Report

Aquaponics System II: The Monitoring

by
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Acknowledgement

Glossary

Abbreviation	Description
EPS	European Project Semester
ISEP	Instituto Superior de Engenharia do Porto
USB	Universal Serial Bus
GRAQ	Grupo de Reações e Análises Químicas
USD	US-Dollar
sqm	square meter
l	liter
LED	light-emitting diode
RoHS	Restriction of Hazardous Substances Directive

1. Introduction

1.1 Presentation

We are a group of 6 students from 6 different countries (USA, Poland, Spain, Germany, Belgium & Romania) who came together at the end of February 2015 to work as a team during the spring semester. Our fields of studies vary from Graphic and Digital Design over Biomedical Engineering to Electrical Engineering.
We were given our project by the Instituto Superior de Engenharia do Porto, where we study and elaborate our task.

1.2 Motivation

Our motivation fulfilling our objective during this semester comes from all the various skills and experience we can gather as a group.
We want to achieve the best possible solution, to make it even easier for private households to possess and control their aquaponics system.

1.3 Problem

financial limits

1.4 Objectives

The goal is to construct a remote control and visualization via a mobile device of an aquaponic system with a 0.72 sqm plant bed and a 700 l aquarium including a food dispenser, a camera as well as temperature and conductivity sensors. This technique then is supposed to increase the function, productivity and the ease of use for aquaponics system specifically.
Also one major objective is to reduce the client's maintenance hours by providing all around supervision. The consumer should be able to access essential information regarding his aquaponics system from wherever he physically is, as long as he has a connection to the internet. Moreover it should be feasible to regulate food dispensation, water temperature and the pump.
Concluding, the improvement of monitoring and controlling of every aquaponics is the central challenge we are facing. In order to provide an enhanced visualization it is mandatory to actually make the handling as easy as possible and at the same time imply as complex functionalities as needed.

1.5 Requirements

The project requirements are:

1. Use of low cost hardware solutions
2. Use of open source and freeware.
3. Comply with the following EU Directives:
    1. Machine Directive (2006/42/CE 2006-05-17);
    2. Electrical Safety: Low Level Voltage Directive (2006/95/CE 2006-12-12);
    3. Restriction of Hazardous Substances (ROHS) in Electrical and Electronic Equipment Directive (2002/95/EC 2003-01-27);
4. Mandatory adoption and use of the International System of Units (The NIST International Guide for the use of the International System of Units)

Furthermore we had to think about the requirements which arise when looking from the perspective of the end consumers.
What do the final clients expect? How could we even outperform these expectations?
Since the goal is to develop a mobile device function to monitor and control one's aquaponic's system from wherever you are, as long as you have access to the internet, several questions came up how to fulfill this task.

The main focus clearly was to accomplish an universal, easy-to-handle and user-friendly technique. The target group is as diverse as it could be. This means that even people with little or almost no technical knowledge should be able to use our system in a satisfactorily way.
The information which the user receives must give him an appropriate overview about the conditions of his aquaponics system.

1.6 Functional Tests

Functional tests are supposed to include a live broadcasting camera from inside the fish tank, measurement of conductivity and temperature as well as food dispensation. These should at least be able to be displayed over a mobile device.

1.7 Project Planning

In order to efficiently work on the project, we divided the next months in specific tasks and fields to work on. After defining these, we allocated them to different members of the team, depending on individual skills and abilities. The table shows the tasks and their allocations.

Table 1: Task Allocation

Task	**Responsible**
Gantt Chart	Jan
Leaflet	Katoo
Research materials	Viorel, Jan & Arick
Marketing Plan	Rasmus & Katoo
Logbook	Rasmus
Eco-efficiency Measures for Sustainability	Rasmus, Arick, Katoo & Francisco
Ethical and Deontological Concerns	Jan
Pre-Development	Jan, Arick & Viorel
Investigation	All
Team Presentation	
Final Presentation	
Interim Report	
Final Report	
Development	
Functional testing	

1.8 Report Structure

The report is structured into 8 major chapters, each containing several minor subjects. These are chosen as following:

1. Introduction: The team and the project are presented and introduced and the requirements are specified more detailled.

2. State of the Art: We present the various existing products and the progress of current technologies regarding our product.

3. Project Management: Is all about the organisation and management of the ongoing project including tasks and timetables.

4. Marketing Plan: Deals with defining our specific target groups and markets and how we seek to differentiate from our competitors.

5. Eco-efficiency Measures for Sustainability: Points out the 3 pillars economical, environmental and social responsibility and develops a life-cycle analysis.

6. Ethical and Deontological Concerns: Focus lies on ethics in general and how these affect our project work.

7. Project Development: The ongoing development of our product and upcoming issues and progress.

8. Conclusion: We draw a final conclusion on the project, our achievements and future perspectives.

Additionally the report contains Acknowledgement, Glossary, Bibliography and Appendices.

2. State of the Art

2.1 Introduction

The use of aquaponic systems is relatively young, under 20 years and at this time there were several companies and many homemade projects. Some of the projects include methods of control of the aquaponic systems and companies sell products at industrial scale, expensive or the products do not bring flexible solutions.

2.2 What is on the market

At this moment you can find some websites online that comes up with multiple offers. One example is: Hydroponic and aquaculture monitoring system, a wifi & bluetooth enabled, cloud-based. The basic package is 500 USD and doesn't have all sensors included and you have to play monthly data storage and access. Second example: monitoring data are posted via Twitter every 15 mins. The bad side of the project is no interaction with your system and just basic stuff. The third example: company motto ”Control everything, monitor everything”. The motto says everything. A negative part is just for industrial use, complex and for the price you have to call (for sure is not cheap). The fourth example: you can design your own project from other homemade projects, but only for special cases developed with different destinations and not a real limit of money.

2.3 Automatic feeder for fish

2.4 Topic 3

2.5 Conclusion

We think, in conclusion we need to develop a product that can be monitored remotely, controlled remotely, local database, streaming video and affordable for the average social class. In order to provide all this advantages, we will use open source software, free software and cheap hardware solutions. With other words, our goal is to offer solutions at low price.

3. Project Management

3.1 Scope

The aquaponic monitoring system uses the established requirements form the project description provided by the customer. With that in mind our focus was to develop a remote controlled aquaponic system with a food dispenser, video monitoring, temperature, and flow sensors. In addition the customer must have continues access information about the system. To manage the project scope we maintained communication with the customer to ensure our product meet the needs without over reaching, or exceeding the budget.

3.2 Time

Table 2: Timetable

Start	End	Task	Who
06.03	18.06	Wiki	Rasmus von Bröckel, Francisco Jose Ruiz Ludeña, Arick Davis, Katoo Van Tendeloo, Jan Rożewski, Stroe Viorel
12.03	18.06	Progress	Rasmus von Bröckel, Francisco Jose Ruiz Ludeña, Arick Davis, Katoo Van Tendeloo, Jan Rożewski, Stroe Viorel
06.03	06.03	Resources	Arick Davis
06.03	11.03	State of the art report	Francisco Jose Ruiz Ludeña, Stroe Viorel
06.03	11.03	Marketing plan	Rasmus von Bröckel, Katoo Van Tendeloo
06.03	11.03	Efficiency	Jan Rożewski
06.03	11.03	Sustainability	Rasmus von Bröckel
06.03	11.03	Concerns	Stroe Viorel
06.03	06.03	Motivation	Rasmus von Bröckel
09.03	09.06	Objectives	Rasmus von Bröckel
10.03	10.03	Requirements	Rasmus von Bröckel
06.03	11.03	Task allocation	Arick Davis
19.03	03.04	Prototyping	Arick Davis, Katoo Van Tendeloo, Jan Rożewski, Stroe Viorel
20.04	15.05	Improvements	Arick Davis, Katoo Van Tendeloo, Stroe Viorel
18.05	22.05	Construction	Arick Davis, Katoo Van Tendeloo, Stroe Viorel
25.05	05.06	Testing	Arick Davis, Katoo Van Tendeloo, Jan Rożewski, Stroe Viorel
08.06	08.06	Power	Arick Davis, Katoo Van Tendeloo, Stroe Viorel
09.06	09.06	Sensors	Arick Davis, Katoo Van Tendeloo, Stroe Viorel
10.06	10.06	Connection	Arick Davis, Katoo Van Tendeloo, Jan Rożewski, Stroe Viorel
11.06	11.06	Controls	Rasmus von Bröckel, Francisco Jose Ruiz Ludeña, Arick Davis, Katoo Van Tendeloo, Jan Rożewski, Stroe Viorel

Start	End	Task	Who
12.06	12.06	Response	Arick Davis, Katoo Van Tendeloo, Jan Rożewski, Stroe Viorel
08.06	18.06	Product	Rasmus von Bröckel, Francisco Jose Ruiz Ludeña, Arick Davis, Katoo Van Tendeloo, Jan Rożewski, Stroe Viorel

3.3 Cost

With budget and customer needs in mind it is important to realize what is with in the scope. The original product specifications asked for the ability to monitor conductivity. The tools and probes to do this would exceed the budget alone. To solve the matter it was critical to come to an understanding with the customer on the importance of this feature. Also to consider if the feature was worth increasing the budget. Once critical components were determined it was necessary to find quality components that were affordable and accurate. These are the components that are on the final budget.

3.4 Quality

3.5 People

3.6 Communications

3.7 Risk

3.8 Procurement

3.9 Stakeholders management

3.10 Conclusion

Provide here the conclusions of this chapter and introduce the next chapter.

4. Marketing Plan

4.1 Introduction

The marketing plan is an important part of the project. It is an essential tool for understanding who our target users and furthermore what their needs are. Every part of this chapter is helping us to act proactive in the market.
By analysing the circumstances and conditions in our environment and target market, it will be possible for us to create an individual marketing strategy in order to stand out against the potential competition.

4.2 Market Analysis

In the market analysis we take a look at the macro and micro environment of our company's product and feasible markets to enter. In doing so we identify the existent competition and their strategies and objectives.
First of all we have do investigate the general conditions our company finds itself in- so the macro environment.

4.2.1 Market Situation

Nowadays people are becoming more and more aware of healthy food and living, especially in the western world, where proportionally more people can afford to take these concerns into account. The sector of organic food and products rose remarkably during the last decade and no end is yet in sight. [1]
This boost in organic food also contributed to the fast growth of aquaponics systems' popularity. Moreover a reason to own an aquaponics system could be that customers seek to become at least partially self-sufficient to be less dependent on modern food industries.

4.2.2 STEEP Analysis

In order to get a better understanding of the market situation and investigate the macroeconomical factors concerning our product, we decided to carry out the STEP analysis, extending it by environmental aspects. This analysis allows us to get a sufficient overview of the current market environment.
The STEEP analysis is divided into 5 sections, which investigate on the social, technological, economic, environmental and political factors. Each one of these shapes our decisions regarding market segmentation and launch.

4.2.2.1 Social

The increasing demand on allegedly healthy food led to a fast growth in organic agriculture. [1] However producing these groceries claim higher expenses that are passed on to the end customers. [2] Due to these significantly higher prices organic food is, among other things, mostly achievable by higher loan households. [3] Spending more money on groceries and being able to do this can be an expression of wealth and high living standards.
Another important point concerning the social factor is the modern food industries which got increasingly into the focus of harsh criticism in the recent past. The aquaponics system offers a brilliant alternative to meet the need of becoming more independent from today's food industry and create self-supplying households. By this means people can take control of the nourishment they consume and how this is grown. Besides the image of a self-supplying household is also contributing to a reputable social status.

4.2.2.2 Technological

Looking at the technological factors plays a crucial role within this project. The system that we design

and build can be declared as a health, self-supply appliance based on electronical tools and resources. It contains many sensors and functions on a web-based monitoring base.
This is the reason why modifications and shifts in this field affect costs and quality and can also involve vast innovative changes.

4.2.2.3 Economic

The development of the organic food market worldwide and on our targeted specifically can be roughly used to determine the economic appeal of aquaponics systems and hereby involved technologies.
The total market size of the organic market rose from 15.2 billion USD in 1999 up to as much as 72 billion USD in 2013. The land on which organic food is cultivated increased from 11 million hectares to more than 43 million hectares in the same period of time, only representing 1 percent of the total agricultural land in 2013. [1]
This high price food sector [2] finds its biggest markets in USA contributing 24.3 billion €, Germany (7.6 billion €) and France (4.4 billion €). [1]

4.2.2.4 Environmental

As most aquaponics systems, especially in private households, are used indoor weather conditions have almost no influence whatsoever on the maintenance of these plants.
One of the major aspects of aquaponics system regarding environmental factors is the savings on water consumption within the production process. There is almost no additional wastage to supply water for the plants because of the circulatory symbiosic relationship of the aquaculture and the hydroponics units.
Nowadays already about 70 percent of the fresh water worldwide is used for agriculture. Additionially as much as 85 percent of the world's fish population is overfished. [4] This points out the need of alternative solutions.
Moreover aquaponics systems entirely avoid the exploitation and pollution of soil. These self-sufficient structures set an example on production efficiency combined with low affects of ecological footprints.

4.2.2.5 Political

Since our system involves a web-based technological gadget targeting domestic use of aquaponics or similar systems, there are no political regulations in place that need to be analysed more profound.
Eventually, on specific markets there exist political funds to subsidize start-ups focussing on sustainable, organic food production.

4.2.2 Competitor Analysis

By now there are several providers for aquaponics systems on the American, European as well as international market.
However only few concentrate on controlling and monitoring and even fewer focus on web-based models or apps to execute these tasks.
We are going to look at the two major of these specialised ventures closer in the course of the

competitors analysis. They are called OsmoBot and Open Aquarium.

4.2.2.1 OsmoBot

http://www.osmobot.com/
OsmoBot is a US-american company, which developed a controlling device especially for aquaponics system. They built an all-in-one gadget to record several data. These include pH-value, dissolved oxygen, water & air temperature, water level, relative humidity as well as light spectrum.
The data can furthermore be supervised via local networks or more distanced via an app by tablets and smartphones.
The system also includes a warning messaging service in case specific values reach a critical level.
OsmoBot has not launched markets yet and is planning on doing so in the middle of this year.
Additionally OsmoBot is planning on extending their system by gadgets to measure ammonia and nitrate.
The starting price for the basic device is 499 USD, the extra equipment for ammonia and nitrate is aimed to cost 399 USD each.

4.2.2.2 Cooking Hacks' Open Aquarium

http://www.cooking-hacks.com/documentation/tutorials/open-aquarium-aquaponics-fish-tank-monitoring-arduino
Open Aquarium is a system built and distributed by the Spanish electronics store Cooking Hacks, located in Zaragoza.
The system is based on a basic and an aquaponics kit as well as several extra devices, that can be additionally purchased. The basic sensors measure pH-value, conductivity, temperature, water level and possible leaks. Moreover the system includes automative functions such as there are a food dispenser, water temperature regulator, water pump and light.
The aquaponics can be monitored and controlled via a web based application, which furthermore runs on Apple as well as Android devices. The basic kit is not kept as small and handy as the OsmoBot device but brings focus into the pragmatic part of aquaponics systems.
To run all these functions properly it is necessary to buy the basic as well as the aquaponics sensor kit. These cost 398 € (199 € & 99 €).

4.2.2.3 major/minor competition threat

OsmoBot and Cooking Hacks don't show a real gap when it comes to prices. Open Aquarium offers a higher degree of flexibility and individualisation due to the fact that several components can be purchased additively.
Both of our main competitors' tools have similar functionalities as our system is going to have.
The crucial differentiation criteria though is, that we basically offer all functionalities in one single device.
Our product combines the aesthetic design as well as the web-based monitoring for mobile devices which OsmoBot offers and furthermore includes controlling devices such as the food dispenser, water pump, temperature regulation and light switch which is partly covered by the Open Aquarium gadgets.

4.3 SWOT Analysis

The SWOT analysis is a planning tool which helps us to identify **S**trenghts, **W**eaknesses, **O**pportunities and **T**hreats the product or company is facing on the emerged markets.

- Strenghts are attributes of our team/company that provide us with a competitive edge over other enterprises.
- Weaknesses are attributes of our team/company that could signify disadvantages on our side compared to others.
- Opportunities are features we could use to create additional value and doing so giving us advantage.
- Threats are circumstances that could possibly cause difficulties for the project and our objectives.

The following figure implies how these characteristics can and should be used in an optimum way. Figure 1 Shows the task derivation of the SWOT analysis.

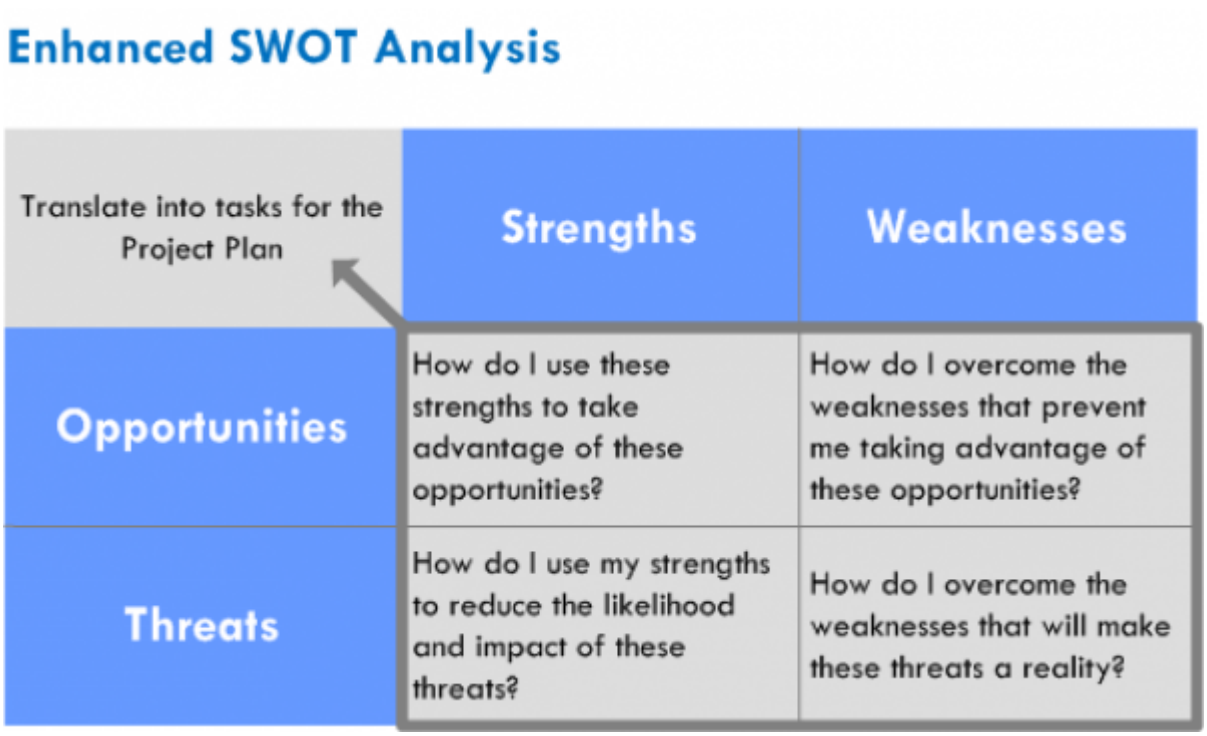

Figure 1: SWOT [5]

Table 3: SWOT Analysis

Strengths	**Weaknesses**
multilingual and -cultural team	limited budget
diverse knowledge	limited developing time
customizable product	new company
self-sustainable and eco-friendly	lack of market experience
Opportunities	**Threats**
quickly achieve large market share internationally	experienced competition
high growth rates in aquaponics worldwide	fast and vast launch of competitor's product
reasonably priced system	saturation of the market
great market potential	relatively easy to copy –> no patent protection

4.4 Strategic Objectives

In our first year we will target our product on the German and French market. Researches show that the demand is high in those countries. In the second year we want to extend our market share with 5% and acquire new European markets. We will observe very closely the evolution of Aquaponic systems and monitoring options in different European countries. So we can decide on which countries we will focus.

In the next year we will launch our product in the USA and Canada after finding American distribution partners.

We are constantly improving our service approach to our customers because the customer relationship is very important to us.

4.5 Segmentation

For the cause of the market segmentation we are having a closer look on 3 major differentiations. Demographics focuses on the customers' characteristics such as age, income and gender. The psychographics part takes attitudes, values and personality into account and the geographics section obviously works on the geographical scope of our target market.
Considering these features of our target group we can moreover derive the markets into smaller segments and devolve this knowledge to specify the scope of our future marketing operations. During this step we have to distinguish between:

- Mass Marketing: undifferentiated, all products, distributions and marketing aims to every person.
- Segment Marketing: differentiates different market segments. Further subdivisions can be concentration on only one segment, selective specialism or product specialization.
- Niche Marketing: high degree of specialization on particular submarkets and/or clearly defined target groups.
- Micromarketing: also known as individual/local marketing. Highest degree of specialization, dissection of the market until the individual costumer and his personal needs. –> “tailor marketing”

4.5.1 Demographics

Following an online survey in connection with commercial aquaponics production states that the mean age of the attendees was 47 ± 13 years with a range from 18 to 72 years.
Furthermore a majority of 77% within the group of participants was male. [6]
These data give a proficient overview about age and gender of our targeting group.
Since our system also intends to provide people with organic food who usually can't afford organic agricultural products, it aims at high and middle income but also at lower income households. A certain amount though must be contributed to build up the aquaponics system. Our clients who mainly purchase the monitoring devices for the reason of abscence from their systems can be assigned to the middle and high income section.

4.5.2 Geographics

Regarding the geographical classification of our future customers we mainly focused on the biggest

markets for organic foods worldwide. [1]
This statistics show that the vast majority of retail sales of organic food takes place in industrialized countries within North America and Europe. Moreover the 10 countries with the highest per capita consumption of organical food is found in these regions.
These findings clearly emphasize the importance of Europe and North America as present and future markets for agricultural products and coming from this, for aquaponics systems and associated technics.

4.5.3 Psychographics

Concerning the attitudes, values and personalities of our clients it is not possible to draw an exact conclusion.
But there are certain specifics we're aiming at. First of all the client should have an aquaponics system, comparable plants or is interested in purchasing or building one.
This can be for reasons such as health consciousness, the desire to be self-supplying, general interest in the field of aquaponics and aquaculture or simply the wish to produce food with one of the most sustainable methods.
Our main customer has an awareness on environmental issues, cares about his surrounding and is furthermore interested in sustainable progress.
Another fact, independent from these characteristics is the possession of an internet enabled device such as a smartphone, tablet or computer so the consumer can actually use the web-based service which comes with our instruments.

4.5.4 Conclusion

All these informations result in a more or less clear target group regarding our product. The majority of our clients is male and between 18 and 70 years old, located in the western hemisphere.
Our customers are interested in alternative methods of organic agriculture and partly technophile, possessing computer devices with internet access. Also they have the need of being able to supervise their systems even if they're not possible to be physically on spot at all times.
The entirety of these cognisances implicates that we follow up a niche marketing.

4.6 Strategy/Positioning

Positioning implies the consistent tracing of a clear, unique and desirable position in the performance of the target segment compared to the competitors.
“An effort to influence consumer perception of a brand or product relative to the perception of competing brands or products. Its objective is to occupy a clear, unique, and advantageous position in the consumer's mind.” [7]
The positioning strategy scan can be divided in 3 stages:

- Identifying possible competitive advantages
- Choosing the appropriate advantages
- representing the choice in the most convenient way

Figure 2 shows the approaches to identify possible competitive advantages and from which section of differentiation these originate.

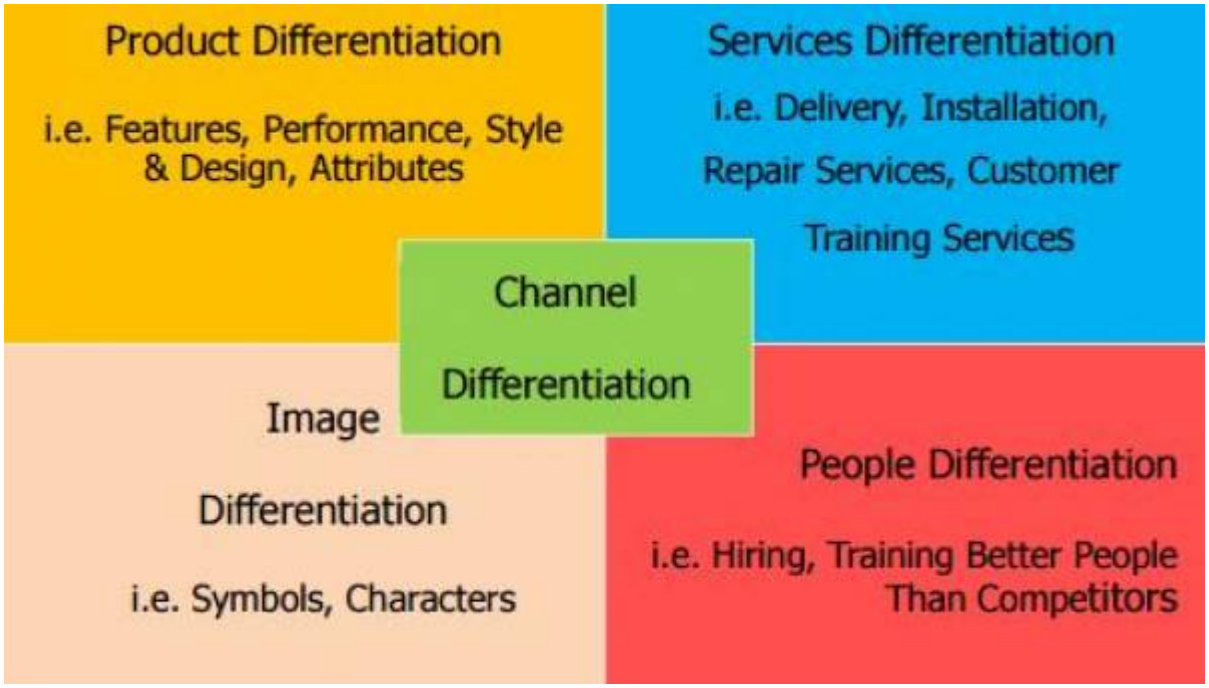

Figure 2: Identifying Competitive Advantages [8]

To elaborate this task, we can have a look back at the SWOT analysis and screen our most precious characteristics that give us the advantage we need to succeed over our identified competitors.
We can filtrate specific Strenghts on all levels.
The aestethic design we strive for and the extremely user-friendly performance of our system stand for the product differentiation. Comparable to Apple's iPhone, we work on a foolproof display control, without neglecting sufficient complexity of our systems.
Additionally the installation is supposed to be as easy as possible in order to reach costumers without a professional technical background. We can furthermore distinguish over a redemption service which comes straight with our sustainability policy.
Moreover we represent a young, vibrant, international and highly motivated team and this is greatly communicated through our product as well as company vision and mission. As a result we can create the image of a self-confident, reliable start-up.
Figure 3 illustrates our targeted product placement regarding to the major important criteria user-friendliness and scope of funcionality.

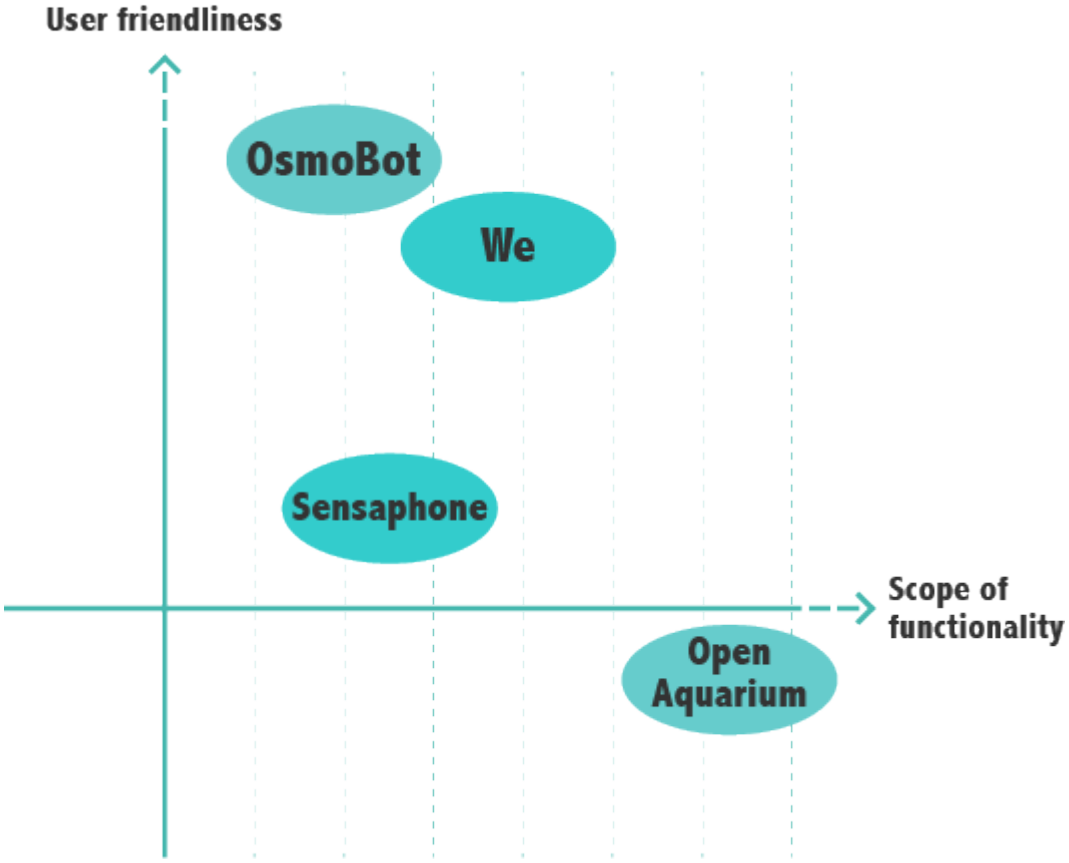

Figure 3: Distinguishing from the competitors

Our objective is to present the market an integral system. It aims at more potential costumers than each of the competitors because we can introduce a system combining all positive advantages without give up on any extras. Our solution makes aquaponics system and the monitoring and controlling which comes with it a cool hobby for a wide range of clients.

4.7 Adapted Marketing-Mix

4.8 Budget

4.9 Strategy Control

4.10 Conclusion

Provide here the conclusions of this chapter and introduce the next chapter.

5. Eco-efficiency Measures for Sustainability

5.1 Introduction

Aquaponics systems inherently offer environmental, economical, and social benefits. The addition of our remote control capabilities makes the system more efficient from the perspectives of power and

energy consumption. As a result of improved efficiency, electrical power consumption is reduced. Ensuring the system functions properly reduces operating cost. The remote access allows the user to have more time for other responsibilities and not have life interrupted by their aquaponics system. In order to effectively implement eco- efficiency and sustainability we consider the importance of the production and delivery of our product. These measures include where we get our components, where we produce our product, how we transport it, and who we hire. These are all key topics for maintaining sustainability.

5.2 Environmental

The electronic components forming the aquaponic remote system can have serious adverse environmental problems. Although, industries do their best to stay within the safety regulations and there is always room for improvement. A problem can be seen in the electronic waste, where a large number of electronic devices need to be processed and disposed of properly.

Improper disposal can lead to serious health problems due to lead, cadmium, and beryllium may be contained in the devices. Currently industries are striving to increase security chemicals and improved methods of disposing of electronics future. The Aquaponics section of this project explores the positive effects it has on the environment. With the establishment of a system of sustainable organic food production people are able to produce their own food without damaging the environment. No byproduct and without chemical waste. The system is a closed loop system with a chemical.

Often referred to RoHS as the “lead-free” directive, but restricts the use of the following six substances: Lead, Mercury, Cadmium, Chromium VI (also known as hexavalent chromium), PBB, PBDE For our remote aquaponic-system work, we need electricity. How do we get that electricity? The most sustainable way to obtain a sustainable energy through renewable energies would. However, the installation of any type of this energy is very expensive and its life is scarce. Furthermore, our priority in our control system is fish. This does not mean that our system is not sustainable, in contrast, have designed an efficient energy aquaponics using the least possible burden, especially at night when there may be little or no electricity is generated. Therefore we studied our sistem acuaponyc for their work in the hours where less energy is consumed getting a lower cost of energy and less pollution.

the remote application medioamientales aquaponic-system brings improvements to its electronic components, also improves the daily use of our system. For example, to control the level of water we can significantly reduce water use, since we have a sensor which determines the water level in the pond. Therefore, the pond will always have clean water as it is constantly renewed and would not use chemicals if the water was not in the best condition

5.3 Economical

The market offers a wide range of control systems for aquaponys system. However, these systems are extremely expensive in relation to the product that we intend to build. For our product as economical as possible we strive to ensure that our system: food security, sustainable decision-making and promote the success of our customers. 100% of our components (software and hardware environment) are Portuguese, which greatly reduces the cost of transportation and encourage job creation in the country. Reducing the electricity bill and water is also very important for the production of plants and fish from our aquaponics system. So our system provides a sensor that measures the water level. If the water level drops, the water level in the tank will increase; so does

the boiler is only activated when the water temperature does not correspond to the optimum conditions. Tank light lights remain off and only when we activate the camera from home to see our fish and feeders are scheduled to throw food at times less energy costs.

5.4 Social

For the user: People these days are always attainable by their use of smartphones, tablets and other devices. Monitoring your aquaponic system from distance would fit perfectly in our lifestyles these days.

Because the app is web based it’s possible for the client to control their aquaponic system from a tablet, a smartphone or a computer. Most likely you always have one of these devices with you. The user can enjoy it more because you can control it wherever and whenever you want.

This also means it is timesaving and the user will have more time for family, hobbies, work and other activities. The user can also safely leave for a holiday or business trip, without having to explain everything to the neighbor who would take care of the system while he is gone.

This can also be persuading for people who want to get an aquaponic system but are in doubt of being able to maintain it.

For the company:

Production: We want a green building that is environmentally compatible and a healthy work environment. We insure that our materials come from sources that do not have a history of abusing the environment. We also insure that all our are employees are capable and comfortable and are treated in a respectful maner

Strong economy: We create all the jobs we need to finish our product. We will offer a faire wage for our employees and healthcare insurance.

Skilled employees: We want skilled employees who basically know what they’re doing so we can create safe environment. In our company there is also space for improving skills by offering skill training.

5.5 Life Cycle Analysis

It is a tool for systematic evaluation of the environmental aspects of a product or service system through all stages of their life cycle. With this tool we aim to assess the environmental impact of our product and create a sustainable product that occurs: the reduction in use of toxic materials, recyclability, use of natural resources and the length of our product. The life cycle of a material which can be separated into the following parts: extraction of raw materials or Adquisition; manufacturing and processing, distribution and transportation, use and reuse, recycling and disposal.

Extraction of raw materials or Adquisition. We do not manufacture all the parts into our system acuaponic system so we will have to contact different suppliers. It is very important that the materials are of high quality and responsible to the environment. To save energy in this process all our manufacturers are Portuguese so the cost component is reduced as energy and transport reduction and increase of the Portuguese economy occurs. Moreover, almost all our components from a

company so the savings on shipping and packaging is much higher. Many of our components are not Portuguese, so they have to be transported; in the case of the boiler, whose country of origin is German. However this product complies with RoHs certificate of conformity so do not hesitate to choose it.

Processing and manufacturing By manufacturing our product must take into account that it is a product manufacturing- intensive product. This means that having many electronic components, to verify that all of these have a long durability. As we ourselves are going to assemble the product, we will save energy.

Product Transportation

Use To use our acuaponic systematic control system is necessary to have electricity. As we know, getting electricity from renewable energy is sustainable but increase the cost of our product, so we do not “autoabastecemos”. However, we have meticulously careful choosing our components therefore thus consumption is lower and its performance resembles the ideal (100%)

Recicling If any component of our aquaponys system stops working. We can take care us Repair I change the component, so that we ensure that the user does not make a bad use of this component and ensure that this component will be recycled. Provision.

5.6 Conclusion

Provide here the conclusions of this chapter and introduce the next chapter.

6. Ethical and Deontological Concerns

6.1 Introduction

The importance of ethics in all aspects of life cannot be neglected. It influences human decisions, points of view and behavior. Because of that, it is essential to consider all concerns that might arise during project designing and production. For example: are the aquaponic systems new chicken farms? Meaning are the animals being grown to exactly fit human needs with minimal necessary comfort given. That concern is being overcome with ensuring that the prototype will allow to give the fish the conditions closest to natural concerning nutrition as well as comfort. Moreover, the ethics is the complex issue connecting different approaches and fields. In this paragraph the doubts connected with project design, development and production will be discussed as well as the marketing strategy ethics, the system impact on the final customer. The intellectual property and liability concerning the project will be also covered. The aquaponic system control is even more difficult and complex task for designing due to having to deal with two different kinds of living organisms – plants and fish, which leads to necessity to consider influence on both of the types as well as codependences between them.

6.2 Engineering Ethics

Engineering ethics is the study of moral issues and decisions faced by individuals and organizations

involved in engineering, also considered as a study of issues related to moral conduct, character, ideals and relations of peoples and organizations involved in technological development. The profession of engineer influences many aspects of life of individuals, such as security, economy and welfare.

OBLIGATIONS OF ENGINEER

Integrity and honesty:

- The Engineer pursue himself behave with honesty and diligence, and during the performance of their services.

- Protection of society and the environment: Engineers, within its scope of action must give absolute priority to safety, health and welfare of the Company and its customers, and always direct their work to obtaining the best results. They should contribute their work to preserve the environment and sustainable use of natural resources. Responsibility

- The engineer must be aware of the importance, at all times, may have their actions and decisions, taking responsibility for them in the form and manner as may be ethically and technically sound Advertising

The Engineer shall not make false advertising of their ability, knowledge or experience. Dissemination of knowledge The Engineer shall, without prejudice to the rights of its intellectual property, has an obligation to contribute their knowledge and achievements for the benefit of the Company and the profession, all provided within the strictest truth without appropriating the ideas , achievements or contributions of others. We also noticed other obligations of the engineers who make aquaponic system monitoring sistem to improve our product.

CUSTOMER OBLIGATIONS

- The Industrial Engineer must always have an attitude of service to your customer, defending their interests as if they were their own .. It will inform its customers of few deviations or incidents may affect the objective of the contracted work. Relationships with suppliers and providers

- Without prejudice to the required discretion, Industrial Engineer shall, with suppliers and vendors, a loyal relationship of collaboration and exchange of information which contributes to increasing the quality of work and service improvement

6.3 Sales and Marketing Ethics

Ethical problems arise in marketing activities. Many companies today do not meet the ethical standards in their actions because a quick profit more interested in the product warranty. However violating the code of ethics in marketing can bring benefits quickly, but then a deterioration in the business, a loss of credibility and customer confidence will occur.

For us communication with the customer is the most important fact and that is why we seek to be transparent, understandable and attractive. Only then get the trust and customer welfare and thus get a mutual benefit. The customer will be satisfied with the quality of the product and we will get benefits and the satisfaction of having done a good job. Therefore we use advertising as a tool of communication with the customer so clearly inform the results that can be obtained with its use and technical details of the device, the customer can choose freely whether the product meets your

expectations . It is not to create false advertising, we want to move in the world of advertising rationally and good manners.

As mentioned in the marketing plan, the demand for organic food makes our customers and savings in water consumption in the production process, as well as other environmental factors cause more interested in aquaponic systems like system . So we want to reach these customers who have these systems to facilitate further their daily lives.

6.4 Academic Ethics

When we formed as a group, we thought we had to take a set of guidelines or what is the same, follow an academic ethics. So we decided it was important to establish an academic ethic group and the other with respect to our coordinators of the subject.

- Obligations as a workgroup: We are aware that each come from a different country, different cultures, different studies so it is very important to establish an academic ethics. We as workgroup we have a relationship of mutual respect, understanding, kindness, solidarity, loyalty and cooperation. In establishing these premises provide a good atmosphere in the team and therefore increase the motivation and enthusiasm for the job.

- Obligations with teachers: maintain respect for our teachers and their work, participate in all classes and go to meetings well prepared for them to help us improve our project Finally we must take into account the definition of plagiarism. “Plagiarism is when a person takes the ideas or words of another person and used in any oral or written work without giving credit to the person whose ideas or words are being used.” Therefore, every time we collect information from internet and make use of it in our work must reflect the place from which the information. To carry out our work we are using open source software to avoid problems licensed programs.

6.5 Environmental Ethics

Environmental ethics is a part of philosophy that deals with the study of the relationship between humans and the environment. He worries that men do not conflict with the development and evolution of natural beings.

At company level environmental ethics requires responsibilities for the care of our natural environment and therefore we must seek the welfare between society and nature to humans can develop in an environment free from pollution. Environmental problems and product life cycle are linked so try to minimize the environmental impact of the final product.

To meet the environment must meet the guidelines set out the EU regarding waste management and electronic equipment (WEEE) which requires collecting electronic devices that are no longer used. So try our product

- Be free from harmful materials such as lead mercury, lead, cadmium … ie comply with European RoHS

- In case of breakage of any component of our product, we will take care of dismantling and repair parts to try to reuse or recycle if that could not be reused

- Ensuring that the product materials are long durability and quality.

- Produce energy savings both in its manufacture and subsequent use

6.6 Liability

To end the ethics of our product, we have to consider the responsibility we have with our customers, supervisors and law. The errors should not exist in our product and we will build on to achieve the following:

-we have to comply with the law of intellectual property related to our product. We have to consider: copyrights, trademarks, and not to infringe existing patents none of these

- Dissatisfied customers: when complaints are reasonable we will be the first to meet customer needs. We comply with the legendary motto “the customer is always right”. so this does not happen we will have to establish warranty terms, so that if failure by our fault (bad installation, poor quality of components …) are repaired as quickly as possible.

- Safety instructions, “user manual”: the client must know what comprises the product you purchased and its operation. We must also warn of the potential risks could have on your health if you use the product in an inappropriate way

6.7 Conclusion

We have established ethical and professional for the manufacture of our product and its subsequent use is optimal bases. Therefore establishing this code helps us to improve relations between us and future customer relationships. Now that we know we need ethics go deeper into the product, make the design, components that are going to be … something we will discuss in the next chapter

7. Project Development

7.1 Introduction

As we know an aquaponic system is a habitat where fish and plants coexist. Buying an aquaponic system is easy, keeping it is a challenge for everybody and that requires time and involvement. Without human intervention aquaponic system doesn't have long life but the technology is accessible for easy maintenance. The objective of our project is to deliver a product that can be installed on a existing aquaponic system which will be easy to control and monitor.

7.2 Architecture

7.3 Components

In order to achieve monitoring and control was created a list of necessary components.

- Rasberry Pi model B+

Raspberry is a single-board computer and will be used to send and receive data over the internet, to control an arduino microcontroller and a webcam for video surveillance.

- Arduino Uno

Arduino is a single-board microcontroller used for receiving data from sensors and controlling the pump, heaters, light and a small motor (motor is for feeder). Arduino is connected with Raspberry Pi trough a USB cable.

- Memory card 16 GB

Role of the card is to run the Linux platform on Raspberry PI and store data.

- Webcam

The webcam is just for video surveillance.

- Relay Module

Relays are electrically switches for: light, pump heater and the motor of the feeder

- Temperature sensor

Temperature sensor is for monitoring the water temperature.

- Water Flow sensor

This sensor will tell us if it pump works.

- Depth sensor

Depth sensor we will tell the water depth.

- Optical sensor

This sensor will be put in food dispenser for measuring how much food is.

- Water Pump

Pump for pump the water from fish tank to plants.

- Heater

Heater is for maintain the right temperatures of the water.

- Stepper Motor

A motor to put in motion the fish food.

- Food dispenser

This parts is to feed the fish and have the following parts: stepper motor, optical sensor and plexiglas.

- Light LED

Light to view fish in the night via webcam.

- Power supply

We need one for Arduino and one for Raspberry Pi

- Switch board for routing power from wall
- Pole plug with switch and fuse door

7.4 Functionalities

7.5 Tests and Results

7.6 Conclusion

Provide here the conclusions of this chapter and introduce the next chapter.

8. Conclusions

8.1 Discussion

Provide here what was achieved (related with the initial objectives) and what is missing (related with the initial objectives) of the project.

8.2 Future Development

Provide here your recommendations for future work.

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Appendices