OPPORTUNITIES FOR URBAN AGRICULTURE

Balcony Hydroponics in Thessaloniki

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ABSTRACT

The economic crisis currently in Greece has led to adverse health impacts as people are more frequently choosing inexpensive foods over fresh vegetables. Local residents of Thessaloniki would like to participate in urban agriculture to grow their own fresh vegetables, but suitable land is scare in this densely populated metropolis. We evaluated balcony hydroponics within Thessaloniki, in collaboration with Dr. Athanasios Gertsis of Perrotis College. Utilizing an iterative, human-centered design approach, we devised three hydroponic systems that are cost, time and space efficient. These designs provide potential users with a variety of options regarding aesthetics and function.

ACKNOWLEDGEMENTS

Thank you to our sponsor, Dr. Athansios Gertsis for his guidance on this project. Dr. Gertsis made us feel at home, provided us with the tools and supplies needed in the greenhouse, and gave us valuable feedback regarding the scale and scope of our project. He has been hospitable and a great mentor to us during our stay in Greece, as has the entirety of the American Farm School and Perrotis College faculty and staff. We feel very lucky to have enjoyed this experience in such a thriving and beautiful environment surrounded by people with a genuine interest in our work.

In addition, gratitude must be extended to the interviewees involved in our human centered design process. We are indebted to the dozens of people who stopped to talk to us on the streets of Thessaloniki, as our conversations formed the parameters for our designs. Interviews with staff at the American Farm School, mainly Georgia Proestopoulos, Leighanne Penna and Katerina Stamatika were key in helping us understand Greece's cultural nuances regarding food.

The assistance provided by the businesses and organizations that led us to form a deeper understanding of the city of Thessaloniki must also be recognized. Urban Soul Project provided us with key points about the unique aesthetic present in the architecture of the city. Callisto Wildlife NGO provided us with a perspective on environmental volunteerism in Greece. Finally, Eleftheria Gavrilidou of KIPOS3, the only urban community garden within Thessaloniki, told us the story of her team's initiative. This conversation gave us great insight into understanding Thessaloniki, and we are extremely grateful.

Finally, thank you to our advisors, Professors Robert Hersh and Nicola Bulled, for their continued support throughout the duration of our project. Their guidance allowed us to realize the true potential of our project, our writing skills, and our commitment to social investigation.

AUTHORSHIP

All members of this IQP team contributed equally to the drafting, editing, and formatting of this report. The team followed a writing process where drafting was divided equally among each member, then each member edited each section they did not write. For each revision, a quality assurance team member was chosen (this role was equally distributed) to ensure the objectives of that revision were met and the document was suitable for submission. This process was followed for all drafts, as well as the final submission, creating a comprehensive report with a unified team voice.

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INTRODUCTION

Urban agriculture initiatives are mechanisms to develop communities, enable self-reliance and improve the environment (Mougeot, 2000). Community gardens, urban farms, backyard beekeeping, and tending individual allotments are all ways that urban residents integrate food production into city life. Weaving food production into the fabric of the city supplements access to fresh food and connects people to the growing process, giving people more agency over how their food is produced. These activities provide urban dwellers opportunities to reconnect with their food which has been shown to serve as motivation for an increase in vegetable consumption (Bellows, 2003).

Figure 1: Market for Produce Downtown

Currently, people of Thessaloniki, Greece buy their produce primarily from one of the many grocery stores located throughout their city, larger supermarkets, or from one of several outdoor markets located downtown. Although opportunities to purchase fresh vegetables are abundant, the economic crisis has led many Greeks to choose cheaper food over healthier alternatives, mainly vegetables (Filippidis, 2015). A study conducted by Filippidis in 2015 revealed that amidst the crisis, vegetable consumption in Greece decreased from 2006 to 2011 by a factor of 82%, 51%, and 69% in the lower, middle, and higher socioeconomic statuses, respectively.

INTRODUCTION

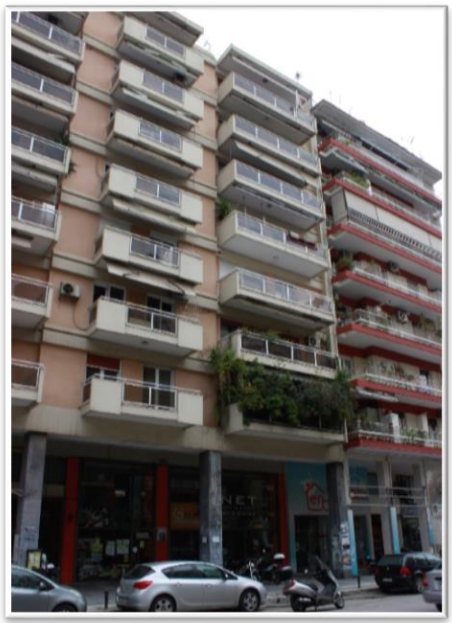

Figure 2: Phalanx of Balconies

Thessaloniki is the second largest city in Greece and home to twelve percent of the country's population in one percent of the space (Hellenic Statistical Authority, 2011). Residents live in multi-story apartment buildings with balconies on all sides. For these people, ground space to plant is, for the most part, non-existent. Our goal is to explore how the residents of Thessaloniki can capitalize on balconies as a space for food production, giving them a cost effective way to cultivate vegetables in what can be underutilized space.

An innovative technology which allows people to grow plants without soil is through hydroponics. Instead, plants are placed in a growth medium, such as clay balls or perlite, and are fed with nutrients dissolved directly into the water in which their roots are suspended (Lee, 2015). This innovative technology complements the non-conventional cultivation setting of an urban balcony and is flexible enough to adapt to the preferences of individual users. Our team has produced multiple designs that are simple, affordable, and low maintenance, capturing a range of aesthetic and complexity preferences. These designs, with proper dissemination of pertinent information, can give Thessaloniki residents the opportunity to supplement the produce they purchase with vegetables they grow themselves.

Figure 3. A hydroponic system

CONTEXTUALIZATION

What is urban agriculture and how is it currently utilized?

Urban agriculture refers to any farming practice conducted in an urban setting. This movement has been gaining traction in recent years alongside global urbanization (Fáczányi, 2014). It takes many forms including green roofs, indoor farms, as well as community and allotment gardens. Generally, urban agriculture is managed by government municipalities, private companies, volunteer groups, or individuals; these efforts have been shown to improve city life both directly and indirectly (Fáczányi, 2014). The environmental, educational, social, and economic benefits of urban agriculture motivate residents to take control of their food production. Many urban dwellers have a desire to improve their living conditions—urban agriculture has been shown to remove pollutants from the air, make access to nutritious food easier and improve the aesthetic appeal of a city (Fáczányi, 2014). Environmental benefits include improving recycling of resources, and taking pressure off of agricultural land surrounding an urban center (Specht et al. 2014). As well as a powerful hands-on learning tool, urban agriculture can be used to connect children to the food they eat through the cultivation process (Specht et al., 2014). Social advantages including fostering community relations and the health benefits that come with eating fresh food are other positive impacts urban agriculture can provide (Haberman et al., 2014; Specht et al., 2014; Fáczányi, 2014).

Urban agriculture often emerges in times of economic crisis because it reduces food insecurity and fosters strong community relationships. For example, to combat the economic crisis and food shortages brought about after the cold war, Cuba began an urban agriculture movement – "Revolution Verde" – in the form of municipality allotment gardens (Fáczányi 2014). By 1995, 40% of households in Havana were involved in urban agriculture,

producing 25,000 tons of food (Ghosh, 2014). Spain also turned to urban agriculture when faced with an economic crisis. By 2012 over 20 gardens were established Madrid, with others initiated in other cities throughout the country (Benitez, 2012).

Urban agriculture is already being implemented in parts of Greece. According to Dr. Orestes Kolokouris (2015, p. 46), the author of a Green European Journal article, the urban agriculture movement has grown alongside "the rapid deterioration of the living standards… due to the deep crisis." Currently, Greece has urban gardens started by residents such as the Elleniko Community Garden which was developed by residents of Athens. The garden was formed after a municipal project aimed at transforming an abandoned airport into a park fell through and citizens decided to take matters into their own hands (Yannacopoulou, 2012; Moran and Casadevante, 2014; Doufekia, 2013). Other urban agriculture programs have been spearheaded by the municipality such as free allotment gardens for the unemployed, retired or low-income citizens in Alexandroupolis, Tripoli, Thermi, and Edesa (Moran and Casadevante 2014). These kinds of initiatives can save citizens up to 150 Euro a year (Doufekia, 2013). From other parts of the world to Greece, urban agriculture has taken shape in times of crisis and economic downtown, allowing people to reap the financial, emotional, and health benefits of weaving food production into the fabric of urban centers.

Can urban agriculture take shape in the city of Thessaloniki?

Some residents of Thessaloniki have already taken strides towards an urban agricultural movement, primarily in the form of community gardens. KIPOS[3], an organization founded by members of the school of Architecture at Aristotle University and guided by the ideas of the 'Red and Green' project, initiated a community garden managed by residents of Thessaloniki in 2015 (Gavrilidou, 2015). The director of the project, Holm Kleinmann, expressed that "the basic assumption of the studio was the belief that (urban agriculture) can be a center for new energies, a source and initial point for

social economic, educational restart with impact to new forms of integration" (Gavrilidou, 2015, p.64). This urban allotment garden was the first of its kind within the boundaries of Thessaloniki proper. Additionally, an urban farming group, PERKA, operates another community garden just outside of Thessaloniki in the former military encampment Karatasou. The group uses the space to grow seasonal vegetables, fruits, flowers, and herbs. While these community gardens are good attempts at urban agriculture, the reach of these initiatives in Thessaloniki is short, and overall the presence of urban agriculture is minimal.

This limited presence may be largely a result of the city's built environment. Conventional community gardens require ample ground space, which is limited in densely populated and compact urban environments, such as Thessaloniki. As the second most populated city in Greece, Thessaloniki has a population of over 360,000 people which is contained in about one percent of the space of Greece (Hellenic Statistical Authority, 2011). This limits both the public and private ground space available for small-scale agriculture. Apartment complexes with balconies make up the city's landscape, a consequence of rapid urbanization in the 1950s (Pyla, 2013). Urban agriculture initiatives can capitalize on this balcony space by utilizing it for growing and revitalizing the structures that dominate the city.

Figure 4. Balconies in Thessaloniki

How might the economic crisis in Thessaloniki invigorate an urban agriculture movement?

Following the economic downturn, food insecurity has become commonplace throughout Greece, including Thessaloniki. Food banks in Athens have emerged through the efforts of various citizens and organizations where they serve as a food source for 90% of families who live in the poorest neighborhoods (Smith, 2013). Solidarity movements have risen to address chronic hunger for those who have been hit the hardest by the economic crisis (Sotiropoulos, 2014). Local bakeries and restaurants donate their unsold food to food banks, and these charities feed the one in eleven citizens visiting soup kitchens daily (Henley, 2016). In addition to the effort of solidarity networks, many unemployed Greek citizens have come together to further close the gap by self-organizing portable, small-scale food banks (Zanolli, 2016). The need for this volunteerism to combat hunger illustrates the severe impact the crisis has had on Greece.

The economic situation has affected different aspects of people's lives, including their vegetable buying habits (Filippidis, 2015). A study conducted by Filippidis in 2015 revealed that people in the lower, middle, and higher socioeconomic statuses had a decrease of 82%, 51%, and 69% in vegetable consumption from 2006 to 2011 during the onset of the crisis, respectively. As has been shown, families are buying fewer vegetables as well as consuming less (Filippidis, 2015). These kinds of cutback can affect people's health. Notably, there was an 18% increase in obesity among poor Greek adults from 2006 to 2011, however, the overall obesity rate increased negligibly (Filippidis, 2015). Although, availability of vegetables is not lacking in Greece, financial burdens are limiting people's willingness to purchase fresh produce.

A rich urban agriculture movement in Thessaloniki has the potential to reverse some of these negative effects of the crisis, specifically related to resident's access to fresh and inexpensive produce. However, as previously explained, ground space for traditional gardening is very limited and in order for urban agriculture to truly take hold in the city, innovative gardening methods must be explored.

What are the advantages of hydroponics over other urban agriculture initiatives?

Hydroponics is a Greek word derived from "hydro" which means water, and "ponos" which means labor; together it means "working water." In Hydroponic systems, plants are grown without soil and are instead fed with nutrient rich water solutions. These systems have the advantage of being able to produce higher yields, which can address the issue of little available space many urban environments see. In one study, hydroponics was shown to offer eleven times higher yields per greenhouse unit, 815 square meters, than traditional soil yields when growing lettuce (Barbosa, 2015). It has also been shown that a shipping container sized farms are capable of producing yields comparable to two acres of soil planted land (Siege, 2013). Globally, hydroponic yields tend to be at least twenty percent greater than

conventional soil culture (Resh, 2015). This potential can be attributed to the high density planting that is possible in hydroponic grows. With ample water and nutrients, plants can be placed much closer together and are limited by the availability of sunlight as opposed to a specific soil volume per plant (Resh, 2015).

Around the world, hydroponic systems are commonly used in greenhouses for commercial growing. On a smaller scale, hydroponics exists widely as hobbyist culture where interested populations look up the information they need to grow various plants and build their own systems while experimenting with growth mediums and other variables. "Do-it-yourself" systems are becoming popular expanding the population of hydroponics enthusiasts. This is evident commercially as the large outlet store, IKEA, recently announced their hydroponic system for in-home use that can fit on a table top or shelf ("Indoor Gardening – IKEA", 2015).

The benefits of hydroponics over a conventional soil garden extend far beyond space. Growing in a hydroponic system allows the user to control the environment and prevent contamination from other plants that may be growing in the soil (Resh, 2015). Plants tend to be healthier because there are many soil-borne pests that are therefore avoided (Resh, 2015). The ample nutrient supply through water reduces the stress on the plant, so maturation rates are higher in hydroponic systems (Resh, 2015).

A common misconception about hydroponics is that systems are expensive and complicated. Many pre-built systems exist for purchase at a list price of several hundred Euro because they contain an intricate network pumps and nutrient feeding systems. This does not always have to be the case, many hydroponics systems are designed to be very inexpensive and low-maintenance. One of the simplest and most versatile forms of hydroponics is deep-water culture. In deep-water culture systems, plants are suspended above a basin of water with their roots in direct contact with the water as seen in Figure 5.

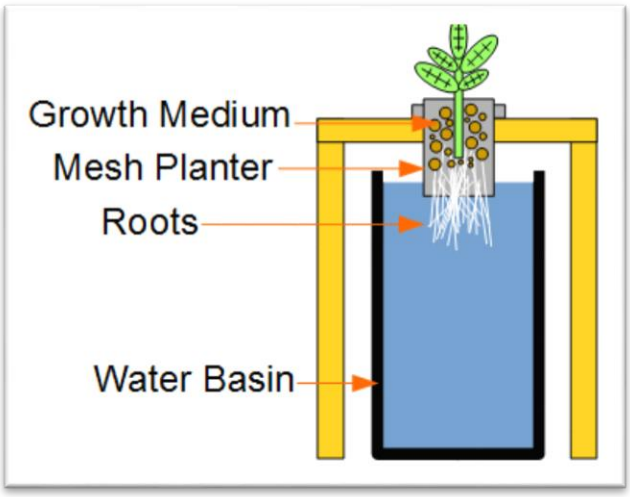

Figure 5. Deep water culture system

Another simple way to grow plants hydroponically is using the wick method. To accomplish this, plants are above a water basin in a growth medium, and a wick is connected from the growth medium to the water basin as seen in the Figure 6.

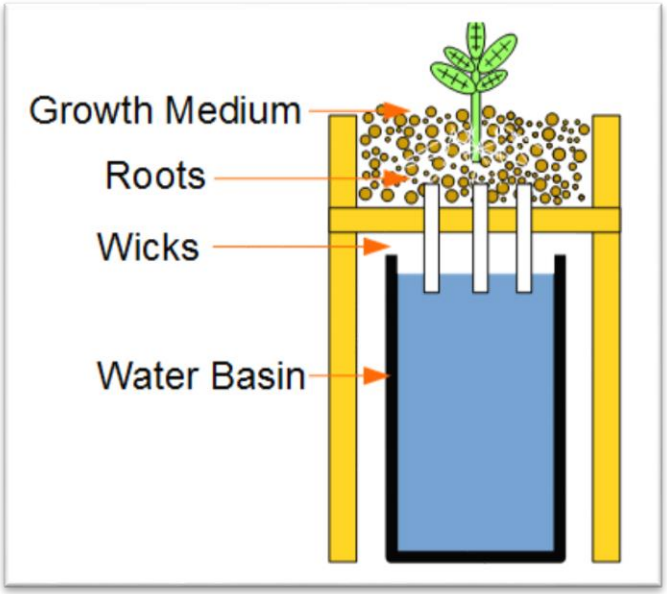

Figure 6. Wick system

Both of these methods can be implemented at a low cost, using inexpensive materials such as household items or even recycled

components, therefore these are the two topologies we focused on during our research. As Resh cites in his *Home Grower's guide*, hydroponics can be a "feasible culture for low-income societies." He later mentions that he has personally visited low-income sites where "people who started just to supplement their diets have expanded to become commercial operations and now make a living by growing vegetables for markets in the large cities" (Resh, 2015, p. 9).

In addition to technical benefits, there are psychological and environmental benefits. High water content and high plants density lead to an increase in the levels of oxygen produced by hydroponic gardens versus soil gardens. In a city that faces issues with pollution, wide use of hydroponics could help clean air photosynthesis which consumes the greenhouse gas carbon dioxide and releases oxygen.

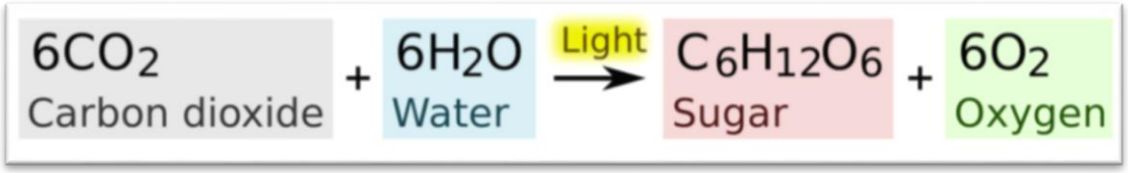

Figure 7. Equation for photosynthesis

Psychologically, hydroponics can provide people a deeper connection to growing because they're able to see the roots of the plants and can be creative in the design. It is less maintenance than a typical soil system and can also serve as a stress reliever. Hydroponics provides an opportunity for economic, social, and environmental improvement in Thessaloniki.

METHODS

OBJECTIVE 1: Characterize the Scope of Hydroponics in Thessaloniki

To understand the impact balcony hydroponic systems could have on the urban residents of Thessaloniki, we needed to understand the current habits, routines, and attitudes of its residents towards food--more specifically toward the purchasing and growing of vegetables. We conducted semi-structured interviews with people living or working on the American Farm School (AFS) campus and people living in Thessaloniki. Special interest groups such as architects, non-governmental organizations (NGOs) and people connected to urban agriculture initiatives in Thessaloniki were interviewed as key informants in their respective area of expertise.

Methods for Interviewing AFS Connections

We first spoke with people we connected with through help from AFS administration and email solicitation. This convenience sample was made up of adult women working at AFS, as well as parents of AFS students. All interviewed were the primary food purchasers and preparers for their household, which provided us with valuable data on food purchasing and consumption habits. However, many of the participants did not live in Thessaloniki and had different experiences regarding food sources and space constraints than a resident of Thessaloniki. When interviewing this group, we followed the semi-structured interview questions included in Appendix A and captured (with permission) voice recordings for transcription. Questions ranged from where they went to buy vegetable to how they felt about people who grew their own food. We also inquired about whether they had a balcony in their home and what they used this space for. We transcribed these interviews word for word so that they could be a source for direct quotes. These responses were not included in our thematic analysis of responses—which we used to guide our designs.

Methods for Street Interviews

To gain insight into the perspective of people living in Thessaloniki, we conducted semi-structured street interviews in various regions of the city over multiple days. To get people's attention we created a poster to display in high foot traffic areas such as Navarinou and Aristotelous Square downtown. Soliciting people in these areas gave us a convenience sample of people that live in the city, have a balcony, and shop for food in a metropolitan area. These apartment dwellers, particularly those who cook and buy their own food, represent the main population we were interested in investigating.

We conducted 33 semi-structured street interviews using the questions in Appendix A, the same questions used while interviewing our AFS connections. The raw data were transferred into a table organizing each interview by the responder and their replies to both short-response and open ended questions. This matrix of responses made for easy comparisons within specific sets of questions. For example, to determine the best vegetables to grow in our system, we looked at responses to our question, "what vegetables do you buy or eat?" and calculated the frequency each vegetable was mentioned. We analyzed open ended responses in a more thematic way. For the question "what do you think of people who grow their own food?" we categorized responses into "positive," "indifferent" and "negative" to allow for generalizations and conclusions about the public's disposition toward people who cultivate food. A word usage analysis was also utilized to identify common themes. For example, descriptors found in responses to questions such as, "What do you know about hydroponics"? were identified as themes. These phrases included an interviewee mentioning of hydroponics prior to us introducing it or an interviewee describing a friend or friends that practice urban agriculture.

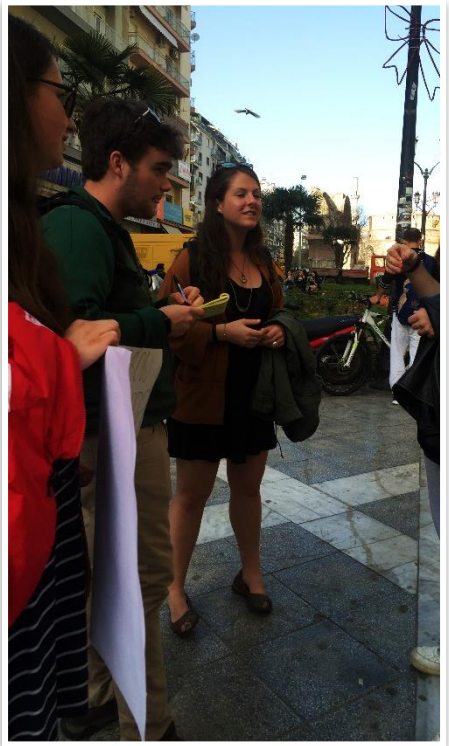

Figure 9. Interviewing in Navarinou Square

We acknowledge that there are both sampling and self-selection biases in our data. For example, our sign was written in English soliciting only those who are confident enough in their English speaking ability. This not only made it difficult to hear the opinions of older generations but also created barriers in responses to our questions. For example, with our question, "what vegetables do you buy or eat"? some responders did not know the English word for vegetables they would have responded with. Later we created a guide containing 13 vegetables, shown in Appendix B, to help lessen this phenomenon. We also observed self-selection bias in our data. This was most clear when using our first sign which had the word hydroponics on it. People familiar with the term approached us and started conversations. We made an attempt to lessen this by making a new sign that did not contain the words "hydroponics" or "urban agriculture." Although we worked to minimize bias where we could we realize this was still a convenience sample and this bias must be addressed.

Methods for Interviewing Key Informants

In order to create a comprehensive and effective set of designs, we needed to reach out beyond street interviews and AFS interviews. We arranged a set of key informant interviews to fill the gaps in our knowledge regarding areas such as environmental volunteerism, hydroponic presence and architecture in Thessaloniki. The key informant interview questions (found in Appendix C and D) were developed based on the specific person or group being interviewed.

As non-Greeks, we wanted to investigate and try to understand Greek volunteer culture, particularly in areas centered around environmental or green movements. An interest in green movements within the city could translate into a willingness to explore urban agriculture for its environmental benefits. Furthermore, in order for balcony hydroponic systems to gain popularity there needs to be a push to disseminate information and resources regarding the benefits of urban agriculture and how to use hydroponic technology. We targeted NGOs as key informants as they are considered experts in congregating individuals behind an idea as well as disseminating information to individuals for their cause. We conducted key

informant interviews with the NGO Callisto Wildlife, an environmental organization.

When looking to start an initiative or encourage others to adopt a new practice, the success and failures of groups with similar aims must be considered. This is why we conducted an interview with KIPOS^3, the only urban community garden in downtown Thessaloniki. As one of the only urban agriculture initiatives in the city it was important to understand the social complexities they encountered starting and sustaining the initiative.

Figure 10. KIPOS^3 garden in downtown Thessaloniki

In addition, we wanted to know if there was any presence of hydroponics in the city currently. We were able to locate one hydroponic store in downtown Thessaloniki after discovering many that we intended to visit were shut down. We interviewed a store clerk who worked at this establishment called Organic Growshop.

To understand the history behind the phalanx of balconies in Thessaloniki, we interviewed architects at Urban Soul Project in Thessaloniki. This conversation investigated how people utilize balconies in practice, as well as informed us of the design principles held by Thessaloniki architects to ensure our design could be aesthetically integrated into the city.

Limitations of these interviews included the potentially narrow perspective and the fact that they do not necessarily represent the majority opinion of their respective fields—we took this into consideration when using their recommendations. Following a full transcription of the interviews, we use the text to cite direct quotes and to provide guidance in understanding the feasibility of our designs in the city.

OBJECTIVE 2: Design and Build Systems for Balcony Use

The next step of our project involved the development of a range of prototype hydroponic system designs that met the social, economic, and technical needs of urban residents in Thessaloniki. To develop these designs, we used an iterative design process, as shown in Figure 12. The process began with the data gathered from Objective 1 which revealed design criteria desired by residents including space requirements, cost limitations, preferred plants to grow and time commitment to maintenance.

To assess rough space requirements, we analyzed how people described their balconies and photographed and observed many Thessaloniki balconies ourselves. We noted keywords that people used in the description of their balcony in terms of size and made sure our design fit that space. By asking how much people spend per week on vegetables, we were able to develop a cost parameter for our systems. Our sponsor was interested in deep water culture systems where weekly maintenance cost is negligible. Vegetables preferred were determined by which vegetables were most frequently mentioned in our free listing exercise. Finally, to assess how demanding the maintenance of the system should be, we asked street interviewees where they liked to shop and why. This revealed their motivations when it comes to buying produce. A person who is willing to spend hours seeking the best vegetables would be interested in a different system than someone who was only concerned with convenience.

Once we developed the initial set of four designs—three of which we built and one used to show a more complex option—we vetted the design with a panel of possible users through both street interviews and a continuous panel of AFS contacts. For this round of street interviews, we chose to solicit interviewees close to the specialty food market, Ergon Agora, located at a busy intersection and near Navarinou square. We spoke with many women with ages ranging from anywhere in their twenties to their sixties who all fit into our target population.

Figure 13. Building a bottle system

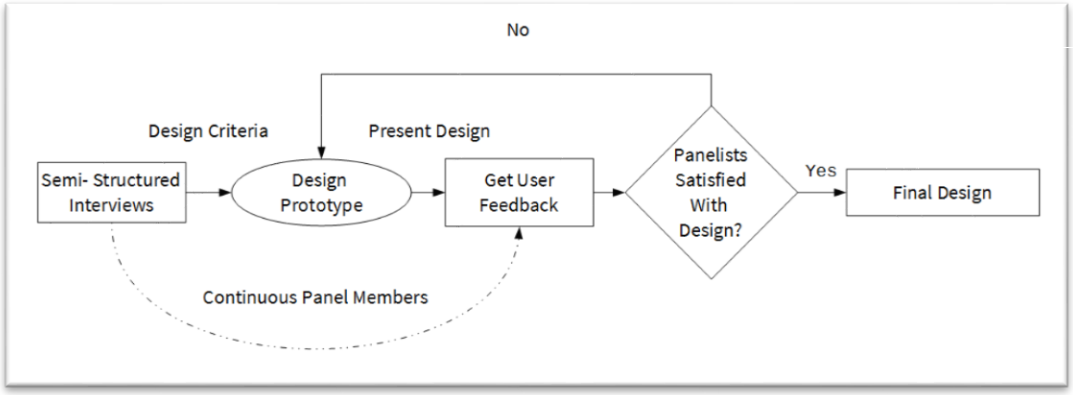

Figure 12. Diagram showing iterative design process

The continuous panel included residents that were interviewed while completing Objective 1, and returned for further discussions about subsequent designs. To objectively assess the popularity of each design, we asked each interviewee which design was their most and least favorite (and why). We assigned a point value of one and negative one to most and least favorite, respectively. If another system was mentioned as being liked or disliked, then it earned a half a point or a negative half a point. This gave us the feedback we needed to complete a second build and subsequent interviews about the systems—including the newest system. The subsequent interviews included the same methodology of asking about most and least favorites to gauge what residents liked best.

We decided on the three best systems not only based on score, but on our assessment of their feasibility. For example, if someone thought the vertical system was visually appealing, but was not interested in taking care of the pump, then the system would not be feasible enough to be considered one of the best. Once the final systems were built, we were able to make a decision with a holistic view of the people in Thessaloniki to decide on the three most appropriate systems.

OBJECTIVE 3: Assess the Viability of a Balcony Hydroponic System

Each system was placed in a matrix ("System matrix") displaying the money, time, and space requirements to assess how the systems compared in terms of design parameters.

Space

To ensure our system fits on most end user's balconies, we measured the footprint of each system and included it in the aforementioned system matrix. We looked at how many plants the system could support in order to estimate the potential yield. This plays a role in understanding the money it could potentially save an end user.

Money

Hydroponics systems can range significantly in price. Our design parameters have led us to design a system that is low cost, small in size, and yet delivers enough product to be worth the initial implementation and maintenance costs. Designing a cost effective and viable system required documenting startup and maintenance costs. In addition, the amount of money Thessaloniki residents generally spend on vegetables was documented to determine if using a hydroponics system to grow vegetables is a cheaper alternative (Objective 1). Other costs that were considered, but not integrated into our cost-benefit analysis include, but are not limited to: transportation costs to markets or grocery stores, sense of connectedness to one's food, and the value of social interactions during food purchasing.

We expensed the materials for our systems using local stores. Then, using the most commonly mentioned vegetable we recorded prices around the city to get an accurate price per kilogram of that vegetable. We utilized that average price (Objective 1) and estimated a serving size of that vegetable using a nutrition data website (nutritiondata.eat.com) to create a consumption profile for a model family of four. We verified this by checking that the price spent on that vegetable per week was in the average range that people told us they spend on vegetables in total per week. This gave us a weekly spending on the choice vegetable and was charted against time.

Using both the system cost and vegetable spending data, we charted the residual amount people would have to spend on that vegetable using each system based on the equation in Figure 16. The results from the equation were charted on the cost graph. This allowed us to identify the point at which different hydroponics growing systems might become cheaper than buying the choice vegetable.

AMOUNT SAVED PER WEEK = (WEEKLY VEGETABLE SPENDING) - [(YIELD OF SYSTEM) X (COST OF LETTUCE)]

RESIDUAL COST OF VEGETABLE = (AMOUNT SAVED PER WEEK) X (NUMBER OF WEEKS)+ INTIAL START UP COST

Figure 16. Equations for cost analysis.

Time

In order to assess the time-cost parameter of the system, we documented, in the system matrix, how long it took us to set up each system as well was as estimated the weekly maintenance time based on how laborious it is to upkeep. This plays also into the complexity for the user regarding both set up, upkeep, and troubleshooting the system. This allowed us to determine if the system will be easy to use, maintain and if it will take less time than a conventional soil garden.

FINDINGS

Current State of Urban Agriculture in Thessaloniki

People like the idea of growing their own food

The first theme that we found among residents of Thessaloniki was that people like the idea of growing their own food. Of the people we asked about growing their own food and urban agriculture, seventy-five percent of them answered yes, they are interested in growing their own food. Positive attitudes to the idea include thinking it is "important," "environmentally friendly" and "healthy." A man who lives outside the city with a farm that produces food commercially stated the following when talking about growing his own food:

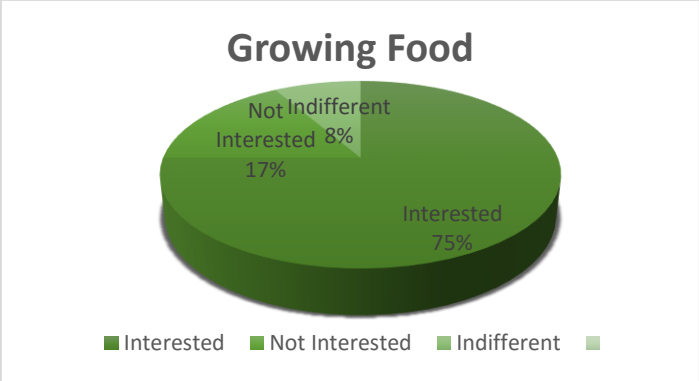

Figure 17. Pie chart showing interest in growing food.

> *"We think this is an extremely positive thing, and even though it demands a lot of effort and time, it's important because in the end, you know what you make and you what it is. It pleases you"*

Interviewees noted the close relationship between food and health by frequently using the word "healthy" in our conversations about vegetables. People expressed that knowing where their food came from implies it is healthier, especially when it is organic, or what Greeks call "biological." An interviewee discussed her thoughts on food connectedness:

> *"Food is, I mean you are what you eat, it's medicine and we have to treat it like that. That's very important, I think more so for my husband who's like one thousand percent Greek, and his family…they're very conservative with what they eat, how they eat, when they eat, they eat seasonally"*

However, some people were less interested in growing their own food—one person stated: "I like watching my fruits, vegetables, flowers growing, but I do not want to be the one to do it."

Motivations for why people purchase vegetables: convenience, price, and quality

People may be interested in growing their own food, but the majority are purchasing them elsewhere. We inquired about where they purchase vegetables and found three motivations when it comes to purchasing vegetables: price, convenience and quality. The places people told us they get their vegetables from are supermarkets, grocery stores, open markets and villages. The Euler diagram shown in Figure 18 shows the frequency for each location. The most popular location was the supermarket, followed closely by the open markets. People justified supermarket shopping by citing it was more cheap and convenient. The supermarkets were described as being close to home—requiring minimal time and effort to visit. One woman told us, she goes to the supermarket "because I'm too lazy to go the open market." Contributing to convenience, the supermarkets have set hours and are often open later than the open markets which either move around the city or close daily around five. This prevents those who work during the day to visit the open market. The large number of people who shop at open markets is reflected in the numerous people that said they value quality when purchasing vegetables. A man who does not live in Thessaloniki, but provides some fresh vegetables to his family from his farm in a village expressed, "We never focused on the cost of the production, we focus mostly on the quality—it's

Figure 18. Euler diagram showing vegetable purchasing locations.

like a hobby." The importance of being able to pick quality produce from the open markets was expressed often. An interviewee was enthused to tell us how her husband "can literally pick up a watermelon and he'll know if it's good or not, it's amazing." Another important factor in where people shop is price. Grocery stores were cited as being more expensive than supermarkets by people that justified shopping at supermarkets. One of the architects we spoke with who lives in the city explained that "if you can manage to find good vegetables, organic, it's too expensive. You have to eat good stuff; you have to pay." It was also evident that price is an important factor people in observations of street markets. Often, multiple vendors would be selling the same products boasting price signs and yelling out deals to people as they walk past to attract buyers based on price.

Most people have family in villages that grow food

Out of the twenty-four people that responded, seventeen of them said they have a way of obtaining fresh produce from a family member who grows food in a village outside the city. Relatives such as mothers, grandparents and aunts are included in the family members people mentioned. Many stated that they spend time helping out at this farm during the summer months, or involving it in family activities with their children.

In some instances, having this designated food growing area contributed to some people not viewing the city as a place for cultivation. People felt that food cultivation was exclusive to rural areas. That sentiment is expressed by an interviewee below:

> *"We come from a village where we have a garden, so a balcony to us is a balcony—not a garden"*

People are interested, but hesitant to pursue cultivation in the city

While the majority claimed to be interested in the idea of urban agriculture, many qualified that statement by expressing they cannot or will not start growing their own food. One person stated:

> *"Yeah, yeah of course, if it is something not expensive to do, if it does not require a lot of experience to do, I think it will be launched, it will be preferred"*

It is apparent that there is a culture and social norms around food consumption and cultivation. In one interview, we discussed the opportunity for systems that were familiar and similar to what's already placed on balconies and she replied with "and they would not be criticized by their neighbor next door." Another responder explained that her "friends could not be bothered with such things" when talking about the idea of urban agriculture.

KIPOS^3 experienced the hesitations of people in the city to start a new urban agriculture initiative when they began the community garden in a neighborhood in the heart of the city. Despite signs and early construction of garden plots, Eleftheria Gavrilidou who is heading the project thought back to when they would watch "the reactions of people around who are seeing us, but are not engaged in a lot. That was in the beginning." The initial skepticism persisted among the residents of the neighborhood who had a negative response to the idea of this construction. As Eleftheria recounted, it was not until later that people began to accept it, "when they saw the soil and the wooden pots, they are just beginning to ask what's happening." Now that there are plots up and running, participation has doubled in the year they have been operational and more people are approaching them about how to get a plot. An expansion in the number of raised bed and members is in the planning process.

As a non-governmental organization, KIPOS^3 demonstrated how NGOs are able to disseminate information or attract people that have interest in urban agriculture. The interview with Calisto Wildlife and Environmental Organization revealed that volunteer effort among the

organization is very strong, and the director mentioned the lengthy waiting list for the various events they do as a group, suggesting that there is a willingness for people to be involved in an urban agriculture initiative.

Opportunity for people to start growing food in their homes is minimal

Through initial research, it was evident that there were few stores available for people to purchase material and supplies to start growing food hydroponically. From the four stores we were able to find online, we were able to locate and visit two of them. The first, Aqua Garden, had been shut down and transformed into an oil and tire warehouse. The signs had haphazardly been covered with the new company's banners, suggesting that this was a recent closing. The other was a hydroponics store called Organic Growshop. The store had many types of seeds and parts available that could be used in systems if an experienced user needed materials. There were a few complete systems for sale as well, the cheapest being a pricey 350 Euro. When asking the store worker why she does not grow hydroponically despite her interest in the technology she told us:

> *"I do not have a lot of free time to make it in home, I work a lot here so in my house I just have soil and left it and hope they will grow by themselves" – Organic Growshop worker*

"This shows that even those with a special interest in hydroponics in Thessaloniki may feel limited by what is available to them in terms of simplicity, time and cost."

People have heard of hydroponics, but know very little about what it does and how it is used

Nine of the sixteen people that were asked had heard of hydroponics. Those that have heard of it were positively disposed and while most did not have enough knowledge on the technology to explain in English, many responded that they think it is "good" and "environment." During one

interview, a family expressed their knowledge of hydroponics: "we do not know anyone that has, but we know that it's environmentally friendly." There were also some concerns with water quality and a fear that the vegetables would not have vitamins if grown in water.

Almost everyone has a balcony

Everyone that we asked about whether or not they have a balcony responded in the affirmative. These twenty-eight people explained how they use this space differently, but their use cases fell into three categories: green space, leisure or nothing. The distribution of how people use their balconies can be found in Figure 19.

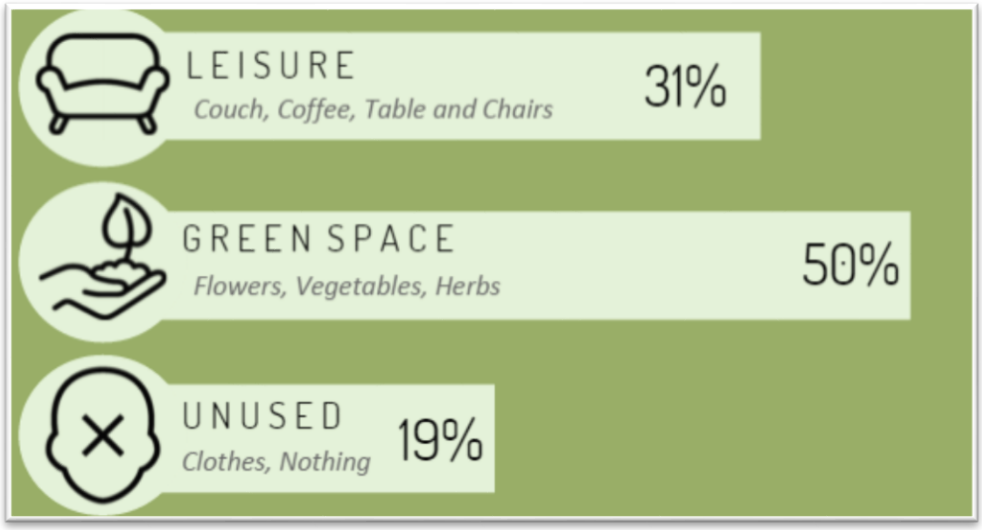

Figure 19. Bar chart showing how people utilize their balconies.

While about half of people claimed to use their balcony for some type of green space such as flowers, vegetables or herbs, it was noted by many that despite this, there is not enough space to grow food, making a clear distinction between what they're growing already and food. Some noted that the strawberries they grow on their balcony are "too small" and one explained why she grows herbs on her balcony: "It takes less space; they do not need so much care." The group that grows flowers elicited it having to do with being low maintenance. A continuous panelist described using her balcony "for hanging there, we have flower pots, we do not really use it."

People largely identified their balcony as being "small" and eight responders used the word explicitly, while others made reference to not

having enough space. The architect from Urban Soul Project discussed the designs that have to do with balconies in saying, "the best idea is to have some plants to make it more beautiful. Nothing else, because they do not expect to go out on the balcony that much." Our observational data suggests that most balconies are large enough to support a hydroponic system.

Figure 20. Balconies in Thessaloniki.

Growing food is perceived as too time consuming

Especially in cities, time is a very important factor because "people do not have time for this in the cities or something fancy to take care of, they have to go to work and do other things." Seven out of the twenty-three persons of our sample noted that they might not be willing to try urban agriculture due to time constraints or they said they would if they had more time. One person that considered time to be a limiting factor mentioned that "every now and then we usually put on our balcony like parsley or basil, the easy stuff." The architect from Urban Soul Project discussed the herbs he grows as well: "What we have in our house tends to be like basil, lavender, oregano, which is nice because you get them in your food. So it's nice to have this fresh. It's easy, it's easy to do it."

Average spent on produce per week is 17 Euro

When asked about how much is spent on produce each week, the responses greatly varied, and some people were unable to give an accurate estimate. The average amount spent for a family of four per week on fruits and vegetables came to be around seventeen Euro.

COUNT	MEAN (EURO)	MEDIAN (EURO)	STANDARD DEVATION (EURO)
22*	17.20908	10.5	13.944

Table 1. The analysis of amount spent on vegetables.

*Some people responded that they could not estimate how much they spend per week

Lettuce and tomatoes are the most frequently purchased vegetables

The responses to the vegetable free listing using pictures can be found in Figure 21. The two most frequent responses, lettuce and tomatoes, are highly feasible for hydroponics and are often used in systems, as previously discussed in our background. Regardless of the other vegetables mentioned, lettuce and tomatoes were consistent in people's diets.

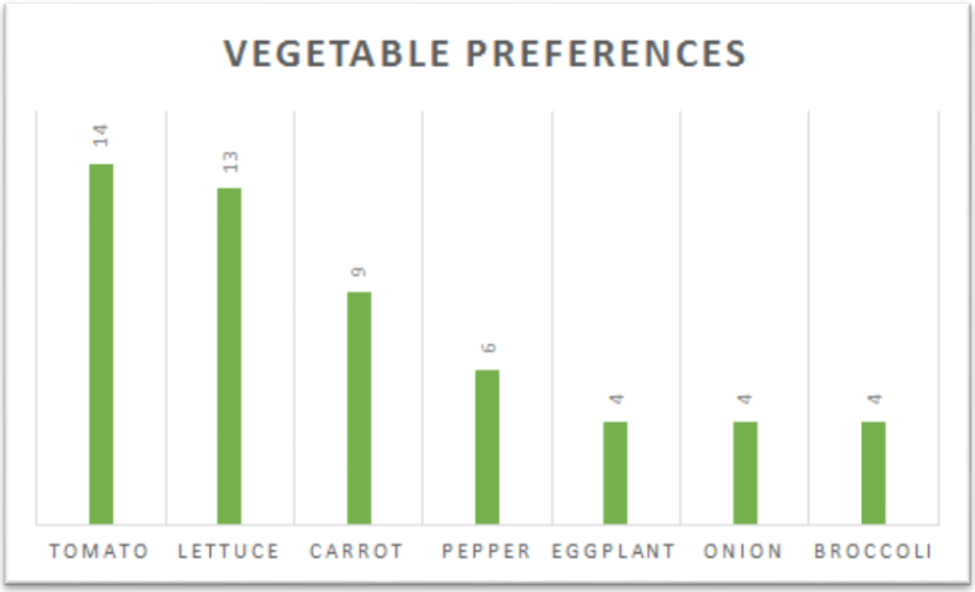

Figure 21. Bar chart showing vegetable preferences.

People have the perception that growing their own food is time consuming and complex

Seven of the twenty-three people we asked cited time as what is impeding them from growing their own food. Even someone who grew their

own food stated: “Every now and then we usually put on our balcony like parsley or basil—the easy stuff.” Many people expressed they would pursue growing their own vegetables if they had the time. Vegetables were considered much more difficult to grow and people felt herbs were easy. An architect we interviewed stated “And what we have in our house tends to be like basil. Lavender, oregano, which is nice because you get them in your food. So it’s nice to have this fresh. It’s easy, it’s easy to do it”

Analysis of System Design Iterations

Designs and Specifications

Figure 22 outlines the five derived from the social data we gathered.

	 FLOWER POT	 BOTTLE	 TORPEDO	 VERTICAL	 STACKED
INITIAL COST	€8	€15	€20	€140	€30
YEARLY COST	€0	€0	€0	€50	€0
BUILD TIME	15’	45’	60’	1 Day	30’
NUMBER OF PLANTS	≈ 6	6	9	12	15
FOOT-PRINT	0.09m^2	0.004m^2	0.1m^2	0.09m^2	0.09m^2
ATTRIB-UTES	Familiar	Environmen-tally Friendly	Mountable	Conserves space, com-plex	Space effi-cient, no elec-tricity

Figure 22. Design parameters for all five designs.

The Flower Pot system was the result of initial feedback saying that many people grew flowers on their balconies and had a desire for an inexpensive and simple system. The design is a very basic deep-water culture system where the water is housed by a flower pot, and the plants are floated on a thin sheet of Styrofoam that floats on top of the nutrient rich water. The flower pot system is the least expensive of all those presented, and requires the least amount of build time to construct it as well. This design satisfies the desire for an inexpensive and easy to build hydroponics system.

Figure 23. Flower pot system

The Bottle System can be hung to form a partition between the residences of a shared balcony. We learned that this was a desire in our interview with the Urban Soul Project, an architectural design firm in Thessaloniki. The bottle system a recycled bottle that has been cut in half and inverted, and a wick made out of twine pulls water out of the lower chamber into the root system of the plant. The bottle system was designed with the environmentally conscious in mind, as it uses almost entirely directly recycled materials. The construction time for this system is lengthy, as users must cut a glass bottle to properly implement the design (pictured is a plastic version), each bottle is also only capable of supporting a single plant at a time, but the materials to construct it are relatively inexpensive and it is projected as a system using six bottles strung together.

Figure 24. Construction of a bottle system

Figure 23. Torpedo systems

The Torpedo System was designed by our sponsor, Dr. Gertsis. This system uses PVC piping to create a simple deep water culture system with no growth medium, only plants floating in water. The idea behind this system was to create a cheap, low maintenance system anyone could use on their balcony. This design has a 1-meter-long footprint and can be placed on a balcony in a variety of ways. It can be stacked on shelves, fixtures to the side of the balcony, or hung up. The only maintenance required is refilling the torpedo when the water level is low. The construction of the torpedo is more involved than most of the other systems. Compared to other hydroponic systems on the market it is very inexpensive and is moderately priced in relation to the rest of the systems we investigated.

We decided to consider a Vertical PVC system in order to gain interview feedback on a more complex design that requires pumps and a long build time to operate. The system has numerous benefits to go along with its complexities, and can grow the second most plants of any design considered. The excess materials needed to construct this design are expensive, due to pumps

Figure 24. A vertical system

and timers, not to mention the kinds of tools needed to actually pull of the build. There are also long term energy costs associated with this system, as it must be plugged in to pump water at all hours of the day or night.

The Stacked System was born out of feedback received on our other four systems. In this design we combined the space efficiency of the Vertical PVC system with the simplicity of the Flower Pot system using stackable trisection flower pots in a deep water culture context. The modular design allows for people to grow as many or as few plants they would like. Out of all our designs the stacked system has the highest number of plants. Compared to the vertical system it is easy to build and maintain. It also cost much less than the vertical system, even though it cost more than our other designs.

Figure 25. Stacked pot system

Cost Analysis

The completed cost analysis required price data that was averaged from stores selling lettuce and tomatoes in urban Thessaloniki. The averages of the price per kilogram of lettuce and tomato were 0.95 Euro and 1.46 Euro, respectively.The values were calculated using our family lettuce purchasing model as seen below, which includes the estimated 3.80 Euro per week the family spends on lettuce.

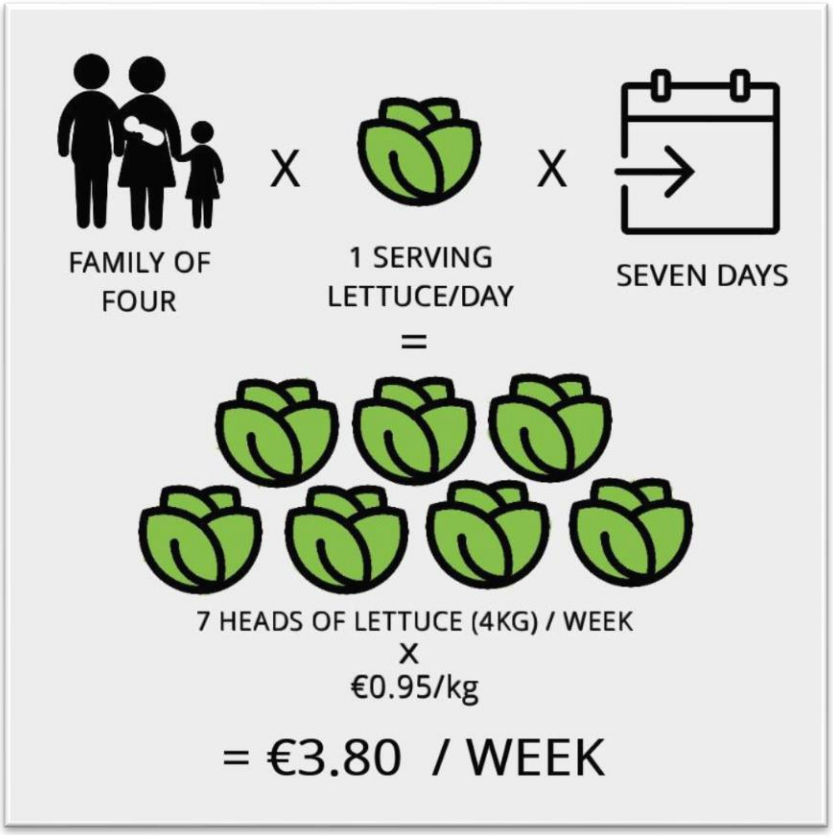

Figure 26. Family lettuce expense estimation

The savings per week and over the first year including the initial start-ups costs, along with the return on investment time, are listed in Figure 27. The system that saves the most money per week, as well as over the first year is the stacked system. The system that pays off the most quickly is the flower pot system, which pays off in 2.6 months. The high cost of the torpedo makes it a weak competitor against no system at all and its yields are comparable to the much cheaper stacked system.

	FLOWER POT	BOTTLE	TORPEDO	VERTICAL PVC	STACKED
Saved per Week (€)	3.07	3.07	4.61	6.14	7.68
Total Save in 1 Year (€)	28.84	22.46	36.17	-31.36	59.24
Time Until Paid Off (Months)	2.6	4.7	4.2	22.8	4.4

Table 2. Return on investment for all systems

The graph organizes the data against the cumulative spending of the model family on lettuce. The compared spending using each system is charted as well, except for the vertical PVC system, due to its expensive initial

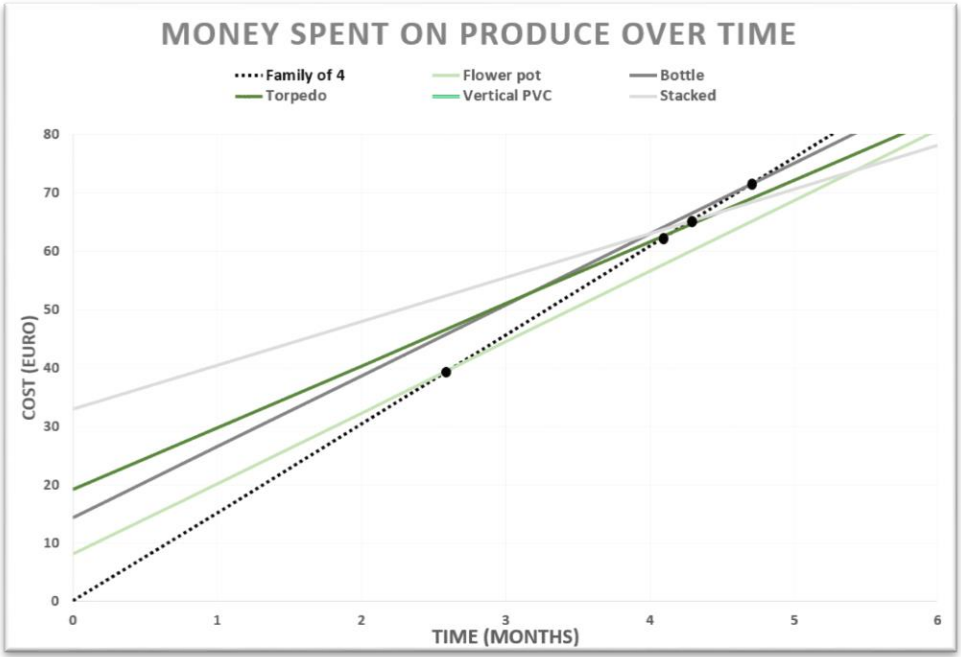

Figure 27. Money spent on produce over time

start-up cost. The time until the system is paid off is noted by the black makers.

Iterative Process

The bar graph in Figure 28 revealed which of the previously explained systems were favored. Scores were calculated based on the process described in methods.

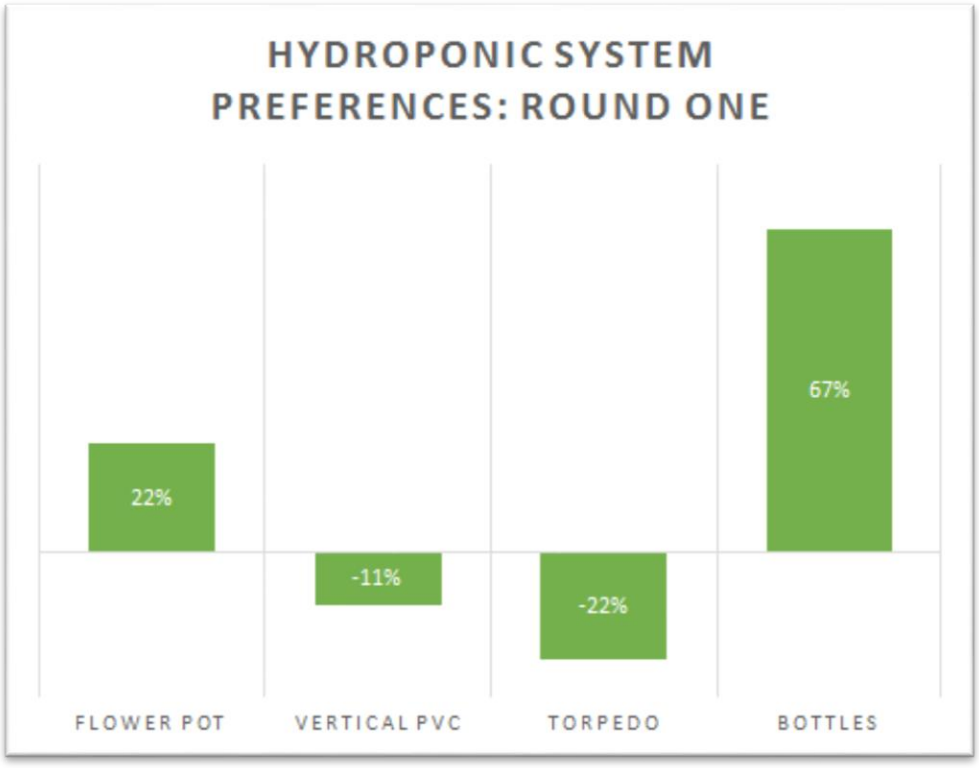

Figure 28. Bar graph of first round of system preferences.

Interviewees justified the low scores of the Vertical PVC and Torpedo systems as being attributed to their difficulty to build and large space requirement, respectively. In a continuous panel interview, an urban dweller noted that the vertical PVC system would provide the greenest space and make it feel more "farmy." Another continuous panel member (who notably had a large balcony) preferred the torpedo system because it could be placed into a wooden box and would be visually appealing. People liked the flower pot idea because they felt it was "most practical because there is not much (balcony) space" and felt the design was familiar—in a good way. The bottles were seen as "innovative", "easy for everyone to have", and "economical." There was a preference for wine bottles as opposed to plastic

bottles and a continuous member said they liked the idea of reusing, but did not like the plastic bottles in terms of aesthetics. People liked that it reused bottles and that it could be kept away from their dogs if hung. Conversely a continuous panel member noted that hanging wine bottles would be quite heavy which is a justified concern as an architect from Urban Soul Projected stated there was not much structural integrity in Thessaloniki balconies. With this feedback in mind, a new system was created combining the compactness of the bottle system and the familiarity of the flower pot system.

> *"I think you can save a lot of space with (the vertical PVC system) and it's really very big and nice and you have a more feeling of being in a planetary and you feel like more farm-y. I do not know though you can have it in your balcony"*

The new system was the stacked vertical pots system which is not only spatially conservative in terms of foot print, but was modular with respect to height, so there were no spatial constraints in terms of height from balcony to balcony. The following bar chart represents the scores of the systems, including the stacked flower pot system, after the second day of street interviews.

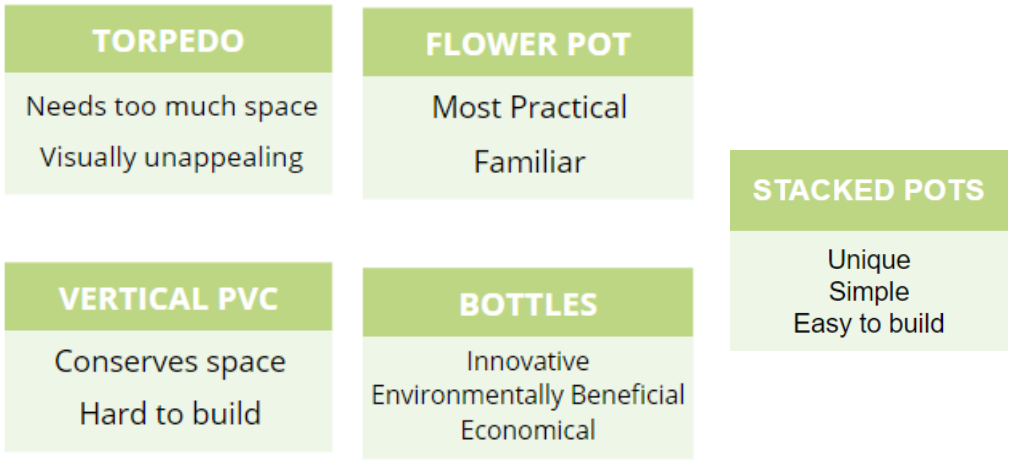

Figure 29. Feedback on all systems

People acknowledged that the stacked pots were both practical and space efficient—similar to the feedback of the stacked pots' predecessors the flower pot and vertical PVC systems, respectively. However, there were mixed reviews on the stacked pots—some people felt it was "too conventional and original" which challenged the feedback that it was "different than what you usually see." This round of interviewees viewed the torpedo system more favorably citing its simplicity and the ability to easily combine multiple torpedo systems. A continuous panel member commented on the torpedo: "I like that, that's different, that's why I like that." The vertical PVC system performed well—but not as well comparatively—this round someone stated that although they liked it, they would not use it on their own balcony. The weighted scores of all systems across all iterations is below.

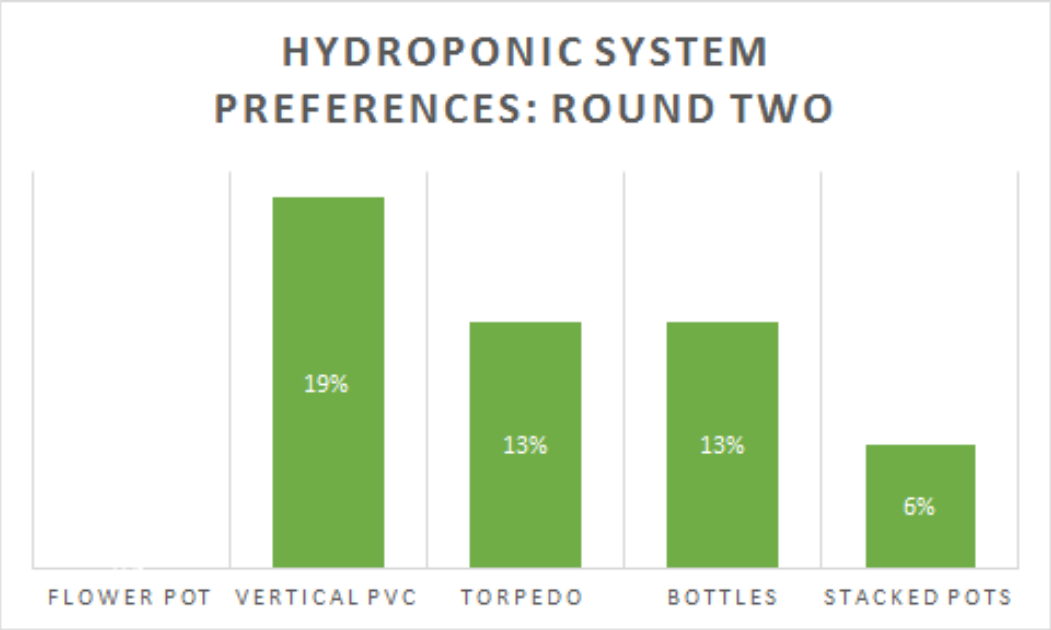

Figure 30. Bar graph of systems following set of street interviews.

Overall, the flower pot, bottles, and stacked pots were praised for their simplicity and space efficiency. The vertical PVC was not as popular due to its difficulty to build and the torpedo for its space requirements. Figure 31 represents the opinions on the systems across all interviews.

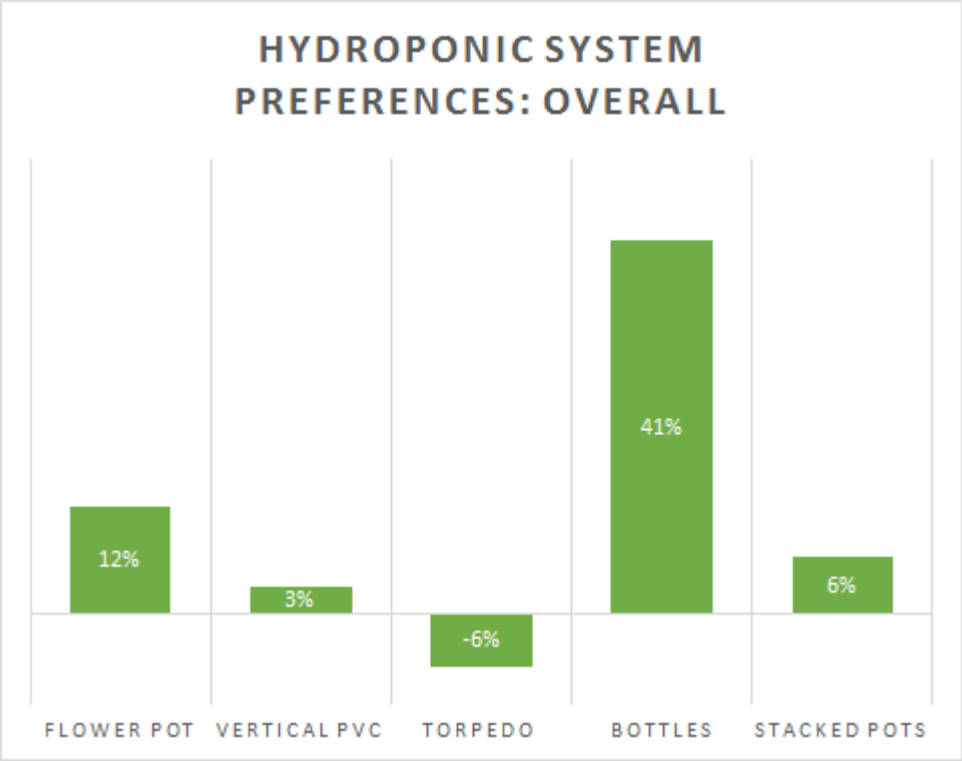

Figure 31. Overall system preferences

CONCLUSIONS

Residents of Thessaloniki are interested in growing their own food, but feel limited in their ability to do so. Many people do not have the resources needed to pursue cultivation in the city and for this reason are hesitant to begin. The limited availability of land prevents traditional soil methods with the exception of a single community garden that supports a mere eleven participants. For people looking to pursue their balcony as a cultivation space, there is only one hydroponic store selling expensive systems, so it is not a viable option for the common resident. While a majority of people are interested in growing their own food, many are limited in time, space and knowledge.

Hydroponics can address the concerns of cost, space and time commitment if implemented correctly in Thessaloniki. Given that people have an interest in cultivating in the city and the balcony space to spare, hydroponics is a viable option for residents to pursue urban agriculture. Through our iterative design process, we determined the following three systems are the most appropriate for Thessaloniki; the flower pot, the bottle and the stacked pot system. These designs address people's main concerns regarding personal food production and had the most positive responses from people living in Thessaloniki.

Figure 32. Three most appropriate system in Thessaloniki.

The savings from these systems offset the initial cost, and the systems would pay for themselves in two to five months. As for space constraints, these three designs take up no more than 0.09 m^2 so they can be seamlessly incorporated even into balconies reported as “small” by residents. The simple hydroponic methods used, two deep water culture systems and one wick system, require little maintenance time. Although these designs provide opportunity for Thessaloniki, they are not useful unless people are introduced to these ideas. People expressed interest and reacted positively to the idea of hydroponics, but it was a new concept to many. This must be addressed through disseminating information on hydroponics in the city.

RECOMMENDATIONS

Outreach & Initiative

KIPOS^3

KIPOS^3 showed a great interest in collaborating with us because they have knowledge on how to implement urban agriculture movements in Thessaloniki. They were genuinely interested in supporting any initiative that encourages cultivation in the city, especially those at an individual level. We discussed implementing a system into their garden in order to familiarize people in the area with hydroponics in hopes that they become interested and eventually adopt the technology for themselves. This idea of creating interest through a public demonstration is something that KIPOS^3 excels at. They were able to double their number of cultivators in one year without using advertising. We recommend that following a donation of our hydroponic systems to KIPOS^3, the urban garden displays them and educates the community on the technology in the hopes of generating interest.

PeaceJam & Entrepreneurship Club

During our time at the American Farm School, we formed a bond with the school's chapter of PeaceJam as well as the Entrepreneurship club. PeaceJam's mission statement is to "create young leaders committed to positive change in themselves, their communities, and the world through the inspiration of Nobel Peace Laureates who pass on the spirit, skills, and wisdom they embody." Led by Leighanne Penna, the Director of Student Life for the Secondary School and Perrotis College at American Farm School, the organization strives to positively impact Thessaloniki through volunteering. Even prior to our arrival, the club was excited about hydroponics as a possible vector for urban agriculture in Thessaloniki, and saw many of the same benefits we did. PeaceJam could be useful in spreading the initiative, and we have created additional documents to help get this process started. They have the knowledge and numbers to be able to effectively distribute these documents, a pamphlet on hydroponics as well as how-to guides on

the three systems to potential users. These deliverables can be seen in Appendix F and G, respectively.

Entrepreneurship Club on campus could also become involved in this project as they have already done work with hydroponics. It was reported that many people would be willing to buy these hydroponic systems instead of make it themselves and Entrepreneurship Club could help assure that the system was properly built and setup for the user. This is a potential business opportunity for the club, and could simultaneously push the initiative forward by getting more systems up and running and onto people's balconies. We recommend that the club look over the research we've conducted including the how-to guides and the pamphlet to help them market hydroponics.

Educational Tool

Many people we interviewed suggested that we implement a hydroponic system with parents of young children or in an educational setting. It would serve as a valuable tool to teach children in the city about how plants grow and about the technology behind hydroponics. Some also implied that if introduced at a young age, urban agriculture would gain traction more easily and be able to overcome social norms. Having hydroponics systems in schools could also be a route to making the technology more available to parents. We recommend anyone continuing this project to investigate designing a system for educational use, as it could aid in the implementation of a balcony system in the long term.

Further Investigation

American Farm School & Perrotis College

We did not have enough time to evaluate performance of our hydroponic systems due to our limited stay at Perrotis College. Research regarding performance could be conducted by students at Perrotis as either a dissertation or other type of agricultural project. Many of the precision agriculture students we talked to during our time at Perrotis College were interested in hydroponics, and some were very keen on continuing our

research once we left. Our sponsor, Dr. Gertsis, expressed an interest in having students test the quality of the vegetables grown using different types of fertilizers in the water. There should also be research done into whether the lack of active aeration in our systems would have a negative impact on the plants. Our team as well as our sponsor suggest there be scientific work done to see if the benefits of having an aeration system significantly impact the cost efficacy of the systems. The investigation into the technical aspects of this project could maximize the performance of our systems.

Future IQP Teams

While it has been determined that hydroponics is an appropriate urban agriculture method for Thessaloniki, there is still more research to be done on how to implement balcony hydroponics on a large scale. Although we felt we reached the saturation point for our interview data, there is more to be explored regarding attitudes toward urban food cultivation and willingness for residents to use our systems if given the opportunity. We have created a survey in Appendix H that can serve as a starting point for future IQP teams to use. We hope future teams can be mindful of the limitations of our data, but still build off of what we have found.

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APPENDICES

Appendix A

Semi-Structured Interview Questions for Potential Users

Walk us through the last time you went food shopping.

What did you buy?

What vegetables?

Where do you go?

How long did it take?

Who did you interact with?

How much did it cost? How much do you spend on vegetables?

Was it a good experience?

What could be improved?

How often do you buy food?

If you are not the person that buys food for your family, how often do they go and buy food?

Describe the last time you cooked.

Who gathered the ingredients?

How much time was spent cooking the meal?

Who were you shopping for?

How many people did you feed?

Please list the types of vegetables do you like to eat.

What do you think about people who grow food for themselves?

Do you or does anyone you know grow their own herbs or vegetables?

Would you want to grow your own food?

What is holding you back from growing your own food?

Why don't you want to grow your own food?

How are you growing your own food?

Do you have a balcony? If so, describe the ways you utilize this space.

Do you have any concerns about what your balcony looks like?

Does your balcony face the sun?

Do you use it during all months of the year?

How much leisure time do you spend at home?

What do you do during this time?

Would you be willing to dedicate some of this time to growing your own food?

How much time would you be willing to dedicate to growing food?

Hydroponics is a type of system that grows plants without soil. Here are some pictures of hydroponic systems.

What do you think?

Would you ever use something like this? Why or Why not.

Closing Question:

We have this idea….hydroponics…would you use something like this on your balcony? If not, what would like prefer it took look like? (take less space, more space, ?)

Key questions to get resolved (not explicitly asked):

What kind of vegetables do people think would be suited for this system?

How much do certain kinds of people spend on food?

Would people want to use our system?

Appendix B

Vegetable Pictures for Interviews

Appendix C

Interview Questions for Urban Soul Project Architects

Can you briefly describe the Architecture in Thessaloniki?

Other cities we've been to don't have as many balconies per building, why do you think Thessaloniki has so many balconies?

When customers come to you, what do they typically want out of an outdoor space?

E.g. garden, leisure, etc.

How do you utilize plants in your architecture?

We're exploring Hydroponic system designs and we were impressed with your projects and how innovative the designs are. We're hoping our design is one step ahead in the sense that we know what people find attractive before they can even think of it. Here are some examples of hydroponic systems *show examples*. How might you take this general concept and revamp the design?

Do think it should blend in as a regular pot?

Or stand out it some way?

Appendix D

Interview Questions for Greek Non-Governmental Organizations

Callisto-Environmental NGO Questions:

How many people participate in Callisto?

When people volunteer to participation in environmental conservation activities:

Why do you think they do this?

How you would you describe the people who volunteer?

Is it popular to join NGOs in Thessaloniki or do community service work?

If yes: what are the incentives, what do people look to get out of community service work?

If no: Why do you think people aren't

Could you describe how people in Thessaloniki respond to environmental issues.

How do you reach out to people about your organization and what you do?

Describe any troubles your organization goes through:

Hard to find volunteers?

Hard to raise money?

In what way are you looking to expand as an organization?

If you could improve one component of your initiative, which you choose?

Urban Ag/Hydroponics pitch:

What do you think of this idea?

KIPOS[3]:

Can you describe the state of Urban Agriculture in Thessaloniki?

How would you characterize it?

Are the initiatives currently in place sufficient for people who are interested in urban agriculture?

Is space in your garden sought after?

What is the reaction you get when you tell people about your organization?

If negative, what kind of criticisms do you receive?

If positive, why are people excited about this initiative?

Excited about the food production?

Just like gardening?

How many people participate in KIPOS[3]?

What is the demographic of people participating? Husbands, wives, families, students, economic class ?

What have you done for outreach/advertising?

How do people hear about what you're doing?

Where do you get resources/money/supplies for the garden, specifically can you talk about where you got them in the beginning/?

Could you describe the process of finding space for the garden.

Can you explain your relationship with agencies and the municipality?

Describe any troubles your organization goes through:

Hard/easy to find volunteers?

Hard/easy to fund the project?

In what way are you looking to expand as an organization?

If you could improve one component of your initiative, which you choose and why?

Hydroponics Pitch - Our project

Feedback - what do you think the mentality of people will be when asking them to adopt this system onto balconies?

We have these designs - get feedback

A good number of people don't know much about hydroponics so we want to get conversations started about this technology - what suggestions do you have on how to do this?

What approach would you take?

What do you foresee as potential difficulties when doing this?

Appendix E

Deliverables Matrix

This project gave way to a series of different documents target at a variety of different audiences. The following table outlines the descriptions and targets of these documents.

Deliverable	Description	Target
Report	A comprehensive report of all the information we have acquired, as well as how we acquired it.	Individuals interested in picking up this project where we left off. Whether that be subsequent WPI teams or dissertation students of Perrotis College.
Informational Pamphlet	A tri-fold pamphlet giving an overview of hydroponics in general, an overview of our findings, and a summary of our design recommendations.	Organizations interested in disseminating information about hydroponics. This document is meant to inform individuals who are interested in learning about hydroponics.
How-To Guides	A series of documents outlining the steps to physically construct the three systems we found to be most suitable for a balcony environment.	Organizations interested in disseminating information. This document is meant to inform individuals who are interested in building one of our systems for themselves.
Hydroponic Vegetable Survey	A survey designed to gain a more comprehensive understanding of people's current vegetable buying habits, their thoughts and reservations on growing their own food and their current balcony uses.	Entities that want to further hone the designs presented in this paper. This survey should be given to target users of our system, and will form a richer understanding of the need, so designs can be better tailored.

Appendix F

Informational Pamphlet

Informational Pamphlet begins on the next page.

How can people in Thessaloniki take advantage of their balcony space?

This information is the result of a student project that investigated people's attitudes toward growing food on balconies through hydroponics The student team, from Worcester Polytechnic Institute in the USA, collaborated with Professor Athanasios Gertsis of Perrotis College at the American Farm School.

WPI

Perrotis College

Agriculture · Environment · Life Sciences

Balcony Hydroponic Systems

A Brief Introduction of the Benefits of Growing Food on City Balconies

Deep Water Culture: Simple, Easy and Carefree

Thessaloniki residents that were interviewed cited time and knowledge to do so as things that are holding them back from growing food in the city. Deep water culture typically requires less maintenance than soil plants.

- No need for daily watering — plants are seated in a growth medium with roots freely floating in nutrient rich water. Water periodically when levels are low!
- Unnecessary to buy expensive manure soils — Liquid fertilizer is highly concentrated and plant roots have direct access!

Hydroponics: A City Solution

Hydroponics is a soilless growing technique that allows plants to be grown at very high densities, making it ideal for small city balconies.

- Common hydroponic crops: lettuce, tomatoes, strawberries, spinach, arugula and herbs (basil, thyme, oregano, dill)
- Yields tend to be 20% higher— allowing you to grow more in a smaller amount of space
- The growing environment is controlled , which limits exposure to pests and other plant diseases
- Oxygen production in hydroponic systems are higher because of the high water content and plant density. This helps recycle clean air back into the atmosphere.
- Due to its variability, users can be creative in finding a system that works for their space

A Deep Water Culture Hydroponic System

What is in a Hydroponic System?

€0.20/Lt @ Praktiker

Growth Medium

TYPES:

- Perlite
- Peat Moss
- Clay Pellets
- Gravel
- Vermiculite

&

€1.29/pack @ Praktiker

Seeds

OR

€1–3 @ Garden Store

Germinated Seeds

Cheap to Build Systems

The 3 proposed systems are simple and materials can be found at your local gardening store.

Materials Cost: **€8**

Return on Investment **2.6 Months**

Amount Saved/Week **€3.07**

Materials Cost: **€15**

Return on Investment **4.7 Months**

Amount Saved/Week **€3.07**

Materials Cost: **€30**

Return on Investment **4.4 Months**

Amount Saved/Week **€7.68**

Appendix G

How-To Guides

How-To guides begin on the next page.

BOTTLE HYDROPONIC SYSTEM

a how-to guide

SUPPLIES

- Water bottle
- Twine
- Growth medium of your choice
- Knife
- Germinated lettuce

DO YOUR PART

One plastic bottle will take more than 450 years to break down.

STEP ONE

Carefully cut between the shoulder and body cylinder of the bottle.

STEP TWO

Carefully stab a hole in the bottle cap.

STEP THREE

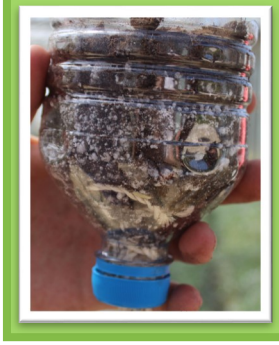
Tie a piece of twine around 10 strands of twine to form the wick.

STEP FOUR

Feed twine through bottle cap hole. Twist cap back on.

STEP FIVE

Add growth medium and germinated lettuce to top half.



STEP SIX

Add water to bottom half, place top half cap down in bottom half

FLOWER POT HYDROPONIC SYSTEM

a how-to guide

SUPPLIES

- Styrofoam
- Flower pot
- Knife
- Germinated lettuce

DID YOU KNOW

You can grow four times the amount of crops in a hydroponic system compared to soil farming.

STEP ONE

Measure the diameter of the flower pot.

STEP TWO

Cut Styrofoam slightly smaller than diameter.

STEP THREE

Measure equally six equally spaced holes on the Styrofoam circle.

STEP FOUR

Cut holes out of Styrofoam.

STEP FIVE

Place in bucket, fill with water so Styrofoam is floating.

STEP SIX

Put germinated lettuce in holes.

STACKABLE HYDROPONIC SYSTEM

a how-to guide

SUPPLIES

Tri-Section Flower Pot, plastic cups, glue gun, glue

DID YOU KNOW

Hydroponics uses 90% less water than soil farming.

STEP ONE

Cut small holes the size of holes in bottom of flower pot.

STEP TWO

Plug holes with glue and Styrofoam.

STEP THREE

Stack and glue pots.

STEP FOUR

Cut three slits vertically in plastic cup without letting the cut hit the edges.

STEP FIVE

Pack plastic cup with growth medium, plant germinated lettuce.

STEP SIX

Put cups in openings.

Appendix H

Hydroponics Survey

Hydroponics Survey begins on the next page

HYDROPONIC VEGETABLES SURVEY

1. Gender:

   ○ Female ○ Male

2. Age:

   ○ 18 – 29 ○ 30 – 39 ○ 40 – 49 ○ 50 – 59 ○ 60 – 69 ○ 70+

3. I eat vegetables X times a day.

   ○ 0 ○ 1 ○ 2 ○ 3 ○ 4 ○ 5

4. I like to buy high quality vegetables.

○ Strongly Disagree ○ Disagree ○ Neutral ○ Agree ○ Strongly Agree

5. I like to buy less costly vegetables.

○ Strongly Disagree ○ Disagree ○ Neutral ○ Agree ○ Strongly Agree

6. I like to know where my food comes from.

○ Strongly Disagree ○ Disagree ○ Neutral ○ Agree ○ Strongly Agree

7. I am worried about chemicals in my food.

○ Strongly Disagree ○ Disagree ○ Neutral ○ Agree ○ Strongly Agree

8. I buy organic vegetables.

○ Strongly Disagree ○ Disagree ○ Neutral ○ Agree ○ Strongly Agree

9. It is important to support local farmers.

○ Strongly Disagree ○ Disagree ○ Neutral ○ Agree ○ Strongly Agree

10. I enjoy growing plants

Strongly Disagree | Disagree | Neutral | Agree | Strongly Agree

11. I grow flowers.

Strongly Disagree | Disagree | Neutral | Agree | Strongly Agree

12. I grow herbs.

Strongly Disagree | Disagree | Neutral | Agree | Strongly Agree

13. I grow vegetables.

Strongly Disagree | Disagree | Neutral | Agree | Strongly Agree

14. I would like to grow my own food.

Strongly Disagree | Disagree | Neutral | Agree | Strongly Agree

15. I wish I could grow my own food but I do not have enough time.

Strongly Disagree | Disagree | Neutral | Agree | Strongly Agree

16. I wish I could grow my own food but I do not have enough space.

Strongly Disagree | Disagree | Neutral | Agree | Strongly Agree

17. I wish I could grow my own food but I do not know how.

Strongly Disagree | Disagree | Neutral | Agree | Strongly Agree

18. I wish I could grow my own food but I do not know how.

Strongly Disagree | Disagree | Neutral | Agree | Strongly Agree

19. My balcony is very small.

Strongly Disagree | Disagree | Neutral | Agree | Strongly Agree

20. My balcony has a lot of space.

Strongly Disagree | Disagree | Neutral | Agree | Strongly Agree

21. I use my balcony a lot.

Strongly Disagree | Disagree | Neutral | Agree | Strongly Agree

22. I don't use my balcony at all.

Strongly Disagree | Disagree | Neutral | Agree | Strongly Agree

23. I have a sitting area on my balcony.

Strongly Disagree | Disagree | Neutral | Agree | Strongly Agree

24. I don't have anything on my balcony.

Strongly Disagree | Disagree | Neutral | Agree | Strongly Agree

25. I grow plants on my balcony.

Strongly Disagree | Disagree | Neutral | Agree | Strongly Agree

26. I care about what my balcony looks like.

Strongly Disagree | Disagree | Neutral | Agree | Strongly Agree

27. I do not have a balcony.

Strongly Disagree | Disagree | Neutral | Agree | Strongly Agree

28. I know what hydroponics is.

Strongly Disagree | Disagree | Neutral | Agree | Strongly Agree

29. Hydroponics is growing plants without soil. Hydroponics is a good idea.

Strongly Disagree | Disagree | Neutral | Agree | Strongly Agree

30. Hydroponics is too expensive for me to use.

Strongly Disagree | Disagree | Neutral | Agree | Strongly Agree

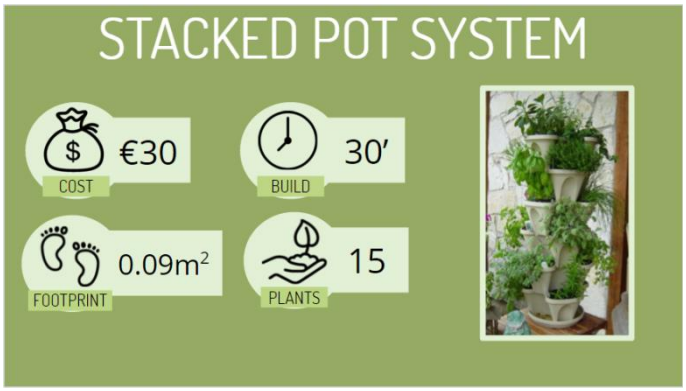
31. Hydroponics is too complicated for me to use

Strongly Disagree | Disagree | Neutral | Agree | Strongly Agree

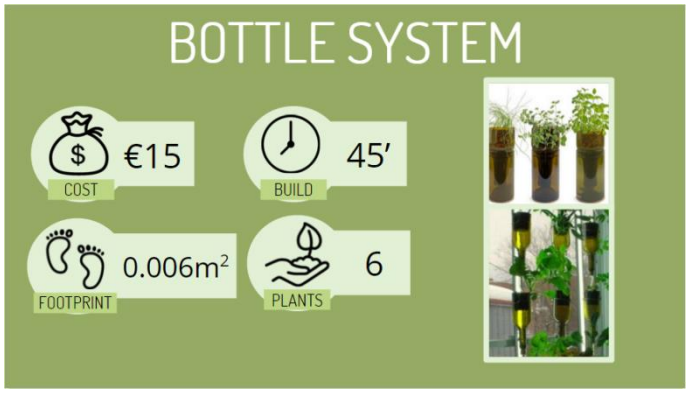
32. Hydroponics is simple for me to use.

Strongly Disagree | Disagree | Neutral | Agree | Strongly Agree

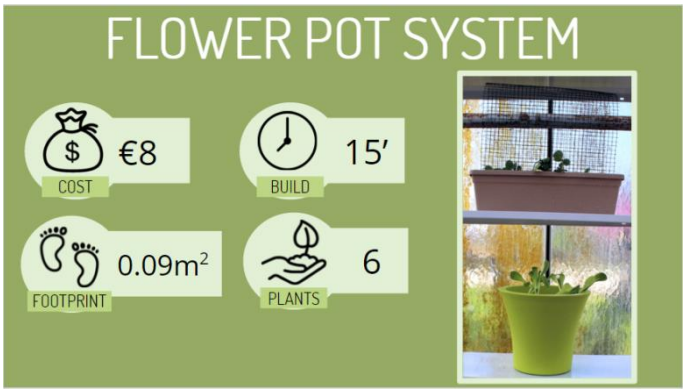
1.



2.



3.



33. Which of the systems above do you like best?

○ 1 ○ 2 ○ 3 ○ None

34. Which of these systems do you like the least?

○ 1 ○ 2 ○ 3 ○ None

35. Would you use any of these systems to grow food?

○ Yes ○ No