Master Thesis in Social Media and Web Technologies

Studying the impact of a mobile application in food waste reduction, circular economy, and social interaction inside the community

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Abstract

Social and ecological sustainability applications are a significant way to bring equality, equity, and happiness in society. Food waste and food security are two of the most significant problems the people have to tackle the next years. In every country, there are huge problems regarding the food waste which cause serious health problems and pollution not only in the atmosphere but in the subsoil as well. Contrary to that, there is a countless number of people facing food security issues every day across the globe. These problems occurred in Greece as well due to the modern way of living on one hand and the financial crisis on the other. A combination of technological ideas in the economic field of the circular economy could be applied to succeed in sustainable solutions.

In this thesis, a literature search conducted in order to identify similar problems in Greece. There are very worrying statistics that indicate the massive food waste that is happening in Greek households. Additionally, the literature search for food security and unemployment reveals the significant problem occurred in society as a result of the financial crisis. An additional search in the field of the circular economy reveals excellent solutions in the agricultural machinery sharing and refactoring that could be applied locally, exploiting the existing infrastructure of the community. These solutions help small and young farmers to improve their financial situations. The author is exploring the effects of the financial crisis in the local economy in an effort to apply technological solutions in a form of a mobile application to interconnect people and make the donation, sharing and job search easier for the community. The ultimate goal of this study is to develop an application that could help the community to move towards social and ecological sustainability.

Even though the ideas applied in this thesis are fresh to the community in the author’s region, the results of this work indicate that there are significant support and willingness to contribute. The development efforts are focusing on a mobile application where its features are focusing on the best possible interconnection among people of the community. Participants believe that the application interconnection along with the features provided, like the food donation, food sales, machinery sharing and job search among people of the community, could bring positive results reducing the food waste, promoting the circular economy, and toning the local economy in general. The data have shown that the author is moving towards the right path in his first attempt to present these ideas to the community in his region. Every participant in this study embraces his efforts finding potential value in the provided features of the application.
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Keywords

Mobile Development, literature review, food waste, circular economy, sustainability, community sharing, financial crisis, donation, Ionic, Cordova, Angular, SASS, HTML, Typescript, Google Firebase.
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1 Introduction

The world is facing one of the biggest challenges ever in climate change. Applying the sustainability principles [1] in the society is critical in order to reverse the negative effects and move towards a more sustainable and prosperous future. Problems like food waste and soil exploitation are two of the most critical problems that concern scientists. However, to achieve ecological sustainability and raise awareness motivating people to act, there is an imperative need to move towards social sustainability as well. Social sustainability is a two dimensional relationship between inequality and poverty with the human resources investment occurring in a society. When a society invest in humans and their quality of life the humans tend to build trust and cooperation among the society groups that lead to a happy and prosperous society. This thesis will focus on how human, and material resources investment and management strategy could reduce poverty and inequality in the community [2]. The investment strategy includes ways to help and provide to people in need and provide new opportunities to a stagnant community.

1.1 Food Waste

One of the most significant contributing factors to food waste is human eating and the poor management of this food [3, 4]. There is an estimation that the 27% of the European environmental impact is related to food consumption [5]. A great part of this percentage of food waste is related directly with food consumption and the leftovers of this process. The rest of this percentage related with expired or rotten food products. Food waste is every composition of raw or cooked food materials that includes food loss, before, during, or after meal preparation in the household. An additional contribution to food waste is the food discarded in the process of manufacturing, distribution, retail, and food service activities [6].

1.1.1 Food Waste and pollution

There are many implications of the food cycle in global warming that makes scientists worry. A huge concern about the wasted food is its relation with global warming. As the author mention above the 27% of the pollution in Europe is produced by wasted food. It is a very big number considering that the rest 73% is all the factories, transportation vehicles, airplanes, livestock industries, and natural disasters such as fires and volcanoes. The food waste emissions contribution identified by greenhouse emissions from biodegraded
food in wastelands or landfills. According to the Waste and Resources Action Programme report [7], most of the food that thrown away could be avoided if at some point before disposal consumed. The modern way of living and the abundance of product in developed countries drives people to overconsumption with various adverse effects on their health and the environment. Having in mind that food management is crucial, general population should understand that food management, along with food wastes related closely with their health and their overall way of living. So if it is done correctly it could have a positive impact on the environment.

1.1.2 Implication of food waste in the economy

The Food and Agriculture Organization of the United States estimated that the European and North American food waste generation is reaching up to 95-115kg/year per capita. If this result is multiplied with the earth’s population, the result is billions of tonnes of food waste globally [8]. In addition to all these data about the environmental impact of food waste, money loss is occurred as well. An estimation of 30 billion U.S dollars is the value of the disposed food in the United States of America [9] alone. In the same time, the United Kingdom throws into the garbage 12 billion British pounds [10] in a country where people claim that they are very cautious with the amount of food they are throwing away [11,12]. The numbers become staggering if every country added in this equation.

1.1.3 ASWR model

Contrary to the numbers presented in the previous sections, there are millions of people all over the world where food security is a continuous struggle. Better food management inside the community is critical. A conceptual model which is called the Availability-Surplus-Recovery-Waste model presented in the figure below in order to identify the categories of food that are consumable and good for people’s health contrary to many people’s beliefs that it is not [13]. The main focus would be on how the model separates and handles the excessive food to apply the same principles and information in the thesis model and application. Below is the diagram which describes how the model works.
1 Introduction

1.2 Circular Economy

The concept of the circular economy was introduced by Robert Ayres in the early 1990s [14, 15]. The circular approach is different from the usual linear production model that the current manufacturers use. It is a very efficient way to reduce fossil fuels consumption from industrial processing, moving towards a cleaner and more sustainable future. This circular economic model suggests to earn money selling or reusing already made artifacts and not rely on the flow of the materials gathered from the soil and new products [15, 16]. In a comparison between linear and circular model Farong and Nan [17] characterize the circular economy as a revolution of economic development models because financial development is focused on the reduce, reuse and recycle model reducing the exploitation of environmental resources for building new materials [17, 18]. As a result of this shift, the product usage approach should be in a closed loops system. This system can be assorted into two types of loops:

1. The reduce and reuse of goods and materials.

2. The recycling of the materials [15, 19, 20].
A very descriptive graph gathered from circular economy lab [21] presents accurately how this economy works.

Fig. 2: Circular Economy Framework [21]

1.2.1 The benefits of circular economy

This thesis focuses on exploring efficient ways to reuse goods without diminishing the value of recycling. In the following sections, there would be a detailed requirement analysis to find useful information about the current status of the community along with efficient ways to manage food and materials like reusing, sharing and extending the life of agricultural machinery and professional tools.

The circular economy is a fantastic concept. As mentioned before and shown in figure 2 circular economy promotes ways to extend the usability of every piece of material. To apply and benefit from this concept, people need to get informed about the potentials of everyday things. Extension of clothes usage, tools sharing, donation and recycling of unused objects and materials, food management, and the pollution humans cause to the environment could
be among this information. People need to understand the concept of carbon footprint fully and comprehend that everything they use and consume daily needs natural resources to be produced and transportation costs to reach to their hands. These resources are finite and considering the overexploitation of many industries all over the world, humanity moves towards the complete depletion of every possible resource and material to the next decades. If this happens, it could radically change the way people live, and the consequences is possible to exceed the boldest imagination. Thinking of a world that people had to live with the existing resources without having the ability to gather more from the soil is somehow terrifying. The greatness of the idea of circularity focus on the way humans create new sources of materials to build things from the existing objects. The circular economy has many extensions in the society and the life of people as well. The extensions of the circular economy include recycling, local shopping, and sharing inside the community. There are many social sustainability connections with the circular economy. When the community living meaningfully and act sustainably the economy of a region upgraded and better opportunities occurred. A significant advantage of this economic model is that it could adapt its features according to the needs of every community envisioning and improvising innovative ways of reuse and recycle of goods and materials. This concept could be applied in every community of every city on the planet. The main requirements are to be receptive and willing to put some mental and physical effort to promote the value of sharing in the community. An unbreakable requirement is to see every person’s needs equally without discriminating and respect our fellow citizen.
1.3 Identifying similar challenges in local communities in Greece

In Greece finding relevant literature that indicates the exact amount of waste produced across every section of the society and industries is extremely difficult. However, in research conducted by Harokopeio University [3], presents interesting facts about food waste in households. In the following graphs, displayed a close estimation of household waste and their classification between avoidable and unavoidable waste. The estimation of avoidable waste is about 30kg per person considering the 100kg of food waste a person generates annually.

Fig. 3: Avoidable (Left) and Unavoidable (Right) Food waste in Greek households [3]

Observing these pie charts, anyone could easily distinguish the large food waste problem occurred in Greek households. Combining the essential categories of bread, fruit, and vegetables, 53.4% of the uncooked food waste is avoidable. If the cooked food and dairy are added in the equation, then the summary rises to 89.2% of avoidable food waste. The main reason for this wastefulness is the poor management of the food regarding the expiration dates and the portion calculation. Most of the times, the lack of awareness and environmental education led to these faults. People should reflect on the impact of this wasted food both in the environment and in many people’s lives who struggling for their food security. Additionally,
citizens should be aware of the food waste pollution and the consequences on their health. An alternative solution to the bad food management is the provision of donation channels inside the community.

1.4 Unemployment in Greece

In an effort to emphasize the problems of unemployment in Greece the author is presenting some useful information about the problems occurred in every region of Greece. As a result of these facts there should be a search for solutions that could be embedded in the current research in order to provide opportunities to people who are in need.

Greece, since 2010, is facing one of the most difficult periods in their financial history. The European countries faced significant public deficit and public debt due to disastrous bank policies and the denial of financial markets to cover their public debt. Greece faced many problems of public deficit and public debt years before the financial crisis [22, 23]. Since Greece was in desperate need for financial help asked from European Instances and International Monetary Fund to support the country sending financial help.

In order to pay back the amount of money sent, Greece had to take serious adjustment measures to lower its deficit and public debt [24]. These hard adjustments have major consequences in people’s lives. A large number of people lost almost thirty percent of their salary. This lack of cash led to a financial meltdown, leaving a huge number of people jobless. The tables in appendix A shows the unemployment rates from 2005 to 2012. Observing the Greek unemployment numbers the years after 2010, the statistics increased significantly. Studying this data of unemployment, the author focuses on the region of Thessaly to bring efficient solutions. This area is the biggest agricultural and food production region in Greece. The departments of Trikala, Karditsa, Larissa, Magnesia have high unemployment rate, which fluctuates between 15.9 and 33.3 and keeps rising the years that followed the financial crisis.

1.5 Circular Economy in Greece

Greek literature on circular economy models focuses mainly on waste management and the recycling process. This thesis, as mentioned in subsection 1.2, will focus on the study of the reuse model of the unused and old materials like metal, fabric and plastic along with the utilization of the standstill agricultural machines using the interconnection that the project application can provide. Additionally, interviewing local businesspeople and prominent persons will unveil their capability to support such kinds of actions and discuss
potential challenges people will face in order to share and reuse the standstill machinery. Another idea discussed is the refactor and the life extension of the withdrawn machines promoting the circularity as a new economic opportunity for the region.

Circular economy concepts are limited in Greece, and considering the insufficient environmental education, this prototype could become an excellent opportunity to raise awareness and promote a combination of technology and circular economy ideas in the community. These ideas should be supported by the people of the community and the municipality to promote cleaner and eco-friendly solutions. The first circular economy forum that took place in Greece tries to bridge the big informational gap of environmental awareness and circular economy applications in Greece [26].

The concepts discussed in the first Circular Economy Forum in Greece took place on 8-9 April of 2019 were:

- How governments can put the Economy in Circular Economy.
- How to keep value in business and job opportunities.
- Getting the economics right for effective waste management.
- Cities and the Circular Economy.
- From Financing Waste Management to Financing the Circular Transition.
- Circular Potential for SMEs.
- Separation Collection and the Biowaste Challenge.

Such concepts are essential for the future of the cities and the communities. Applying circular economy concepts could lead to a cleaner and brighter future where people will live with respect to the environment. The overall effort of the author is to integrate these concepts into the prototype aiming to raise awareness as much as finding ways to drive people to take action in favor of the environment and fellow citizen.
1 Introduction

1.6 The motivation behind the idea

As a community member and part of the constantly changing labor market the author experienced first hand the problems related to financial instability in the last eight years. As an active environmentalist for over a decade, he is aware of the sustainability problems of society and nature. As a result of this awareness of the problems many ideas came into his mind. The most promising was to apply all the knowledge gathered from this Master Program and consolidate all the data gathered during this thesis to develop an application where it could combine sustainability solutions to food waste management and circular economy to provide solutions for the revival of unused and unnecessary things contributing in the local economy.

There would be no efficient solution if it could not add the human factor inside the equation of this research. After the discussion with many influential people of local communities in Larisa and surrounding areas, the researcher concludes in section 3 that adding people who are in need into the study is crucial.

This addition is the main reason to use unemployment statistics presented in section 1.4. The decision to inform about job opportunities in jobless people gives the author an extra motivation for the value of this study. Social sustainability is one of the most critical parts of a harmonious society. It is defined by all the positive and negative effects of all society systems and organizations on people and their social life [27]. So the improvisation of solutions that could provide equality and stability in the community is crucial. The noblest act in a meaningful life is to help people who are in need. So the combination of concepts that implicate food management, circular economy, and ways to reduce local unemployment makes an excellent recipe for a successful effort.

1.7 Research Domain

The research domain of this Master Thesis will focus on the potential impact of a mobile application in food waste, circular economy and people’s interactions inside the community. The first question formulated to focus on the essential parts of the circular economy and sharing. The second question formulated to focus on the ability of the application to raise awareness and induce people to search for new social opportunities that promote equality and welfare.
1 Introduction

1.7.1 Research Questions

The research questions that seek justification are:

1. Can a mobile application be an efficient mean to induce people to share and promote circular economy in the community?

2. Are the provided features of the mobile application foster people’s willingness to share, donate and promote circular economy principles within their communities?

These research questions explore the value of a mobile application inside the community to bridge the communication gap and be a strategic addition to the limited informational system applications in the region. Expanding the research, the author studies the features a mobile application should have in order to make a potential impact to the community triggering the willingness of the users to provide and promote meaningful actions for a better community.

1.8 Ideas and technology in action

To frame the project and establish the ground work for the technology development a set of requirements had to be defined. For application development, a question-option-criteria analysis will be applied to choose the best framework for the prototype. The idea is to select the hybrid development approach that provides the ability to use the same code base for almost every existing platform. The detailed framework analysis, along with the selection criteria, is described thoroughly in section 5.

1.9 Thesis Outline

Initially, the thesis starts with sections 1 and 2 presenting the introduction and state of the art. This section introducing the comprehensive planning of the literature, the choice of topics, and the criteria followed to conclude with the most relevant research articles and books. The following sections focus on the mobile application. Section 3 suggests the requirements of the application as described by influential persons of the local community. Subsequently, the sections 4 and 5 describe the conceptual design along with the technological specifications. The sections 6, 7, and 8 of the thesis present the implementation of the prototype and the overall evaluation framework which consists of the settings, documents, and methods followed in this piece of work.
Finally, the sections 9, 10, and 11 present the findings and the analysis of the evaluation. The document finishes expressing some reflections in the discussion. Last but not least, the conclusion describes the work and efforts, envisioning the future work that could make the prototype even better. The following diagram presents the overall thesis structure.

Fig. 4: Overall Thesis Structure
2 State of the Art and Research Methodology

This section presents the path to evidence in the literature that indicates the seriousness of the researched problems. Considering that the thesis is administering sustainability problems inside communities, the exploration of the seriousness of these problems and their effects in society is compulsory. Additionally, the author is going to address how technology could provide efficient solutions to these problems.

A mobile application, which is an essential part of the research, will be developed afterward. So, the exploration of the appropriate mobile technology is mandatory as well. Previously published related work examination is critical in order to build a better understanding of the research topics. This method needs proper literature planning to obtain the most accurate information and approaches in the field, as mentioned in section 1.7.

2.1 Sharing Economy

Sharing economy is a concept where groups of underutilized assets find flourishing opportunities in web-based platforms [28, 29]. Sharing economy is applied in numerous organization in various fields that play the role of the mediator between the users and the owners. Sharing economy models is applied in areas like the automotive industry, people’s accommodation, education, and countless others [30].

Sharing economy is a unique opportunity for ordinary people without extensive business knowledge to build a profitable business and find financial opportunities on the one hand and provide efficient solutions to their everyday problems on the other.

Similar to this concept, the author is trying to utilize the standstill and unused agricultural machinery and professional tools using a mobile application that plays the role of the mediator using the provided technology. The prototype presents a very early stage of the presentation and the functionalities of the features due to the lack of time.

The final idea is people who are interested in sharing machinery or tools to pay a small amount of money every time they use something or pay a monthly subscription that could support the technological infrastructure and the maintenance of the machinery and tools. In this case the application focus solely on customer to customer connection inside the community bridging the gap between the person who has standstill machines and in professionals who need them trying to provide the best possible value to both ends.
2.2 Applications to support the sharing economy principles

Many applications support sharing economy principles in many different categories. In ride sharing, there are two very popular among many applications which are Uber and Lyft. These two applications can provide transportation services using private cars. This concept not only connects professionals with consumers but it offers the ability to share the ride with many people to reduce the moving cost.

As regards the people’s accommodation, there are popular applications like Airbnb and Home Away that provide the opportunity to rent private homes or condos all over the world and use it for vacation. The owners of the house are setting the rules of accommodation along with the price and the availability.

Additionally, some applications support the sharing economy in education, as well. Such applications are Udemy where a user who is an expert in a specific field can create its educational material and provide it for free or on fee through a mobile and web platform. In a slightly different approach, Codementor provides the ability to hire an expert developer to help the user with coding problems, like bugs, performance issues, and compatibility problems.

Sharing economy applications have many potentials and help numerous people across the globe not only to earn money but also to find opportunities for a reduction to the daily transportation cost, for cheap vacations and educational material that help people to achieve their goals [31]. So the application of similar ideas in machinery and professional tools sharing could be beneficial for the community especially for financially insufficient groups of people or young professionals who do not have the proper financial ability to start a job spending thousands of euros for new equipment.

2.3 Applications to support the reduction of food waste

Discussing the huge issue of food waste in the introduction of this document, the author investigates similar applications that exist and operates in other countries and help people to reduce food waste. The main goal of these applications is to help people with food management using expiration dates tracking and smart informational features on the one hand and informing them about the money people lose from the wasted food on the other. Such applications are No Waste and Winnow.

No Waste helps the users to organize, manage, and track expiration dates
of their food in their kitchen and their fridge. Additionally, it informs users about the foods that need to be consumed first so they can manage their cooking schedule efficiently.

Winnow is another application that tackles the problem of food waste differently. The application let the user add relevant data calculating the weight, the amount and the category of the wasted food in professional kitchens presenting the results, not in kilos or environmental pollution but in wasted money for the business in a defined period. So the restaurant or the catering business will know the exact value of lost money according to their wasted food. This way is an alternative but an efficient motivator for the professionals to be more careful and precise in the portions calculations and the cooking process of the food.

2.4 Consolidating the information

Gathering inspiration out of these applications and consolidating the data from the preliminary work that made in the introduction of this thesis the author provides information about the huge problems of food waste, soil exploitation, and unemployment in Greece. Furthermore, the author tries to get the best features of these applications and combine these ideas into an application where it can potentially make an impact in the community. This prototype application will be designed especially for the needs of Greek communities trying to provide the best possible information using the existing infrastructure like drop points, social groceries, food banks, and other social services to help vulnerable groups of people.

Additionally, the concepts of sharing and circular economy could tackle the problem of standstill machinery, reducing the carbon emissions of the production of new machines helping the environment in a significant way. Moreover, the idea will provide financial solutions to young or poor farmers who need these machines to produce a better and bigger crop, but they do not have the financial means to acquire them. Connecting and applying all these ideas, the author tries to bring new opportunities and provide helpful solutions to the community.

2.5 Research Methodology

In the initial sections of this thesis, secondary research, [32] was conducted gathering data that already exists in the form of articles and books. The author use a descriptive research methodology and specifically a user study in order to search about data that indicated the current situation that is happening and shaping the community [33].
After the initial literature research phase, interviews with influential people of the region were set up in a natural setting. The choice to interview these people gives the development effort extra credits and make it more specific to the problems this piece of work wants to tackle. These people are gaining much experience striving all these years to find solutions for citizens’ problems every day. So the conversation gives to the researcher a deeper understanding of the world of the interviewee and his perspective [34]. Additionally, narrativity is more potent than questionnaires and forms because people’s view could be analyzed in-depth [34, 35].

The data are accumulated from the interview process, analyzed and used in order to define the application requirements as described in section 3. After analyzing the requirements, a mobile application was developed and implemented. Subsequently, the user studies takes place and describes the evaluation process, and every detail from the procedures followed in section 8. In order to succeed in the data collection, primary research conducted. Primary research is related with the gathering of new data using surveys, questionnaire and interviews. A combination of qualitative and quantitative research [36] is applied in order to assemble the data. It is known as a mixed research method and help the researcher to use all the tools to collect better and more comprehensive data.

All the results of the user study and the descriptive analysis of the data were presented in section 9. Finally, all the analysis tools 9.1 and methods 7.3 that help the author to make a conclusion were presented in section 11.

2.6 Literature Review Methodology

The literature review methodology followed during the writing of this thesis is a simple literature review. This method provides a summary of the findings of the defined literature on the research topic, [37]. Although there was not any systematic literature review, some of the components and ideas were used to some extent in order to identify and approach the problem better and in detail. Consequently, after the description of the complete framework, the final results of the literature review were presented in section 2.8.

2.6.1 Literature Planning

The literature review would be pointless without the distinction of the most relevant publications in the form of books, papers, articles, and other scientific documents. In the following sections, there is a detailed description of how the search and the choice of references has been made.
2.6.2 Choice of the topics (Keywords)

Initially, the choice of the correct keywords will help to find the most relevant content. The set of keywords that defined for the literature search was:

- circular-economy
- community-sharing
- donation
- financial-crisis
- food-waste
- mobile-technologies
- sustainability

In the effort to find the most relevant literature for this thesis, every possible combination of these keywords tried as a search term in the websites mentioned in section 2.6.4. During the research, there were many failed simple-keyword search sessions. After numerous iterations and more complex search terms combining two or more keywords, the most relevant results finally returned.

The criteria of the literature applied in the thesis in order to conclude to the most appropriate ones displayed in the table 1. Sometimes, the most precise results by title did not guarantee the relevance of the content. As a result of this drawback, the author needs to sift every relevant title. This process is very time consuming, but it is an essential step to identify the best literature for this research.

2.6.3 Criteria of the Literature

The criteria of the literature used varied for every section of the thesis. The research literature timeline expands from 1990 to 2019. Some critical parts of the literature related to sustainability problems and other essential research documents ranged between 2007 to 2019. More recent literature help the author tackle the problem better bringing an up-to-date understanding of the topics to develop more efficient and future-proof solutions.

Many recent documents have older references pointing to the original publications. These references are used mostly in definitions and author’s sayings. The fact that the recent publications use references relevant to food waste and sustainability problems that go back to 2000 makes the author reflect
on the longevity of the problem. These reflections are closely related to the future of the planet, the people’s awareness and understanding of the magnitude of the problem and the struggle to find efficient ways to minimize the effects and the consequences.

<table>
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<td>Food Waste</td>
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<td>Circular Economy</td>
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<td>Social Sustainability</td>
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<td>Rest of the document</td>
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Tab. 1: Literature chronological criteria table

### 2.6.4 Selection of the literature sources

To discover the most relevant literature, many scientific websites, online libraries, and article databases explored. Some of them had redirection to unique web addresses, but the main search took place in these four websites. The web locations of the literature search were:

- Google Search
- Google Scholar
- Science Direct
- Springer Link

The first step towards the literature search is to choose the search engine for the queries. The most obvious solution was Google Search. Subsequently, the most relevant scientific websites identified in order to bring the best possible results to this research. These websites have many redirections to other websites and other web addresses. The diagram shows the
number of literature sources initially identified without taking into consideration any additional redirections. An unforeseen drawback occurred since most of the publications were not provided for free. This problem surpassed thanks to the Linnaeus University account credentials, which provide the author access to the majority of them. Another thing worth mentioning is that Google Scholar redirections were many times to individual URLs regarding some books, papers, and articles. Sometimes the finding of the most relevant title occurred following some internal links of the papers and the articles examined. Any potential errors in chronological order of the literature eliminated in the search engine. The literature sources presented in the picture below:

![Literature Sources Diagram](image)

Fig. 5: Literature Sources Diagram

### 2.7 Overall Conclusion of the Literature Review

Concluding, the literature review was a great process trying to explore relevant and helpful information. This information could inspire the reader and raise awareness in a try to cultivate a more thoughtful way of how people manage food and everyday things. Sometimes the research of relevant literature was straightforward and sometimes was tricky. All the reading journey between articles, books, research search engines, and scientific websites reveal significant information and statistics about social and environmental problems. These problems should be studied thoroughly in order to find potential helpful solutions. The gathered data showed the depth of the food waste, food insecurity, and pollution problems inside the society along with exciting ways to reinvent the way people use the food and things in everyday life. The literature of this thesis helps to gather interesting statistics and insights about the researched issues. All this information about the problems and the consequences give extra motivation to the author, and the participants that provide their opinion, to explore ingenious and technologically advanced ways to help people and the environment. Additional information gathered about
the big problem of unemployment in Greece that affects social interactions and people’s attitude. In the following sections to the end of this thesis, the author is going to propose and implement interesting ideas, trying to explore the effect of them in society. The ultimate goal of this thesis is to inspire people and make an impact in the community for a better future in every possible way.

2.8 References Outline

62 initial literature references
  ignored
  10 duplicate content
  used
  46 literature, articles, papers references
  added
  27 scientific and technology websites references
  summarized
  73 total references

Fig. 6: Literature Outline Diagram
3 Application Requirements Analysis

The application requirements analysis with interviews is most of the times imperative when analyzing everyday problems of society. The sooner the developer gathers this information about the expectations, intentions, and goals of the participants, the better for the later conceptual design, application development, and testing phases. Other benefits of this section occurred in the analysis of the interviewee’s point of view, that the developer can hardly detect without the face to face approach, at this early stage of the thesis [38–40].

Initial interviews are going to provide useful information about the current situation of the community. The produced data could provide a blueprint of the features of the application. These insights are incredibly beneficial for the limited timeframe of the development since there is no need for major readjustments when the prototype released for testing and evaluation.

3.1 Discussion with Relevant Informants

Many brainstorming sessions happened in an effort to identify the most appropriate persons to interview. The primary milestone was to gather the most relevant and valuable information for this thesis. Close relations with local politicians and other relevant informants in the area lead to the approach and the interviews’ booking for the requirements analysis. The interviews were conducted using a fixed questionnaire and open discussion. The fixed questionnaire plays the role of the guidance to the interviewees in order to provide relevant information and the open discussion used to gather additional information inducing the participants to provide details and describe personal experiences in depth.

The gathered data help to tackle the problems using the most relevant approach. These valuable data help to the development of a better prototype.
In details, the chosen people for the initial phase interviews were the city mayor, the head of the social grocery of the region, the former president of the local agricultural cooperative and businesspeople, like a local farmer and English teacher, and an agricultural machine manufacturer. The personal point of view of the interviewees could help distinguish the requirements such as appropriate sections and functionalities inside the prototype. The gathered data can give a better understanding of the current situation of the community using the knowledge, and the hands-on experience of these people. Gathering information about personal experiences is more accurate technique than a simple survey or questionnaire. Trying to construct the most accurate view, the author designed a questionnaire where it includes all the researched topics. The design of the questions try to elicit useful information and interesting suggestions. An overview of the interviews and the discussions conducted will be presented in the sections below. The complete interview questionnaire of the politicians and the citizens, along with all the transcripts can be found in appendices B and C respectively.

3.1.1 Overview of the interview with city mayor

During the application requirements analysis, the mayor of the city asked and agreed to give a short interview to express his opinion about the researched concepts of this thesis. He initially expressed his opinion about the financial problems and food security in the community nowadays. He mentions that the social grocery of the municipality is a constant search for food sources and stuff. He point out that the ability to transform every house into a donation and sharing beacon would be a very good idea. Furthermore, he expressed his opinion about the concept of the circular economy. In the author’s satisfaction, he was very informed about this concept, and his suggestions are precious. He also described his personal experience about a past trip in Canada that help him to open new horizons and gather useful information about circular and sharing economy, promoting interesting ways to utilize the existing machinery, professional tools and everyday objects. He finds that the idea of a circular economy solution in the community could be very promising. In rural places, like the region that the research occurred, the technology could bridge many informational gaps. He added that a circular economy solution can not only find applications in the local market but also is an excellent opportunity for these stores to apply this technology in their favor. The benefits of this interconnection in the local economy are many. There is a unique opportunity for the local market to promote products with posts informing buyers about sales and offers when these these products are
close to their expiration date. People should support community stores in favor of the local economy. Moreover, the mayor, as a citizen, is a great supporter of the concept of shopping locally. His decision to hang a huge banner in the center of the city with the message "Shop Locally, to support your local merchants for the favor of the community." was personally financed and support his claims. In the question about the job seasonality of the region, he mentions that unemployed people should shift towards the direction of agricultural regions to find job positions easier. Additionally, he admits that there is a substantial seasonal job demand in every category of agricultural and labor jobs. This demand is not only high but also follows some continuous patterns that people should identify and analyze. There is no efficient way to gather these data until now. An informational system that let people know about job availability informing about the number of workers, the work hours and the overall demand in different seasons of the year could provide useful information both for farmers and workers for the years to come. He also supports that everyone could earn a decent amount of money working legally in the fields. Finally, he mentioned that he is more than willing to help young people with bold ideas in every technological field. Technology solutions are missing from the community and many communities across the country. He concludes that he already supports an application where people can post a city problem and inform the council to fix it. The interview closed with his opinion that citizens could support an application like this one, and it pinpoints that it could be an efficient way to promote, support, and raise awareness about everyday problems. Finally, he promised to provide the best possible support if this idea released to the public.

3.1.2 Overview of the interview with the head of the social grocery department of our region

In a constant search to find real data about the suffering people of the community, the author approaches the head of the social grocery in order to gather information about the people who are in need. The author begins the interview, asking about the community people who are in need. She reveals the data about these people and how difficult is the task to provide them with the essentials every day. She mentioned that the number of people has increased in the last five years. It is an obligation to clarify that the municipality accountant holds the files of the social grocery. Since these files contain sensitive personal data, access to them was forbidden. The financial crisis started in 2010 in Greece, but in the provincial cities, the problem starts to
reveal a few years later.
She emphasizes the importance of the role of social grocery to these people and pinpoints the struggle and the endless searching for food donation sources in Greece of crisis. The idea of connecting people who are willing to give was excellent according to her sayings, and every effort towards this point could improve and make the food donation search more efficient. However, her knowledge of the circular economy is not sufficient. After a short description of what this economy professes, she finds this idea very interesting and realizes that social grocery is a part of this economy along with many others. During the interview, she makes a clear picture and understood completely the circular economy concept and its potential applications in the community.

Being a member of a small agricultural family, she is experiencing the problems of this profession every day. She is very supportive of the idea of sharing tools and providing jobs through the connectivity of a mobile application because she believes that this movement could help needy families and small farmers. Finally, she mentions that she is willing to contribute to every technological interconnection between people and goods that could bring efficient solutions to community problems. Concluding, she expressed her gratitude to the people who support the social grocery, and she strongly believes in the power of the united community.

3.1.3 Overview of the interview with the former president of the local agricultural cooperative

The interview of the former president of the local agricultural cooperative was very content and comprehensive. He recognizes the problem of food security in the region and the greater area of the department. He agreed that many people need help nowadays, and he reveals that he many times witnesses people in his neighborhood’s waste bins who search for food and many other things. Additionally, as an experienced man in agriculture and a very knowledgeable in the whole lifecycle of farming processes, he admits that there is a significant problem in agriculture regarding the waste. This problem happens because people are very interested in the presentation of the fruit without focusing primarily on taste and quality. So many traders do not pay the whole amount of money if the fruits are ugly, having a negative outcome for the farmers. This outcome was to leave the ugly or small fruit to the trees or in the field. This treatment has a significant consequence in the overall crop season and food waste as well, because the fruits are rotten on the trees or thrown away.
Additionally, he recognizes the food waste in catering companies, bakeries,
and other food stores and finds value in an application where it could network all these professionals for a common cause. This cause includes the informing of people about food donations or last-minute food sales in chains and stores. Moreover, he sees value in the idea of making a network of borrowing or renting with some concerns of how it will work with integrity. The proper functionality and the maintenance of the machine during the continuous use of different people is a significant consideration to make this possible. Furthermore, he mentions that the seasonality of the agricultural jobs and as an extension, the search for workers is a very painstaking process during high seasons which is a summary of 250 days across the year. Overall he was very supportive with the idea of adhering all the things that discussed during the interview into an application. He was very excited with the concept of locality and he is willing to use this application to promote the ideas of mutual help, circular economy, and support acts towards sustainability. Finally, he mentions that the biggest problem in Greece is the lack of awareness. Every problem that affects society should be studied and acknowledged, and he was offered to help in every process of the development of this prototype.

3.1.4 Overview of the interview with local businessman and farmer

Subsequently, an interview with a local businessman and member of an agricultural family with many farms across the region was set up in order to explore first hand issues like the search for personnel, the usage of the machinery, and other relevant with the research topics. These information can be used later during the design phase of the application to build proper functions and features. In the beginning of the interview he was asked about the financial struggle of people inside the community. He responded saying that after the financial crisis, many people approach him asking for a job both in his business and in farms. The fact that these people previously worked in other fields and suddenly left jobless made him recognize the problematic situation in the region and the country. Additionally, he agrees with the fact that many people lose their jobs and find difficulties due to the fact that the seasonality of agricultural and many other relevant jobs make permanent job provision difficult. Although many seasonal job positions are created during high season which is an advantage for people who are in need. Moving towards the interview part of food waste, he mentions that he, as a producer forced to sell better-looking fruit to big traders. The money loss is huge since he spent thousands of euros every year in fertilizers and other chemicals to enhance his crop. He also reveals the food loss occurred, leaving
a decent amount of fruits and vegetables uncut because of their shape and size. He finds it very interesting to find a way to raise awareness and find market channels for these products. This way, people could have access to very cheap fruit and vegetables without mediator traders. "Producing fruit by locals for locals is a great idea he applied and should be implemented widely" he added.

Moreover, he presents some interesting facts about the usage of agricultural machines saying that, if the rush period of August is excluded, the rest of the year the sixty percent of the machinery is staying still in the shed. This fact gives extra motivation for the research to promote sharing and borrowing concepts which found very interesting. Concluding, he finds high potentials in an application that could potentially make the everyday life of the community better. Finding a way to interconnect the weaker parts of the community with people who want to help and provide could be beneficial. Concluding, he expresses his faith that community people all together could change the current financial situation and find solutions for the most suffering parts of the community.

### 3.1.5 Overview of the interview with local agricultural machine manufacturer

Consequently, an interview arrangement with an agricultural machine manufacturer took place to discuss the plans of the circular economy. The context was machine circularity and possible ways to transform and reuse these machines for the good of the farmer and nature.

The author follows the same process with previous interviews emphasizing in the circular economy part. Initially, the discussion began with the food security and food waste part. He admits that the last years in Greece food security becomes a significant concern especially in families that work in big cities where the competition and living cost is more prominent than provincial areas.

Additionally, he provides useful information about the manufacturing process and the massive workload of manufacturing new machines. He surprises the author, revealing that the refactoring of old machines has a considerable profit margin since the cost of brand new materials are significantly high. Used parts that fit correctly is significantly cheaper than brand new. He aptly mentions that the designers of these machines should consider reusability and life-extension as a primary objective and not focus on profits solely. To reuse or fix the broken parts, the manufacturer improvises last minute patents in order to make the machine work again. These actions save a considerable amount of money for the farmer. Due to the nature of the job,
the endurance of these machines is tested to their limits in rough terrains and extreme conditions. He is doubtful about the machines sharing solution without taking security measures. However, he predicts great success if the plan works. Finally, he admits that every action towards the invigoration of the local economy could benefit the region. Concluding, he expressed his gratitude to the local people who support all these years his business, and he is sure that people could support technological advancements that upgrade the place and benefit its people.

3.2 Reflecting on the problems of the community

During these years, Greece is struggling to survive this financial meltdown, which left many people struggling for everyday food. Contrary to this fact, food waste from groceries, food stores, and supermarkets exist in significant amounts. Solutions should be applied in order to provide food security to people who are in need. The donation as a mean to provide food security for everyone in the community is not enough.

An enhancement to the community economy must be achieved. This research focuses to upgrade the way of living using technology in the form of a mobile application. This application can provide the connectivity and the features that could bring together all the members of the community. This technology solution gives the chance to needy people to find efficient solutions to their problems.

Living in a rural area provides many opportunities to promote circular economy solutions that could help the community. Additionally, better food management solutions could potentially make a significant impact on the environment and promote donation. The most significant change can be achieved raising awareness about the overall way people face food, their stuff, and the nature.

3.3 Conclusion about application requirements

The effort to connect all these information with a functional prototype demands many parameters. Using the interview questions and analyzing the feedback of these people, the author could manage to build a conceptual design of the application. The components and functionality were carefully considered in order to give value to the prototype.

The concept to promote social and ecological sustainability are justified by talented and relevant people who actively interact with hundreds of people every day. They provided their valuable opinion and guaranteed that the whole thesis leans towards the correct way. As a result of this initial inves-
tigation, the author justified his concerns about food donation needs, food waste problems and unemployment. However, he took courage and support to explore innovative ways to promote the circular and sharing economy and solidarity in the community. Circular economy solutions focus on the machinery and tools sharing and the support of the local stores and producers. Additional, functionalities promote excessive food deals and donations, using notifications, to needy people and social services.

The main reason the author adds politicians into the equation is their power to promote and support such ideas and actions. The municipality plays a vital role in the implementation of concepts that implicate the community and social services. It is worth mentioning that it is natural to find many opposing opinions. New, and radical ideas to the ordinary way of living are hardly digested. However, the constant effort to cultivate the spirit of sharing and support across every person could lead to a better future and a meaningful way of living. This meaningful way of living could lead to prosperity in the community and harmonization with nature.

Consolidating all the information gathered the author can efficiently conclude that the main features of the application should focus mainly on food donation, agricultural machine and professional tools sharing. Additional features can include promotion of local shops sales in an effort to tone the local economy and give the opportunity to small businesses to thrive. Moreover local food businesses like restaurants and super markets can post sales and promote their products in an effort to apply the zero food waste concept in the community and give the opportunity to people in need to buy food or groceries cheaper or even free.

Last but not least the addition of job search feature is an important step for jobless people to search for local jobs quick and efficient connecting the employer and the employee directly in an effort to provide opportunities to the most vulnerable part of the community giving the opportunity to live with dignity and financial security.
4 Application Conceptual Design

Conceptual design is the process where the fundamental ideas are captured, analyzed and translated into a design of the future implementation. This process is critical as it affects the product’s overall design, performance, usability, development time and the overall value [41].

The conceptual design is following the selection of topic and the preliminary requirements identification. It connects the user needs as defined in the application requirement analysis in section 3 with technological and functional requirements in section 5.2 and 5.3 respectively.

4.1 Complying with the user’s requirements

Analyzing the feedback gathered from the interviews and the personal point of view of the author about the community current situation, there are four main categories where should focus and find solutions. The first one is food waste. There are many businesses like restaurants, bakeries, and food stores that they continuously have excessive amounts of food. Unconsumed food can find excellent donation opportunities. A connection establishment between this food and the people who need it is essential. An additional solution is to give a chance to local businesses to announce last minutes sales in consumable food or products providing an additional opportunity for profits from the food that they would have thrown in the garbage at the end of the day.

Moreover, people could contribute to the circular economy, as mentioned in section 1.2. Circular economy model is popular and applied in many countries across the globe for years [42]. Circular economy studies how the products’ lifespan could be expanded using the reduce, reuse, recycle concept. This way, people of the community could be a part of this economic model and benefit from it. Living in a rural area makes the idea of a sharing pool of
unused machinery during specific periods a great way to reduce the cost of buying and maintaining this equipment. Expensive machinery sharing could benefit financially insufficient farmers to find better opportunities to grow a bigger and better crop. As discussed in many sections, the vision to create a connecting link between people who have these machines and stay standstill and the people who want them is imperative. This connection is creating a continuous stream of machine usage, giving more opportunities to the local economy to develop. Additionally, sharing actions could lead to a reduction in the carbon footprint of the production of these products. An increasing usage rate among the professionals will promote a cleaner future since better and more efficient equipment will be used.

Last but not least, the seasonality of the agricultural jobs, that is a particular branch of the labor market make the farmers constantly searching for workers. These jobs provide flexible payment and good wages regarding the overall financial situation in Greece. Creating an additional link between the farmers and the workers brings great opportunities for the unemployed people of the community.

4.2 Identifying the prototype requirements

For the identification of the prototype requirements, the author needs to conceptualize the right parts that is possible to make this idea a reality. The next step after the user requirement analysis is to find the right combination of hardware and software in order to make the minimum viable product. The application should have the design and functionality to present all the categories to interested people. An additional component is the ability to post in any of the provided categories and interact with the functionalities. The next section presents the conceptual design and use-case scenarios of the application.

4.3 Prototype Design

Consequently, the analysis of the interaction towards every screen of the prototype is essential. The best way to initialize this presentation process is to design use case diagrams and show all the possible use case scenarios across every screen and functionality. These diagrams describe efficiently all the processes that make the later design easier to conceptualize and the development more time efficient.
4.3.1 Login and Register Page

The Login Page is the first page of the prototype application. This page would provide input boxes, and a submit button so the user could add its credentials to be authenticated and log in the application. If the user opens the application for the first time, he needs to choose the registration page to be able to pass the authentication process of the application. Both forms send the produced data in the database in order to check the validity cross-examining the actual saved values to authorize the access. The use case diagrams below show the described steps.

**Login Use Case**

![Login Use Case Diagram](image)

**Register Use Case**

![Register Use Case Diagram](image)

Fig. 9: Use Case Diagram of Login and Register Pages
4.3.2 Categories Page

Categories Page is the first page the users see when they pass the login process of the application. In this page, the user can choose between the categories that the application provides in order to navigate into the existing posts of each category and see individual details.

Categories Page Use Case Modeling

![Use Case Diagram of Categories Page](image-url)
4.3.3 Categories Posts Pages

When the button at the bottom of each category card clicked a new page opens and unveils all the posts made in this category by every existing user. The information varied for every category. If the users choose to see the donations, they have to click the "explore" button, and all donations will unveil. The same idea applied across every card of the other three categories of borrow, local sales, and jobs. Additionally, inside each category, the user could see details about every post made and gather useful information.

Donation Post Use Case  
Borrow Post Use Case

![Use Case Diagram of Donation & Borrow Posts Pages](image-url)

Fig. 11: Use Case Diagram of Donation & Borrow Posts Pages
Sales Post Use Case

Inside Local Sales Menu Selection

See all users' sales posts

Select to see details about individual sale posts

Jobs Post Use Case

Inside Local Sales Menu Selection

See all users' job posts

Select to see details about individual job posts

Fig. 12: Use Case Diagram of Sales & Jobs Posts Pages
4.3.4 Categories Manage Posts Pages

In a similar manner with the categories page, the user can see posts in every category. The main difference in this page is that the users could see only the individual post made by them. In this page, the users have a clear picture of their posts having the ability to update or delete them. Additionally, at the bottom of the page, the user can create a new post by clicking the button "Add a new post".

Donation Manage Post & Borrow Manage Post Use Cases

![Use Case Diagram of Donation & Borrow Manage Posts Pages](image-url)

Fig. 13: Use Case Diagram of Donation & Borrow Manage Posts Pages
Sales Manage Post & Jobs Manage Post Use Cases

Fig. 14: Use Case Diagram of Sales & Jobs Manage Posts Pages
4.3.5 Map and List Pages

The map page is helping the user to find his current location and see relevant information about points of interest. Another ability is to pin these points for a future reminder.

List page contains the list of the most significant points of interest of every city in the region like city hall, community center, and social grocery. An additional ability is to see useful information like telephone and address and navigate to the map to find them.

Maps Use Case            List Use Case

![Use Case Diagram of Map & List Pages](image)

All the information provided in this section presented in section 6.4 as well, where the design and the described features visualized with pictures.
5 Application Technological Requirements

A typical mobile application development cycle requires technology that could deliver the developer’s vision and users’ expectations in a specific timeframe. In order to achieve these objectives, the developer needs two things. The first thing is to build the best possible user interface for the time provided. In the design terms, a user interface is a place where pieces of information are displayed.

The second thing is how the developer can gather and save the information stream produced by the user’s interaction with the application. These two things are an integral part of the application design and implementation. A beautiful, functional user interface and an efficient information storage system complete the user experience. Since the user experience with the prototype is efficient and satisfying, the interaction with the prototype will be more convenient and the user’s feedback will be more accurate and useful.

5.1 Mobile Platforms

The definition of the best development platform for the prototype is crucial. The current technologies in mobile application development are limited in two options. The first option is a native development solution. Native solutions programming language are Java for Android [43] and Swift for iOS [44]. The second option is the cross-platform solutions. Most of the cross-platform solution are using Javascript [45] based frameworks like Angular [46] or React Native [47] as their codebase. Another popular solution is Xamarin [48] that use C Sharp and ASP.Net [49].

Cross-platform development solutions use the same codebase for the interface and the server making the development significantly faster and incredibly efficient compared to a native solution. Several studies analyze cross-platform app development. Some of them compare the most innovative and successful ones like Ionic and React Native [25].

Since hybrid solutions are numerous and recent studies were not conclusive about the best platform, the author took the initiative to explore the most appropriate solution for this thesis. Useful information for the comparison gathered from reliable web sources [25,50,51]. Subsequently, a question criteria analysis give extra validity to the effort. Many benefits occurred from this process since the chosen platform harmonizing completely with the prototype requirements. The next table shows the advantages and disadvantages of the six most popular frameworks.
### Cross-Platform criteria

<table>
<thead>
<tr>
<th>Platform</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>PhoneGap</td>
<td>1. Similar UI across all platforms.</td>
<td>1. Abundance of graphic elements affect the performance.</td>
</tr>
<tr>
<td></td>
<td>4. Open-source.</td>
<td>4. Extensive testing sessions needed.</td>
</tr>
<tr>
<td></td>
<td>5. Access to native APIs using plugins.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>6. Does not require specific development skills.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2. Easy to use.</td>
<td>2. Not good for games.</td>
</tr>
<tr>
<td></td>
<td>3. Great designs.</td>
<td>3. Limitations on high performance features.</td>
</tr>
<tr>
<td></td>
<td>4. Many Ready-to-use UI features.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>5. Huge &amp; supportive community.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>6. Quick prototyping.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2. Cordova, PhoneGap or Sencha SDK native features.</td>
<td>2. Unsuitable for freelancers and individual developers.</td>
</tr>
<tr>
<td></td>
<td>3. Native look at all platforms.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4. Library of components &amp; APIs.</td>
<td></td>
</tr>
</tbody>
</table>

**Tab. 2:** Comparison between the most popular hybrid platforms 1/2
<table>
<thead>
<tr>
<th>Platform</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Xamarin</td>
<td>1. Open-source.</td>
<td>1. Limited access to open source libraries.</td>
</tr>
<tr>
<td></td>
<td>2. Close to native performance.</td>
<td>2. Small Xamarin community.</td>
</tr>
<tr>
<td></td>
<td>3. Great user experience.</td>
<td>3. Requires the knowledge.</td>
</tr>
<tr>
<td></td>
<td>4. Simplified maintenance.</td>
<td>4. The application is large in size.</td>
</tr>
<tr>
<td></td>
<td>5. Reduce costs.</td>
<td></td>
</tr>
<tr>
<td>Framework7</td>
<td>1. Open-source.</td>
<td>1. Incompatible with all platforms.</td>
</tr>
<tr>
<td></td>
<td>2. Lots of UI elements.</td>
<td>2. F7 framework must be used.</td>
</tr>
<tr>
<td></td>
<td>3. Customization.</td>
<td>3. Create the basic HTML file by yourself.</td>
</tr>
<tr>
<td></td>
<td>4. Easy to learn.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>5. Great documentation.</td>
<td></td>
</tr>
<tr>
<td>React Native</td>
<td>1. Multiple Platforms</td>
<td>1. Lack of some custom modules.</td>
</tr>
<tr>
<td></td>
<td>5. Open Source.</td>
<td></td>
</tr>
</tbody>
</table>

Tab. 3: Comparison between the most popular hybrid platforms 2/2
5.1.1 Criteria of the framework choice

The choice among the most popular solutions demands a Question Option Criteria table to analyze the positives and negatives of every platform. The best available frameworks for the development requirements of this thesis prototype chosen according to the implementation needs. Considering all the advantages and disadvantages of table 3, a further analysis that uses a scoring process for the options provided needed in order to define the most appropriate framework [52]. The scoring process followed is examining three things. If the framework criteria meet the requirements, if the framework criteria are insufficient and if the framework criteria do not meet any requirements at all. Then each feature of the platform will be scored with 1, 0, and -1 respectively. The prototype of this thesis should be developed in a predefined limited timeline. So the whole development process should be fast, efficient, and the prototype should be fully functional and well presented. The next step is to question each of the criteria and summarize the score to choose the best framework for the development.

The conclusion about the most appropriate framework for the prototype is difficult, but it is worth the effort since the right choice could save a considerable amount of time in the implementation process. One of the most significant things to take into consideration is to be fully compatible and provide a significant number of components to every available web or mobile platform. Additionally, due to the limited timeline, the prototyping phase should be fast. The fast prototyping could help to tackle efficiently severe bugs and provide the ability for faster modifications. So fast development and fast implementation are two crucial criteria for the selection.

Quick prototyping requires a smooth learning curve. Code examples, educational videos, proper documentation, and supportive developers community, makes the learning process more comfortable. Therefore additional framework criteria are a smooth learning curve, open source materials, proper documentation, and an active community for support. Last but not least, a functional prototype should have a proper comprehensive design. User interface and user experience, most of the times, differentiate a successful from a failed application in the beta phase. The right framework should provide plenty of UI components, along with access to native APIs. Closing this question, option, criteria process, and having discussed the choices of a proper criteria selection along with the scoring system, it is essential to present the selection results in a table for better comprehension.
Having analyzed every advantage and disadvantage of the most popular hybrid platforms and discussing the project requirements using a question option criteria table the most significant reasons of author’s choice is the enriched UI, the native APIs access, the active community and the fast learning pace. The conclusion is the Ionic framework, which is one of the best hybrid frameworks for web and mobile development. The section below recap the advantages of the Ionic framework:

- **Speed.** The fact of building for multiple platforms using only one codebase make the completion three times faster than native coding. The usage of the same codebase for the backend makes it even faster and easier.

- **Efficiency.** The coding process is using the most common web programming languages of HTML [53], CSS [54] and Javascript [45]. Additionally, the cost is significantly reduced when using cross-platform development.

<table>
<thead>
<tr>
<th>Options</th>
<th>PhoneGap</th>
<th>Ionic</th>
<th>Sencha</th>
<th>Xamarin</th>
<th>Framework7</th>
<th>React</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Criteria</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Multi-platform</td>
<td>+1</td>
<td>+1</td>
<td>+1</td>
<td>+1</td>
<td>-1</td>
<td>+1</td>
</tr>
<tr>
<td>Fast Development</td>
<td>+1</td>
<td>+1</td>
<td>0</td>
<td>+1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Fast Implementation</td>
<td>0</td>
<td>+1</td>
<td>0</td>
<td>+1</td>
<td>0</td>
<td>+1</td>
</tr>
<tr>
<td>UI Components</td>
<td>-1</td>
<td>+1</td>
<td>+1</td>
<td>+1</td>
<td>+1</td>
<td>0</td>
</tr>
<tr>
<td>Easy To Learn</td>
<td>+1</td>
<td>0</td>
<td>0</td>
<td>-1</td>
<td>+1</td>
<td>0</td>
</tr>
<tr>
<td>Active Community</td>
<td>0</td>
<td>+1</td>
<td>0</td>
<td>-1</td>
<td>0</td>
<td>+1</td>
</tr>
<tr>
<td>Open Source</td>
<td>+1</td>
<td>+1</td>
<td>+1</td>
<td>+1</td>
<td>+1</td>
<td>+1</td>
</tr>
<tr>
<td>Native API’s</td>
<td>+1</td>
<td>+1</td>
<td>+1</td>
<td>+1</td>
<td>0</td>
<td>+1</td>
</tr>
<tr>
<td>Documentation</td>
<td>-1</td>
<td>+1</td>
<td>0</td>
<td>0</td>
<td>+1</td>
<td>+1</td>
</tr>
<tr>
<td><strong>Score</strong></td>
<td>3</td>
<td>8</td>
<td>4</td>
<td>4</td>
<td>3</td>
<td>6</td>
</tr>
</tbody>
</table>

Tab. 4: Question Option Criteria Table
5 Application Technological Requirements

- Multiplatform. The hybrid approach supports almost every platform and runs on a desktop or mobile browser. The application runs on both major mobile platforms and in a browser as a progressive web application [57].

- A large number of UI elements and access to native elements. This prebuilt elements could provide great application design and a native look in the final prototype application.

- Huge background support in Stackoverflow [55] and Github [56] something critical in troubleshooting.

5.1.2 Apache Cordova

Although Apache Cordova considered by some people one of the competitors of the Ionic in hybrid mobile development, it is not. In fact, it is undoubtedly one of the most critical parts of an Ionic implementation. Ionic is built on top of the Cordova. This integration signifies that the Ionic framework provides the front-end part with individual mobile-friendly user interface components, and the Apache Cordova gives access to the native elements of each device like geolocation, audio, video and countless others [58]. As a result, the user enjoys an enriched mobile experience similar to native solutions. So a direct comparison in any of the sections 5.1 and 5.1.1 is irrelevant.

5.2 Identifying the Technological Requirements of the Prototype

The technological requirements of this prototype include the hardware to install and interact with the application and the software tools to build the user interface and the server storage. For the prototype testing, there are two devices one Android and one iPhone in order to ensure the correct design presentation of every component in different screens. Additionally, WebStorm by JetBrains used for the code development and the debugging. JetBrains [59] is one of the leading companies in integrated development environments providing endless features to the developer making the overall effort more convenient. Thanks to the Linnaeus University student account, free access is provided to these useful development tools making the overall effort simpler and faster. Finally, a server-side solution will make the prototype fully functional, providing authentication and storage. Google firebase [63] is one of the best BaaS choices from usability and options perspective. BaaS means backend as a service, and it is one of the fastest ways to connect the prototype to a database and an authentication system. The services provided by
the platform are numerous like authentication, analytics, databases, messaging, and crash reporting. All technologies used, are described thoroughly in section 6.

5.3 Identifying the Functional Requirements of the Prototype

After building the conceptual design and defining the technological requirements of the prototype, it is now possible to enumerate the functional requirements. First of all, the user should have an individual account where they could manage posts, explore, and interact. In order to implement this functionality, the author should set up the database and the connectivity with the application.

In the first page, the two entries accept text data, one for the email and one for the password. These two fields should check every time if the user inserts the data correctly and cross-validate the form data with the authentication database. These data should be entered before everything else; otherwise, the application restricts access to unauthorized or unregistered users. All users have equal rights inside the application besides the administrator who has complete control of all the components and functionalities.

Every registered user can see the same screens and use the same functionalities. The feed screen presents information about the predefined categories and detailed data if the user wants to see further information. The manage post screen should provide the functionality to post in any of the given categories the user desires and manage the already existing individual posts. The available choices will be to update the already existing post or delete it. Two additional screen should present location information and useful addresses and communication information. The first screen element is a map so the users can tag their current position and find relevant places in the area. The list screen element presents a list with useful place for the user such as city hall, social grocery and many others.

Finally the information hub screen presents useful information about ecology and sustainability tips. Reading the content of the cards, the user could promote sustainable living and cultivate a spirit of empathy. As a last but important step, the user should be able to log out from the application and terminate the server connection stopping all the interaction with the prototype across every page.
5.4 Technology Limitations

Even though most of the software tools and frameworks are free, some technology limitations may occur. The first limitation lies in the hardware. Apple restricts application installation without being an authorized developer paying the fee of ninety-nine dollars per year. However, Ionic provides the Ionic DevApp application where the prototype application could be accelerated using a local IP. Some limitations occurred in the available requests to the database of the Firebase platform but the application does not reach these limits. Additional limitation occurred is the time frame which should be managed wisely to meet the draft deadlines.
6 Implementation of the Prototype

After concluding about the application requirements, the conceptual design and the application technological requirements, the next step is to implement the prototype application. After the implementation, the author is going to test and evaluate it as the following diagram presents.

![Prototype Implementation Process Diagram](image)

This prototype will contain all the elements defined in sections 3, 4, and 5 in order to study its potential impact on the community. The whole effort focus towards the ability of the prototype to raise awareness, bringing opportunities, and convey environmental and humanitarian messages. The ultimate goal is to justify the research questions formulated in section 1.7.1. The following section is presenting in details snapshots of the integrated development environment, prototype pictures, code snippets, and the technologies used along with their limitations.

6.1 Hybrid Application Development

The options criteria analysis showed that the Ionic framework is the most appropriate framework for the developing of the prototype. The following step is to choose the best possible IDE that could take the massive workload of the development, the compilation, and the debugging.

For this purpose, the most profound choice was the WebStorm by JetBrains. JetBrains handles all the vital processes and provide the best possible features such as compilation, component installation, local server, debugging console, terminal code inspection, and many other features as well. The complete code consists of almost four thousand and five hundred lines, including all pages and services in HTML, CSS, and Typescript without counting all the original framework code, which is pre-installed. The entire application stands above Apache Cordova, as mentioned in section 5.1.2, which provides all the native elements access that this project needs for the best possible user experience.
6.2 Project Files

The pictures below show all the files included in the prototype application development. Inside every page file, there is the main code compiled to run the application.

Fig. 17: Prototype code files
6.3 Code Structure

Every page folder contains three files: one HTML, one SCSS, and one TypeScript file. The HTML file configures the user interface, and the SCSS file provides the ability to code design options like alignment, color, height, width, and many other parameters. The TypeScript file contains the main functions of every page that enhance the user experience.

![Prototype code structure inside the files](image)

Fig. 18: Prototype code structure inside the files

6.4 Developing the Prototype Pages

Developing the prototype pages according to the feedback gathered, was imperative. The goal is to efficiently build a prototype that meets the requirements as described in the conclusion of application requirements analysis section after analyzing the interviewees’ opinion about the current situation of the community. In this stage of the development, the author presents the images of every page of the application as they are envisioned and designed. The introductory slides inform the users about the purpose of this application and encourage them to act for sustainability. Figure 19 shows snapshots of the introductory screens. Subsequently, the next two screens, in figure 20 present the login and register pages. These pages use forms that connect with Firebase authentication service. The next three screens in figure 21 present the initial screen with the post categories, all the posts of the users and their details as they were displayed inside each category. The following images in figure 22 present the management page of the individual posts and the functionalities to update or delete them. This feature connects with
Firebase database service in real time providing an instant update of every modification. Moreover, the snapshots in figure 23 show ecological tips where the users can educate themselves about sustainability. Finally, the snapshots in figure 24 display local places of interest where people can find support and a map to navigate there. Example scripts of HTML and SCSS shown below in section 6.4.1.

Fig. 19: Prototype Introduction Pages examples

Fig. 20: Prototype Login and Register Pages
6 Implementation of the Prototype

Fig. 21: Prototype Categories Pages

Fig. 22: Manage individual Posts
6 Implementation of the Prototype

Fig. 23: Educational Eco Tips

Fig. 24: Google Maps and places of interest
6 Implementation of the Prototype

6.4.1 Coding the design elements of the prototype

The figures 19, 20, 21, 22, 23, 24 present prototype elements designed with Ionic UI components. These components provide specialized design for mobile screens. Additional modifications in design occurred utilizing the properties of plain HTML and CSS. These minor adjustments focus on the alignment, the color, and the fonts of some elements. The ultimate goal is to provide a proper user experience using minimal and clean user interface.

HTML with Ionic tags

The prototype pages design occurred with Ionic User Interface components. These specialized tags give the developer versatility, and ability to design fast and efficiently. Ionic tags are HTML specially integrated to work across every mobile device screen. This integration is the most significant reason why Ionic tags used instead of standard HTML tags. An additional reason for using Ionic HTML tags is the simplification of complex design logic that otherwise would be significantly harder to implement [60]. Even though Ionic components presentation is compelling the design is not limited to their predefined parameters. As described in section 6.4.1 the developers are free to use plain HTML and CSS at will.

```html
<ion-header>
  <ion-nav-bar color="secondary">
    <ion-title>Community Sharing</ion-title>
    <ion-buttons end>
      <button ion-button icon-only (click)="logout()">
        <ion-icon name="power"></ion-icon>
      </button>
    </ion-buttons>
  </ion-nav-bar>
</ion-header>
```

These lines of code present Ionic the use of the specialized Ionic HTML tags. `<ion-header>`, `<ion-nav-bar>`, are many among others that used instead of the common HTML to implement the UI elements. These tailor-made components are very convenient and time efficient solution in large applications.
SCSS

Moreover, SCSS is a superset of CSS3 with a new syntax. Every valid old CSS3 syntax is working flawlessly with SCSS. SCSS works with block formatting and uses braces to separate block and semicolons to separate lines inside the block. Even though this project does not reclaim the full power of SCSS, this specific scripting language has many features to provide like conditions, variables inheritance, and many others. To clarify some important restrictions CSS scripts could be used without any problem in SCSS, but SCSS scripts need to be compiled and translated to CSS to work on the browser and the mobile devices [61].

```css
page-welcome {
  .welcome-page{
    background-color: #d3d3d3;
  }
  .navigation{
    text-align: center;
    background-color: #ffffff;
  }
  .button{
    align: center;
    font-size: large;
    border-radius: 5%;
    width: 50%;
  }
}
```

In order to clarify the SCSS and CSS misconception, the code snippet above shows a block of plain CSS syntax used for the design of different elements of the prototype. This CSS syntax saved in a document with SCSS extension, as shown in figure 18 without any problem. The nested properties of the page-welcome are executed from top to bottom. Each nested class code made the modifications to the exact item in HTML as written. The developers choose their aesthetics, and the CSS do the rest. In the example case, the main page background color is light grey, the cards text is aligned in the center, the background is white, and the button is large with slightly rounded edges occupying 50 percent of the card’s width.
6.4.2 Typescript

Typescript is a superset of Javascript developed by Microsoft as an open source language. This feature is significant as open source programming languages have great and active support by the developers’ community [62]. Another benefit of Typescript is that support static typing. It is compiled to standard Javascript, so it is possible to run in any device. Last but not least, Microsoft and JetBrains developed excellent developing tools like the Visual Studio Code and JetBrains IDEs, respectively. The complete functionality of the prototype was written in Typescript as being the main coding language of the Ionic framework. In the sections 6.5, 6.5.1, 6.5.2 below is presented a small part of the Typescript used for the functional requirements of this application. At the beginning of every typescript file, the developer adds all the modules and services. Subsequently, in the page file, the developer adds the desired functions in order to control the behavior of the prototype.

6.5 Google Firebase

Google firebase [63] as mentioned in section 5.2 is a web and mobile development platform. This solution provides all the backend support an application needs. In details, firebase provides authentication, real-time database, machine learning features, hosting, and cloud storage. The Firebase features were presented in the pictures and the description below.

![Firebase Features](image)

Fig. 25: Firebase Features

Authentication tabs contain user information like emails, passwords and the desired sign-in method. Some advanced features include the notification messages templates and the request counter monitor as well. Requests are subject to some limitation, as presented in section 5.4.

Database tabs contain all the information about the tables used, and the security rules of the database. Some advanced features include indexes and usage counter are provided as well. Requests are subject to some limitation, as presented in section 5.4 as well.
6.5.1 Authentication

The authentication system is one of the most critical parts of every application implementation. It secures that every user will provide their email and their data to register and subsequently login to the application. Additionally, authentication ensures that the server monitors every action inside the application by the unique ID of every user. These unique ID’s could be used to identify, manipulate, and separate the different posts, comments, or shares the user made. In this case, the unique IDs of every user retrieved when he/she want to manage the individual post. Similar actions occurred when the application retrieves the overall data from the server to display all the posts in every category page. The service function that makes the register and login actions possible is connected with the login and register page to check if the form request complies with the predefined email patterns and the password length as the developer coded in the typescript file of each page.

```typescript
Register(value){
    return new Promise<any>((resolve, reject) => {
        firebase.auth().createUserWithEmailAndPassword(value.email,
            value.password)
            .then(
                res => resolve(res),
                err => reject(err))
    })
}

Login(value){
    return new Promise<any>((resolve, reject) => {
        firebase.auth().signInWithEmailAndPassword(value.email,
            value.password)
            .then(
                res => resolve(res),
                err => reject(err))
    })
}
```

The Typescript code snippet above is presenting the register and login process of the prototype. The function is wrapped inside a Promise return and starts with a firebase auth session to register or check the validity of the provided credentials. A "promise return" is a synchronous error handling function that informs the users if the process executed correctly, or they should check the correctness of the credentials provided. The complete code structure showed in Appendix J.
6.5.2 Storage

Firebase Storage is a real-time database solution for startups and prototype application. So the prototype will have a proper functionality using an authentication system and a database that saves the different types of data like text and images. The users can retrieve or edit their posts according to their needs. This excellent backend service provides a straightforward interface and a simple connectivity mechanism with the prototype. One of the most significant features is the real-time updates of every piece of saved data. The continuous updates feature achieved with the synchronization of the data, which is stored in JSON format inside the database, with every client of the application. One of the most significant advantages of this database technology is the ability of the developer to build an application in every platform without any problem. All platforms will share one real-time database instance that is constantly receiving updates with the latest data. A code snippet is shown below in order to understand how this technology works.

```javascript
createDonation(value){
  return new Promise<any>((resolve, reject) => {
    let currentUser = firebase.auth().currentUser;
    this.afs.collection('donate').doc(currentUser.uid).collection('donations').add({
      fullname: value.fullname,
      title: value.title,
      description: value.description,
      image: value.image
    }).then(
      res => resolve(res),
      err => reject(err)
    );
  });
}
```

Same principles with the login and register process applied here. The complete functionality is wrapped inside a "Promise return" function and it is using the current user uid to save the data according to the developer’s needs inside the database. In the prototype’s case, the data saved is the full name of the user, the title of the post, a short description of the post, and an image for better presentation and understanding. All this information saved in the predefined collection path. For the donations the path is do-
nate/currentuserID/donations. If the saving process is successful, all these values saved into the database in JSON format as described in the section above and the promise function will return a successful message to the console. The database will then update all posts, and the users can see their new or updated post inside the prototype application. In case of an error, the Promise function will display a message to warn the user to try again. The complete code structure presented in Appendix J

6.6 Adding Native Elements

Native elements are the core elements of every mobile phone. These core parts of the mobile operating system are audio, video, permission, ads, and countless other features a smartphone can provide. The complete list of the features provided can be found in Ionic native page \(^1\). The native elements incorporated for the needs of this mobile application are four, and they were limited to the most important for the prototype. The first element was the splash screen, which is the prototype’s launch screen and a fundamental part of every application. The second one is the status bar where the developers can change the appearance of the native status bar of the mobile phone according to their needs. Additional native element in the prototype is the in-app browser where the user could see the eco-tips and other web-pages. Last but not least is the image picker that gives the ability to the users to choose a picture from the gallery of their phone and add it to the post. The last feature needs user permissions in order to function correctly.

6.7 Testing

The next step after the implementation of the prototype was to begin the testing iterations. Two different persons took the responsibility of making the testing runs. The first was an author’s peer and software developer, and the second was the author of this thesis himself. The testing process demands many iterations applying different scenarios each time a testing session begins. The scenarios include the running of the application across different platforms and browsers and observe the behavior. The testing process inspects all the functionalities, the graphics transition, and the correctness of the information displayed in every screen according to the conceptual design. Close observation reveals design faults or functional errors. It is complicated to identify such errors as the operational philosophy, and the design constraints among platforms and browsers differ. However, developer tools like

\(^1\)https://ionicframework.com/docs/native
implementation of the prototype are sophisticatedly designed for application testing. The prototype testing phase needs patience and time to observe the behavior of the functionalities and every aspect of the application. These aspects include smoothness, graphics transition, feedback messages, and overall usability. Additional parameters that need to be monitored are memory management, database connectivity, and hardware behavior. During the testing, many iterations of the same sequence of starting, login, posting, retrieving, observing, and log out attempted. As a result of this process, many errors and bugs revealed, giving the developer the ability to fix them on time and provide the best possible product meeting all the deadlines the same time. Finally, a pedantic look reveals some minor design flaws that later fixed, bringing both testers to a consensus.

6.8 Open Source and Licenses

Closing the implementation part of this thesis, it is essential to mention the licenses granted for images, text and code parts of this application. Ionic Framework is an open source framework running under MIT License that provides an entirely free-to-use platform for every developing purpose. The same principles applied in the Apache Cordova license. It is an open source project as well and can be used under the Apache 2.0 license freely for any purpose commercial or not. Moreover, all the pictures used in this prototype application development were taken from image galleries websites [64–66]. All these websites provide the images under free of use license. All licenses notes could be shown in appendix G. Last but not least, all the website links to the information used in the eco tips shown in appendix I

6.9 Limitations

Some limitations applied here as well. The firebase limits its requests in the free plan. However, the number of these requests are more that enough for the testing and evaluation phase. Some limitations applied in the Ionic Framework as well. These limitations observed in high-performance utilization. Although the prototype is not using any complex computations or high-performance graphics in this early stage, this limitation should be considered. Finally, the limited timeline keeps the number of UI components to the essentials for the minimum viable product. The complete list of the Ionic UI components presented in Ionic components webpage.

\(^2\)https://ionicframework.com/docs/components
7 Research Ethics, Documents, Settings and Scientific Methods

Research should be governed by guidelines, settings, documents, and methods. First of all, a research domain should be defined in order to have a subject to search, as described in section 1.7. Consequently, full planning of the process should be envisioned and defined as well. All the parts of the research should be connected to give the overall impression. These parts involve people, surveys, experiments, evaluation, analysis, literature, and a lot of processing power. The information about the research along with empirical study, and analysis and could be found in sections 1.7, 1.9, 2.5, 7, 8 and 9.

7.1 Research Ethics

Research is an important part of this thesis as the author try to justify the two research questions as formulated in the first section of this document. Adhering to ethical norms promotes credibility, knowledge, truth, and correct presented data. Additionally, every research should be governed by values like respect, trust, and fairness to the people who participate. Another essential part is to consolidate a framework where the complete process complied with the regulations according to the subject of research, federal laws, moral and social values like human rights, providing the proper data confidentiality according to the General Data Regulation Framework.

The most significant part of every research is ethical guidelines. This thesis follow these guidelines as described thoroughly below. These principals [67] are:

- **Honesty.**
  There should be a continuous struggle for honesty in research. All the data provided should not be falsified, fabricated, or wrongly presented. The thesis needs an honest, straight opinion about the facts and honest reporting of the data results and methods.

- **Objectivity.** Objectivity demands carefulness during a research. Establishing an objective opinion needs to avoid bias towards any personal or financial interests that may affect the whole work. The objectivity builds with the unbiased presentation of all the facts concluding using the scientific analysis methods.
• Integrity.
The thesis needs the integrity to support the promises, agreements, and other written or unwritten consents.

• Non-Discrimination.
Fairness and impartiality are some of the most important parts of research. Discrimination is against human rights, and having an open mind for every participant is crucial. The research should be independent of racial, gender, social class, and financial situation in order to make it acceptable and credible to the readers.

• Carefulness.
The author needs to be careful with all the processes like works, records, data collection, and activities that govern the research.

• Openness.
The research is not having any value if the reader did not share it with the public. Openness suggests sharing the results, the data, the ideas, the resources, the tools, the technology, and comprehensive planning like a decent thesis work. The most interesting part is the receiving of constructive criticism that could bring modification in the existing work, reflection, and the most important inspiration and new ideas.

• Intellectual Property respect.
Intellectual property respect is of crucial importance in the scientific research. There is no author, writer, student, scientist, researcher, or people across the globe that could assent to use their work, research, data, or property without using the proper license or permission.

• Confidentiality.
Confidentiality is also a crucial part, especially when experimental research or empirical study conducted. Keeping the participants’ data confidential is mandatory. This way, they will be individually protected from public criticism, opinion biasing, or any other harmful situation that could affect their lives. Having peace of mind, the participants could be more relaxed and express their honest opinion about the research or the experiments that participate.

• Responsible Publications.
Responsive publication and proper literature review are always together. Avoiding duplicates, irrelevant information, and colloquialism in order to provide credibility and trust in the author’s work. Section 2.8 describes how this process takes place in this thesis.
• Respect for participants.
  Respect shows the path towards a meaningful life. Respecting other people as righteous human beings without discrimination is to respect yourself. Valuable researches conducted in order to explore new horizons and give people a better and meaningful life. So respect and research should be tight together in every published work.

• Legality.
  Legality in research and this thesis means to know and obey civil, data protection, institutional, and governmental laws in order to provide a valid work to the reader.

Applying these values [67] is an essential part of proper research, either experimental or theoretical. The described way of how research should be conducted it is an unbreakable part of this master thesis as well.

### 7.2 General Data Protection Regulation

The general data protection regulation is one of the most significant changes in data privacy and data handling ever made. In order to have complete control of the data [68] websites and application that handles data should comply with GDPR. This regulation is protecting every kind of data every citizen of the European Union shares on the web or in person using the traditional means. Every transaction that demand personal information regarding contact, health data, sensitive information, political and religious beliefs, and any other content that is related to people’s data should be available anytime to their respective owners.

#### 7.2.1 Data Privacy

This thesis is obliged to comply with the general data protection regulation in order to avoid any future problems and penalties. The manipulation of personal data like interviews, discussions, evaluation results, and any personal content that will be used for the completion of this document should be protected. Consent forms shared among the participants of this work, either local politicians, other interviewees, testers, or evaluators. The two samples of consent forms shown in appendix K.
7.2.2 Data Maintenance

Additional responsibility for the author is to maintain these data private and not share any information with third parties by any means. The author of this master thesis is the GDPR officer who is responsible for the data handling and secure maintenance during the years to come.

7.3 Scientific theories and methods

First of all, science means knowledge based on data which can be demonstrated and reproduced. It is a systematic and logical approach to discover how things work, and all the knowledge gathered from the discoveries about everything in the universe [69].

An empirical study needs to be conducted to understand in practice how people react to the prototype of this thesis. The empirical study is one of the most significant parts of every study. In this document, scientific methods used in order to give credibility to the document. These methods dictate to justify the research questions. In this case, the research questions seeking for justification using the evaluation process. It is worth mentioning that additional hypotheses related to the research questions were not formulated in the analysis. Research needs users’ data to analyze and conclude and data gathering needs software tools like Google Forms, Google Docs and Google Sheets. Therefore the author uses questionnaires, interview questions, and observation to accumulate knowledge about the users perspective for the application and its purpose. Finally software tools specially made for data analysis 8.5 used in order to draw a conclusion 11 and reach to the research questions justification.
8 User Study

The user study is one of the most important parts of any research. The user experience data gathered through questionnaire and open ended questions help the researcher to make a constructive conclusion about the overall development effort. The user study is one of the last steps towards the completion of this research. Gathering useful information is crucial for the researcher to decide if the prototype meets the requirements and answer to the research questions. Otherwise, he needs to rethink and rebuild parts or even develop from scratch a new prototype and go into a new evaluation round.

![Fig. 26: Prototype Testing and Evaluation Phase](image)

8.1 Evaluation Methodology and Usability Testing

First of all, an evaluation methodology must be set up to gather useful data from the users. These data could help with the further analysis and the justification or not of the research questions. There will be a justified conclusion of whether or not the efforts have a potential impact on society and the environment. If the overall results are positive, then the prototype fulfills its developing purpose. There would be usability testing where the evaluators will test the prototype on mobile devices and decide whether this prototype meets their expectation or not.

The evaluation elements consist of a fixed answers questionnaire and a discussion that the participants will answer four questions. The questionnaire divided into sections focusing on the design, interaction, usability, and the participants’ willingness to contribute. The contribution is a significant indicator that shows if people are willing to act towards social and ecological sustainability or not. Initially, the evaluators interact with the prototype for one day. After the application usability test, the author set up personal and online meetings, either in person or in groups as described above. The evaluation group took place in an office workspace, where each participant submits the questionnaire without having
communication with others. The complete process took nineteen days to finish. The timeframe extends from twenty-sixth of April to the fifteenth of May. The feedback data transferred later into the analysis tools that help the author to present the results efficiently. The results of the analysis help the author to make safe conclusions about the research questions and the overall effort.

8.2 Evaluation Sampling

The evaluation sample consists of people of any age, gender, social, and financial groups. The author tries to approach every angle of this community without discrimination and prejudices. As a result of that, the data will be more valid and will represent the opinion of every part of the community. It is useful to elucidate that the value of each answer is not weighted in favor of their gender, race, educational level, or social class, and they are all considered as equal. The details about the demographics of the evaluators shown below.

The participants sample consists of thirty one people.

Gender of the evaluators.
- Women : 11 persons
- Men : 20 persons

Age group of the evaluators.
- 21 - 30 years old : 9 persons
- 31 - 45 years old : 21 persons
- 45 - 60 years old : 1 persons

Education level of the evaluators.
- High School : 31 of 31 persons
- Bachelor Degree : 25 of 31 persons
- Master Degree : 7 of 31 persons

Employment status
- Employed : 22 of 31 persons
- Unemployed : 4 of 31 persons
- Self-employed : 5 of 31 persons
8.3 Evaluation Questionnaire

Evaluation questionnaire is one of the most significant parts of an empirical study. Proper evaluation needs a decent questionnaire design in order to be relevant, content, and meaningful. The principles followed in this thesis are carefully selected to have the best possible outcome regarding the results. The questionnaire development follows the guidelines provided by the Center for Effective Global Action [70].

In order to design the questionnaire, the author defines the points of interest to make the most out of this process. The main focus of this research to the local community, gives the overall effort has a unique character. The first step of the questionnaire design was to decide the sections and the combination of the questions. The questions should reflect the requirements and the objectives of this research. These objectives are focusing on the correct presentation and usability of the prototype application. Moreover, the effectiveness of every feature is questioned in order to identify the correctness and their value in the community. An additional significant part of this investigation is to find out if the prototype application can potentially impact the community. A primary objective is to raise awareness and inform people about the researched problems. An additional exploration section is the users’ willingness to contribute to the idea of helping people who are in need. In the same manner, the author should define if users are willing to push local politicians and other prominent persons to act towards social and ecological sustainability.

Another primary objective is to make the questionnaire comprehensive for everyone. The questions should be short and user-friendly and phrased in an obvious way. After the questions formulated, the author needs to choose the correct response format in order to give the best possible value in every question. In order to eliminate mistakes in responses, the author chooses an apparent format with pre-defined answers. A linear Likert scale from one to five describes in details the values every number represents. The answer variations from one to five are: "Totally Disagree", "Disagree", "Neutral", "Agree", "Totally Agree". Finally, the author adds four short answer questions highly relevant to the content and the purpose of the research so the evaluators could express their opinion freely.

The questionnaire was divided into five sections. The first two sections consist of questions carefully selected to focus on separate parts of the effectiveness, usability, and the overall design efficiency of the application. The last two sections focus on users’ opinion about the potential impact and the willingness to contribute to the overall effort as parts of the community. The complete questionnaire were presented in appendix D.
8.4 Evaluation Reporting

The evaluation report takes into consideration the preliminary interviews from local politicians and other relevant informants. The author tries to combine the perception of the initial interviews with the actual evaluation data and make a conclusion. The participants express their opinion about the prototype and their intentions for a better community. In the results section, the evaluators’ answers to the discussion part connected with the relevant sections of the questionnaire. Both the interviews and the evaluation questionnaire focus on building a holistic approach to the overall effort. To justify the potential impact and the ability to promote social and ecological messages the fixed-answers questionnaire and the overall discussion part cross-examined. The results of this study let the author conclude and envision future developments for a more sustainable society.

8.5 Evaluation Tools and Technology

The tools used in the evaluation phase were numerous. First of all, a questionnaire designed to gather the user’s feedback. This questionnaire made in Google Forms and Google Docs and shared with links to the evaluators after the initial usability test of the application. Subsequently, the data of the Google Forms and Docs transferred in Google Sheets to summarize and categorized the data into a manageable and comprehensive format. Finally, the feedback data carefully transferred to IBM SPSS’s specialized analysis functions. The author tries to find significant leads in the results to justify the research questions. SPSS was made data analysis efforts easier since it can provide a considerable amount of information in a single analysis session. It is one of the best analysis tools that help students and scientists analyze every possible scenario for many years [71]. Its contribution was beneficial in the presentation and the translation of the results.

8.6 Evaluation Limitations

In every step of this thesis as in life, many limitations occur. The first and most significant limitation is the available timeframe to conduct this evaluation. To make the most of the given timeframe a prudent milestone plan designed to find a sufficient number of evaluators and finish the analysis on time.

Another limitation is the number of participants in the evaluation process. Initially, forty-five people consent to take part in the evaluation. The number of people who ultimately took place was thirty-one. A complete demographic
analysis presented in section 8.2. The percentage of resigned people was well calculated long before the beginning of the evaluation. Previous experience from the Master program courses showed that a minimum of twenty to thirty percent of people who are willing to participate in the evaluation they are refusing in the end. Users denial reasons are unforeseen personal problems or limited free time. The fact that not every research is financially supported make people’s participation more difficult. Since voluntary work demands to sacrifice personal plans and spent time with the researcher, people avoid to put themselves in this situation. However, all these factors were unable to stop the effort from reaching the desired number of evaluators. Patience and persistence in the approach of every person helped significantly.

Moreover, the language barrier was a significant burden since the conveyance of the meaning in every interview, and discussion part was very time-consuming. All the interviews were given in Greek and later translated into the English language. The carefulness not to lose the real meaning of every answer was the most challenging part of this process.

Last but not least, it was impossible to approach the mayor and the head of social grocery during the evaluation process due to their participation to the Greece municipality election campaigns of 2019 the exact period of the evaluation. All other persons participated in the initial interviews approached and give their valuable opinion.
9 Analysis of the Application and the Evaluation Results

The analysis of the application and the evaluation results presented in this section. The results of the first section of the evaluation displayed in tables. These tables contain the descriptive statistics of the responses of the thirty-one evaluators. The data can reveal potential issues about the design of the prototype application along with the effectiveness of it. Moreover, the results show the user’s opinion about the potential impact of the application on the social and ecological sustainability along with its ability to raise awareness. Furthermore, the descriptive statistics will be connected with the four short answer responses. Finally, after the presentation and the analysis of the results, the author will be able to conclude effectively. The conclusion will reflect on the potential impact of the prototype and the intention of the participants to support the overall project.

9.1 Analysis Techniques and Tools

The analysis techniques consist of many steps in order to justify the results. The first step is to gather and present the final data of the questionnaire and the short answers inside the Google Sheets document. Consequently, the data will be moved for further analysis in IBM’s SPSS Statistics. The variable and data view of the SPSS is a great way to correlate nominal and numeric values. Subsequently, the questionnaire pass through many analysis iterations such as a Cronbach’s Alpha Test, and descriptive statistics analysis. The first test checks the internal consistency of the questionnaire and provides useful information about the questionnaire design. The descriptive statistics provide significant statistical results like the mean and standard deviation that could help the author to evaluate his efforts. It is good to mention that not any data analysis technique comply with every dataset and the choice of the most appropriate for this one was significant. The thesis supervisor approved all the analysis techniques and results. The complete questionnaire and its design guides presented in appendix D, F and in section 8.3 respectively.

9.2 Questionnaire Results

The following sections provide all the data analysis in SPSS Statistics. This analysis helps the author to justify the research questions that formulated in section 1.7.1. These results indicate information about the design, the correct implementation, and the overall effort of this thesis. The responses
also reveal the respectful opinion of the users about the overall idea, the execution, and their willingness to be a part of an active and helpful society.

9.2.1 Cronbach’s Alpha Reliability Test Results

<table>
<thead>
<tr>
<th>Cronbach’s Alpha</th>
<th>CA based on Standardized Items</th>
<th>N of Items</th>
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<tbody>
<tr>
<td>.982</td>
<td>.984</td>
<td>17</td>
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</table>

Tab. 5: Cronbach’s Alpha Reliability Test Table

Cronbach’s Alpha is an important reliability test for the evaluation questionnaire. Many times Alpha values have been criticized as a value of poor understanding and interpretation. In this case, the Cronbach’s Alpha reliability test was successfully passed with a very high percentage, something that indicates an excellent and robust relationship between the questions [72]. Some references mention that high values indicate redundancies in the questionnaire. This questionnaire was built with a reasonable number of questions aiming to provide the best possible outcome in the time given. Taking into account that the inter-relation values between items varied from 0.600 to 0.948, and the majority of the items having inter-relation values over 0.750, it is a clear indication of a decent questionnaire building effort. Any possible modification will not provide significant changes to the results. Additionally, in item-total statistics table presented in appendix F.1 the reader can identify high values over 0.980 in Cronbach’s Alpha if any of the items deleted. This result is another indication that shortening the questionnaire will not lower the Alpha value significantly. The questionnaire design passed through many iterations of editing and focused approach to the problems discussed in order to finalize the number and the content of the questions to the most relevant. The questionnaire design guideline presented in section 8.3. The final version was carefully inspected and accepted by the thesis supervisor.

Concluding, the values of Alpha is a result of a robust relationship between the questions and the possibility of duplication or huge similarities among the questions eliminated from the design phase of the questionnaire. The variety of the content and the quality of the questions shown in the questionnaire description in appendix D. Finally, the Cronbach’s Alpha value of 0.982 is indicating an excellent internal consistency of the questionnaire, something that can succeed correct and reliable results.
9.3 Statistical Analysis

The statistical analysis of the final data sample made in SPSS Statistics. The aggregated data saved in Google Sheets transmigrated in the data and variable view fields of SPSS for detailed analysis and result interpretation. The values the author focuses on are Mean and Standard Deviation. The mean value is the same as average. This value explained as the addition of all values inside the dataset divided by the number of observations in it. The standard deviation value shows the variability of the users’ answers from the mean value of the groups [73].

9.3.1 Design Efficiency Questionnaire Results

The design efficiency section examines the overall design of the application. The questions’ design focused on many sections. These sections examine the navigation through the pages, the understanding of every page, the overall page layout, the providing of adequate amount of instructions, and the categories and functions provided inside the prototype. The questions description of this section presented below.

- Question 1: The overall navigation throught the pages was easy.
- Question 2: The interface was easily understood.
- Question 3: The pages layout was well designed.
- Question 4: The instructions provided were clear and well understood.
- Question 5: I am satisfied with the provided categories and functions.

<table>
<thead>
<tr>
<th></th>
<th>Question1</th>
<th>Question2</th>
<th>Question3</th>
<th>Question4</th>
<th>Question5</th>
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<td>4.38</td>
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<td>.55</td>
<td>.70</td>
<td>.49</td>
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<td>3</td>
<td>4</td>
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<tr>
<td>Maximum</td>
<td>5</td>
<td>5</td>
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</table>

Tab. 6: Design Efficiency Results
Table 6 presents the results of the five questions where the users express their opinion about the design of the prototype application. The values analysis indicated that all the answers are very positive. The mean values of the questions varied between 4.35 and 4.61 and the standard deviation from .49 to .70. These results satisfy the author to a great extent. The highest value observed in the fifth question with a mean value of 4.61. However there is no significant difference from the other questions where the mean values fluctuate from 4.35 to 4.58.

Since the evaluation of the prototype didn’t focus on the discrimination or differentiation among groups the author wants to present some statistics about the different groups of participants to investigate if any huge differentiations occurred. However the evaluation process among different age groups did not reveal any significant distinctions in the answers given. All the people that participate in the evaluation is familiar with the technology according to their answers. There is not a major technological knowledge gap a claim that is justified by the results of this section of the questionnaire. Likewise, the answers between the gender groups of male and female behave similarly. The author did not find any differentiations worth mentioning because all answers mean values fluctuate from 4.46 for men and 4.55 for women something that justify the previous claims that participants are knowledgeable and familiar with technology. Additionally, neither the age group nor the job occupation shown big differentiations. The mean values fluctuate between 4.44 and 4.72 for job occupation and 4.45 and 4.52 for age groups. The percentage numbers can be found in frequency tables 13, 14, 15, 16, and 17 in appendix F and E.

The overall outcome of this section is the user satisfaction of the design, which is not only limited to the user interface but in user experience as well.

### 9.3.2 Effectiveness Questionnaire Results

Subsequently, the effectiveness questions examine the features’ functionality of the prototype. The effectiveness not only focus inside the prototype but also in the outcome of these features and functions to support the needs of the community.

The questions description of this section presented below.

- **Question 6**: The prototype features provide an efficient way to support the needs of community.

- **Question 7**: You can easily find the desired posts and information about the provided features.
- Question 8: You can easily post or edit the desired information.
- Question 9: I believe that the prototype features can be an effective way to promote solidarity inside the community.

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<tr>
<th></th>
<th>Question 6</th>
<th>Question 7</th>
<th>Question 8</th>
<th>Question 9</th>
</tr>
</thead>
<tbody>
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<td>.52</td>
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<td>Minimum</td>
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<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Maximum</td>
<td>5</td>
<td>5</td>
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<td>5</td>
</tr>
</tbody>
</table>

**Tab. 7: Effectiveness Results**

Table 7 present the results of how the feature behaves inside the prototype and how these features could provide an effective way to support the needs and promote solidarity in the community. The results in this section are following a positive pattern with values (M:4.48, SD: .56), (M:4.7, SD: .46), (M:4.67, SD: .54), (M:4.68, SD: .52). Users’ opinion about the features of the application are encouraging. The developed features could help and provide an efficient way to bridge the connectivity gap in the community.

Observing the behavior among different groups of evaluators, the author cannot distinguish any major flags or differences in the answers. The age groups mean values fluctuate among 4.64 to 4.67 and the mean values among gender groups is the same with mean value of 4.64. The acceptance of the users that the features provided are an effective and efficient way to support the community is encouraging. Additionally, the results indicate easiness to find relevant information or edit an individual post.

These results give motivation for further development of the prototype to become an application accessible to everyone. The answer percentages to every question can be found in tables 18, 19, 20, 21 in appendix F and E.1.
9.3.3 Impact Questionnaire Results

In the next sections, the evaluation moving towards a more personalized approach. The author uses the questions to examine the users’ opinion about the potential impact of the application. The main fields examined are the circular and local economy and the application as a mean to provide solutions. These solutions focus on job searching and make the application an informational hub to raise awareness about social and ecological sustainability.

The questions description of this section presented below.

- **Question 10**: The application features could provide solutions to the people who are in need.
- **Question 11**: The application features could promote circular economy actions.
- **Question 12**: The application could be an efficient way to promote local economy.
- **Question 13**: The prototype could raise awareness about social and ecological sustainability problems.

<table>
<thead>
<tr>
<th></th>
<th>Question10</th>
<th>Question11</th>
<th>Question12</th>
<th>Question13</th>
</tr>
</thead>
<tbody>
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<tr>
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<td>4.32</td>
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<td>Std, Deviation</td>
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<td>5</td>
</tr>
</tbody>
</table>

Tab. 8: Impact Results

The table 8 results indicate the users’ opinion about the potential impact of the prototype in the society. Among the thirty-one users answered the questionnaire; the majority of them believe that almost every part of the discussed and researched topics can find a place in this application. The real-life impact estimation is challenging in this early stage of the development. These results demand months if not years of testing and analysis in
order to conclude sufficiently. The actual value of this section is to gather an 
early stage evaluation of the actual worth of the prototype. The evaluation 
of these people is worth a lot for these efforts because every one of them has 
a unique position in the community and their opinion matters. 
Analysis of the results, shown explicit consent that the application could 
provide solutions using the developed features. Additionally, evaluators re-
sponses fluctuate in the same levels regarding the circular economy and local 
economy with some minor disagreements about the ability of the application 
to promote the local economy. Two answers are not something that worries 
the author or indicates potential flaws. The majority of people believe that 
it is possible for the application to bring efficient ways to promote the local 
economy. Finally, the author distinguishes some doubt in the ability of the 
application to raise awareness about social and sustainability problems using 
the informational features. 
The neutral responses are not a drawback since the vast majority of these 
users answered with an agreement and complete agreement to the other ques-
tions related to the potential impact of the application. Another reassuring 
factor is that doubt of some participants of the application ability to raise 
awareness covered by the willing of these users to share the word about the 
prototype with their peers in the community in section 9.3.4. So the neu-
trality in the responses about informational ability of the application is not 
something that could hold back the overall effort. 
There are no major differences observed among the groups. There are not 
any variances worth mentioning in the results neither in age groups where 
the values fluctuate from 4.34 to 4.42 nor gender groups where the values 
fluctuate between 4.36 to 4.3. The same pattern follows the job occupation 
group, as well with values to fluctuate between 4.35 to 4.38. All the answers 
are lean towards the positive direction justifying the previous claims. The 
table with the percentages of every question presented in frequency tables 
22, 23, 24, 25 in appendix F and E.1. 

9.3.4 Contribution Willingness Questionnaire Results 

Finally, continuing a similar personal opinion approach, the author try to 
explore the users' willingness to contribute. This section considered as one 
of the most critical parts of this questionnaire and the evaluation in general. 
The author pays close attention to the questionnaire since all actions to 
provide and inform are useless without people's assistance. The race for a 
change towards a more sustainable community depends on its people. 
The questions description of this section presented below. 

- Question 14: I am willing to support acts that help the community.
• Question 15: I am willing to push local politician to act in favor of people who are in need and local economy.

• Question 16: I am willing to share the word with my peers to raise awareness about the community problems.

• Question 17: I am willing to contribute for the good of the community.

<table>
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Tab. 9: Contribution Willingness Results

Last section results presented in table 9 show the user responses in willingness to contribute. The responses of this section are a huge encouraging factor to support the effort for a better community and better future. The people willing to contribute is a decisive factor for the future of this application, and the development efforts as an extension. There would be no application nor technological advancements in this world without people’s efforts and contribution. The result analysis of these questions indicate a great willingness to support not only the features and the effort related to the application but also to spread the word across the community and push local politicians to act in favor of the community. The observation of the results did not indicate any significant differentiation among the different groups of the users. Some individual negative results which represent the 6% of the evaluators’ sample cannot change the overall picture of the results since most of the answers are following a positive direction on the agreement scale. The willingness to act could bring radical results towards social and ecological sustainability. Three of the four questions fluctuate in the same levels of agreement with the vast majority of the evaluators to be ready to act for the community and the greater good. The only question that shows some
doubts and negativity is the question related to the willingness of the users to push local politicians to actions. This disaffection is related to the notion that these people are acting biased and do not care about people’s lives. This notion is not entirely true in local municipalities since most of the people know and care for each other. The rest of the sample responded positively. The great majority shows the imperative need to act in any possible way. Activism is something difficult that demands effort and courage. However, when people’s rights are at stake or inequalities occurred in society, most of them act instinctively. The actual results shown in tables 26, 27, 28, 29 in appendix F and E.1.

9.4 Open Ended Questions Results

Short answer questions are designed to make it possible for users to express their opinion freely. This way, the author could gather more information about the evaluators’ opinion and give attention to details. These details can hardly be revealed in a fixed questionnaire. When people answer in the open ended question, they do not only evaluate or judge, but according to the context of each question, they express their feeling, suggestions, and creative solutions. This information can help the author to gather useful insights about the developed product or service. A very important thing of the open ended questions is that the participants can express their opinion and reveal many interesting facts and suggestions from their interaction with the application that otherwise, it was very difficult to be expressed and distinguished. The questions do not focus on every function or service provided but focus on the overall experience and the feelings this prototype brings to the surface. The overall feedback either positive or negative can benefit the thesis effort because the developer uses the opinion of every user to find potential drawbacks. The most prominent companies and every modern organisation value the users’ opinions highly and use the data of the users feedback frequently to validate if their efforts meet the customers requirements. Constant feedback improve the quality of their products, and services in a continually effort to identify bugs and improve the user experience and their sales.

The short questions users need to answer were:

1. Do you face any difficulties using the prototype?

2. Do you find any irrelevant content or issues inside the prototype?
3. Is HandToHand an efficient application that could achieve its purpose of promoting sustainability and sharing inside the community?

4. Are you willing to use this application for the best interest of the community and as an extension of the environment?

Short answer questions analysis is an essential step in the evaluation process either the outcome is positive or negative. In the following pages, the author will present a summary of the answers given to every question. All the answers can be found on appendix E.1

**First Question Responses**

The first question focuses on the usability of the app across every page and every functionality. So if any potential drawbacks occurred that missed in the testing process, it would be revealed by the users feedback. The analysis of the first questions shown excellent results in the usability of the prototype. All thirty-one participants answered negatively in the question of facing any difficulties using the prototype. All the answers given follow the same mood. In details answers like "I did not face any difficulties using the prototype. All were very simple" and "Nothing that could raise an alert or questions the usability of this app." reveal that the overall design process that focuses on the ease of use and the clean interface paid off. The rest of the answers follow the same manner something very encouraging for the overall effort. Some minor remarks in three answers though show a kind of confusion with a button inside the tabs. Since tabs are main pages in the design, there are no back buttons that direct into a parent page. These comments make the author reflect if he could modify all the pages to point back to a parent page. This idea seems promising, and it will find a fix in a future release if more users identify this as a problem. Concluding on the first question responses, the author could tell that the overall perception about the usability is very positive and encouraging. So the overall effort deliver positive results and comments.

**Second Question Responses**

Next question focuses on the content of the prototype trying to reveal possible drawback regarding the functionality and the relevance of the information provided. As a result of that, the author needs to tackle any possible misguidance or mistakes that slipped away during the development and
testing process. Additionally, he needs to gather useful information about different approaches that could enhance the prototype in a future release. Analyzing the responses of question two, the author gladly realizes that the users found the content along with information provided utterly relevant to the researched topic. Answers like: "Everything was clear and as far as I am concerned there was not any technical issue." and "The content was absolutely relevant and carefully written to cover everything about community sustainability issues. No issues found." leave a sense of satisfaction.

Moreover, no significant issues identified except a mention for minor lag at the beginning of the app and a crash report. These problems fixed after some time doing a reboot at the phone. These minor bugs are sometimes happening because the application is still in the prototype phase. In a production release, these minor bugs will be eliminated in the least possible.

Concluding with the second question responses, the author’s analysis of the comments was satisfying. The lack of irrelevant content or pressing issues that could jeopardize the overall effort is very relieving. The most critical part of every app is to contain relevant information and services and work flawlessly according to the development purpose.

**Third Question Responses**

The third question focuses on the users’ beliefs about the application and its ability to fulfill its purpose as a tool to promote sustainability and sharing in the community. Since this question is personal according to every user’s opinion, the author wants to analyze if this application could become a tool and help the community. Moreover, he hopes the users to express their true beliefs about the research topic of the circular economy, donation, and helping efforts.

Analyzing the responses of the third question, they were fulfilling and supportive. Most of the people are informed about the sustainability problems, and they are pretty convinced that this application could provide to the community with the new approach to everyday problems. Answers like: "As stated above with its ease of use, this app can be used by any person whatever the age. This can be a major factor for the achievement of the prototype, which will have a beneficial impact on communities." and "Yes, if people start using the application and blooms, it will help to achieve a more sustainable society. I think the idea of the prototype is very promising. I hope people will use it." is more than gratifying and motivate the author to escalate this effort providing efficient solutions that help the society and the environment. Some concerns about the efficiency of the app and the community embrace- ment are typical in this early stage of the prototype. It is useful to mention
that the future of the community and society towards sustainability is in people’s hands. The technology only provides the communicative bridge to all these efforts and ideas.

Concluding, the author wants to mention that all participants not only responded with positive comments of agreement that the prototype could become a tool for the community but also many of them hope this idea will be embraced and used by the people in the future. As a result of all these comments, the author was satisfied that the majority of the people see value on this idea and they are willing to use this kind of application that could benefit the society and the environment.

Fourth Question Responses

The fourth question formulated as a more natural way for the participants to express their opinion. Willingness to contribute following the same logic as the last sections of the fixed questionnaire. Following the same personal attitude, the author wants to explore further into the responses trying to figure out the real feelings and intentions of the evaluators.

Analyzing all the answers, it is easy to distinguish the energy that people are willing to give in order to provide in every possible way. Answers like: "Being as simple as it is, I do not see a reason why anyone who loves his/her community will not take part in this effort." and "Yes, as it would be a good way to improve the quality of life of the people in the community." have a positive impact on this research and development efforts.

People are willing to provide and use new ideas to promote solidarity, circular economy, and job solutions in the community and the environment as an extension. Some concerns identified in the participants answers that focus on the way the community should embrace this app in order to become an efficient way to promote all the topics discussed. These concerns do not impact the overall effort because the way this app will be used depends only by its users. Everyone can promote such kinds of actions and share the word to their peers and friends.

The answers about the willingness to contribute were decisive, and every one of the evaluators agreed to provide and participate in community actions that lead to a better and sustainable future.
9.5 Making a Complete Connection of the Results

Taking into consideration the results of questionnaire analysis in SPSS and the short answer questions, the author can finally conclude using the produced analysis data. The purpose of this process was not only to evaluate the development efforts of the prototype but also to gather useful information about the evaluators’ opinion and their willingness to contribute to this kind of actions.

The overall effort consists of ideas to promote the circular economy, sharing, and job availability in the community. The outcome of this implementation was to move towards a more humane and ecologically sustainable society. The prototype questionnaire separated into four sections. These sections were design, effectiveness, personal opinion about impact, and willingness to contribute. Four open-ended questions formulated to let the users express their opinion freely and cross-validate the results of the questionnaire with these answers.

First of all, the prototype design evaluation brings great feedback results. The edges of the mean values of all questions fluctuated among 4.35 and 4.61 with the edges of standard deviation among 0.49 and 0.70. These results reveal an appropriate design approach. The first question responses could support this claim, as well. The analysis of the first question shown very positive answers with the majority of the users not finding any difficulties using the prototype.

The next section of the questionnaire evaluates the effectiveness of the prototype in their functionalities inside and outside the prototype. To clarify the actual meaning of outside, the author wants to explore if the functionalities can work in real life. The majority of the answers to the questions was terrific. All Mean values fluctuated between 4.48 and 4.70 and all standard deviation values between 0.46 and 0.56. The effectiveness and the overall functioning of the application supported by the answers of the second question as well. The analysis of the second question shown no severe issues about the functionality and the content was highly relevant with the topics and the problems this thesis want to tackle.

Subsequently, the third section of the questionnaire wants to explore the user’s opinion about the potential impact of the application to the community. The edges of the mean values of these questions fluctuated between 4.03 and 4.64 and the edges of standard deviation between 0.52 and 0.90. The majority of the answers in the impact section of the application’s evaluation questionnaire were positive with some minor concerns in the ability of the application to raise awareness. The third short answer question reveals that these concerns related to the actual promotion and the correct use in
the community. Since the app used adequately, it could raise awareness efficiently and utilize its features to help people and bring solutions at the same time. The overall evaluation results were incredibly encouraging and very supportive.

Finally, the last section of the questionnaire explores one of the most critical parts of every actions to promote sustainable solutions in favor of the community and its people. The contribution willingness section results were positive. All mean values fluctuated between 4.00 and 4.45 and every standard deviation value between 0.68 and 0.93. The lowest value of the results was the willingness of the users to push local politicians. The short answer question reveals a strong will to support all kinds of actions that promote all the discussed topics. Looking in question 15 of the appendix F only two of thirty-one persons refuse to push local politicians. The other twenty-two was positive, and the rest were neutral. Combining these results with the short answers, the author could conclude that this small minority will not make any difference in the final positive results.
10 Discussion

The findings of this thesis suggest that technology in the form of a mobile application can potentially induce and promote the circular economy and sharing in the local community. People are very supportive of the overall idea, and the user study results have shown that this application can be an efficient way to support the needs of the community. Additionally, the overall effort to bring new ideas about the local economy and raise awareness about sustainable problems was fruitful. The overall study has shown that people are open to new ideas, and they believe that technology is a very efficient way to bridge the informational gap of the region. This bridging could bring new opportunities to the people. These claims are supported from the early stages of this thesis in application requirements analysis in section 3, where it is evident that the area demands new technological ways to connect the people of the community. This study can be a beacon for future studies that want to consolidate technology and similar values in every community. An additional reason this study made was to reveal problems of the society that many people know, but a small group of them have the opportunity and the knowledge to tackle them across every region of Greece. Such development efforts demands many resources in order to implemented correctly and used widely. The need for resources was the main reason local politicians and relevant informants took part in the interviews of the study. The most encouraging thing in this study was the willingness of the people to support actions towards sustainability. Many applications support such kind of actions as we mention in state of the art section. The most discouraging thing is the lack of information and awareness about the environmental problems and potential solutions that could help to decrease the negative effects in the people’s lives and the environment. The most popular application that were embraced by the users and supports sharing economy in Greece is Airbnb. So a potential solution that can combine all the discussed topics that can help the community to find opportunities, support and promote circular and environmental solutions could be very promising. This study, as several other studies, is subject to some limitations. These limitations include lack of financial resources to support the extensive infrastructure of such implementations like the setup of proper server systems, the establishment of new drop points all over the city and the financial demands of the continuous maintenance of the overall integration. Moreover, the lack of communication between different operators of the municipality holds back technological efforts for many years. If this idea finds the proper support, it could possibly be an efficient way to help people and promote sustainable
solutions across every regional community in the country.

10.1 Analysis of the overall Prototype Development Efforts

Prototyping is an enjoyable process as long as the developer knows his/her goal and how to reach there. There are lots of drawbacks during this process. Since the developer starts from a white sheet of paper trying to bring his vision to life, there are lots of possibilities to reach a dead end. The one thing a developer should never forget is never to get disappointed from the drawbacks and try to find alternative solutions to the problem. It is very convenient to work in a cross-platform framework like Ionic, but building for many platforms could have many difficulties regarding the correct presentation of every component in the screen.

Despite these difficulties, there is no faster way for prototyping than a cross-platform framework. Ionic, with its ready-to-use mobile friendly components and the Cordova native components access, make the prototyping a lot easier than building completely native with Java or Swift. A prototype could never be perfect from any perspective, but it could be substantial considering the time given. Even the biggest technology companies rely on minimum viable products for testing and experimenting.

The application needs further development, both optical and functional, in order to become a production application. The reality is that the development relies upon the developer skills and the timeline. Considering that this is a Master Thesis, the author knows the value of this work both for him and the institution. As a result of that, the author and developer give his best to achieve the best possible result in this limited timeline.

10.2 Reflections About the Prototype Value

As described above a prototype could never be compared with a final product. As its name explains, a prototype is an initial effort to build something using a combination of theoretical and technical knowledge with bold imagination. In this case, the author uses all its coding knowledge gathered from this Master Program to build the application of this study.

However, only the knowledge of building applications could never solve any real-life problem. So decent background research and deep understanding of the community problems that the developer wants to solve is imperative. The prototype consists of many parts and functionalities, which they can help people to support each other and induce environmental and financial solutions the same time. Such acts of sharing and caring can develop respect,
love, and induce opportunities that can contribute to the promotion of social and ecological sustainability.

10.3 Reflections About the Prototype Evaluation Process

An evaluation process could be beneficial when it comes to prototypes because it presents the actual value of the whole effort. A proper application of the theory does not mean that the final prototype will meet the requirements of the users and serve its purpose. The evaluation could bring additional value to the original study, gathering valuable data from people who are going to be potential users or customers in the future.

The evaluation process was painstaking and time-consuming. It demands a lot of dedication and stubbornness in order to gather the desired information in the time provided. It is a slightly complicated procedure to find a sufficient number of participants that will evaluate the product or the service. This process demands diplomacy and constant motivation in order to inspire the evaluators to participate. All these factors and values are an unbreakable part of every voluntary evaluation. However, an accurate and popular topic is always an advantage for every empirical study.

10.4 Analysis of the Overall Evaluation Efforts

In many sections of this thesis, the author mentions the value of an empirical study. In many papers and articles, there is a plethora of useful information that utilizes the data of the empirical studies. Hardly the reader who does not implicate him/herself in an evaluation process could understand the struggle and the effort needed in order to justify and validate these data. Many different and unforeseen parts implicated in these studies. First of all, the researcher needs to find people that are willing to participate in this process and provide their data. If the research is not funded, the researcher has an additional clutter to persuade people to participate voluntarily. The information a participant is willing to provide varied. This information could be an opinion, demographic data, or even personal health data or a combination of them. A considerable amount of effort required to convince a person to participate in every stage of the prototype spending valuable part of his/her free time. The lack of personal motivation or inspiration makes most of the time, these efforts to fail. As a result of this drawback, the author tries to motivate and inspire people to take place in the evaluation describing the actual value of this study in society and the community.

The main number of the participants who took part in this evaluation were
peers, acquaintances, friends, and additional peers’ connections. The participants selection was made without discrimination or partiality trying to reach every possible group of people in the community. Finally, all participants were explicitly told about ethics and urged to evaluate the prototype impartially, expressing their real opinion as accurately as possible.

10.5 Overall Reflections about the Thesis Development

The literature search, the overall project development process from the idea to the final version of the prototype, to the completion of the evaluation, was nothing but easy. Many sleepless nights spent trying to fix bugs and make corrections to the design. The literature review took many days of unstoppable reading, trying to find the most relevant content that describes the problems the author want to tackle. Additional effort applied to the distinction of similar content in order to make the comparison and keep the best articles and papers. Several obstacles overcame in the development phase as well. Bugs, functional problems, and design declinations were some among many during the implementation of the prototype.

Last but not least, the most stressful part of this thesis was the evaluation process which implicates thirty-one persons, and it was a race against time. The evaluation process is, most of the times the most challenging part because people’s opinions are always unpredictable. The overall process of writing a Master Thesis was a beneficial experience. It demands theoretical knowledge and technical skills among many other things that already mentioned to postpone this kind of work. It is one of the most intense academic experience a student could have at this level. Concluding, it is worth mentioning that the completion of this document required a large amount of additional knowledge that accumulated during the writing of this document and the prototype development in order to meet the requirements and finish all the parts successfully.
11 Conclusion

In this study, the author examines the ability of a mobile application to induce people to share and promote the circular economy in the community. A supplementary close related examination subject was to find answers about the ability of the same mobile application to provide new opportunities to the people and promote equality and welfare in the community. The author put this application through many testing iterations and finally gives this application to volunteers for evaluation. This evaluation took almost twenty days and engaged thirty-one persons over every group of society. The region that the evaluation conducted was the greater area of Larisa, Thessaly.

This piece of work is a different approach to the everyday problems of the communities in Greece. It is a technological bridge to close the informational gap between the people who face difficulties in their lives and the municipalities who do their best with the available tools to help as much as they can. Moreover, it is a new way to promote interesting solutions that could be applied and promote the circular economy and better food management even though the overall effort need much more resources and information in order to become the Swiss army knife of the community applications.

However, it was the first step to induce people to share and promote sustainable solutions that could benefit society. These ideas can benefit low-income families who struggle uniquely providing many opportunities and solutions to their problems. The only thing needed to do is destroy the walls and embrace actions of share and care. It is an honest approach to find solutions to the consequences of the financial crisis and an innovative way to manage the everyday things and resources efficiently for the best of the environment and the society as an extent.

11.1 Justification of the Research Questions

This thesis work explore technological ways to find efficient solutions for the good of our fellow citizens and the environment. The research questions formulated in the section 1.7.1 will be answered in the section below.

Can a mobile application be an efficient mean to induce people to share and promote circular economy in the community?

From the application requirement analysis carried out, it was discovered that there is not any information system that focus in the specific needs of the community. Many prominent people and relevant informants of the community pinpoint that the society demands technological advancements
that will bridge the informational and connectivity gap. This kind of solutions will benefit every region across the country that faces similar problems. Additionally, from the empirical study results in section 8 that followed the interviews of section 3 it was evident that this prototype could be an efficient way to induce people to share promoting solidarity and support to the community.

The non-existence technology in the region makes this solution an entirely new approach to many problems of social grocery and local economy. All these results could be achieved using the immediacy the technology can provide and the power of the information when this refers to a highly targeted audience like the people of a community. This exclusivity is very difficult to be achieved using conventional technologies and media that already exist. As a result of the targeted connectivity, this application can find value in a completely different way than all other applications.

Are the provided features of the mobile application foster people’s willingness to share, donate and promote circular economy principles within their communities?

In a similar setting and having analyzed the interviews of the relevant informants in the application requirements analysis section and the results of the evaluation process, it is evident that the provided features of the prototype could foster people’s willingness to share, donate, and promote the circular economy. The data gathered during the interview process help the author to distinguish the problematic areas of the community early during the development of the thesis and focus on them in the later stages of the development and the evaluation. Examining the results of the preliminary interviews and every questionnaire section, the author concludes that the outcome was very encouraging. The cautious approach to the design of every one of these features brings the desired results. Participants believe that application’s features that support donation, machinery sharing, and the promotion of circular economy principles can be beneficial for the community. They were very positive that the provided features will provide solutions, to people who are in need, making it an efficient way to promote the local economy and enhance the overall financial situation of the community. Finally, the results from the contributions willingness section have shown that the participants are willing to support, share, and contribute for the good of the community and the environment.
11 Conclusion

11.1.1 Overall Conclusion to the research questions

Concluding to both research questions, the solutions provided with this prototype is an entirely new approach to the obsolete and dated ways that people see things till now. A mobile application and a potential future platform can become an efficient tool for the community that is completely unaware of the endless opportunities the technology can introduce to them and their businesses.

Additionally, all these solutions discussed will not only provide solidarity, equality, and equity in the society but can be a very efficient and effective way to promote sharing and the circular economy. The features of the application is utilizing the power of technology interconnecting different groups of people in an effort to support people in need and promote circular and sharing economy solutions that could benefit the community. In the community, a big group of people will share a specific number of machines and tools, finding not only new ways to utilize them but also new ways to manage the dated and old machines using the spare parts to build new or fix the existing ones.

Moreover, supporting the previous arguments all this circularity, the immediacy of information and sharing can reduce food waste, and overexploitation bringing new financial opportunities in the community that all these years were unexplored.

11.2 Future Work

The future direction of this research is moving towards the implementation of these solutions in real-life producing an entirely new economic model for the region. The widespread implementation of this system could find support from the state and municipality or even private ventures. It is a unique opportunity in the current situation that can open new horizons for the people.

This thesis effort should be examined and further developed because all these problems exist and can be justified by everyone leaving and working in rural areas in Greece. This piece of work has endless opportunities for further development that could make it a unique tool for the people. Additional components can be developed to provide more information to the people. Technologies like geofence could automate and enhance many functionalities like job search or donation points indication in nearby areas.

Moreover, this application has the possibilities to expand into a social media ecosystem where all the people across every community in the country could communicate and change opinions. Furthermore, weather data and financial
management solutions can be developed to help all the self-employed people, farmers, and professionals to manage their money income and expenses. The author of this master thesis finds it obligatory to mention that this study was not made to present the best community application ever envisioned. This study was made in order to examine the people’s opinions about the problems of the community and reveal the possibility to transform trash into money and desperation into solutions. The real value of this study is to inspire more people who respect the environment and their fellow citizens to support these progressive actions. Because a good start is half the success, and this start is a collective effort to find the way towards sustainability.
References


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[54] CSS. W3Schools. CSS is a language that describes the style of an HTML document. CSS describes how HTML elements should be displayed. https://www.w3schools.com/css/.


A  Statistical facts used in introduction

In this section the author presents all the statistical facts and tables used in introduction of this thesis.

A.1  Unemployment rate in Greek Departments table 1/2

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Tab. 10: Unemployment rate at Greek departments 1/2 [24]
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Tab. 11: Unemployment rate at Greek departments 2/2 [24]
B Interview Questions

This interview questions were formulated in order to gather useful information from local politicians, influential people and businesspeople. Using these interview questions the author can explore the viewing angle of these persons to fellow citizens problems. Additionally it is an effort to explore the knowledge about circular economy, food waste and sharing and their opinion about these topics. Moreover having in mind that their opinion matters, because these people excel in their areas, they can promote the thesis ideas to the public efficiently. Their experience and their knowledge can benefit the overall thesis value and provide useful information both for application requirements analysis and for the results validation.

B.1 Mayor Interview

This is an interview as part of the research entitled: Studying the impact of a mobile application in sustainability, circular economy and the interaction between people of the local community.

Taking into account of the financial situation in Greece, do you think there are people in our community who need help such as food, clothes and other useful items?

Are you willing to use an application that could connect directly or inform relevant people about the availability of goods in certain points?

Given the dramatical impact of climate change, many scientists and economists strongly support the development of the circular economy. The circular economy promotes the expansion of life of thing from the production to their disposal. In the context of the circular economy and having in mind that we are living in a predominantly agricultural society with a huge number of agricultural machines there is a lot of potentials to apply this idea. Do you believe that lending or sharing of agricultural machinery that are in a standstill could benefit the environment?

Do you believe that an application can contribute in the networking process between farmers and the community to make this idea work?

Knowing the seasonality of farming jobs and the urgent of every task it is almost impossible to find workers on time and there is a constant lack of human hands. Taking into account the unemployment rates of our region,
would an application contribute in the communication of the agricultural jobs with people who want a job?

Another issue that concerns the scientific community is the waste of food that amounts to 100 kg/year for every European citizen. All the more so in Greece, which is a country which produce many agricultural products, have a great number of tourists which and as an extension have a huge number of food retailing stores, food and catering companies. What would you say if any producer, restaurant, food-retailing or food-processing company have the ability, through an application, to offer food at very low prices in an effort to reduce the waste of food and promote sustainability?

Would you use an application to promote everything that has been discussed in order to contribute to a better future of this place and as an extension the planet?

Would you promote such actions as a political figure in our region and community?

Do you believe in the power of the community to support and promote such technological actions for a better future in our region and our country?

B.2 Citizens Interview

This is an interview as part of the research entitled: Studying the impact of a mobile application in sustainability, circular economy and the interaction between people of the local community.

Taking into account of the financial situation in Greece, do you think there are people in our community who need help such as food, clothes and other useful items?

Are you willing to use an application that could connect directly or inform relevant people about the availability of goods in certain points?

Given the dramatical impact of climate change, many scientists and economists strongly support the development of the circular economy. The circular economy promotes the expansion of life of thing from the production to their disposal. In the context of the circular economy and having in mind that we are living in a predominantly agricultural society with a huge num-
ber of agricultural machines there is a lot of potentials to apply this idea. Do you believe that lending or sharing of agricultural machinery that are in a standstill could benefit the environment?

Do you believe that an application can contribute in the networking process between farmers, and the community to make this idea work?

Knowing the seasonality of farming jobs and the urgent of every task it is almost impossible to find workers on time and there is a constant lack of human hands. Taking into account the unemployment rates of our region, would an application contribute in the communication of the agricultural jobs with people who want a job?

Another issue that concerns the scientific community is the waste of food that amounts to 100 kg/year for every European citizen. All the more so in Greece, which is a country which produce many agricultural products, have a great number of tourists which and as an extension have a huge number of food retailing stores, food and catering companies. What would you say if any producer, restaurant, food-retailing or food-processing company have the ability, through an application, to offer food at very low prices in an effort to reduce the waste of food and promote sustainability?

Would you use an application to promote everything that has been discussed in order to contribute to a better future of this place and as an extension the planet?

Do you believe in the power of the community to support and promote such technological actions for a better future in our region and our country?
C.1 Mayor Interview Transcript

This is the interview of the mayor as part of the research entitled: Studying the impact of a mobile application in sustainability, circular economy and the interaction between people of the local community.

Taking into account the financial situation in Greece, do you think there are people in our community who need help such as food, clothes, and other useful items?

Given the current situation in our country, the financial crisis provokes significant problems in a significant number of people. Especially in jobless people, small farmers, and workers that struggle to cover the basic needs in their life. The lack of this basic stuff not only make their everyday life a tough situation but also hold them back from many other meaningful things inside the society and the community like education, health, civilization, and other things. These problems should be tackled with the help of the society the social structures and the community itself. Many families are using the social structure of social grocery and benefit from this. Making every house a social grocery would be divine. Additionally, the municipality makes a huge step towards the clothes donation using clothes, shoe donation bins where the clothes collected, cleaned, fixed if needed and donated into families in need.

Are you willing to use an application that could connect directly or inform relevant people about the availability of goods in specific points?

In our region, we start using a brand new informative tool where the citizens could make an informative of their problem, and the municipality connects with this app real-time and take care of every problem. So this answer is straightforward. Of course, I will use every piece of technology that helps the community. We start with the municipality these early steps with the information systems and every technological weapon that could alleviate
and help people is more than welcome.

Given the dramatical impact of climate change, many scientists and economists strongly support the development of the circular economy. The circular economy promotes the expansion of life of thing from the production to their disposal. In the context of the circular economy and having in mind that we are living in a predominantly agricultural society with a vast number of agricultural machines, there are many potentials to apply this idea. Do you believe that lending or sharing of agricultural machinery that are in a standstill could benefit the environment and provide financial solutions to the community?

This is one of the most innovative economic ideas ever presented. The circular economy should be the epitome of every society in an over-exploited world. As I mentioned before, our community start using clothes and shoes, disposable bins to reuse and recycle this kind of materials. As a region, we use paper and glass recycling for many years, and we are going to expand the next years. So answering the question, a borrowing or a lending system of agricultural machines which the number in our region is enormous should be an excellent solution for the many small farmers who are struggling with small tools and hands. A sharing model applied in Canada, where I visit many years before professionals have a sharing service for tools and machines. The agricultural machines are a costly investment, and a small group of farmers has all the machinery to make their lives easier and their harvest bigger. I personally as a mayor and member of an agricultural community that supports me, I know that the hours every farmer use their machine are varied from 250-500 hours per year. So it is easily understood that these machines stay still for the rest of the year waiting for the right time to be used.

Do you believe that an application can contribute to the networking process between farmers and the community to make this idea work?

One more time I believe in the power of technology and I admit that even though this idea exists in other agricultural oriented countries like Canada where I meet a system close to this idea in Greece we are still struggling with the informational systems provided. The idea to make a “bank” of machines could not only benefit the environment saving a significant amount of resources but also could provide the necessary machine power to the farmers
that struggle to give them equal opportunities to better and more efficient farming techniques that require expensive machinery and tools.

Knowing the seasonality of farming jobs and the urgent of every task it is almost impossible to find workers on time, and there is a constant lack of human hands. Taking into account the unemployment rates of our region, would an application contribute to the communication of the agricultural jobs and many other jobs with people who want them?

The agricultural jobs demand is another issue that concerns the local farmers. There are many harvesting seasons, according to the fruits and vegetables produced. Our region has a great variety of cultivations and as an extend a high demand in workers. The biggest problem of every season is the lack of workforce the time we need them. The time window for harvesting every crop is limited and measured in days. As a result, the fruits and vegetables need to cut from the tree in a specific time. This particular demand for workers makes every technological informational tool an excellent opportunity for many people to find a job. The current stream of information about agricultural jobs are the farmers itself and some group leaders that they choose the people that they want to inform. So an application that could inform people who want to work legally under the protection of the laws for health and safety could provide transparency and equal opportunities to everyone. Additionally, it could provide useful data that could be collected and analyzed in order to make the farmers and the workers prepare better for the seasons to come. This kind of analysis demands a technological infrastructure from our municipality and people who know the technology, like you, to support this kind of actions.

Another issue that concerns the scientific community is the waste of food that amounts to 100 kg/year for every European citizen. All the more so in Greece, which is a country of tourism and as an extension of the mass catering. What would you say if any, restaurant, food-retailing or food-processing company have the ability, through an application, to offer food at meager prices shortly before their closure or expiration in order to reduce the waste of food?

I am pretty sure that this number is much higher for the greeks, due to lack of awareness, but I did not stay to these numbers. As a mayor, I know pretty well that waste management is one of the most critical systems inside
the city and the community. The organic waste, which in our case, is the food waste can produce significant problems to its disposal and destruction. The food waste produces the most significant pollution in the environment similar to the plastics. The gases produced promotes the pollution from the rotting and the brewing of the enzymes inside the food waste. As a result, any action towards decreasing this kind of wastes should be one of our top priorities. The idea of the posting last-minute sales of products and cooked food from the restaurants along with the excessive food donation could alleviate the problem of food security and the food waste pollution at the same time. Moreover, products close to its expiration date could be promoted at lower prices as a way to sell them and benefited from this action. All the previously discussed solutions it could be a great opportunity for the businesses to find additional income and for people in need to get access to more food providing social stability.

Would you use an application to promote everything that has been discussed in order to contribute to a better future of this place and as an extension of the planet?

Every piece of technology that promotes solutions to the discussed problems should not only be used by the community but also should be an obligation for every citizen to support such kind of actions. Of course, me as a person, I could be a user of such an application. I am a huge supporter of local shops and economy and induce the citizens to shop locally in every possible way. The latest action was to add a huge banner to the center of the city that says: Shop Locally, to support your local merchants for the favor of the community.

Would you promote such actions as a political figure in our region and community?

As an extension to the previous answer, I state that I will promote such kind of actions as I did with every piece of technology that promotes solidarity, safety, support to the community and the people who trust me as a mayor and as a person. Recently a new tool introduced to the municipality where the people post their problem and the municipality team try to fix it as soon as possible.

Do you believe in the power of the community to support and promote such technological actions for a better future in our region and our country?
In the information age, we live every person inside the community should be aware of the technologies, and the informational tools the municipality use in order to make their lives better and easier. Every attempt that promotes the discussed topics should and will find the proper support from the municipality and the community. I believe the people of this community to support any actions that promote environmental, personal, and financially viable solutions for a better future for our children and ourselves, as they believe in me all these years.

C.2 Head of Social Grocery Interview Transcript

This is an interview as part of the research entitled: Studying the impact of a mobile application in sustainability, circular economy and the interaction between people of the local community.

Taking into account the financial situation in Greece, do you think there are people in our community who need help such as food, clothes, and other useful items?

Being a member of social grocery for many years, I live the food security struggle every day. People face big financial problems and in top of all the food security puts in jeopardy every opportunity for a happy and prosperous life. There are a significant number of people who visit the social grocery to get access to food and clothes especially the last five to seven years and the municipality do whatever is possible to provide sufficient amounts of food to hungry people and families in need. I wish I could provide you with the actual data, but due to their sensitive character, the accountant of the social grocery keeps them confidential. I think that working for social grocery and struggling to find and provide the necessary things every day makes me a better person every day, and I am glad to be a part of it.

Are you willing to use an application that could connect directly or inform relevant people about the availability of goods in specific points?

We as a community service do whatever is possible to cover the demand all over the city and having an application where the people can donate food and other stuff informing the people who are in need about the availability in real time is undoubtedly a great tool that I would happily use.
Given the dramatical impact of climate change, many scientists and economists strongly support the development of the circular economy. The circular economy promotes the expansion of life of thing from the production to their disposal. In the context of the circular economy and having in mind that we are living in a predominantly agricultural society with a vast number of agricultural machines, there are many potentials to apply this idea. Do you believe that lending or sharing of agricultural machinery that are in a standstill could benefit the environment and provide financial solutions to the community?

As a philologist, I am not very familiar with economic sciences, but the idea of reusing and recycling is a great idea especially when we see in daily news facts about pollution, plastics waste, deforestation and many other problems the modern world is facing. I think that social grocery is a part of this model as it takes the unconsumed food and distributes it in other members of the community. Being a member of an agricultural family one of the biggest concerns was the availability of proper agricultural tools and machinery. The huge cost of these machines was a significant financial drawback when it comes to jobs that demand a considerable amount of workforce. A big concern is the time needed for the people to get the job done something that could be solved in a fraction of this time if we had the proper machinery. The idea of creating a lending system of machines and tools could benefit the small farmers and especially young people who start from the bottom with zero machines or tools.

Do you believe that an application can contribute to the networking process between farmers and the community to make this idea work?

As mention before this idea could become an excellent opportunity for the local economy of financially weak and young people. So the idea of putting an application as a technological tool could provide connectivity, efficiency, and transparency to the transaction.

Knowing the seasonality of farming jobs and the urgent of every task it is almost impossible to find workers on time, and there is a constant lack of human hands. Taking into account the unemployment rates of our region, would an application contribute to the communication of the agricultural jobs and many other jobs with people who want them?
A second concern of the farmers across the region is the workforce provided every time for the agricultural jobs. There is a huge demand, especially in harvesting seasons, and the search could become a nightmare, especially when the number of workers does not cover the demand. An application could expand over the borders of the city to the neighboring regions and inform people who want to work about the available jobs. This idea could become a tool for many businesspeople as well who want employees for their shops enhancing the local economy.

Another issue that concerns the scientific community is the waste of food that amounts to 100 kg/year for every European citizen. All the more so in Greece, which is a country of tourism and as an extension of the mass catering. What would you say if any, restaurant, food-retailing or food-processing company have the ability, through an application, to offer food at meager prices shortly before their closure or expiration in order to reduce the waste of food?

The food waste is a significant problem that needs a solution in every community, especially when the social grocery struggle every day to provide the minimum amount of food to the people in need. So every idea that could help this problem reduced is very welcome, and I find it extraordinary especially if this idea could provide more food to our social service and help people get access to food resources quickly and trouble-free.

Would you use an application to promote everything that has been discussed in order to contribute to a better future of this place and as an extension of the planet?

I am new to technology as a middle age woman, but I find the new technologies fascinating and very helpful. They connect people all over the world and something that was unimaginable years ago now is something self-evident. So every technological action towards a better tomorrow for all these people and the community would be an excellent tool that I will use with pleasure.

Would you promote such actions as a person in our region and community?

As a woman devoted to social services for many years, I would gladly
provide every piece of support in every action that supports and promotes the community making the lives of the people inside this community better from every aspect.

Do you believe in the power of the community to support and promote such technological actions for a better future in our region and our country?

As a head of the social grocery where the work is voluntary, I see the passion of these people providing all these years. These people give with their hearts the minimum amount of help to every person who is in need; I am grateful for their efforts. I am pretty sure that the community will hug such actions that could make their lives easier and promote the local economy.

C.3 Former President of the local agricultural cooperative Interview Transcript

This is an interview as part of the research entitled: Studying the impact of a mobile application in sustainability, circular economy and the interaction between people of the local community.

Taking into account the financial situation in Greece, do you think there are people in our community who need help such as food, clothes, and other useful items?

Being a part of the community all my life and having experience in both productive and managerial areas, I could say that the last five years was some of the most difficult for people who struggle financially. As a result of that, many people stay without a job trying to secure their everyday food. So this continuous effort to provide the elementary needs to their and themselves put their lives in halt. Our society has many of these people that need support and efficient solutions to their problems.

Are you willing to use an application that could connect directly or inform relevant people about the availability of goods in specific points?

Of course, I am willing to provide help as I am already doing and if an application could bring better understanding and efficient connectivity I
would gladly use it.

Given the dramatrical impact of climate change, many scientists and economists strongly support the development of the circular economy. The circular economy promotes the expansion of life of thing from the production to their disposal. In the context of the circular economy and having in mind that we are living in a predominantly agricultural society with a vast number of agricultural machines, there are many potentials to apply this idea. Do you believe that lending or sharing of agricultural machinery that are in a standstill could benefit the environment and provide financial solutions to the community?

Machinery in agricultural jobs is one of the most fundamental parts if you want to be competitive and efficient in your crop. So every farmer needs these machines to save time and money. The agricultural machinery is well known that is used for specific kind of work, and many different tools serve their purpose in every cultivation. So a farmer who has a different kind of fruits and vegetables need to possess every kind of machinery if he/she wants to be competitive. As a result of this situation, a farmer has to spend hundreds of thousands of euros in order to buy them. An interconnected network of sharing machines that will be used and maintained correctly could be beneficial for the economy of the region. This model can have many extensions in the overall situation since these machines are used combined for small periods in a year. So if there were the possibility to create a stable financial solution for everyone, it would be a great idea.

Do you believe that an application can contribute to the networking process between farmers and the community to make this idea work?

If the overall idea benefits the community, then it has great possibilities for the people to use it. This idea should be embraced by both the community and the municipality to become a reality.

Knowing the seasonality of farming jobs and the urgent of every task it is almost impossible to find workers on time, and there is a constant lack of human hands. Taking into account the unemployment rates of our region, would an application contribute to the communication of the agricultural jobs and many other jobs with people who want them?
In agricultural jobs, seasonality is something that we as farmers get used to and adapt because seasonality demands proper financial and human resources management. Although through the season, sudden shifts or destruction may occur. This is a significant problem that needs a solution for many farmers, either big or small. A proper human resources management could be vital for our business and having prior experience, the search of workers could be a painstaking process that could delay the harvest with incalculable results. Agricultural jobs are an unbreakable part of the Greek society and economy that provide jobs for over 250 days a year with reasonable payments and health insurance. A technological solution in the way of an application could bring many opportunities for farmers who search for workers and people who want a job.

Another issue that concerns the scientific community is the waste of food that amounts to 100 kg/year for every European citizen. All the more so in Greece, which is a country of tourism and as an extension of the mass catering. What would you say if any, restaurant, food-retailing or food-processing company have the ability, through an application, to offer food at meager prices shortly before their closure or expiration in order to reduce the waste of food?

Food security becomes a significant issue the latest year in Greece and considering the statistics you already present I think that we should consider seriously how to reduce the amounts of waste produced. I the field lots of fruits stay in the trees or left in the field due to its presentation. Many traders are reducing their prices if the fruits are not well presented, losing much money from quality but ugly fruits. Similar problems occurred in catering, bakeries and other local groceries and supermarkets. Finding interesting ideas to stream the excessive fruits and food of the farmers, catering companies, bakeries, and other local shops could be an excellent solution for both citizens and the shops that could have the opportunity to sell the unconsumed food. Donation is another way to stream cooked food in the closing of the shops to the people that need it. So I think that it is a fascinating idea that it has not used before.

Would you use an application to promote everything that has been discussed in order to contribute to a better future of this place and as an extension of the planet?
I grow up without having the comfort of modern amenities, but as the years’ pass, the technological advancements are booming in a way that we cannot follow up. I introduced to the new technological world in the last decade, bringing new solutions to the farming processes. So I become a huge supporter of the technology. Considering the value that will potentially provide I would use an application that supports the discussed issues.

Would you promote such actions as a person in our region and community?

I try to help people who are in need all my life. So anything that could bring better solutions and technological advancements in this process will be supported.

Do you believe in the power of the community to support and promote such technological actions for a better future in our region and our country?

Living in an area where most of the people occupied in relevant fields I believe that the community could support any solutions that could make the future better and brighter.

C.4 Local Businessman and Farmer Interview Transcript

This is an interview as part of the research entitled: Studying the impact of a mobile application in sustainability, circular economy and the interaction between people of the local community.

Taking into account the financial situation in Greece, do you think there are people in our community who need help such as food, clothes, and other useful items?

The financial crisis in Greece hit not only the middle and low-class workers but self-employed people as well. Everybody struggles to cope with financial obligations such as taxes, payments, and family expenses. Many people left jobless and searched job in other occupational fields. I am pretty sure, and I can see it from the job demand and the way people asking for a job that there is a significant need for help out there. The low-income people left with nothing and struggle for a plate of food every day. There are many kids at
schools that cannot afford a toast and many children did not even bring their foods from home. The social structures should work in order to provide, and every one of us should help in this situation in every possible way.

Are you willing to use an application that could connect directly or inform relevant people about the availability of goods in specific points?

Being an active businessman, I learn to use technology in every aspect of my job to make my life easier and more convenient. So if an application could connect efficiently, the community and the desired services I would use it to help people in need and make my business a big sponsor and donor since the availability of food and vegetables is my business occupation.

Given the dramatical impact of climate change, many scientists and economists strongly support the development of the circular economy. The circular economy promotes the expansion of life of thing from the production to their disposal. In the context of the circular economy and having in mind that we are living in a predominantly agricultural society with a vast number of agricultural machines, there are many potentials to apply this idea. Do you believe that lending or sharing of agricultural machinery that are in a standstill could benefit the environment and provide financial solutions to the community?

Having many farms cultivated with different crops the agricultural machinery become the number one priority if you want to work efficiently and take out the most of every farm. Since these machines are a significant investment that most of the times cost tens of thousands of euros and some times could reach hundreds of thousands. These kinds of investments benefit the big farmers and being a member of the agricultural cooperative and a businessman the same time I can say that a community should not develop and thrive without all its people helping each other. If anyone could think that a small group of wealthy people could make a community, then, answering from my experience in many jobs that they are wrong. A system that could let people who do not have access to the machinery to have the opportunity to use it could upgrade the community. A significant impact of this model could be seen in the financial situation of these people. I am not very informed of a circular economy, but the idea of using the machinery that is standstill across the year has high potentials in my opinion. Except for some small period in August where is the rush period of the crops, the sixty
percent of these machines are unused. As mentioned in the introduction of this question the expansion of the lifetime of these machines could benefit the environment as well as using fewer resources to build them.

**Do you believe that an application can contribute to the networking process between farmers and the community to make this idea work?**

Being a businessman is to have excellent networking skills. If the application become widely used to the community and knowing that most of the farmers have small farms, then it could be a great tool in their hands. However, a system that controls the use and the maintenance of these machines could be beneficial to this plan.

**Knowing the seasonality of farming jobs and the urgent of every task it is almost impossible to find workers on time, and there is a constant lack of human hands. Taking into account the unemployment rates of our region, would an application contribute to the communication of the agricultural jobs and many other jobs with people who want them?**

The job demand is high many times throughout the year, and the find of a sufficient number of people is sometimes painful. This kind of jobs in our region is difficult to post in any job searching site because of the locality and the urgent of every one of them. An application used by people of the community and the region could be a more efficient solution. So I think that could help unemployed people find the opportunity to earn a decent amount of money.

**Another issue that concerns the scientific community is the waste of food that amounts to 100 kg/year for every European citizen. All the more so in Greece, which is a country of tourism and as an extension of the mass catering. What would you say if any, restaurant, food-retailing or food-processing company have the ability, through an application, to offer food at meager prices shortly before their closure or expiration in order to reduce the waste of food?**

The food waste is a significant loss for everyone not only inside the community but globally as well. Food waste is both money loss for the farmers and businesspeople and a missing opportunity to feed the people who strug-
gle. Let alone an application where the people could see the food availability every time of the day. Food management is critical, and it begins from the community and extend to the cities and globally. Everyone is focusing on the presentation, and traders force the farmers for bigger and prettier fruits. The only way to succeed this is to add fertilizers and other chemical substances to take the desired results. People should educate themselves and learn to focus on quality and not on presentation. Finally, I believe that every community should consider its people and all united to support each other. I use the model produced by local for locals giving my merchandise to many groceries and shops of the community at lower prices without the mediator traders that increase the prices. Concluding I think in general that every idea that could help reduce this wasted food either fruits and vegetables or cooked food would be great.

Would you use an application to promote everything that has been discussed in order to contribute to a better future of this place and as an extension of the planet?

I would use an application that promotes all the discussed topics as an opportunity to find an additional financial solution for my businesses and help people in need as well.

Would you promote such actions as a person in our region and community?

If this application works efficiently, I would gladly promote everything that could benefit the community and me as a part of this community. Finding exciting ways to connect and help the weaker parts of the community is imperative for the overall quality of life.

Do you believe in the power of the community to support and promote such technological actions for a better future in our region and our country?

People always have the power to support actions that bring good to them, and I feel that if this application work, the people will embrace it for the sake of a better and happier life because the community is its people.
C.5 Local Machine Manufacturer and Mechanic Interview Transcript

This is an interview as part of the research entitled: Studying the impact of a mobile application in sustainability, circular economy and the interaction between people of the local community.

Taking into account the financial situation in Greece, do you think there are people in our community who need help such as food, clothes, and other useful items?

Peoples’ financial situation in Greece has shifted during the financial crisis from regular to pretty bad. As a result of that, many people stay homeless and even more do not have the necessary food to feed themselves and mainly their families. This situation is observed both in big cities and in our community in individual situations.

Are you willing to use an application that could connect directly or inform relevant people about the availability of goods in specific points?

As a person, I am very sentimental regarding people who are in need because I grow up in a very low-income family. As a result of the financial situation in the community, I do my best to provide in favor of people in need so I would say that I am willing to use this application to provide when possible.

Given the dramatical impact of climate change, many scientists and economists strongly support the development of the circular economy. The circular economy promotes the expansion of life of thing from the production to their disposal. In the context of the circular economy and having in mind that we are living in a predominantly agricultural society with a vast number of agricultural machines, there are many potentials to apply this idea. Do you believe that lending or sharing of agricultural machinery that are in a standstill could benefit the environment and provide financial solutions to the community?

As a machine manufacturer, I can find high potentials in this idea. In my job, there are significant problems regarding the payment of the machinery, especially when these machines cost thousands of euros to build or repair. As
a result of this situation, a standard number of machines that could be used, serviced, and maintained by everyone that uses them could reduce the cost incredibly, especially for the small farmers. Additionally, the maintenance and the refactoring of the machinery have higher profit margins than buying a new one. This occurred because of the import taxes and the mediator trader that take high commissions of these transactions. The designers should consider making all these machines with reusability and endurance in mind as the condition in the fields are extreme and test every machine. Most of the times, improvising patents is the most significant way to fix broken pieces of these machines and make them function properly. The machine sharing though have some drawbacks, and precaution measures should be considered to ensure proper use and the continuous function and maintenance of the machines.

Do you believe that an application can contribute to the networking process between farmers and the community to make this idea work?

I believe that if this application idea comes into reality, then the farmers could be benefited and the local economy could become better. To succeed in this many moving parts of the community should cooperate harmonically.

Knowing the seasonality of farming jobs and the urgent of every task it is almost impossible to find workers on time, and there is a constant lack of human hands. Taking into account the unemployment rates of our region, would an application contribute to the communication of the agricultural jobs and many other jobs with people who want them?

Seasonality is characterizing our country not only in agricultural regions but also in touristic places like seaside regions and islands. I believe that a mean to inform people about local job demand fast and efficient could be a great tool.

Another issue that concerns the scientific community is the waste of food that amounts to 100 kg/year for every European citizen. All the more so in Greece, which is a country of tourism and as an extension of the mass catering. What would you say if any, restaurant, food-retailing or food-processing company have the ability, through an application, to offer food at meager prices shortly before their closure or expiration in order to reduce the
waste of food?

Knowing how hard it is to live with limited food and how many insecurities you have I find the food waste one of the most significant issues we have to face as Greeks and as a humanity. I usually do not leave any leftovers, and I try to manage my everyday food as good as possible keeping motes in the supermarket. An application where people could be informed about food availability and quality cooked food that remained is an excellent idea.

Would you use an application to promote everything that has been discussed in order to contribute to a better future of this place and as an extension of the planet?

Yes, I will use this application, and I hope people like you follow your example and help you or take initiatives like this to exalt the community.

Would you promote such actions as a person in our region and community?

I think that the previous answers have shown that I would promote this application in my job field to inform the people about the potentials of such actions.

Do you believe in the power of the community to support and promote such technological actions for a better future in our region and our country?

People are strange and outlandish sometimes, but I think that when the community is facing severe problems, especially in Greece that we are well known for our hospitality and localism, people act as a team to bring solutions for better living quality. As a result, if this idea could make what is promising, then I am sure that the community will embrace it as it did with my business all these years and I thank them a lot.
D Evaluation Questionnaire

The questions description presented below.

1. Question 1: The overall navigation through the pages was easy.

2. Question 2: The interface was easily understood.

3. Question 3: The pages layout was well designed

4. Question 4: The instructions provided were clear and well understood.

5. Question 5: I am satisfied with the provided categories and functions.

6. Question 6: The prototype features provide an efficient way to support the needs of community.

7. Question 7: You can easily find the desired posts and information about the provided features.

8. Question 8: You can easily post or edit the desired information.

9. Question 9: I believe that the prototype features can be an effective way to promote solidarity inside the community.

10. Question 10: The application features could provide solutions to the people who are in need.

11. Question 11: The application features could promote circular economy actions.

12. Question 12: The application could be an efficient way to promote local economy.

13. Question 13: The prototype could raise awareness about social and ecological sustainability problems.

14. Question 14: I am willing to support acts that help the community.

15. Question 15: I am willing to push local politician to act in favor of people who are in need and local economy.

16. Question 16: I am willing to share the word with my peers to raise awareness about the community problems.

17. Question 17: I am willing to contribute for the good of the community.
E Evaluation Short Answers Questionnaire

1. Do you face any difficulties using the prototype?

2. Do you find any irrelevant content or issues inside the prototype?

3. Is the HandToHand an efficient application that could achieve its purpose of sharing and helping inside the community?

4. Are you willing to use this application for the best interest of the community and as an extension of the environment?

E.1 Questions Results

The detailed question results are available on demand among the author and all the professors participate in the examination, presentation and supervision process. All the users’ data are subject to the General Protection Data Regulation framework described in section 7.2 in order to protect their identity from third parties that will gain access to this document after the publish in DIVA. As a result of GDPR the link to the tables below presents the results without the personal data of the evaluators.

https://docs.google.com/spreadsheets/d/1FSMS5g5fR8xpbuunILn6wRm0Q0hxYP_4yj5yTgyr8Fw/edit?usp=sharing

F SPSS Notes and Results

In this appendix section the author presents the results and the notes of the IBM SPSS Statistics results.

F.1 SPSS Cronbach’s Alpha Values

Item Total Statistics Table
A : Scale if item deleted
B : Corrected ItemTotal Correlation
C : Cronbach’s alpha if Item Deleted
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**Tab. 17: Question 5 Frequency Results**

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**Tab. 18: Question 6 Frequency Results**
<table>
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<td>22</td>
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</tbody>
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**Tab. 19: Question 7 Frequency Results**

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<tr>
<td>Agree</td>
<td>8</td>
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<td>25.8</td>
</tr>
<tr>
<td>Totally Agree</td>
<td>22</td>
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**Tab. 20: Question 8 Frequency Results**

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<tr>
<td>Agree</td>
<td>8</td>
<td>25.8</td>
<td>25.8</td>
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**Tab. 21: Question 9 Frequency Results**
Impact Analysis Results

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Tab. 22: Question 10 Frequency Results

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</table>

Tab. 23: Question 11 Frequency Results

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<tr>
<td>Neutral</td>
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Tab. 24: Question 12 Frequency Results
### Tab. 25: Question 13 Frequency Results

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<td>51.6</td>
</tr>
<tr>
<td>Totally Agree</td>
<td>8</td>
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<tr>
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### Willingness to contribute Results

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<td>29</td>
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### Tab. 26: Question 14 Frequency Results

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<td>100</td>
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</table>

### Tab. 27: Question 15 Frequency Results

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<th>Valid Percent %</th>
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<tr>
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<td>Valid Percent %</td>
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Tab. 28: Question 16 Frequency Results

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<td>51.6</td>
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</tr>
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</table>

Tab. 29: Question 17 Frequency Results
F.3 SPSS Notes to reconstruct the results

The next appendix section is the links to the respective websites that describes in details the way IBM SPSS Statistics works and guide the user step by step to the desired outcome. The website links used are:


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G.1 MIT License

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G.2 Apache License

The official Apache License is 315 lines. As a result of that the license could be found in the links below:

https://github.com/apache/cordova-android/blob/master/LICENSE
https://github.com/apache/cordova-ios/blob/master/LICENSE
https://github.com/apache/cordova-webos/blob/master/LICENSE

G.3 KissPNG and PNGfly License

The DMCA notices could be found in the following links:

https://www.kisspng.com/dmca.html
https://www.pngfly.com/dmca.html

G.4 Pexels License

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H All Technologies and Features

All technologies, online libraries, software and features either online or not used in this thesis are presenting alphabetically in this section. Everything that made possible to make the idea into reality are:

1. Android
2. Android Studio
3. Apache Cordova
4. Firebase
5. GitHub
6. Google Scholar
7. Google Search
8. Google Sheets
9. Google Docs
10. Google Forms
11. Google Translate
12. Grammarly
13. IBM SPSS Statistics
14. Ionic
15. Ionic DevApp
16. iOS
17. JetBrains WebStorm
18. KissPNG
19. LNU
20. Overleaf
21. Pexels
22. PNGFly
23. Science Direct
24. StackOverflow
25. Springer Link
26. W3Schools

I Links of the information displayed in application

Application Images:


Additional application pictures and icons gathered from pexels, kisspng, and pngfly under free license as described in section G.

Food Waste Information:


Social Sustainability Information:

https://www.unglobalcompact.org/what-is-gc/our-work/social
Circular Economy Information:


Shop Locally Information:

https://www.greenchildmagazine.com/what-does-it-really-mean-to-shop-locally/

J Codebase

This section provides the complete code of the Master Thesis along with notes of how to run the application in developer mode as described in readme file. The fact that the codebase consists of multiple files and thousands of lines of code make it almost impossible to present it here. So a github link to the author and developer of the prototype profile will be provided. The next link redirects to the original code of the prototype:

https://github.com/ChrisGk89/HandToHand.git
K Documents

K.1 Consent Form 1

Consent Form

Declaration of consent for participating in the interview which is part of the research for the requirements of the prototype application. This application will be developed for the Master Thesis purpose with course code 5ME11E-VT2019. This is a course of Master Program: Social Media and Web Technologies of Linnaeus University.

I am Chris Gkalfas, MSc student in the Master Program of Social Media and Web Technologies of Linnaeus University. I am the author of the thesis and the developer of the prototype. The purpose of this research is to explore the needs of local communities to promote sharing and sustainability. This information will be used in order to develop the prototype according to your feedback.

Participation in this evaluation process is absolutely voluntarily and all the participants will remain anonymous in order to keep their personal information confidential as the latest European General Data Protection Regulation suggests.

All information and data will be used exclusively for the purpose of this Master Thesis. All collected data like transcripts, information and the recordings that I will analyze later will be in the researcher’s position and they will never be shared with third parties. After the end of the thesis, all the data will be kept in digital form cryptographically locked in my computer or cloud.

Please read the next lines carefully: I am fully informed about the purpose of this research. I will provide my information voluntarily giving permission to Chris Gkalfas MSc student at Linnaeus University to use this information for any purpose within his Master Thesis. I have received a copy of this document from the researcher.

Location:

Date:

Participant’s Signature

Researcher’s Signature
K.2 Consent Form 2

Consent Form

Declaration of consent for participating in the interview which is part of the research for the requirements of the prototype application. This application will be developed for the Master Thesis purpose with course code 5ME11E-VT2019. This is a course of Master Program: Social Media and Web Technologies of Linnaeus University.

I am Chris Gkalfas, MSc student in the Master Program of Social Media and Web Technologies of Linnaeus University. I am the author of the thesis and the developer of the prototype. The purpose of this research is to explore the needs of local communities to promote sharing and sustainability. This information will be used in order to evaluate the prototype according to your feedback.

Participation in this evaluation process is absolutely voluntarily and all the participants will remain anonymous in order to keep their personal information confidential as the latest European General Data Protection Regulation suggests.

All information and data will be used exclusively for the purpose of this Master Thesis. All collected data like transcripts, information and the recordings that I will analyze later will be in the researcher’s position and they will never be shared with third parties. After the end of the thesis, all the data will be kept in digital form cryptographically locked in my computer or cloud.

Please read the next lines carefully: I am fully informed about the purpose of this research. I will provide my information voluntarily giving permission to Chris Gkalfas MSc student at Linnaeus University to use this information for any purpose within his Master Thesis. I have received a copy of this document from the researcher.

Location:

Date:

Participant’s Signature .................................. Researcher’s Signature