susceptible to attacks by hackers,
thereby reducing the risk of intrusion. The proprietary communication protocol as well
as permit the different devices to communicate each other adds even an additional layer
of security by encrypting communications in order to prevent any intrusions during the
communication between the devices and the central system.

Intellectual property

Like most of our competitors, we intend to protect the rights of our intellectual property
through patents where possible. Not all packets will be patented, for example in the case
of the central unit that uses an open-hardware platform will be patented only the software
part. The initial cost of patents is around 10,000€, in later years the maintenance cost
will be increased by approximately 20% for annuity starting from 600€for the first year
of maintenance.

2.6 Organizational Structure

2.6.1 Value chain

The value chain of Kaalisy Domotics implements all the primary activities identified by
Porter Figure2.17 logistics inputs, operations, logistics outputs, sales, marketing and ser-
vices. The activities of (support for Porter) R&D and Procurement are also essential for
our company. In the organization chart of the company (Figure2.18) are identified the
functions responsible for each activity.
2.6.2 Organization chart of the company

CDA
Board of Directors. Formed by the 5 founders, who will play the roles of Executive, will be the place where strategic decisions are taken.

CEO
Chief Executive Officer. Responsible for the implementation of strategic decisions within the company and the administrative / legal, personnel management.

CFO
Chief Financial Officer. Head of financial assets.

CTO
Chief Technical Officer. Responsible for the activities of product development and
technology (R&D). It also coordinates all activities and personnel related to hardware and software development.

CMO
Chief Marketing Officer. Responsible for the activities of sales, marketing and communications and customer services. It also coordinates all activities and personnel related to design, including the one of the website.

COO
Chief Operating Officer. Responsible for procurement, logistics and input and output operations. It also coordinates all activities related to the management and staff orders.

2.7 The economic and financial plan

To estimate the amount of sales of the devices we started with the data provided by Assodomotica and we have estimated the number of new plants planned in the next 3 years, assuming a reasonable penetration of the market (Figure 2.19) and taking into account that in the first year sales will begin only in the second half of the year.

![Figure 2.19: Hypothesis of market penetration](image)

The economic and financial simulations were made based on the configuration type envisaged in Figure 2.1.

![Figure 2.20: Type of configuration expected](image)
All the other financial analysis are showed on the Appendix 1.

Figure 2.21: *Plan of sales by product*
Chapter 3

Software Requirements Specification

3.1 Introduction

Developing a domotic system is a sort of challenge, a lot of companies tried to do it and most of them failed in this attempt. The reason why they did so are not so obvious, the largest part failed not because the system does not work properly but the reason is that the system does not comply with the needs of the users. Due to this assumption we can deduce that the analysis of the requirements of the system is very important, we need to find all the requirements that Kaalisy should have, not only with the goal of build a Smart Home System that works fine, but also with the goal of fitting all the necessities of the user, especially the one that usually are considered boundary.

3.1.1 Purpose

The purpose of this Software Requirements Specifications (SRS) document is to explain clearly which are the requirements needed for the development of the home automation system named Kaalisy. At the end, the reader is able to understand which are the functionalities that the system must respect, allowing to achieve good result during the development and implementation phase. This SRS will be used as a starting point for the entire system, because it is used during the design, implementation and test phase.

3.1.2 Scope

Currently in the area of Home Automation System there is a need for a home automation system that does not force the user to modify the home’s electrical system and that can be purchased at an affordable price. Kaalisy Domotics is able to achieve these two aspects
and offers to the end user the possibility to install the same home automation system on a different house.

### 3.1.3 Definitions, Acronyms, and Abbreviations

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arduino</td>
<td>An open-source electronics platform based on easy-to-use hardware and software.</td>
</tr>
<tr>
<td>Browser</td>
<td>A program that allows you to use the connectivity services in the Internet or a computer network, and surf the World Wide Web.</td>
</tr>
<tr>
<td>CE mark</td>
<td>Indicates the conformity to all the obligations incumbent on manufacturers about their products, allowing the free marketing of branded products within the European market.</td>
</tr>
<tr>
<td>Database (DB)</td>
<td>Indicates a data store, or a set of well-structured archives, in which the information contained in it are structured and connected to each other according to a particular logical model.</td>
</tr>
<tr>
<td>Domotics</td>
<td>The science that deals with the study of technologies to improve the quality of life in the house.</td>
</tr>
<tr>
<td>HTML5</td>
<td>A markup language for structuring the web pages</td>
</tr>
<tr>
<td>LAN</td>
<td>A computer network connection between multiple computers, covering a limited area, such as a home, a school or a complex of buildings adjacent.</td>
</tr>
<tr>
<td>Marketplace</td>
<td>Indicates the websites of brokerage for the sale of a good or service.</td>
</tr>
<tr>
<td>Open-Hardware</td>
<td>Refers to electronic and computer hardware that have been designed with the same policy of free software and open source.</td>
</tr>
<tr>
<td>Operating System (OS)</td>
<td>A set of software components, which allows the use of various computer equipment by a user.</td>
</tr>
<tr>
<td>PCB</td>
<td>A type of electrical component used for the construction of modern electronic circuits such as electronic cards.</td>
</tr>
<tr>
<td>Router</td>
<td>An electronic device that, in a packet switched computer network, is responsible for route data, subdivided into packets between different networks.</td>
</tr>
<tr>
<td>Widget</td>
<td>A component of a graphic user interface of a program, which has the purpose to facilitate user interaction with the program itself.</td>
</tr>
<tr>
<td>Z-wave</td>
<td>A wireless communication protocol, used especially in home automation systems.</td>
</tr>
</tbody>
</table>
3.1.4 Overview

This chapter is organized in three main sections, the first one "General Description" will describe the requirements of Kaalisy home automation system in a general way, the second one "Specific Requirements" will explain in detail the requirements of the system and the last one "Analysis Model" will list the specific schemas, according to the specific requirements, needed for the development phase.

3.2 General Description

This section provides an overall description of the entire project created by Kaalisy Domotics. The main functionalities of the system will be explained and none of the specific requirements are specified, instead, the system will be presented in an understandable way for the user.

3.2.1 Product Perspective

The goal of Kaalisy Domotics is to launch a new concept of smart home, based on four main factors:

- Simplicity
- Not Invasive
- Low Cost
- Re-usability

To understand better how the system works and why it can be seen as a new concept of smart home it is better to divide it into two main categories, Packages and Management.

Packages

There are seven packages offered by Kaalisy Domotics and they are able to provide a full smart home environment. The key factor that distinguishes the packages of Kaalisy Domotics from all the others present on the market is the simplicity to install them at your home. They do not require any electrician, everything works over Wi-Fi, moreover they can be uninstalled and reused at another place. All the packages are already preconfigured, and all of them are driven by a central unit, called Kaalisy. Another important aspect about this system is that it does not force the user to buy all the packages at the first time, but they can be purchased step by step.
Management

Once the user has bought and installed the system, he has the possibility, through a web page and an App (Android and iOS) to interact with the house. He is able to create scenario according to his daily routine, to control the house when he is not at home, and so on. The web page is loaded into Kaalisy (central unit, which is connected to the router) and it can be accessible from all PC thanks to a login and a password, while the App is available on the Play Store and the App Store.

![Kaalisy infrastructure](image)

**Figure 3.1: Kaalisy infrastructure**

Inside the packages

Inside each packages will reside a microcontroller (Arduino nano or ATtiny 85) plus a transceiver and other electrical components. The transceiver will allow the communication between Kaalisy (central unit) and the packages through wireless, while the microcontroller will perform the actions made by the user. All the microcontroller are programmed in C language and are Arduino compatible.

Inside the central unit

Kaalisy, the central unit, as described above is the brain of the entire system, it is consisted of a very little computer (Raspberry Pi) which can interact, thanks to the transceiver, to all the Kaalisy components installed at home. Moreover it has an additional Z-Wave module, which allow the central unit to interact with Z-Wave smart devices. On the Raspberry, a dedicated Web page is loaded which allows the user to configure and interact with all the packages.
3.2.2 Product Functions

The functions provided by the whole system can be divided into three main categories:

<table>
<thead>
<tr>
<th>Function</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lighting management</td>
<td>Interaction with the lighting system of the house</td>
</tr>
<tr>
<td>Doors control</td>
<td>Ability to open and close the main door of the house</td>
</tr>
<tr>
<td>Temperature management</td>
<td>The User is able to adjust and check the temperature of the house through a special thermostat</td>
</tr>
<tr>
<td>Sensor monitoringDatabase (DB)</td>
<td>Check the humidity, temperature, light and prevent gas leaks, flooding and fire in the apartment</td>
</tr>
<tr>
<td>Surveillance management</td>
<td>Ability to video surveillance and detect possible intrusion by thieves</td>
</tr>
<tr>
<td>House’s appliance energy consumption management</td>
<td>Ability to control the consumption of group of house’s appliances</td>
</tr>
<tr>
<td>House’s appliance control</td>
<td>Interaction with groups of house’s appliances</td>
</tr>
<tr>
<td>Remote Access</td>
<td>The User can interact with the system through a dedicated browser installed in Kaalisy (central unit)</td>
</tr>
<tr>
<td>Scenario management</td>
<td>The Admin can program the actions of the packages to fit his needs</td>
</tr>
<tr>
<td>Mobile app</td>
<td>The user can interact with the system through a dedicated mobile application</td>
</tr>
</tbody>
</table>

3.2.3 User Characteristics

- Internet Experience: little (referring to customers that use Internet for search informations and social media, and not customers that use Internet for job purpose)
- Knowledge of Kaalisy Domotic system: none (referring to customers that do not have any knowledge about the internal architecture of the Kaalisy System)
- Electrical skill: low

3.2.4 General Constraints

Some packages of Kaalisy Domotics may not be easily installed, due to a particular home electrical system, and it requires some electrical skills or a technician to install it; on the web site all the necessary specifications regarding the installation requirement of each package are reported. If Internet is shut down, the entire system is not anymore connected to central unit. In response to this particular situation, all the devices will work in "prevention mode" which allows the user to have only manual access to the packages.
3.2.5 Assumptions and Dependencies

An internet connection must be present and work properly, the entire system is accessible through PC and smartphones only via Internet. To have full access to the system the user must own at least a PC to be able to configure and interact with the packages installed, the smartphone is not required for the system’s operation, but it can allow you to have a better interaction with your house.

3.3 Specific Requirements

3.3.1 External Interface Requirements

User Interfaces

Kaalisy claims an interface easy-to-use, this means that in the Web pages everything should be clear, reachable in a few clicks, intuitive and easy to learn. There are two main interfaces that we need to develop and their purposes are different, one is Kaalisy Website (sort of MarketPlace) accessible by everyone on Internet and the other is Kaalisy Management (used to set and control the system) accessible just by the owners of the system.

Interfaces accessible by everyone

**Kaalisy WebSite MarketPlace** This interface will be used to show and sell the products to the potential buyers and it is important to catch their attention and to do not confuse them. Due to this, we will pay a lot of attentions in how to show the information and how to categorize the pages in an easy and functional way.

- Homepage
- Purchasing page
- Documentation page
- Forum

Interfaces accessible by the owners

**Kaalisy Management Control Panel (Browser)** Once the Kaalisy central unit is properly installed, the end user can manage all the packages (previously installed) through a browser directly from his computer. At the first use there will be a walkthrough tutorial aimed to explain how to use the interface.
• Control
• Setting
• Scenario
• Status

**Kaalisy Management (Mobile Application)** An application is available on the market and it can give to the user a direct access to the entire system.

**Color and Style**

Every interfaces signed Kaalisy Domotics use the same colors and style, it is useful to recognize the product just by looking a web page and it does not disorient the user.

**Hardware Interfaces**

Each package has its own requirements to be installed in the house, in most of the case it fits perfectly with the common electrical systems and the installation can be done by yourself, even because it is one of our principal goals. In other case, the intervention of a technician can be required. When the home requirements are established, each package can be installed, but to set it properly, a PC with a browser is needed. The Operating System used is not relevant because all the procedures and functions are made on the browser. As said in **Assumption and Dependencies** Smartphone is needed, but not required.

**Software Interfaces**

No matter what OS will be used, actually even a browser on a Smartphone allows the user to set the system. The Mobile Application does not require huge performance.

**Communication Interfaces**

The Central Unit must be connected to the router through an Ethernet cable to let it connect on Internet and enable the remote management. The other packages communicate with Kaalisy using a wireless standard (different from Wi-Fi) or if they are bought from another company they can communicate through Z-wave.

### 3.3.2 Functional Requirements

In this section different cases of interaction between user and Kaalisy system are explained. It is important to remind that, first of all the Kaalisy central unit must be connected to a working router. Secondly an internet connection must be present, no matter
which devices it will be used (smartphone, tablet, PC). Finally, due to the possibility to interact with the system outside of the house, it does not matter specify where the user is located (outside or inside the apartment) the system will behave at the same way.

**Lighting Management**

<table>
<thead>
<tr>
<th><strong>Initial assumption</strong></th>
<th>The user has a Smartphone with the Mobile Application installed and the login data saved or a Computer with a browser.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Normal flow</strong></td>
<td>The User opens the App, he selects the room in which he wants to turn on/off the light and afterwards selects the light.</td>
</tr>
<tr>
<td><strong>Alternative flow</strong></td>
<td>The User selects the widget Kaalisy present in his Smartphone and say: “Turn on/off light n”.</td>
</tr>
<tr>
<td><strong>Alternative flow</strong></td>
<td>The User switches on/off the light using the wall switch.</td>
</tr>
<tr>
<td><strong>Alternative flow</strong></td>
<td>The User access through the browser at the Kaalisy Management Interface, makes the login and selects the light he wants to turn on/off.</td>
</tr>
<tr>
<td><strong>What can go wrong</strong></td>
<td>The signal does not reach the bulb adapter and the light will not turn on/off.</td>
</tr>
<tr>
<td><strong>Other activities</strong></td>
<td>It can happen that many Users turn on/off the light in the same time, in this case the light will be off/on depending on the number of Users</td>
</tr>
<tr>
<td><strong>System state or completion</strong></td>
<td>The light is turned on/off, this state is saved on the system and shown in the interfaces.</td>
</tr>
</tbody>
</table>

**Temperature Management**
<table>
<thead>
<tr>
<th><strong>Initial assumption</strong></th>
<th>The user has a Smartphone with the Mobile Application installed and the login data saved or a Computer with a browser.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Normal flow</strong></td>
<td>The User opens the App, he selects the room in which is present the Thermostat and afterwards inserts the temperature.</td>
</tr>
<tr>
<td><strong>Alternative flow</strong></td>
<td>The User selects the widget Kaalisy present in his Smartphone and says: &quot;Temperature n&quot;.</td>
</tr>
<tr>
<td><strong>Alternative flow</strong></td>
<td>The User access through the browser at the Kaalisy Management Interface, makes the log in and inserts the temperature.</td>
</tr>
<tr>
<td><strong>What can go wrong</strong></td>
<td>The signal does not reach the Thermostat and the temperature will not change.</td>
</tr>
<tr>
<td><strong>Other activities</strong></td>
<td>It can happen that many Users change the temperature in the same time, in this case the signals will be elaborated atomically and in different time, the last one takes effect.</td>
</tr>
<tr>
<td><strong>System state or completion</strong></td>
<td>The temperature on the Thermostat is setted, this state is saved on the system and shown in the interfaces.</td>
</tr>
</tbody>
</table>
## Doors control

<table>
<thead>
<tr>
<th><strong>Initial assumption</strong></th>
<th>The user has a Smartphone with the Mobile Application installed and the login data saved or a Computer with a browser.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Normal flow</strong></td>
<td>The User opens the App, he selects the room in which he wants to open the door and afterwards selects the door.</td>
</tr>
<tr>
<td><strong>Alternative flow</strong></td>
<td>The User selects the widget Kaalisy present in his Smartphone and says: &quot;Open door n&quot;.</td>
</tr>
<tr>
<td><strong>Alternative flow</strong></td>
<td>The User access through the browser at the Kaalisy Management Interface, makes the login and selects the door he wants to open.</td>
</tr>
<tr>
<td><strong>What can go wrong</strong></td>
<td>The signal does not reach the locker package and the door will not open.</td>
</tr>
<tr>
<td><strong>Other activities</strong></td>
<td>It can happen that many Users open the door in the same time, in this case the door will be opened anyway.</td>
</tr>
<tr>
<td><strong>System state or completion</strong></td>
<td>The door is open but this does not change the state of the system.</td>
</tr>
</tbody>
</table>

## Sensor monitoring

<table>
<thead>
<tr>
<th><strong>Initial assumption</strong></th>
<th>The user has a Smartphone with the Mobile Application installed and the login data saved or a Computer with a browser.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Normal flow</strong></td>
<td>The User open the App, he selects the room in which he wants to control the sensor and afterwards selects the sensor.</td>
</tr>
<tr>
<td><strong>Alternative flow</strong></td>
<td>The User selects the widget Kaalisy present in his Smartphone and says: &quot;Read sensor n&quot;.</td>
</tr>
<tr>
<td><strong>Alternative flow</strong></td>
<td>The User access through the browser at the Kaalisy Management Interface and selects the sensor he wants to control.</td>
</tr>
<tr>
<td><strong>What can go wrong</strong></td>
<td>The sensor does not write any data because the signal does not reach Kaalisy.</td>
</tr>
<tr>
<td><strong>Other activities</strong></td>
<td>It can happen that many Users read the same sensor in the same time but obviously nothing will happen.</td>
</tr>
<tr>
<td><strong>System state or completion</strong></td>
<td>This function does not change the state of the system.</td>
</tr>
</tbody>
</table>
## Surveillance Management

<table>
<thead>
<tr>
<th>Initial assumption</th>
<th>The user has a Smartphone with the Mobile Application installed and the login data saved or a Computer with a browser.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal flow</td>
<td>The User opens the App, he selects the room in which he wants to see through the camera and afterwards selects the camera.</td>
</tr>
<tr>
<td>Alternative flow</td>
<td>The User selects the widget Kaalisy present in his Smartphone and says: &quot;Anyone in room n?&quot;.</td>
</tr>
<tr>
<td>Alternative flow</td>
<td>The User access through the browser at the Kaalisy Management Interface, makes the log in and selects the camera he wants to look.</td>
</tr>
<tr>
<td>What can go wrong</td>
<td>The signal does not reach Kaalisy and the video is not available.</td>
</tr>
<tr>
<td>Other activities</td>
<td>It is possible that many Users look the camera in the same time, this does not create any inconvenient.</td>
</tr>
<tr>
<td>System state or completion</td>
<td>This function does not change the state of the system.</td>
</tr>
</tbody>
</table>

## House’s appliance energy consumption management
<table>
<thead>
<tr>
<th><strong>Initial assumption</strong></th>
<th>The user has a Smartphone with the Mobile Application installed and the login data saved or a Computer with a browser.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Normal flow</strong></td>
<td>The User opens the App, selects the energy record and reads the consumption of an appliance or a group of appliances (if previously setted). To check the graphic that shows the history of the consumption, he has to select the appliance or the group.</td>
</tr>
<tr>
<td><strong>Alternative flow</strong></td>
<td>The User selects the widget Kaalisy present in his Smartphone and says: &quot;Read appliance n&quot;.</td>
</tr>
<tr>
<td><strong>Alternative flow</strong></td>
<td>The User access through the browser at the Kaalisy Management Interface, makes the log in and reads the consumption of an appliance or a group of appliances (if previously setted). To check the graphic showing the history of the consumption he has to select the appliance or the group.</td>
</tr>
<tr>
<td><strong>What can go wrong</strong></td>
<td>The wall plug adapter does not write any data because the signal does not reach Kaalisy.</td>
</tr>
<tr>
<td><strong>Other activities</strong></td>
<td>It can happen that many Users check the energy consumption in the same time but obviously nothing will happen.</td>
</tr>
<tr>
<td><strong>System state or completion</strong></td>
<td>This function does not change the state of the system.</td>
</tr>
</tbody>
</table>
**House’s appliance control**

<table>
<thead>
<tr>
<th>Initial assumption</th>
<th>The user has a Smartphone with the Mobile Application installed and the login data saved or a Computer with a browser.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal flow</td>
<td>The User opens the App, he selects the room in which he wants to turn on/off the appliance or group of appliances (if previously setted) and afterwards selects the appliance or the group.</td>
</tr>
<tr>
<td>Alternative flow</td>
<td>The User selects the widget Kaalisy present in his Smartphone and says: &quot;Turn on/off appliance n&quot;.</td>
</tr>
<tr>
<td>Alternative flow</td>
<td>The User access through the browser at the Kaalisy Management Interface, makes the log in and selects the appliance/group of appliances he wants to turn on/off.</td>
</tr>
<tr>
<td>What can go wrong</td>
<td>The signal does not reach the wall plug adapter and the appliance will not turn on/off.</td>
</tr>
<tr>
<td>Other activities</td>
<td>It can happen that many Users turn on/off the appliance in the same time, in this case the appliance will be off/on depending on the number of the Users.</td>
</tr>
<tr>
<td>System state or completion</td>
<td>The appliance is turned on/off, this state is saved on the system and shown in the interfaces.</td>
</tr>
</tbody>
</table>

**Scenario management**

<table>
<thead>
<tr>
<th>Initial assumption</th>
<th>The Admin has a Computer with a browser.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal flow</td>
<td>The Admin access through the browser at the Kaalisy Management Interface and he can set for any action (trigger) a reaction that will success that action. When he has finished to set the rules he has to click on Save and Exit.</td>
</tr>
<tr>
<td>What can go wrong</td>
<td>The chain of action and reaction form a loop.</td>
</tr>
<tr>
<td>Other activities</td>
<td>The simultaneous access is forbidden for the Admins.</td>
</tr>
<tr>
<td>System state or completion</td>
<td>The scenario is saved on the system and any time that a trigger will be pulled an action will take effect.</td>
</tr>
</tbody>
</table>
### 3.3.3 Use Cases

**Actors**

The actors that will use the system are divided into two main categories: the admin and the normal user.

As we can see from the previous figure the admin user has more privilege than the normal user, because we wanted to give access to some feature of the system not to everyone.

**Lighting Management**

It consists in the step that leads the user to change the status of a specific light.
The user has four different choices to perform the same action, the fastest one is through the widget and using the voice command. But it is also quick and fast using the other two options.

**Temperature Management**

Path that the user has to follow to increase, decreases or turn off the thermostat of the apartment

![Temperature Management Use Case](image)

Figure 3.4: Temperature Management Use Case

Even in this case the widget and the vocal command are the fastest one, giving to the user an immediate control of the thermostat selected.

**Scenario management**

The scenario management is completely different from the above use case illustrated.

![Scenario Use Case](image)

Figure 3.5: Scenario Use Case

As the above picture shows, there is only one way to create the scenario and it can be done only by the admin and only using the web browser.
3.3.4 Non-Functional Requirements

A non-functional requirement is a requirement that specifies criteria that can be used to judge the operation of a system, rather than specific behaviours.

Performance

The system is able to process simultaneously actions performed by two or more users, and ensure the correct working flow. The 80\% of its execution, the system is in sleeping mode, which reduce the energy consumption and hardware damage, the remaining 20\% the system is in standard workload (less than 50\%). For example the system will take almost one second to execute an action (turn on the light, set the temperature to 27°C, etc...)

Reliability

The system is able to execute the action made by the user with a tolerance of 90\%, which means that each ten transmission, one might fail which is absolutely reasonable because it will be sufficient to resend the action, with an acceptable delay of 0.2 Ms.

Availability

The system shall not be unavailable for more than 1 hour per year of operation, if any failure happens, it is able to restart in less than 5 minutes.

Security

The system is accessible only through a browser or mobile application, which requires authentication from the user. Moreover the whole system is working inside the LAN network, which ensure an extra level of security (router firewall and WPA-PSK password)

Usability

The user interface used for the browser and the mobile application should be understandable by the user in less than 2 minutes. The user should be able to reach all the "sections" in an easy and rapid way, no more than two clicks are necessary to reach the desirable section. Moreover, the user interface must be enjoyable by the user, he should not feel bored during its usage; to achieve this result, an accurate decision of colors, fonts and animations are taken.
Maintainability

The upgrade of the system is available on the web site, the user can download and install it easily. All the packages and the central unit are purchased with a warranty of two years, in case of hardware failures within the two years, he can send it to the company and get a new one, without expense and in two working days.

Reusability

The system can be reused in different contests, in case of moving into another apartment, the whole system can be easily adapted to it. The user can decide to erase or keep the changes made on the previous configuration.

3.3.5 Design Constraints

It exists different standards in the Domotics field and each one has its own constraints, for this reason we decided to embrace only the Z-wave, that forces us to adapt the system to fit its constraints during the design phase. One constraint that must be taken in consideration is the power consumption, the system shall permit at the user to save energy, to reach this goal each component inside the package and the design of the PCB has to be done with the maximum attention.

3.3.6 Logical Database Requirements

The integrity of database is very important given that every state of the system and every rule is saved there. It is important to update the DB immediately after that the state of a package is changed, almost as atomic action, to prevent incongruence on the data. The amount of data and complexity of link are not so much then the data formats and the storage capabilities are not significant

3.3.7 On-line User Documentation and Help System Requirements

The Documentation and the Help System are a critical part and they must done carefully. The more the documentation will be understandable, the easier the installation and the choices of the components will be. We want that everybody will be able to choose the system and install it.
3.3.8 Purchased Components

Choice and purchase components is our first issue, the prices, the reliability and the maintenance of the system depends from this. We do not need the best quality components but the best concern the price and quality, this means that a lot of time will be spend to select the right component from the right company.

3.3.9 Licensing Requirements

To be conform to the current normative in the market we need to get a CE mark, then the buyer has the security to buy a compliant product. Get the mark means being aware during the design phase that every component, PCB and package has to be conform to the current regulations in the field of electronics.

3.3.10 Legal, Copyright, and Other Notices

We intend to protect the rights of our intellectual property through patents where possible. Not all packets will be patented, for example in the case of the central unit that uses an open-hardware platform, only the software part will be patented.

3.3.11 Other Requirements

Integrability

All the packages purchased by Kaalisy Domotics can be bought separately and work together with the one that are already present in the system. Moreover it is possible to add other smart devices, that are not purchased by Kaalisy Domotics but they have the Z-Wave protocol installed, which are perfectly compatible with the system.

Testability

To guarantee the efficiency of the system, a unit test task is executed several times per day, which can detect any malfunctions of the system or of the packages. If any failure happened the system will immediately inform the end user.

3.4 Analysis Models

In this chapter, all the analysis model needed to develop the specific requirements described in the previous chapter will be listed.
3.4.1 Sequence Diagrams

Not all the functional requirements are shown, due to their similarity. It was opportune decided to illustrate only four different functional requirements. The purpose of this section is to illustrate the function sequences required to perform a specific action from the user.

Lighting Management (Mobile app)

The sequence diagram showed below is made taking into account a normal user which is using the mobile application to turn on the light1 (which is physically installed in the system).

![Sequence Diagram](image)

Figure 3.6: Lighting Management’s Sequence Diagrams

As we can see with one tap a signal is sent to kaalisy, which will parse it, change the status of the light1 and give back an ACK message at the end the user interface of the mobile application is updated.

Temperature Management (Mobile app)

Same actor of the example before and same device, but this time the situation is different: the user has to change the temperature up to 28 °C.
Once the user has selected the proper thermostat using an input box he will insert the desired value and send it to the kaalisy central unit, which will act as the previous case, parse the message execute the action and give back the ACK message.

**Sensor monitoring (Widget)**

This example shows the interaction of a normal user through the widget, the goal is to know what the temperature of the apartment is.

The mechanism is the same as the previous two examples except that this time the user will not use the finger to select the desired item but he will simply use his voice to ask...
what the current temperature is. To achieve this goal the widget has some default key word in order to understand the specific commands.

**Scenario management**

As said previously it is the only case that differs from the others, in this case the user is the admin and the device is the browser, the goal is to create and insert a specific scenario.

![Sequence Diagram](image.png)

Figure 3.9: *Scenario Management’s Sequence Diagrams*

As expected the procedure requires two main actions. Once the user has inserted all the information needed, the system will ask a confirmation to the user, only at this moment the user can save or not the new scenario.

**3.4.2 Data Flow Diagrams (DFD)**

Through the data flow diagrams it is possible to define how the information flows within the system, as we can see the main object is the information that will be represented as a data. It is really important to understand where data (information) are stored, the source from where they come, on what source they come, which components of the system process them.
Lighting Management (Mobile app)

Figure 3.10: *Light Management’s Data Flow Diagrams*

The main informations that flow within the system are the identification of the packet its current state, which will be sent to the central unit (Kaalisy). Once the command is executed the database is updated, the status of the packet will change and the mobile application will receive an update message which will cause the refresh of the view.

Temperature Management (Mobile app)

Figure 3.11: *Temperature Management’s Data Flow Diagrams*
Same behaviour of the previous example: the information involved in this process are
the identification number of the thermostat selected and the value (23, 24, ...). Once the
user will confirm the desired temperature the system will change the status of the packet,
update the database and refresh the user interface of the mobile application.

**Sensor monitoring (Widget)**

This example takes into account the environment of the widget, while in the previous two
examples the mobile application was the environment chosen.

![Diagram](image)

**Figure 3.12: Sensor Monitoring Data Flow Diagrams**

In this special case the informations are given by vocal command by the user, then the
widget will parse the message and detect which type of command the user said. Then the
parsed command will be sent to the central unit which will get the desired value from the
database and show it to the widget interface.
Scenario Management

Figure 3.13: Scenario Management Data Flow Diagrams

The scenario case has more informations flowing within the system due to its structure, when the user will access to the scenario management he will have to fill the field needed to create the scenario (name, first condition, second condition) then if the syntax is correctly parsed and the confirm box accepted, the scenario will be saved into the database, while if the syntax is incorrect or the confirmation box is not accepted the user will be redirected to the previous view.
Chapter 4

Implementation

4.1 Project Technologies

In the previous chapter we described the software requirements that Kaalisy Domotic System must respect, in order to develop a functional and responsive system. It is necessary, before to start the implementation phase, to introduce the technology used to develop the Kaalisy Domotic System, and the reasons that led us to choose one software instead of the others. According to the purpose of the thesis, only the software tools regarding the development of the user interface are taking into account.

4.1.1 LAMP

LAMP is an acronym for a software platform for developing web applications that takes its name from the initials of the software components it is made. It is a cross-platform tool which contains Linux as operating system, Apache as Web Server, MySQL as Database, Php and Perl as Scripting language and last but not least it is an open source tool which means that it is free.

4.1.2 Dreamweaver CS6

To realize the user interface of the control panel, previously described in the previous chapter (Kaalisy Management), it was decided to use Dreamweaver CS6, this software provides an easy and rapid way to develop web pages. Created by Macromedia in 2005 and then acquired by Adobe System, it offers to the user several tools which simplify the serve-side and client-side implementation, it also provide to display the WebPage in different browser(Chrome, Firefox, Explorer,..) and devices (Tablet, Smarthpone and PC) allowing the user to adopt rapid and fast improvements.
Dreamweaver CS6 fits perfectly with the needs we were looking for, because in only one software the user is able to implement and test the WebPage on different scenarios, allowing the user to have a better final result. It is important to say that Dreamweaver CS6 offers the possibility to create Fluid Grid layout in an extremely easy way.

### 4.1.3 Fluid Grid

With the grow of smartphone and tablet used to navigate on the Internet, the importance to have a web page with responsive design is increased. For responsive design we mean the ability of resize the layout in a way that all the important informations are displayed in a readable way. Regardless of what the device or screen size is, components in fluid grid are going to flow and adapt themselves to the user environment.

### 4.2 Project Implementation

In this chapter we will analyze in details the implementation tasks needed, in order to implement the Kaalisy Management page and the mobile application. As said in the previous chapters the aim of the project is to realize a user friendly interface able to provide to the user an easy and fast instrument to control the Kaalisy Domotic System. This chapter will be divided into two main sections, the first one, which is focused on the Management page implementation and the second one, which is focused on the mobile implementation task.

#### 4.2.1 Back-end Management Page

The management page, as said in the software requirement specification chapter, has to allow the user to control Kaalisy System, providing all the functions displayed in a readable and functional way.
Database

The database is the place where all the informations are stored, its organization is fundamental for the efficiency of the entire system. As we will see in the next sections, all the informations displayed on the web page are taken from the database through dedicated query. After that considerations, lets have a look on how the database has to be organized. First of all, a table for the user is necessary, how access the control page has to be logged in order to avoid unauthorized user able to control our home automation system. After that, a table for the packets and for the variable must be created in order to memorize all the packets installed in the apartment. We differentiate the packet table from the variable table because it exists packets that can have more functionalities, like Wally, which can act as a sensor (check the energy consumption of a specific household appliance) and as a actuator (turn off or on the household appliance connected to it). The packet table will store basically two informations: the identification number of the packet and the type (Lumus, Ocio, Wally, ...), while the variable contains all the necessary informations for a correct representation (i.e name, value, room-name, ...). Other important tables that must be created are the rule table, where all the scenario are stored, and the room table which contains the rooms setted by the user. As we will see in the next sections others table will be added according to specific needs.

Login Page

The first aspect that has to be implemented is the user authentication, in order to provide a certain protection, even if the system runs locally, which means that all the informations never go through internet. The user authentication consists in a pair of user inputs, username and password, which are stored into the database.

![LoginPage Kaalisy Management Page](image)

Figure 4.2: LoginPage Kaalisy Management Page
The Figure 4.2 shows how the login page looks like. To achieve this result a login.php script was created and stored into the site folder generated by Dreamweaver CS6. The input field are made using the Spry Form Validation, this widget displays updated informations about the users inputs. For example if the input field username is not filled the form will inform the user that he must fill it.

In order to enable the Spry Form Validation it is necessary to include a dedicated javascript and css file, after that it is necessary to use dedicated html tag and set few parameters, in this way it is possible to achieve the result showed in the Figure 4.3.

Once the user submit the form, the login.php script will check if the inputs given by the user are already stored into the database, in the case of a positive answer, the user will be redirected to another page (we will discuss about that later), otherwise the login.php is shown again, at that point the user can proceed with the registration. The registration.php is pretty much similar to the login.php script, it uses the spry form validation and once the user submit the form all the data are stored into the database with the result of a new user. Every time that the login form or the registration form is submitted a database connection is established and a specific query is made and a dedicated session is launched. In that way all the modifications done to the system are referred to a specific user giving to the system the possibility to create functions accessible only to a specific user (i.e admin).

```php
<?php
    $con = mysqli_connect($hostname_localhost, $username_localhost, $password_localhost, $dbname_localhost);
    if ($con === FALSE) {
        echo "Error: Unable to connect to MySQL: " . mysqli_connect_error();
    }
?>
```
As said before all the user informations are stored into a database named Control-Panel, at this moment the database contains only one table named Users, but as it is described in the Software Design chapter of the MSc Thesis of Claudio Tesei it will contains several tables.

**MyHome**

Once the user is correctly logged into the system (through the Login page) it has access to the MyHome page, where all the packets (previously installed into the system) are displayed. At that point it is important to describe how the MyHome has to be implemented in order to provide an user-friendly experience.

To achieve that goal it was decided to divide the back-end implementation from the front-end implementation, which means that the web page was first developed only thinking about its functionality and then, only when the back-end was completed, the front-end implementation was started, giving to the back-end functionality a better shape, improving the overall user experience.

The aim of MyHome is to give to the user access to all the packets installed in the house, which means that it has to provide all the informations necessary to let the user immediately understand the context of each single packet and easily control them. For example if the home page simply display all the packets, let’s say through a list, giving as information only the name of the packet and its status (on, off, ...), it will force the user to remember the position (bedroom, kitchen, ...) of each packets, which will obviously confused the user experience. But if we organize the main view as list of rooms, and display the packets of each room as a listed item, where each item show to the user the status of the packet as a clickable image, the overall organization is more comprehensible and lead the user to have a hierarchical view of the system. At this point, once we decided how the MyHome page has to be organize it is necessary to establish the way in which the Web Page will provide this informations. As introduced in the previous subsection, all the data are stored into a database accessible only by the authenticated users, then to populate the view of the Home Page it is necessary to get the data from the database, parse and display them.

**Client-Server Communication**

To retrieve the informations stored into the database we need to instantiate a Client - Server Communication, because the Client (browser where the home page is displayed) asks to the Server (place where the Database and the entire Management Page is stored) specific informations. In other words, the client makes a request to the server and waits until it gives back the desired informations. To perform this request we need to use JAVASCRIPT
which will handle the function request() which will make the request to the server using AJAX.

**What is Javascript**

It is a scripting language used exclusively on the client-side (browser) which through script functions enables certain events, these events can be invoked by the user according to specific situations (mouse-click, keyboard press,...) or by other script functions. In our case we used Javascript in several situations, the most frequent one is to perform AJAX request to the Server and display the result on the view of the MyHome.

**What is AJAX**

AJAX is not a new programming language, its main functions are to provide a way to exchange data between the server and the client and update part of the web page without refreshing it. In our case we use AJAX to instantiate the communication with the server passing some values and waiting for an answer.

Now that we understand how javascript and AJAX work and why we use them, we can have a look on how they were implemented in order to provide a Client-Server communication. First of all we need to create three files HomePage.html Update.php and long-polling.php. The first one we will display the informations retrieve from the other two php scripts, the HomePage.html it simply invoke three javascript functions (Init(), Update() and Polling() ).
The Figure 4.5 shows the three functions used to instantiate the communication with the server. As we can see, all of them use ajax to open a communication with the server. In order to perform the connection it is necessary to specify to ajax who is the receiver of that request, in the case of the init() function is the php script named room.php, then if the client needs to send with the request some parameter they must specify them inside the "data" array() of the ajax function. After that, the request is delivered and the client will wait until the server will perform some output. It is important to say that the call is an asynchronous call, which means that the client is not blocked and can execute its functions while he is waiting for the output of the server. When the answer is ready it will be informed by ajax and the result will be handled.

The three functions are used to accomplish three different goals, the init() function is responsible to display the main content of the Web Page, as we will see in the next section once the HomePage.html is displayed on the browser the javascript will invoke the init() function which will make a request to the room.php script. That script according to the configuration of the environment stored into the database will dynamically display the result into the web page. For example if the database has two different rooms with three lumus packets each, the room.php script will output the relative configuration. In this way if any changes of the database configuration occur they will immediately change the view of MyHome. As said previously MyHome is organized in sections according to the number of rooms, each section has a listed item according to which packets are installed, each item has a clickable image which allows the user to modify the status of that packet.
(on, off, 26°C,...). Every time that the user will modify the status of a packet through the clickable image, the Update() function is invoked. Its goal is to inform the server that the user has modified the status of a certain packet and wait for an answer. Once the server has made the appropriate calculation (Rule based Control System for Home Automation, Claudio Tesei Master Thesis) it will return back an ACK message, after that the Update.php script perform an output with all the informations needed for the javascript function in order to update only the item modified. In this way the HomePage.html is never refreshed entirely and only a specific item will be updated, as a result of a better and more fluid user experience.

The function polling() is the one responsible of the maintenance of the view updated. In order to achieve this result, it is important to make some observations.

**Real Time Communication**

In this section we will introduce the techniques available in order to perform Client-Server real time communications, let assume that the Client is a normal browser and a Server is the place where the web page is stored.

**Ajax Polling**

It consists in a request from the client to the server, then the server will execute a response which will be returned immediately to the client and the communication will end. In order to perform a kind of real time communication, the client has to perform periodically requests to the server.

For example if we want to inform the user when a change of a specific field of the database occurs using polling technique, it means that the client has to perform periodi-
cally requests to the server and check if any modification on that field happened. As we can observe, if we want to implement a system which is more real time possible, we must set a very small interval between the request. It results in overwhelming the server and increasing the probability of crash of the entire system.

**Ajax Long Polling**

The long polling technique consists in a request from the client to the server, where the server maintains the connection open for a certain period (i.e. 20 seconds), if a new data is detected within that time, the server send the new data to the client and close the communication, otherwise if the time elapse the server will close the connection and the client will immediately start again a new request. With this technique it is possible to create a kind of real time communication and do not overwhelm too much the server, but it is still not a full duplex bi-directional channel of communication.

![Ajax Long polling](image)

**WebSocket HTML5**

The WebSocket HTML 5 provides the first real time Server-Client communication, the client will perform a request to the server using HTTP, when the server will open the connection a full-duplex, bidirectional communications channel is open and both of them are able to communicate without close and re-open the connection.
Conclusion

It is simple to understand that WebSocket HTML5 is the best way to create real time communication, but the big drawback is that they are not supported in all the browsers.

It is important to notify that there are other alternatives to create real time communication, for example WebRTC and HTML5 Server Sent Events (SSE) / EventSource. Both of them have the same disadvantages of the WebSocket HTML5, that is, Browser support. Taking into account our situation, the development of the kaalisy Management web page, it is clear that there will not be too many requests to the server from the client, because the number of users that have access to the system are the owners of the Kaalisy Domotics System, generally it consists in a restricted number of users. According to the purpose of our system and the observations made above we decided to implement a long polling technique, which is for my personal opinion the best solution that fits our needs, because we do not have huge traffic of informations between Client and Server. The server has to handle only a restricted possible number of requests (depending to the owners of the Kaalisy Domotics System). Moreover, implementing a long polling does not require any external libraries or specific modification of the server configuration, and it is supported by PHP.

Now that we understand what is long-polling and why it was decided to adopt that method we can have a look on how it was implemented into our long-polling.php script. This script is called by the polling() javascript function showed in the Figure4.5.
As we can see from the Figure 4.10 at the beginning an interval time of 20 seconds is set, if the script detects any change within this interval, the script will break the loop and inform the client (our polling() javascript function) that he has to update the view because there are new informations available, otherwise it will loop. It is important to specify that everytime that a modification occurs a php script called modify.php is invoked. The aim of the modify.php script is to update the field "data" of the table "pool" with the current time. In this way with a simple query to the "pool" table it is possible to keep track of the last modification made.

Scenario/Packets

In this paragraph another section of Kaalisy control panel will be introduced, called Scenario/Packets. Its goal is to give to the user another control page, where all the scenario and new packets are listed. The Kaalisy home automation allows the user to create custom scenario that can be activated and deactivate as a normal packet, and an example of scenario can be "turn on the lights of the garden when outside it is dark", as explained in the previous chapters. When a new packet is installed the system will detect it and the user must be informed. In order to meet this goal, in the scenario/packet section the user can detect if there are new packet, if a new packet is available then he must configure it. Now that we explain what the scenario/packet has to display, it is possible to go through its implementation phases. The method adopted to display all the informations is the same used for the MyHome section, which consists in an ajax request from the client to the get-
scenario.php script. Once the result is ready, the output is displayed on the web page.
The activity of get-scenario.php script is to instantiate a connection with the database and
through a query check the presence of scenario and new packets, and finally store the
information inside a bi-dimensional array.
Once we have all the informations stored into two different bi-dimensional arrays we are
able to organize them into a listview, where each item are represented by a clickable im-
age.
At the end we will have two main listviews: one for the scenarios and one for the new
packets, but their behaviour is different. The item present inside the scenario view, when
selected by the user, simply modify their status, for example if the user selects and clicks
on a specific scenario which has an active status, then a script scenario-changed.php is
invoked and its relative status will be modified (in this case from active to inactive) and
displayed on the list view with the updated status. While the behaviour of the item in-
side the new packets is totally different: when the user clicks a specific packet, a dialog
box will appear and the packet must be configured, after that the user can see the new
packet into the MyHome section. For the configuration of the new packet three fields are
required, the name, the name of the room where the packet is physically installed and the
status, which can be also unfilled (default status). Once the informations are inserted and
the confirmation box accepted the new packet will be removed from the NewPackets list
view and added to the selected room.
The two behaviour explained before are performed by two scripts, scenario-changed.php
called by the ScenarioUpdate function and add-packet.php called by the NewPacket func-
tion. The two functions are invoked by the onclick event of each item of the two listview.

**Rule**

Rule is the third and last section of Kaalisy control panel, its goal is to provide to the
user an easy way to insert a new rule which will be displayed in the scenario listview,
previously introduced. As explained in the previous chapter the user has the possibility to
create and a new scenario, according to the packets installed into the system. To achieve
better its goal, the Rule section must be simple and easy to use, because if the informations
and the elements are not presented in a readable way, insert a new rule or scenario can
result in being complicated for the user. Probably the reader is thinking “why the creation
of a new scenario(rule) is in a separate section and not in the section of the scenarios?”,
we decided to split the two topics because we wanted to create a dedicated section with
as more informations as possible, in order to let the user understand how to insert a new
scenario.
To achieve this goal we decided to create four different listviews, the first three are used
to help the user inserting the new scenario, while the last one consists in a form where the user has to insert the desirable rule. The first listview shows a list of all the operators that the user can use while he is creation a new rule, for example the operator ">" it can be use to create the following scenario "when the temperature of living room > 28 then turn of the thermostat ". The second listview it simply displays all the packets installed in the system that the user can use to create a scenarios. While the third one gives some example of scenario illustrating the correct syntax that the user must use, for example when the user sets new rule, the keywords WHEN and THEN must be inserted. Finally there is the Insert form where the user has to insert its own scenario following the examples provided, after that the new scenario will be saved into the database and displayed on the scenario listview.

4.2.2 Front-end Management Page

The design process of any web pages or web applications, requires to go through two main tasks: Discovery and Implementation

Discovery consist in, try to get as much informations as you can about the potential users that will mostly use it. The important aspect is, to well understand which is the target of users you are referring to and consequently to be able to catch their attention. In our case, the web page consists of a "control panel of Kaalisy Home Automation System" and it was not necessary to make an intense research about potential users, first of all because they already are our customers (the control page is installed into the central unit of the kaalisy system) and then because the goal of the control panel is to be simple and efficient. We finally decided that from the control panel the user must be able to: recognize that is a "Kaalisy product" and that all the informations and commands are reachable within three mouse clicks.

Now that the basic informations are detected the implementations tasks can take place, but before to analyse how do we organize the user view and why, a little introduction about different design approach is necessary

State of art of responsive web design

Actually in the community of web designer two are the main ways to organize and display the content inside a web page: fixed and relative approach.

Fixed layout

This method display elements inside a web page based on a unit measurement that it is
not dependent to other factors, for example the dimension of the screen where the web page is displayed. Supposing that we are adding a table inside our web page with a fixed dimension, this means that no matter what will be the screen-width, the table will have the same dimension everywhere. Adopting this method, the designer has more control of how the element (in our case the table) will be displayed and where, and he is sure that it will be rendered in all the browser and screen available. In the other hand if the element’s width is bigger than the screen size the user has to scroll horizontally in order to see the right side. This way to organize a web page is obviously the simplest, because it takes into account only one precise fixed "resolution", but it needs continuous revisions and reorganization depending on the screen-size availability.

Relative layout
This method organizes the content of the web page using unit measurements that are referred to the dimension of the screen, allowing the element to be displayed into different way, size and dimension, according to the user screen resolution. If a table is created adopting a relative layout approach, its size will change according to the screen resolution of the device (smartphone, tablet, PC), in that way the table will be always displayed within the screen and will never produce horizontally scroll-bar. If we decide to adopt a relative layout method to create the web page, we also need to decide what kind of relative measurement do we want to use. Actually with the term of relative layout we are referring to several implementation methods, like Liquid Layout, Elastic Layout and Hybrid Layout, each of them adopts different techniques. For example the Liquid Layout it use the % as measurement, the Elastic Layout it use the em (height of the font size) as measurement, while the Hybrid Layout it mix both % and em to achieve different result. As we can see there are different ways to implement the relative layout all of them with their pro and cons. A web page designed using one of the previous three techniques has a responsive design, no matter where the web page will be display (PC, tablet, smartphone) it will adjust its contents inside the width of the screen. Even if the Relative layout seems to be the perfect solution it is currently matter of study because there are still many issues that have to be solved and actually the perfect responsive design does not exist yet.

From the previous brief explanation of what are the current methods adopted by the major part of the web designer, we are able to introduce the design of the Kaalisy Control Panel. The method adopted for the realization of the web page is the liquid layout, it was preferred to use this technique instead of the other because of two main reasons. The first one is because we wanted to provide to the user an interface which is able to guarantee a high level of usability no matter on which device the user is using it (smartphone, tablet,
PC). While the second one is the possibility to create mobile applications displaying the content of the web page. In this way we do not need to design entirely the interfaces according to the mobile devices (Android, iOS, WindowPhone), we can simply redirect the mobile application to the web page, which will automatically resize its contents according to the mobile device adopted.

To implement a Responsive Layout using the liquid layout technique Dreamweaver provide a pre-formatted layout (Liquid Grid Layout) which generate two css style sheets allowing the user to set up the main container which will include the element of the web page. Of course Dreamweaver through this template provide you the basis to start implementing a responsive web page, after that the user must respect the rules described above. Once we defined the type of organization we want to adopt, we should decide in which way the element must be displayed into the web page. Different solutions were draw with different feedbacks, allowing to have more possibility and more choices.

![Figure 4.11: Solution n1](image)

The Figure4.11 shows one solution that was finally not implemented for two main reasons. First of all the usability, MyHome has to give to the user the possibility to interact with the packets installed into the Home automation system, with this configuration the packets are not displayed as primary information. Scondly I thought it could confuse the user, when he is selecting the packet if the room has a high number of packet installed.
According to the weaknesses of the previous solution we decided to present the packets into a more readable way, as showed in the Figure 4.12 there is a navigation bar where the user can switch between the different areas of the control page, and the contents of each page (i.e MyHome) is displayed filling almost entirely the available space. This solution was preferred because it also provide a more easy way to interact with the system, the packets are showed into bigger category and the use of bigger buttons gives a better selection even in the case of multiple items.

Now that the internal organization of the control page it is ready, is time to transform what we draw on a paper into a real web page.

**MyHome**

The first element shown in Figure 4.12 is the navigation bar, which allows the user to navigate through the pages of a specific web site. In our web page it was decided to show all the contents in only one single html page, because the use of links to other html pages (i.e Rule, Scenario/Packets) forces the user to load the selected page each time, increasing the waiting time and decreasing the performance of the user experience. To organize better the three main different sections (MyHome, Scenario/Packets, Rule) it was decided to display all of them inside a single table (which can not be seen) and then use jQuery and jQuery UI to customize it. The goal was to give to the user the sensation of using a navigation bar to navigate through the main topic when actually there was only one single html page.
jQuery

It is a library written in javascript for web applications and it simplify the use of event, animation, and manipulations of the data. jQuery is free, open source software, licensed under the MIT License.

jQuery UI

It is a set of GUI widgets, visual effects and themes implemented using jQuery, CSS and HTML, to be able to use jQuery UI a jQuery library has to be present.

For our purpose it was decided to use the tabs widget of jQuery UI, this widget give to the user the possibility to create custom, animated and interactive content area with multiple panels, each associated with a header in a list. As introduced previously, all the contents of the web page are displayed according to the output of precise php scripts. In the content area of the widget we need to fill the contents of each panel according to the output of different scripts, in our case there will be three different panels named (My-Home, Scenario/Packets, Rule) each of these panels are related with different php scripts (script-MyHome.php, script-ScePack.php, scenario-Rule.php).

The widget has to display different contents according to which header in a list is selected, which means if the MyHome header is selected then the relative panel has to invoke the script-MyHome.php script and display its output.

```html
<ol id="tabs">
  <li><a href="#script_MyHome.php">My Home</a></li>
  <li><a href="#script_ScenarioPackets.php">Scenario / Packets</a></li>
  <li><a href="#script_Rule.php">Rule</a></li>
</ol>
```

Figure 4.13: Tabs Widget jQuery U

From the Figure 4.13 it is possible to see that each panel is linked with the appropriate script, which will display its output into the panel selected.

After that each panel are able to display correctly their contents, it is time to give to the widget a nice look, using css and some animations. jQuery UI allows the developer to customize the theme of the plug-in before to download it, thanks to the ThemeRoller features. In our case it was decided to use both the CSS and ThemeRoller features because we had the necessity to give different style and animation to different jQuery widget used for the control panel.

Once the Tabs widget is correctly displayed and with the right style we can have a look at
the contents that are displayed from the different Php scripts. As explained in the back-end section, the elements are displayed in a hierarchical way. There are the rooms and for each of them a list of packets is showed. To represent these informations into a more readable way it was decided to create collapsible panel for the rooms, and custom button for the packets. The buttons has: an icon that represent the type of packet (Lumus, Ocio, ...) a name and the status (On, Off, 23 °C, ...). Moreover to allow the user to have an immediate feedback about the status of each packet we decided to give to the icon different behaviour according to its status (on, off, 23 °C,...).

![My Home](image)

**Figure 4.14: HomePage MyHome view**

The table rooms are collapsible panel, which means that they can be closed or opened by the user according to their preferences, we decided to adopt this strategy because we wanted to give an optimal usability even on the mobile view, allowing the user to have the desirable panel at the top of the screen.

Everything looks well organized and the informations are well displayed, lets see how the user can interact with each different packets.

**LUMUS**

As we know each packet is showed as a button, then the user has to turn on a specific light, and the only thing that he has to do is to simply click on the relative packet and the light will change its status.
LOCKER

The same behaviour adopted for LUMUS, only one click to open and close a specific door.

OCIO

Ocio is the thermostat of the house, to increase or decrease the current temperature the user as to click on the packet, after that a dialog box will appear where he can change the temperature of the apartment and click on the confirm button.

![Thermostat set value view](image)

Figure 4.15: *Thermostat set value view*

With three click (assuming that the user increase of 1 degree the temperature) the user is able to set the temperature and return on the main page.

SENSY

It only displays the state of sensor then it will have the same behaviour of Ocio except that the user will not change the status of anything it is just an informative dialog box. As we saw for Ocio and Sensy we use a custom dialog box, it was realized using the dialog widget on jQuery UI.

Scenario/Packets

The second section that we can see from the Figure 18 is the Scenario/Packets, as described in the paragraph of the back-end, this section will display the scenario configured by the user and the presence of new packets. The scenarios and the new-packets are rep-
presented as the packets in the MyHome list-view, which means using a collapsible panel that contain a list-view of click-able images.

![Scenario/Packets view](image1.png)

**Figure 4.16: Scenario/Packets view**

When a scenario item is clicked then it will act as a normal packet which means that it simply changes its status, if it is active it will be set to inactive. The behaviour of the new packet item is different, after a user click a dialog box contain a form will be displayed. The form will containing all the necessary informations for a correct configuration, once the form is filled and the user has clicked on the confirmation button, the new packet will be displayed on the selected room in the MyHome section and removed from the New packets listview.

![Newpacket dialog box view](image2.png)

**Figure 4.17: Newpacket dialog box view**

**Rule**

The last section present in the Kaalisy control panel is called Rule, where the user can insert a new scenario as described in the back-end section. In this section we find four
different collapsible panels, three of them only display informations while the last one is used to insert the new scenario or rule.

![Figure 4.18: Newscenario view](image)

Once the user will click on the button "save" then the new scenario is configured and will be displayed in the scenario listview of the Scenario/Packets section.

**Color and Fonts**

The decision of the colors and the font were done thinking about two main criteria. First of all we wanted to use the same color used for the logo in order to do not create confusion between the product and the web page, secondly using contrast colors on the web page. Indeed, it helps the user to organize the contents in a more schematic way and the contents are presented in a more readable way. Of course if the contrast is too high and the colors are too bright it can lead the user to have a difficult user-experience. For that reasons we tried different combinations, and from a set of possible solutions we decided to choose the one illustrated on the previous five figures.

### 4.3 Mobile application

As said in the implementation chapter the user can access to the Management Web Page even through the Smartphone. In order to achieve this goal we wanted to give to the control page a responsive behaviour, to display the information no matter which smartphone will be used. This decision was taken because the main goal of this project is to implement and test the first prototype as soon as possible, after that it will be probably necessary to develop a dedicated application, but at this stage we retain appropriate to
create a user interface which can be adapted on different devices (PC, tablet, smartphone) and operating system.
Chapter 5

Observations

In the back-end section, the development of the control panel was explained in detail, and as we can see the server-side structure was entirely written in Php. An important phase that occurred at the beginning of the implementation, was the decision regarding the use or not of a specific PHP framework, then a study of the possible available solution was done. "A framework is a logical architecture of the media on which software can be designed and implemented, often facilitating the development by the programmer. At the base of a framework there is always a set of libraries" [16] Now that we know what is a framework we can analyze more in detail why it should be used to develop a web application. First of all it is the organization of the files and the code: when you set up a framework a certain folder structure is created, keeping everything well structured. Another positive aspect is the library and helpers already included, which help the developer while he is implementing, form validation, database abstraction, session and cookie handling. Last but not least the MVC pattern, frameworks separate your code in a more clear and maintainable way, the MVC pattern is implemented on almost all the php framework that are available on the internet. The MVC pattern is based on the division of the code in three main parts, models, views and controllers, in this way the developer can organize the code according the their scope. Frameworks are really powerful and helps the developers in many situations, but they are more suitable in specific contexts and less in other. For example they are strongly recommended when the size of the project is big and there are more than one developer working on the same task. While it is less suitable for situations where the size of the project is not big and the data with little to no dynamic functionality. At the beginning of the implementation we decided to keep going on the implementation of the back-end of the control panel without any framework, because we though that using a framework in our project was not suitable. The control panel as we saw previously simply query the database and perform an output, it does not perform any other functions. Moreover set up a framework
requires more memory than a pure php implementation, the framework come with several libraries and helper pre-installed and secondly it requires a study on how to use that specific framework, each of them with different approaches. But as we will see in the Future Works chapter it can be suitable to adopt a framework if other functionalities needs to be implemented.

Finally for the purpose of this thesis it was a good decision to avoid using any kind of framework, but for future implementation and upgrading. An approach based on a framework is better, because it helps to increase the maintainability of the entire system.
Chapter 6

Conclusion

In this chapter we will recap all the work done and we will give an overall view of the entire project. We started giving to the user an overall description of the project where we analysed the main aspects that our system must respect in order to end up with the right performances. Then we made a business analysis, where we transformed the first idea into a more and readable way. In this section we tried to give to the reader the essential informations to understand what is Kaalisy, why it is different from the others solutions available on the market and how do we want to implement and sell it. Then once the business documentation was completed, it was time to start developing the system. We started from the requirements software specifications that the system has to respect, proceeding with the software design specifications, used to have a schema of how the software of the entire project has to be implemented. An we concluded with the development of one part of the system, the control panel, where we gave more technical informations about the processes of each implementation phases. At this point the user was able to understand that to have a complete overall of the entire project he must read also the work done by my colleague Claudio Tesei in his MSc Thesis.

I would like to conclude saying that the contents of this thesis is only one side of a process started almost one year ago, which was originally a simple idea born from personal desires and became more concrete day after day. We have still a lot of work to do, but with the passion and hard work we are sure that sooner or later we will be able to come out with a first complete solution.

For the interested, it is possible to visit the web page www.kaalisy.com which display the main features of the system (it is a beta version but it will be improved soon). Moreover we are present also on the social media which we thought is way better to promote the product, at least at this phase.
Chapter 7

Future Works

In this section we will introduce some aspects that we though it was important to be improved in order to perform the best possible solution for the final customer. Two main sections are listed to better divide the possible improvements.

7.1 Software architecture

This section will introduce some possible improvements concerning the software implementation of the control panel page, covering both the back-end and front-end side.

7.1.1 Security

The server is located inside the LAN (Local Area Network) reducing the possibility of unauthorized access to the system, but to provide a much more secure system an extra level of security should be implemented. This goal will be achieved acting on the front-end trying to encrypt the data sent from the user to the server and improve the detection of unauthorized users. While the back-end must implement more secure way to manage the data received and use more protective way to perform request to the database.

7.1.2 MVC pattern

The MVC pattern was introduced in the Observation chapter, and as we conclude if the overall dimension of the system will increase, adopt a MVC pattern in the server side will be adequate. The same observation can be applied for the client-side of the control panel. In this way the organization of the entire system will be improved.
7.1.3 Widget

As we introduced in the software requirement chapter the mobile widget is another possible way to interact with the system, due to have the first prototype ready as soon as possible it was decided to implement the widget once the feedbacks of the first prototype are obtained. In this way we have more informations on how to implement it according to the users needs.

7.1.4 Grounding

Once the user submits a certain command (Light1 ON), this command will be executed by the system, but what happen if the user submits a command by mistake? In order to prevent that situation, a confirmation box should appear before the command is executed. Of course the confirmation box can not be applied to any user’s commands, because it might decrease the usability of the overall system. For example, imagine that you want to turn on a specific light, then once you have selected the appropriate command, you also have to confirm that command. All this procedure might slow the performance and the usability of the system itself. In order to maintain the same level of usability it might be useful to adopt a confirmation box only for advanced command, for example a confirmation box can be used when the user decide to create a new scenario.

7.1.5 Speech Recognition

The widget will provide the possibility to use also the voice instead of using buttons to perform actions. The voice recognition will be implemented using the Google Api which provides an optimal solution for the purpose of our project.

7.2 System development

In this section we will introduce the phases that should occur during the first period of the system development.

7.2.1 Components

After that the system is ready to be installed, it is time to choose the material that we want to use for the realization of each single packet. Once the material are chosen, it is important find the correct shape, which has to respect specific standards according the the type of the packet (width, height, color, â€¦).
7.2.2 Prototype

Once the components are choose we need to present the prototype as soon as possible, in order to begin a testing phase and to show the product to potential investor. It will be an important phase where the customer or the investor will have the first feeling about the product and also because we will test for the first time the entire project in a real environment.

The phases described before are only few of the one that we have to improve, modify and adjust to produce the best possible solution. As we can see we are at the beginning of a long and difficult way and there are many possible future works that can be taken into account, for this reason we decided to list some of them, which we thought more important for our purpose.
Appendix A

Appendix 1

Figure A.1:  *Expected Revenue by product*

<table>
<thead>
<tr>
<th>Italian market</th>
<th>Year 1</th>
<th>Year 2</th>
<th>Year 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Central Unit</td>
<td>47,920</td>
<td>119,600</td>
<td>299,500</td>
</tr>
<tr>
<td>Lumus</td>
<td>167,200</td>
<td>418,000</td>
<td>1,045,000</td>
</tr>
<tr>
<td>Lumus Switch Wall</td>
<td>89,040</td>
<td>222,600</td>
<td>556,500</td>
</tr>
<tr>
<td>Wally</td>
<td>121,280</td>
<td>303,200</td>
<td>756,000</td>
</tr>
<tr>
<td>Coo</td>
<td>18,320</td>
<td>45,600</td>
<td>114,500</td>
</tr>
<tr>
<td>Looker</td>
<td>9,520</td>
<td>23,800</td>
<td>59,500</td>
</tr>
<tr>
<td>Sensy</td>
<td>111,660</td>
<td>279,200</td>
<td>696,000</td>
</tr>
<tr>
<td>Intrusor</td>
<td>95,760</td>
<td>239,400</td>
<td>596,500</td>
</tr>
<tr>
<td>Total revenue Italian market</td>
<td>660,720</td>
<td>1,651,600</td>
<td>4,129,500</td>
</tr>
<tr>
<td>Annual growth rate</td>
<td>150,00%</td>
<td>150,00%</td>
<td></td>
</tr>
</tbody>
</table>

Figure A.2:  *Plan of marketing costs*

<table>
<thead>
<tr>
<th>Italian market</th>
<th>Year 1</th>
<th>Year 2</th>
<th>Year 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fairs and Exhibitions (+mission)</td>
<td>20,000</td>
<td>30,000</td>
<td>40,000</td>
</tr>
<tr>
<td>Advertising on press</td>
<td>40,000</td>
<td>50,000</td>
<td>100,000</td>
</tr>
<tr>
<td>Radio advertising</td>
<td>20,000</td>
<td>50,000</td>
<td>100,000</td>
</tr>
<tr>
<td>Internet advertising</td>
<td>20,000</td>
<td>50,000</td>
<td>100,000</td>
</tr>
<tr>
<td>TV advertising</td>
<td>0</td>
<td>50,000</td>
<td>200,000</td>
</tr>
<tr>
<td>Total revenue Italian market</td>
<td>150,000</td>
<td>220,000</td>
<td>540,000</td>
</tr>
<tr>
<td>Impact on sales Italy</td>
<td>45,44%</td>
<td>43,92%</td>
<td>43,08%</td>
</tr>
</tbody>
</table>
Kaalisy domotics: implementation of a user friendly interface complying with a new business model

<table>
<thead>
<tr>
<th>Investimenti materiali</th>
<th>Anno 1</th>
<th>Anno 2</th>
<th>Anno 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Offices</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Laptop</td>
<td>4.000</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Tablet</td>
<td>1.000</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Printer</td>
<td>1.000</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>PC</td>
<td>2.000</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Total investments in tangible assets</strong></td>
<td><strong>6.000</strong></td>
<td><strong>0</strong></td>
<td><strong>0</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Investimenti immateriali</th>
<th>Anno 1</th>
<th>Anno 2</th>
<th>Anno 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Establishment Expenses</td>
<td>7.000</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Certification CE Expenses</td>
<td>4.000</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Patents Expenses</td>
<td>30.000</td>
<td>50.000</td>
<td>50.000</td>
</tr>
<tr>
<td>Purchase of new software</td>
<td>1.000</td>
<td>1.000</td>
<td>1.000</td>
</tr>
<tr>
<td><strong>Total investments in intangible assets</strong></td>
<td><strong>51.000</strong></td>
<td><strong>51.000</strong></td>
<td><strong>51.000</strong></td>
</tr>
<tr>
<td><strong>Total investments</strong></td>
<td><strong>58.000</strong></td>
<td><strong>51.000</strong></td>
<td><strong>51.000</strong></td>
</tr>
</tbody>
</table>

**Figure A.3: Investment Plan**

**Figure A.4: Plan of staff costs**
# Figure A.5: Income Statement

## Assets

<table>
<thead>
<tr>
<th>Year 1</th>
<th>Year 2</th>
<th>Year 3</th>
<th>Year 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cash</td>
<td>7,436</td>
<td>0</td>
<td>995,774</td>
</tr>
<tr>
<td>Receivables</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Note payable</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

## Closing balance of commodities and FG

<table>
<thead>
<tr>
<th>FG</th>
<th>FG</th>
</tr>
</thead>
<tbody>
<tr>
<td>176,395</td>
<td>70,735</td>
</tr>
</tbody>
</table>

## Current assets

<table>
<thead>
<tr>
<th>FG</th>
<th>FG</th>
</tr>
</thead>
<tbody>
<tr>
<td>182,833</td>
<td>73,212</td>
</tr>
</tbody>
</table>

## Fixed assets

<table>
<thead>
<tr>
<th>FG</th>
<th>FG</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,134,223</td>
<td>92,123</td>
</tr>
</tbody>
</table>

## Net fixed assets

<table>
<thead>
<tr>
<th>FG</th>
<th>FG</th>
</tr>
</thead>
<tbody>
<tr>
<td>82,000</td>
<td>52,000</td>
</tr>
</tbody>
</table>

## Net invisible assets

<table>
<thead>
<tr>
<th>FG</th>
<th>FG</th>
</tr>
</thead>
<tbody>
<tr>
<td>82,000</td>
<td>52,000</td>
</tr>
</tbody>
</table>

## Financial assets

<table>
<thead>
<tr>
<th>FG</th>
<th>FG</th>
</tr>
</thead>
<tbody>
<tr>
<td>30,000</td>
<td>12,000</td>
</tr>
</tbody>
</table>

## Net capital assets

<table>
<thead>
<tr>
<th>FG</th>
<th>FG</th>
</tr>
</thead>
<tbody>
<tr>
<td>48,400</td>
<td>28,767</td>
</tr>
</tbody>
</table>

## Total assets

<table>
<thead>
<tr>
<th>FG</th>
<th>FG</th>
</tr>
</thead>
<tbody>
<tr>
<td>118,873</td>
<td>100,000</td>
</tr>
</tbody>
</table>

# Figure A.6: Balance sheet - assets

## Liabilities

<table>
<thead>
<tr>
<th>FG</th>
<th>FG</th>
</tr>
</thead>
<tbody>
<tr>
<td>221,997</td>
<td>16,213</td>
</tr>
</tbody>
</table>

## Income statement

<table>
<thead>
<tr>
<th>FG</th>
<th>FG</th>
</tr>
</thead>
<tbody>
<tr>
<td>3,000</td>
<td>24,000</td>
</tr>
</tbody>
</table>

## Balance sheet - liabilities

<table>
<thead>
<tr>
<th>FG</th>
<th>FG</th>
</tr>
</thead>
<tbody>
<tr>
<td>3,000</td>
<td>24,000</td>
</tr>
</tbody>
</table>

# Figure A.7: Balance sheet - liabilities
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![Figure A.8: Statement of cash flows](image)

![Figure A.9: Ratios](image)
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