



# Kōen

Urban Garden Solution

Industrial Design Thesis Report  
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# **Urban Garden Solution**

by

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Submitted in partial fulfillment of the requirements for the degree of

**Bachelor of Industrial Design**

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## Abstract

Research has shown that those who grow vegetables are more conscious about maintaining a healthy diet. By doing so, it can also provide a cheap and effective method towards healthy eating. However, not every individual is able to garden. Some live in apartments or other small living conditions that do not offer enough space. Others simply do not have a place to call home. That is where the benefit of community gardening comes into play; community gardening allows individuals to have their own plot to garden and grow produce. However, the demand for community gardening has skyrocketed in Toronto and similar cities. The ratio of available plots to people wanting a plot is more than 1:6, with only 5% of plot owners choosing to give up their plots yearly. Due to the current structure of community gardening, it is offered only from April-October of each year—leaving some individuals to fend for themselves. With ever increasing inflation leaving individuals with less income, the solution to these issues might come from facilitating community gardens within city living conditions. Changing these community gardens will not only benefit the user economically, but also mentally. It is scientifically proven that gardening can aid in mental health and reduce stress. However, none of this can happen without increasing availability and changing the current primitive design within community gardens. This thesis provides an in-depth study on societal factors and issues that relate to community gardening using data collection methods such as interviews, observational studies, and surveys. By doing so, a one-to-one scale model will be developed to understand ergonomics, human factors, and determine the feasibility of the design. A solution will be developed in order to aid those related to community gardens.

**Keywords:** Community garden, space, mental health, inflation

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## Chapter 1 – Introduction

The primary objective of chapter 1 is to identify potential opportunities, common challenges, and social factors that can serve as a logical and substantial foundation for the research and proposed solution presented in this thesis project.



Figure 1 – Children Gardening, Retrieved from

[https://stock.adobe.com/ca/search/free?k=gardening&search\\_type=usertyped&asset\\_id=154841914](https://stock.adobe.com/ca/search/free?k=gardening&search_type=usertyped&asset_id=154841914)

### 1.1 Problem Definition

Community gardens are a common occurrence amongst urban living. It allows users who can't garden in their own homes to rent a plot within their local community garden and grow their own plants. Currently, these gardens are at full capacity and their waitlists only increase. In Coquitlam, B.C., for one instance, individuals are waiting up to seven years to get their own plot (Norman, 2022). However, these gardens are not able to keep up with such a high demand as they do not have the required space to do so. Furthermore, these individuals who desire

community gardens do not have sufficient space or lighting within their own homes to garden. They also are in a society that is in an economic recession, with inflation increasing the costs of living and decreasing the quality of it. Due to this, these individuals are further pushed towards community gardening as it is not only a solution for typical gardening but also an economic and societal solution.

This thesis report will investigate the development of a comprehensive design solution aimed at improving the existing community gardening system. Specifically, the focus will be on providing an alternative option for individuals residing in small spaces and urban areas.

## **1.2 Rationale and Significance**

As the cost of living continues to rise, a growing number of Canadians are struggling to meet their basic needs and provide for their families. In 2022, there was a significant surge in the number of Canadians seeking assistance from food banks, while donations to these organizations decreased (Lavoie, 2022). To address the issue of food scarcity, individuals are exploring alternative approaches, with community gardening emerging as a popular option. Community gardening offers a viable solution for those living in high-density urban areas, and its demand has been steadily increasing in both metropolitan centers and their surrounding suburbs.

The goal of this thesis is to acquire knowledge, insights, and data to inform the development of the final design. To achieve this, various research methods will be utilized to gain a comprehensive understanding of the issue at hand. The methods employed to gather information include:

- 1:1 Interviews
- User Observations
- Surveys
- Literature Reviews
- Video Observations
- Ergonomic and Semantic Analysis

### **1.3 Background / History / Social Context**

Community gardens have been in Toronto since 1986, with the first one being established in Regent Park. Community gardeners are a diverse group of individuals, all of whom come from varying tax brackets and reside in both the inner and outer city. Community gardens allow individuals to occupy their own plot, typically from April-October, and grow their own crops. These gardens provide an important reliever for individuals and families who do not always have the funds to afford healthier food. Community gardens not only allow individuals to provide for themselves and their family, but also provide essential food to other organizations. Within Ontario, there are some community gardens that donate part of their harvests to local food banks and nonprofit organizations (Lavoie, 2022).

Failing to adequately prepare, traditional gardening may result in physical injury and long-term harm to the gardener (Powell et al, 1998). In addition, community gardens in Toronto and the Greater Toronto Area do not provide their users with further equipment or resources other than the plot of land. Consequently, users must bring their own tools and equipment, as well as carry a bucket of water to the community gardens. This situation can exacerbate the physical injuries and long-term strain experienced by the user.

Lower-income individuals take up relatively 35% of community gardens. Typically, families with low incomes face constraints that lead to unhealthy habits, including reliance on fast food, social isolation, chronic stress, and limited opportunities for exercise. Nevertheless, community gardens can help alleviate food-related financial burdens or generate extra income by selling produce, thereby addressing food insecurity and reducing associated unhealthy behaviors. Additionally, community gardens can provide a secure environment, fresh produce, and an engaging, physically active, and socially interactive leisure activity (Chow et al, 2020).

## Chapter 2 – Research

Gathering information on potential stakeholders, their environments, and the existing products being used can help to determine the potential for a new product. This process can involve various methods such as user observation, stakeholder interviews, literature reviews, and benchmarking of existing products to collect relevant data.

### 2.1 User Research

By gathering data on the activities and usage of current community gardens, a more comprehensive understanding of the target users' lived experience can be obtained. Moreover, attention will be given to the health and safety of existing products, as well as human factors and product feasibility.

#### 2.1.1 User Profile – Persona



**Info:**

**Name:** Ruth W.

**Job:** Receptionist

**Income:** \$35,000-45,000

**Education:** College diploma

**Location:** Toronto, ON, CAN

**Primary User:** Individuals in community gardens

**Secondary User:** Individuals in small space living

**Tertiary User:** Food banks/nonprofit organizations

**The User Behaviour**

Ruth has loved to garden ever since helping her grandmother with gardening as she was a little child. She has been attending her local community garden—High Park

Community Garden—for the past 6 years. She was lucky enough to add herself to the waitlist and be drawn as the next person to join the garden. She is very grateful she was given the spot as she sees some of her family and friends struggling to afford healthier food options. With a current

economic recession and inflation still on the rise, Ruth is gardening as many of her family's day-to-day vegetables in order to cut costs.

However, Ruth is also very frustrated at times with community gardening as she struggles carrying all her needed tools and supplies to the garden. The garden does offer access to water, but Ruth is lucky enough to have a friend living nearby who is nice enough to let her refill her bucket of water. Ruth requires this bucket as her plants require a lot of water during the hot Toronto summers. She also offers water to her friends in the garden whose only choices are to carry a bucket of water from their homes.

### **2.1.2 Current User Practice**

While at the community garden, Ruth is responsible for her own supplies. She maintains and tends to her own crops and makes sure there is nothing out of the ordinary going on—this can be plant issues or issues within the overall garden. Theft has been a problem lately and Ruth has noticed some of her tomatoes were missing since the last time she checked.

### **Method**

Maps based on surveys, interviews and user observations were generated (see Ch. 2). These maps filtered the data to emphasize pain points, points of delight, as well as the thoughts and feelings (user experience) of the user. The main points related to usability are summarized below.

### **Analysis**

#### **Empathy Map**

An Empathy Map was generated from a user interview. The main pain points related to usability are: Lack of supplies/tools available. Struggling to bring those supplies/tools to the community garden.

1. Body is strained while carrying all those tools.

2. No proper spot to place tools, so they are on the ground usually. This creates more strain having to bend down and pick them up often.

### User Journey Map

A User Journey Map / User Experience Map was generated from the first user observation (big picture) The main pain points related to usability are: Lack of supplies/tools available. Struggling to bring those supplies/tools to the community garden.

1. Bucket full of water is very heavy. Very inconvenient to bring in.
2. No proper spot to place tools, so they are on the ground usually. This creates more strain having to bend down and pick them up often.

### 2.1.3 User Observation – Activity Mapping

Specific Task-based		USER TASK MAP		
TASK: Community Gardening	Ergonomics	Efficiency	Interaction	Satisfaction
<b>Gather &amp; prep tools:</b> Gardening tools, water, and any seeds or new plants	Bending and straining body to assemble everything	The users needs to bring every tool they require to garden – including water. This is a hassle and is very strenuous.		A frustrating experience
<b>Usual day-to-day routine:</b> Tend to existing plants and garden new	Bending and straining body to assemble everything	Not enough space to lay out tools		
Water plants	Bending and straining body to assemble everything	Very heavy bucket of water requires slower pouring		
Check for disease/bugs	Bending/straining due to improper posture and strenuous activity	Speed depends on how lush/plentiful the plants are		
Harvest plants	Bending/straining due to improper posture and strenuous activity	Typically fast to do		The most satisfying part
<b>Clean everything up and take tools</b>	Bending and straining body to assemble everything	Overall a lighter load to handle.	Not applicable in this case	Minor irritation overall when workflow is disrupted
	<b>Ergonomics – Safety</b>	<b>Efficiency</b>	<b>Interaction</b>	<b>Satisfaction</b>
	<b>Most common 'risk' tasks</b>	<b>Most common efficient challenges</b>	<b>Indicators</b>	<b>How frustrating it is to do some tasks</b>
	1. lifting heavy items (bucket of water)	1. unnecessary requirement of bringing water and other tools to garden	N/A	
	2. bending	2. wasted time spent gathering needed tools	<b>Controls</b>	Feelings of control and distress.
	3. reaching overhead	3. layout of tools - non-optimal		
	4. pushing and pulling heavy loads.	4. lighting of workspace inadequate	N/A	
	5. awkward body postures	5. lack of skill / training		
	6. repetitive motions	6. lack of correct tools / eqpt		
	7. slips, trips and falls	7. distractions		



	Planning	Preparation	Task 1	Goal	Finish Up
User Goals	Go to the community garden	Ready everything to start gardening	Gardening - tending to plants	Gardening - harvesting	Packing everything up
Problems/Challenges	Carrying all the supplies to the facility (gardening tools, bucket of water, etc).	Everything is laid on the ground. This creates further aching and pain to the user.	Ensuring there are no issues with the garden (disease, theft, bugs).	Making sure not to accidentally harvest a vegetable that is not ready.	Packing all of the supplies and carrying them back home is very frustrating, once again.
Ideas/Takeaways	These actions are done as leaving these supplies at the facility will lead to their theft. Water should be a necessity there.	Something needs to be done to place the supplies on a spot where it doesn't create bodily strain.	Disease and bugs are expected issues. Theft isn't. Something should be done about this.	This is the best and most satisfying part for a gardener.	This issue makes the community gardening process much harder and frustrating.

	Planning	Preparation	Task 1	Goal	Finish Up
User Goals	Go to the community garden	Ready everything to start gardening	Gardening - tending to plants	Gardening - harvesting	Packing everything up
User Actions	Ensure the user has all needed materials	Ensure all supplies are laid out and ready to begin with	Water plants, pulling out weeds, evaluating for disease or any other type of issue.	Harvesting vegetables that are ready	Clean up work environment pack up tools and water bucket.
User Thoughts	Thinking how heavy and frustrating it is to bring in all these items instead of leaving them at the facility.	Questioning whether or not they have everything they need	My wrists hurt from carrying this large bucket of water over from home. I need to garden slower.	I can make some delicious and healthy dishes with these! This is all worth it if I can provide a healthy lifestyle for my family.	Happy I was able to harvest some food. Last time didn't go well.
User Feelings	Tired/ Anxious	Worried/ Second guessing	Pain/Pressure	Satisfied	Relief/Happiness

## Results

### 1. Gains:



- Social benefits through interactions with others, psychological benefits through stress relieving hobby, and economic benefits through food safety
- 2. Pains:**
  - Theft is very common as some community gardens aren't properly regulated
  - Not every gardener does their fair share within a shared community garden. This creates anger/annoyance amongst those who do
- 3. Usability & Ergonomics**
  - Improper posture & chronic bending
- 4. Efficiency**
  - Efficiency depends on the status of the user's plants and the overall garden—including trust in others.
- 5. Interaction**
  - Interaction is high as it is a communal setting
- 6. Satisfaction**
  - Mastery and Control is prevalent as repeated tasks within gardening allows for honing the user's skills and knowledge over time.

#### **2.1.4 User Observation – Human Factors of Existing Products**

The products used in the human factor study are related to the essential gardening tasks: planting, watering, and maintaining.

- **Raised Gardening Bed:** typically a rectangular, wooden frame that is 3-4 feet wide, 8-12 feet long, and 16-18 inches tall. This product not only encourages better water retention and discourages weeds, but it also resolves debilitating back and joint pain.



### **2.1.5 User Observation – Safety and Health of Existing Products**

Common gardening products encourage user safety through protective materials and design. However, gardening safety is typically up to the user. Out of 10 products that were analyzed, they only promote gardening safety if the user is knowledgeable and aware of the proper preparation to take. Gardeners must take the time to stretch beforehand as it can become a strenuous activity since it targets muscles and joints within the body that is typically not always used. By doing so, the use of these existing products can be at their maximum potential.

## **2.2 Product Research**

Gaining insight into the current products available in the market can unveil potential avenues for introducing new products. In the upcoming segment, we will delve into the benchmarking of already existing products, encompassing their functionality, aesthetics, and ergonomics.

### **2.2.1 Benchmarking – Benefits and Features of Existing Products**

Existing community gardening equipment is very prevalent. They do not provide their users with tools or supplies. They only provide them with a gardening bed or sometimes a raised gardening bed. There are not any existing products specifically for community gardening use. The ones that were found were for regular gardening usage.

### **2.2.2 Benchmarking – Functionality of Existing Products**

While the functionality of these gardening products enhances productivity in community gardens, they exclusively cater to aeroponic/hydroponic-style gardening. Given that a significant proportion of community garden users are aged 35 and above, expecting them to embrace a novel method of gardening seems impractical. As these products do not facilitate conventional-style gardening, they are unsuitable for the target audience (Chow et al, 2020).



**Aerospring 27-Plant Vertical Growing System**  
<https://brookpad.ca/products/aerospring-27-plant-vertical-hydroponics-indoor-growing-system-patented-vertical-hydroponic-kit-for-indoor-gardening-grow-tent-led-grow-lights-fan-grow-lettuce-herbs-veggies-fruits>

**Nutraponics Hydroponics Tower**  
<https://www.ebay.ca/itm/353637942922?chn=ps&mkevt=1&mkcid=28.html>

**Benefits and Features- from Promotional Literature**

Benefits	Features
<b>Highly energy efficient</b>	- In control of air humidity, amount of water supply, spray timings and energy used. - Saving approximately 66% of the energy.
<b>Effortless results every time</b>	Significantly higher plant yield
<b>Multi-functional</b>	Optimum controlled environment for growing a wide range of agricultural products in all environments and climates.

	Modular and stackable.
--	------------------------

## Results

### **Benefits of both**

- Both plant stands allow hydroponic gardening *Shelter for plants*
- The plants within the stand have proper light, water, and nutrients. *Shelter for plants*
- The plant stands protect the plants from theft. *Security for plants (feels safe)*
- It protects the plants from the elements (weather, too much/too little light). *Shelter for plants*

### **Benefits of Each**

#### **Product A: AeroSpring Hydroponic Plant Stand**

- Protective cover *ease of use for user*
- Multiple pods to allow for large quantity plant growth *ease of use for user*
- Durable, modular design *ease of use for user*
- Simple tech breakdown for user friendliness *ease of use for user*

#### **Product B: Nutraonics Hydroponic Plant Stand**

- Multiple pods to allow for large quantity plant growth *ease of use for user*
- Durable, modular design *ease of use for user*
- Simple tech breakdown for user friendliness *ease of use for user*

### **2.2.3 Benchmarking – Aesthetics and Semantic Profile of Existing Products**

The correlation between gardening and mental wellbeing has been established for millennia. Research indicates that spending as little as one hour per week gardening can significantly reduce stress levels. Hospitals and detention centers have integrated gardening and nature-based design into their facilities due to their calming impact on occupants. The proposed design aims to create a tranquil and serene atmosphere for users, particularly those experiencing high levels of stress, while also harnessing the psychological advantages of gardening.

### **2.2.5 Benchmarking – Sustainability of Existing Products**

The strength, durability, and long-lasting nature of plastics make them a remarkable feat of human engineering. However, these same characteristics render plastics a significant environmental threat. Their lightweight and affordable nature make them a popular choice for constructing plant stands and planters. Aeroponic and hydroponic systems primarily use Polyvinyl chloride (PVC), while polypropylene (PP) is a common material for planters and other plastic pots. However, neither of these materials can be deemed sustainable as they take a considerable amount of time to degrade.

## **2.2 Summary of Chapter 2**

Observational studies, surveys, and one-on-one interviews with users have revealed that community gardens offer inadequate support to their users, yet the benefits they provide are highly sought after. The research phase highlighted the significance of Ruth, a low-income individual seeking support from a community garden, and the challenges she faces.

As community gardens typically offer no products beyond gardening beds, this research segment focuses primarily on spatial gardening solutions and provides limited scope for benchmarking.

## Chapter 3 – Analysis

### 3.1 Analysis – Needs

According to the Consumer Product Safety Commission, emergency rooms treat more than 400,000 garden-related accidents each year. Gardening typically requires the use of muscle groups and joints that aren't exercised often. This opens the door for bodily strain and aching (Hall, 2018). Musculoskeletal and osteoarticular injuries are related to gardening, agricultural practices, and farming (Lampert et al, 2021). The lumbar spine can be easily strained when doing gardening tasks. This can cause vertebral fractures, lumbago, spinal canal stenosis, foot drop, and sciatica (Richard, 2021). Due to the occurrence of these injuries, the ergonomics of the paramedics must be analyzed. Further research must be conducted on the needs of the user and its stakeholders.

#### 3.1.1 Needs/Benefits Not Met by Current Products

Section 2.2.1 Benchmarking – Benefits and Features revealed that current gardening products are user-friendly, offer solutions for small-space living, and enhance gardening capabilities. However, upon examining the Benefits Categorization table, only three products were found to market themselves as offering "savings." Community gardening users require ways to streamline their routines to improve productivity, but existing solutions do not allow for that.

#### Benefits Table

<b>Key Benefits of Comparable Products</b>	
<b>Keyword</b>	<b>Frequency</b>
Ease of Use	6
Gardening Benefits	9
Savings	2



### 3.1.2 Latent Needs

A guided framework using Maslow’s theory of Fundamental Human Needs will be used to gather data. Various information sources will be tapped to gain information through user observations, user interviews, and reports to identify the existing latent needs of a gardener in a community setting.

Ultimately, the biggest latent need the user needs is a psychological stress reducing benefit.

**Statement:** Community gardens do not have adequate resources, space, or tools for their gardeners.

**Opportunities:** Create a spatial solution that provides the necessary resources and knowledge for one to garden.

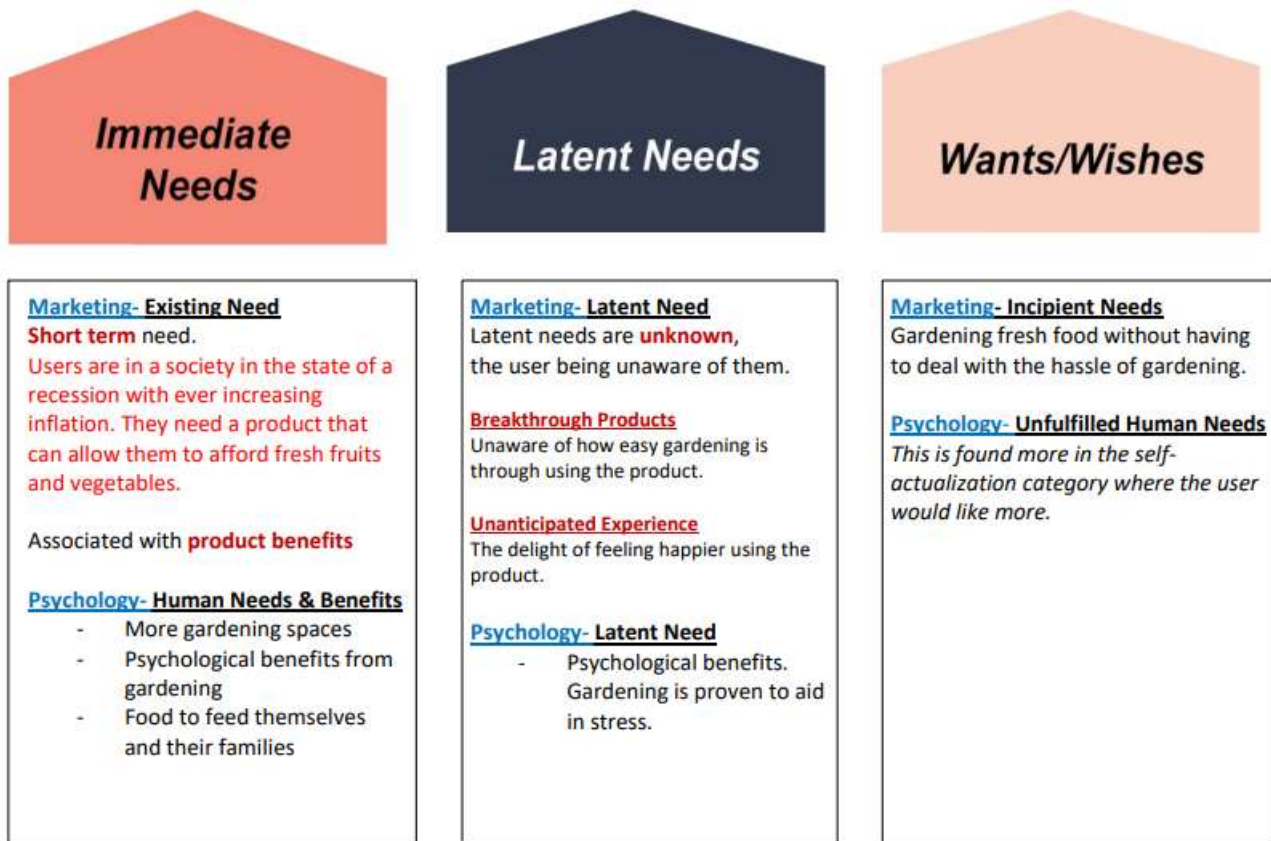
### 3.1.3 Categorization of Needs

The categorization of needs collects the user’s latent and immediate needs. It also seeks to understand some of the users wants/wishes. Gardening typically requires the use of muscle groups and joints that aren’t exercised often. This opens the door for bodily strain and aching (Hall, 2018).



<p><b>Marketing- Latent Need</b>                  Latent needs are <b>unknown</b>, the user being unaware of them.</p> <p><b>Breakthrough Products</b>                  Unaware of how easy gardening is through using the product.</p> <p><b>Unanticipated Experience</b>                  The delight of feeling happier using the product.</p> <p><b>Psychology- Latent Need</b></p> <ul style="list-style-type: none"> <li>- Psychological benefits. Gardening is proven to aid in stress.</li> </ul>
---





### 3.2 Analysis – Usability

To effectively analyze usability, it is helpful to break it down into smaller components:

- Interaction
- Satisfaction
- Ergonomics
- Efficiency

#### Main Usability Issues

##### 1. Ergonomics & Safety

- **Safety:** Bodily strain hazard: Too much movement and bending over, lifting heavy objects.
- **Bending** Lifting heavy bucket of water and other tools.
- **Reaching** for tools and plants.

## 2. Efficiency

- **Uneven** available space within garden.
- **Cluttered** with objects laying around and gardening beds.
- **Disposal:** The user deals with disposing. There is not an available disposal spot.

## 3. Interaction

N/A

## 4. Satisfaction

- When plants are harvested, there is the most satisfaction. There is also the overall feeling of being content while gardening.

### 3.2.1 Journey Mapping

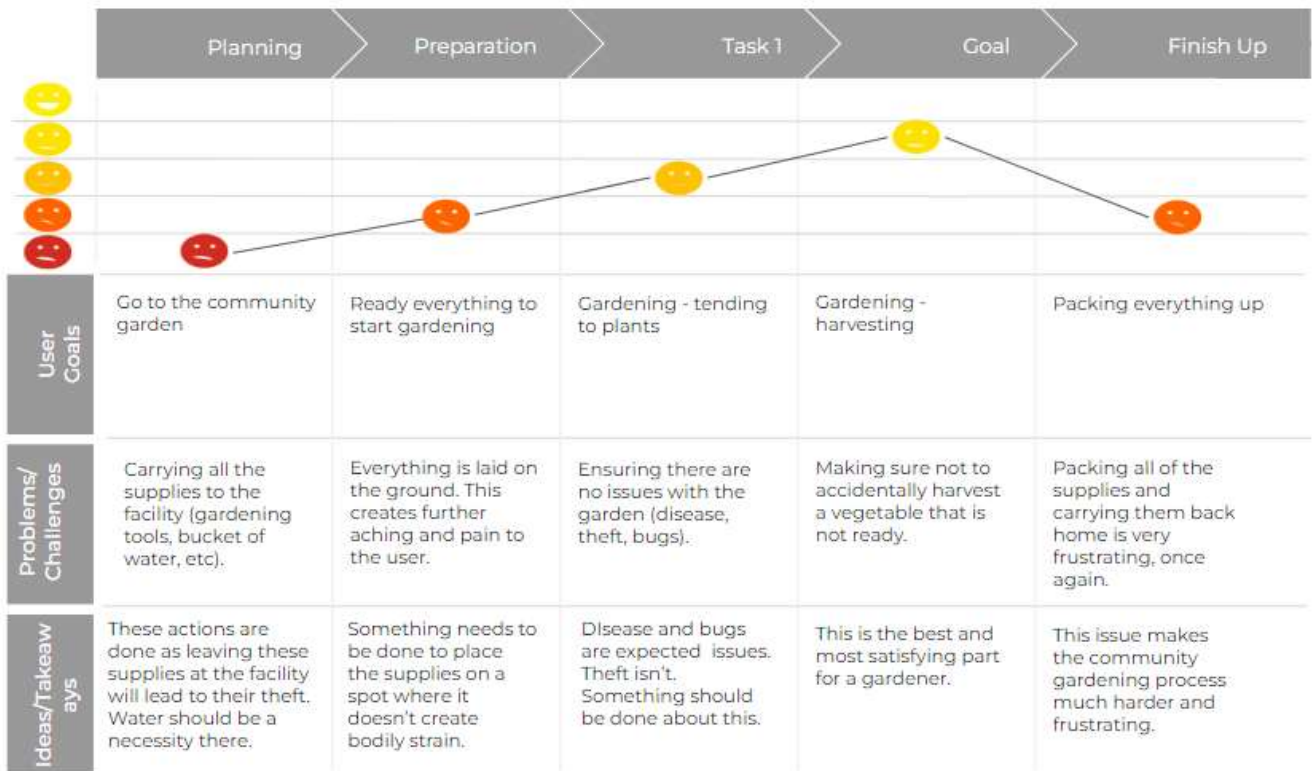
Community gardeners employ different methods to achieve their objectives compared to regular gardeners. To design equipment that caters to their specific needs, it is crucial to gain an understanding of both the routine and challenging scenarios they encounter. A journey map was employed to achieve this.

	Planning	Preparation	Task 1	Goal	Finish Up
User Goals	Go to the community garden	Ready everything to start gardening	Gardening - tending to plants	Gardening - harvesting	Packing everything up
User Actions	Ensure the user has all needed materials	Ensure all supplies are laid out and ready to begin with	Water plants, pulling out weeds, evaluating for disease or any other type of issue.	Harvesting vegetables that are ready	Clean up work environment pack up tools and water bucket.
User Thoughts	Thinking how heavy and frustrating it is to bring in all these items instead of leaving them at the facility.	Questioning whether or not they have everything they need	My wrists hurt from carrying this large bucket of water over from home. I need to garden slower.	I can make some delicious and healthy dishes with these! This is all worth it if I can provide a healthy lifestyle for my family.	Happy I was able to harvest some food. Last time didn't go well.
User Feelings	Tired/ Anxious	Worried/ Second guessing	Pain/Pressure	Satisfied	Relief/Happiness

### 3.2.2 User Experience

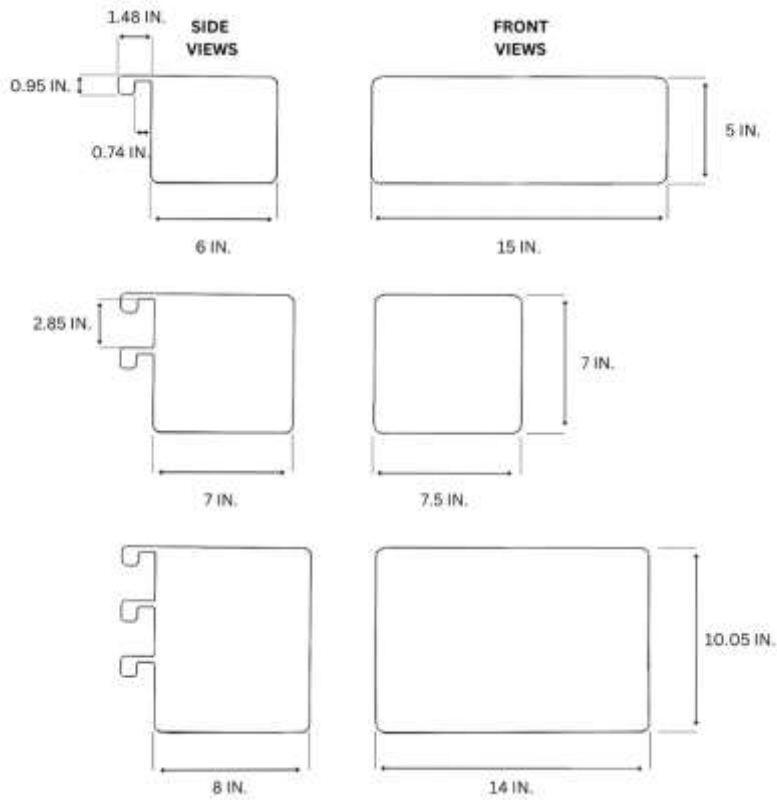
Building upon the journey mapping analysis outlined in section 3.2.1, the user's experience during each task will be documented and illustrated. The journey begins on a tense note as the gardener struggles to transport the required equipment to the community garden. As the gardening tasks progress and are completed, the gardener's stress levels decrease, culminating in a sense of

satisfaction upon finishing work in the garden.

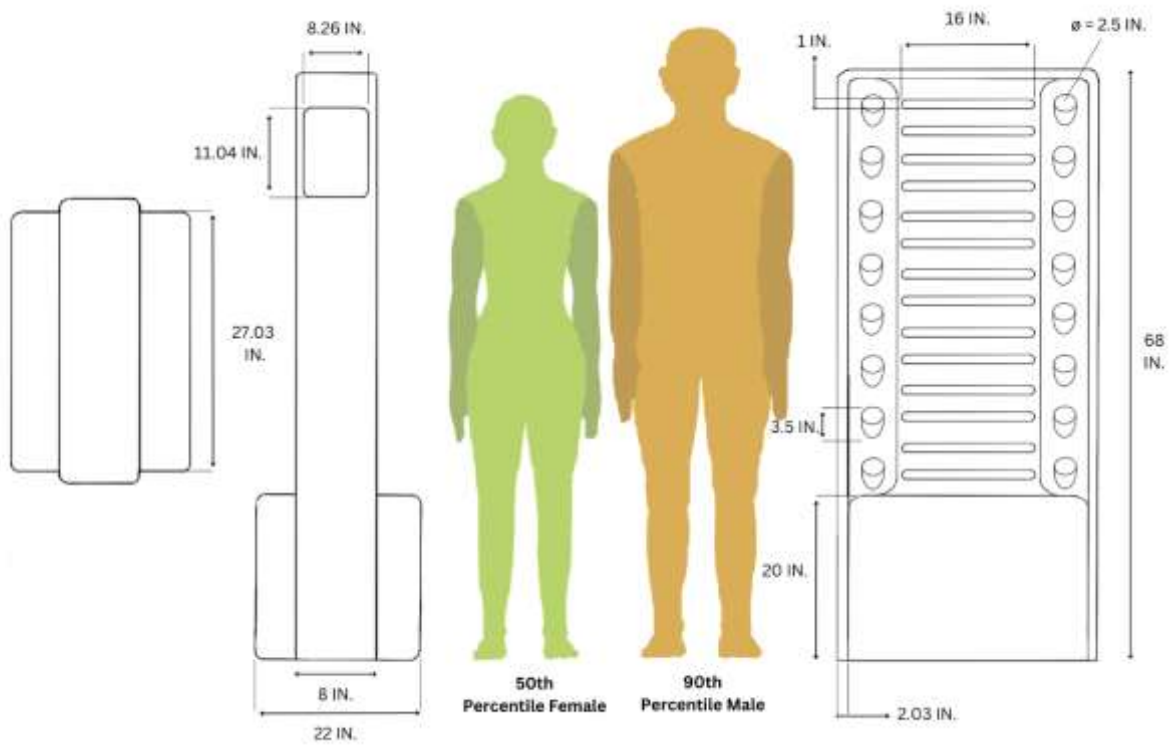


### 3.3 Analysis – Human Factors

In order to comprehensively comprehend and evaluate the necessary human factors, a set of two-dimensional and three-dimensional exercises were conducted. The two-dimensional exercises consisted of tasks like reviewing a product schematic diagram and configuration diagram, whereas the three-dimensional exercises involved creating and constructing a full-size ergonomic buck. This section presents the approach and outcomes of both the two-dimensional and three-dimensional analysis techniques mentioned previously..



**3.3.1 Product Schematic – Configuration Diagram**



### 3.3.2 Ergonomic – 1:1 Human Scale Study

Constructing a life-sized model allows for deeper understanding of how the product will interact with the human body. Due to the large scale of the design, only the central seating was constructed to provide ease and simplicity. This piece was specifically chosen as its measurements overlap with every other piece within the design. This piece also has a seating element which makes it more necessary to create a life-sized model of to develop proper ergonomics.

However, this concept was eventually scrapped and the design was shifted to a singular plant stand. There was no 1:1 human scale study conducted for the new design.



Figure 8



Figure 11



### 3.4 Analysis – Aesthetics & Semantic Profile

Considering the usage environment of the solution, it is important to ensure that its aesthetics and tactile qualities are appropriate. The design should primarily prioritize functionality for the gardener while also considering form and expressive style. The exterior components and

frame of the solution will be designed with durability and longevity in mind, while the interior features will focus on functionality and ease of use. In addition, the solution must maximize crop yield and provide protection from the elements to ensure its viability.

### **3.5 Analysis – Sustainability: Safety, Health and Environment**

Many gardening materials are not eco-friendly, but the Kōen concept aims to address this issue. To minimize environmental impact, Kōen primarily employs galvanized steel, a type of steel that has a relatively low environmental footprint because it uses natural resources efficiently. Additionally, the zinc coating on galvanized steel makes it suitable for outdoor use. The plant stand is also constructed with high density polyethylene (HDPE), which is recognized as the most environmentally stable plastic. HDPE is produced using recycled materials and is fully recyclable, requiring minimal energy to manufacture.

### **3.6 Analysis – Innovation Opportunity**

As seen in Section 3.1.1, only a few benchmarked products promote saving time and creating efficiency towards the community gardening user. Additionally, some of the primary users latent needs are increasing gardening productivity and thereby decreasing their stress through psychological gardening stimulation. Furthermore, some of the immediate needs of the primary user are having more space to garden and having the necessary supplies/tools readily available.



### 3.6.1 Analysis – Needs Analysis Diagram

#### LINKING BENEFITS WITH NEEDS – Hydroponic Plant Stand

Product – Hydroponic Plant Stand		
Needs	Benefits and Underlying Needs	Level of importance
<b>Basic Needs</b> <i>Physiological</i>		
Food, water, shelter	Allows users to grow their own fresh vegetables.	High
Pleasure, gratification <i>(sensory, compulsive responses)</i>	<b>User:</b> Sleep, modern design that requires less space and allows for various plant growth for large quantities.	High
		Moderate
<b>Security</b> <i>Safety, securing resources</i>		
Safety	Protection of plants	
State, Group, Individual		
Securing resources <i>Optimization of limited resources (cost effectiveness)</i> • Value • Accumulation of resources (wealth)	Price is important for lower income families/individuals (limited wealth)	High
	Reliability	Moderate
<b>Control over environment (tasks)</b>		
	<i>Product (tool) that amplifies human abilities</i>	
Convenience <i>Ease of Use</i>	Allows a more hands-free approach to gardening as there is no soil required.	Moderate High
Speed <i>(fast, less time)</i>	Faster and more reliable growth period	High
Control <i>(precision, responsiveness, power)</i>	Full control within every aspect of plant growth	Moderate
<b>Long Term Security/Stability of Group</b>		
Health/care Environmental sustainability Insurance <i>(car, house), pension, investments</i>	Will this product last against the test of time?	High
	The design will protect the plants against typical gardening elements.	Moderate

<b>Social Belonging</b> <i>Effort / resources to belong to a 'tribe'</i>		
Fear of Abandonment	Plants will be kept safe.	High
Fear of the enemy	No worries of theft from others or disease on the plants.	High
Tribal Identity		
Behavior cues for survival <i>(copying behaviors... safe to eat, learned skills)</i>	Recommended from other gardeners	Moderate
Behavior cues for social interaction of group <i>(copying behaviors... interaction cues, play, have fun)</i>		
Peer Pressure	Other gardeners	Moderate
Social Expectation <i>(social covenant (gift))</i>		
<b>Esteem</b> <i>Personal influence in 'tribe'</i>		
<i>Social Status</i> <i>The elite have it...I want to be like them'</i>	Very popular amongst more modern-style gardeners	Slight
Social Recognition		
Sexual attractiveness		
<b>Self-Actualization</b> <b>'Higher order' Functions/Needs</b> <i>Needs that are pre-dominantly 'outer cortex'</i>		
Intrinsic pleasure		
Creative endeavors		
Experiential (extrinsic)		
Experiential (intrinsic)	Will this be hard to execute? I'm not tech savvy.	Moderate
Emotional	<b>Empathy:</b>	High



## Results

### Needs Statement 1 (before research)

The users **needs** a spatial gardening solution **because** they lack the required space.

### Needs Statement 2 (after benchmarking)

A spatial / gardening device to allow a user to reap the benefits of gardening.  
Further needs include ease of use, comfort, and psychological.

### Needs Statement 3 (after benchmarking **AND** linking with fundamental human needs)

Infant transportation is a purposeful activity (food need) based on ease of functioning (transport) (**control, mastery**), and reliability of plant stand (**security**).

**Control** and **mastery** of the device is related to the performance of the machine (**effectiveness, ease and comfort**).

## 3.6.2 Analysis – Desirability, Feasibility & Viability

Based off Maslow's theory of Fundamental Human Needs, the immediate needs for the user are shelter and water. The next level would be storage and ease of use. The final levels would be for aesthetic and semantic appeal.

## 3.7 Summary of Chapter 3 – Defining Design Brief

Community gardeners lack several of the immediate needs within Maslow's theory of Fundamental Human Needs. Further research within this chapter displayed the immediate, latent, and wants/wishes of the user. The user ultimately needs an opportunity for psychological distress, which ties into the aesthetic and semantic appeal of the design. Two dimensional and three-dimensional exercises were done to gain relevant and key insights into the design process.

## Chapter 4 – Design Development

### 4.1 Initial Idea Generation

Once thorough research has been conducted on the various aspects of the defined problem, the design process can commence. To establish a clear direction for the design process, a mind map was created with three main categories: User, Products, and Environment. This approach facilitates identification of key areas that require attention, ensuring that the design process does not result in just another ordinary plant stand commonly found in gardening stores. The design will also encompass various styling options, leading it towards a utilitarian approach. During the ideation phase, different aesthetics and visual styles will serve as inspiration, refining the design to incorporate sleek and elegant shapes, while maintaining a tranquil and serene appearance.

#### 4.1.1 Aesthetics Approach and Semantic Profile



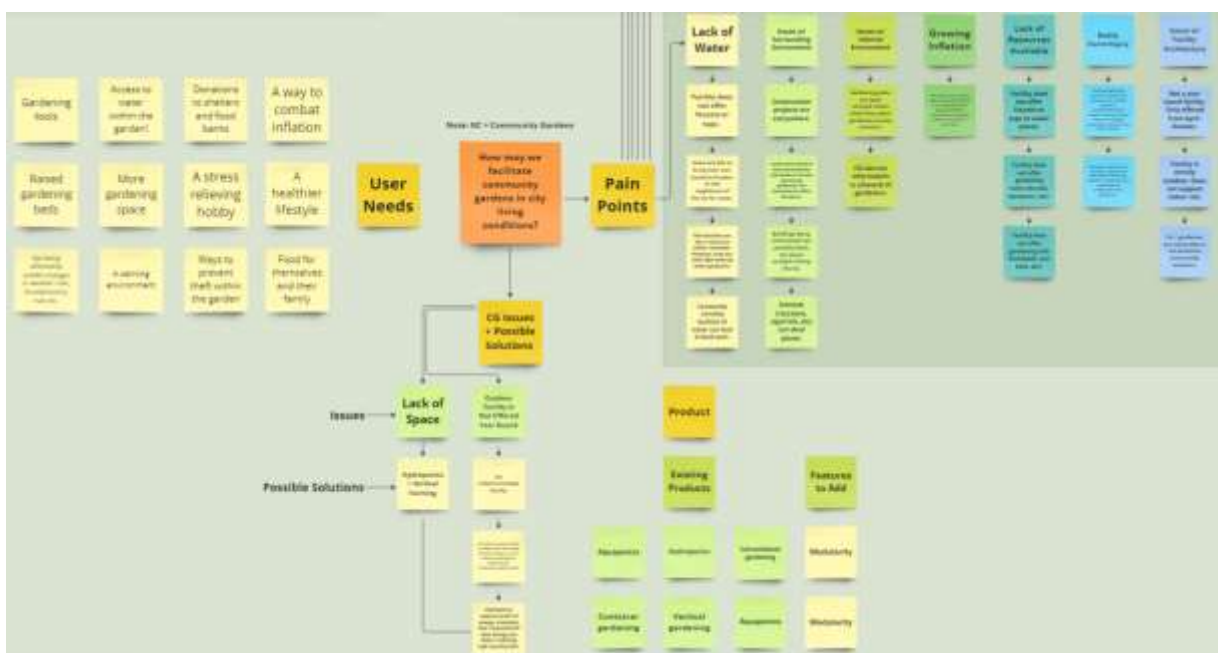
The purpose of the mood board on the previous page was to provide styling references to inspire the ideation process and steer the design away from the conventional design language of existing planters, aeroponic, and hydroponic stands. Organic shapes found in nature and textures were used to influence the aesthetic appeal of the design, while perforated metals and aeroponic towers were examined to evaluate the feasibility of the final design. The intention was to generate novel ideas and develop a unique design concept that goes beyond the usual approach to planters and hydroponic systems.

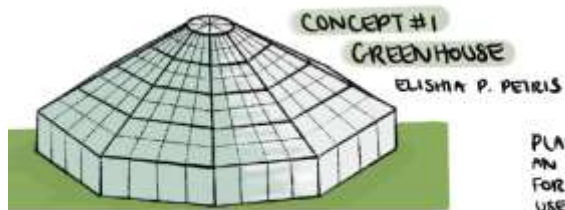
### 4.1.2 Mind Mapping

To gain a deeper understanding of the target audience and their preferences, a mind map was created. This map helped to identify the products that the audience currently uses, as well as the environment in which the solution will be deployed. This approach enabled the design team to focus on the most viable path and generate ideas that aligned with the audience's needs and preferences.

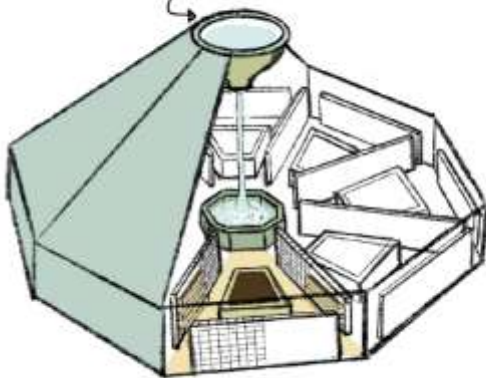
### 4.1.3 Ideation Sketches

During this phase, six distinct design concepts were developed, each targeting different aspects related to community gardens. The sketches were created on an Apple iPad Pro 12.9", utilizing Procreate as the primary medium. Since all the concepts were merely ideations at this stage, no specific names were assigned to each design until the final design direction was determined. The aim of this process was to generate a wide range of ideas, each intended for completely different areas and styling aspects. This approach created many possibilities that could be refined, evolved, or merged together for the final design direction.





OPENING IN ROOF  
AS A NATURAL  
WATER COLLECTOR



PLANTERS ARE AT  
AN ANGLE TO ALLOW  
FOR EASE OF  
USE

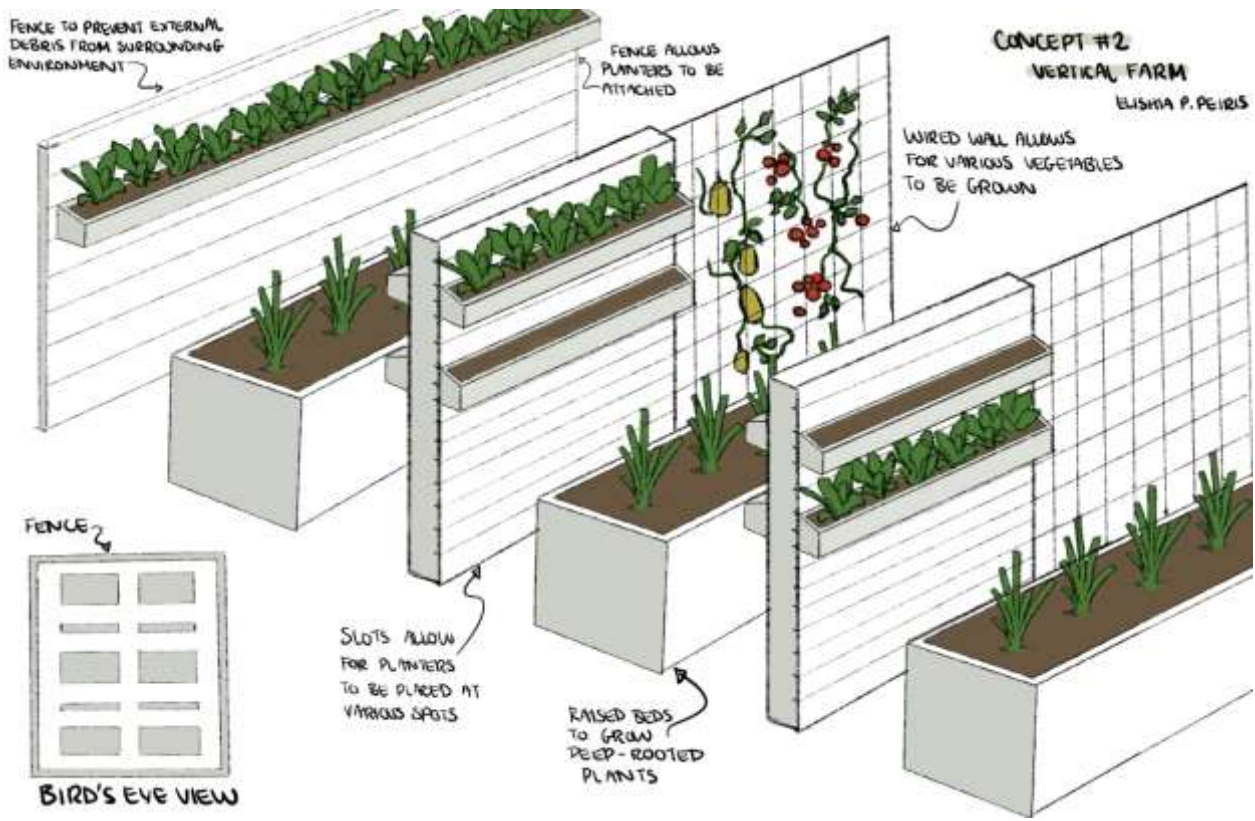


WIRED WALL  
ALLOWS FOR  
VARIOUS VEGETABLES  
TO BE GROWN

CENTRAL BASIN  
ALLOWS WATER TO BE  
STORED FOR GARDENER  
USE

SLOTS ALLOW FOR  
MULTIPLE PLANTERS  
TO BE PLACED, AT  
DIFFERENT SPOTS





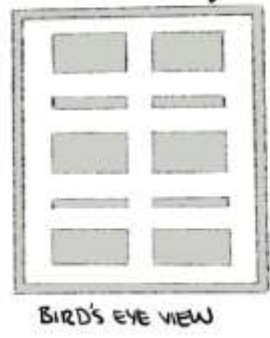
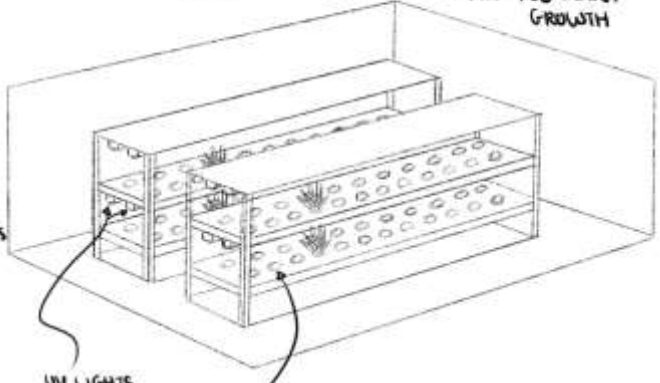
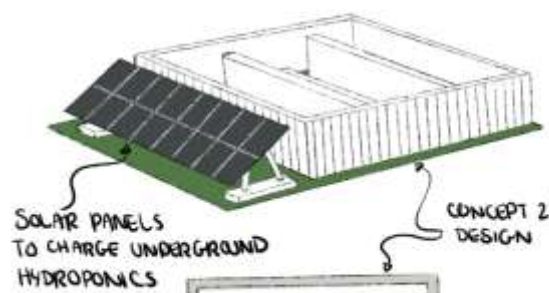
**CONCEPT #3**  
**ABOVEGROUND/BELONGROUND**  
ELISHIA P. PEIRIS

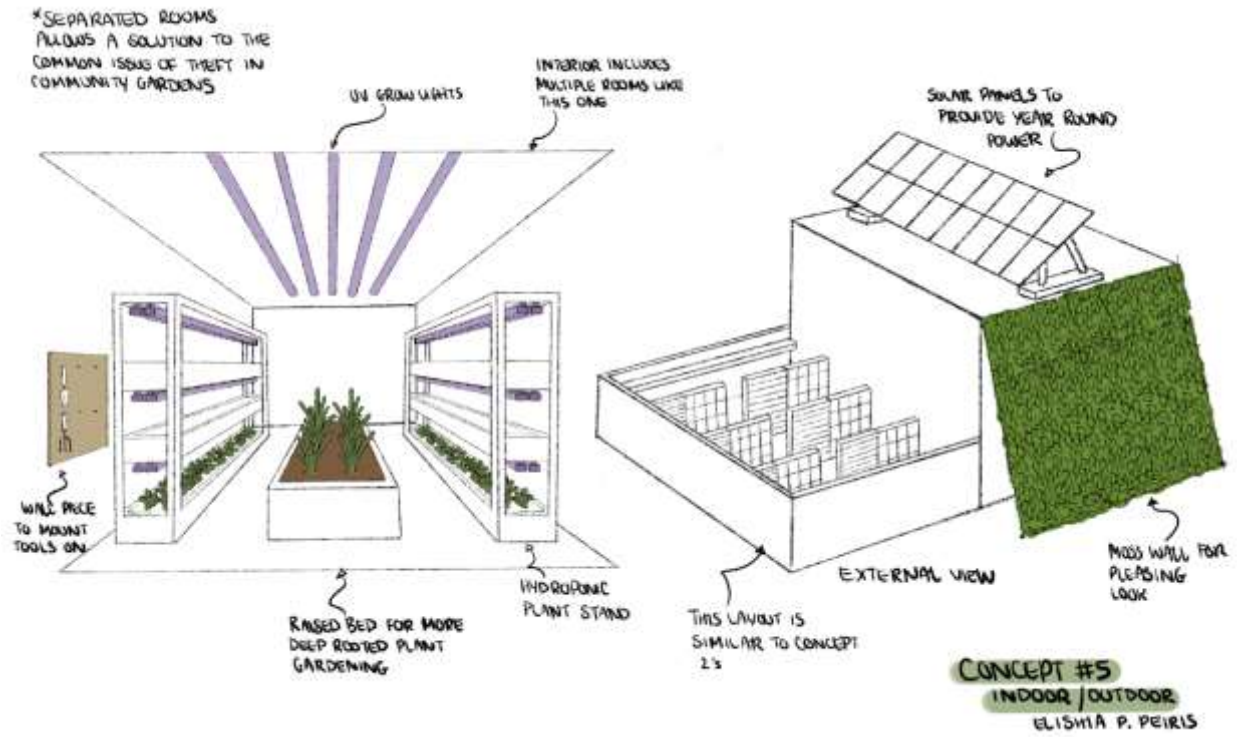
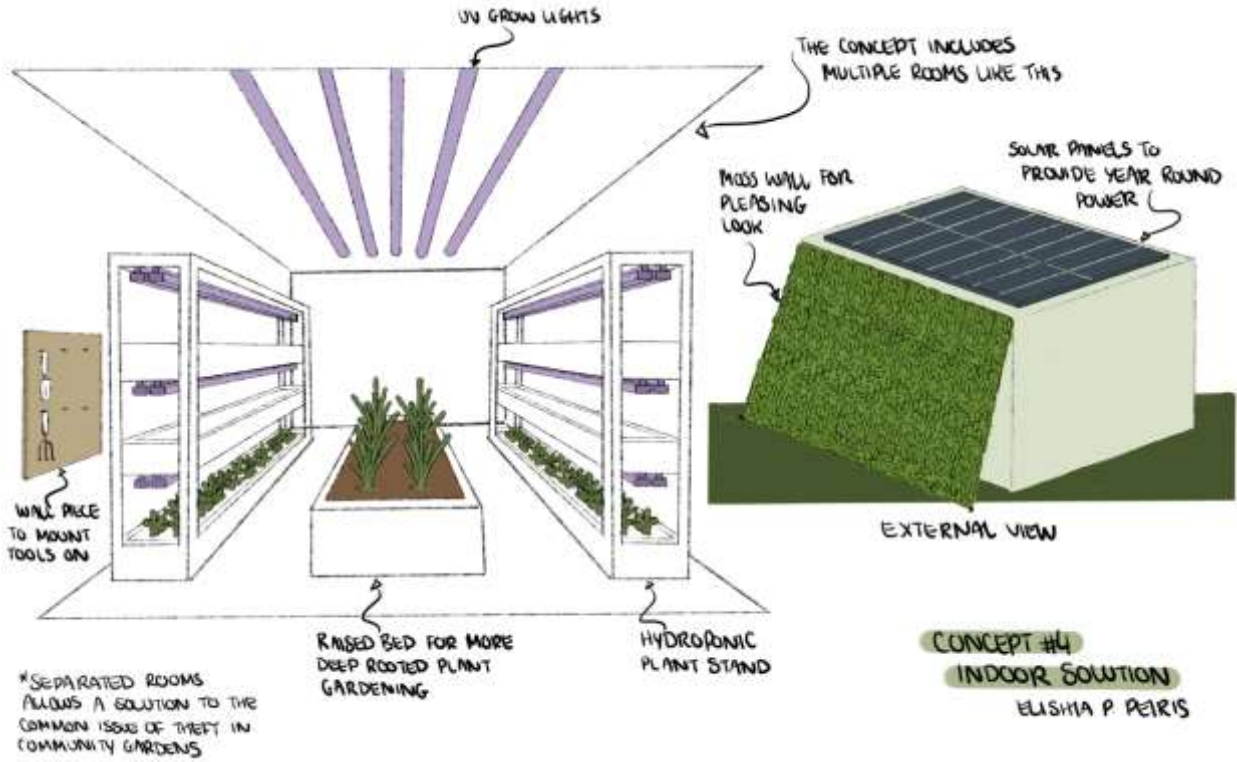
- SATISFIES REGULAR GARDENERS

- PROVIDES A YEAR-ROUND GARDENING SOLUTION  
- ALLOWS FOR FAST GROWTH / PLENTIFUL PLANT GROWTH

**ABOVEGROUND**

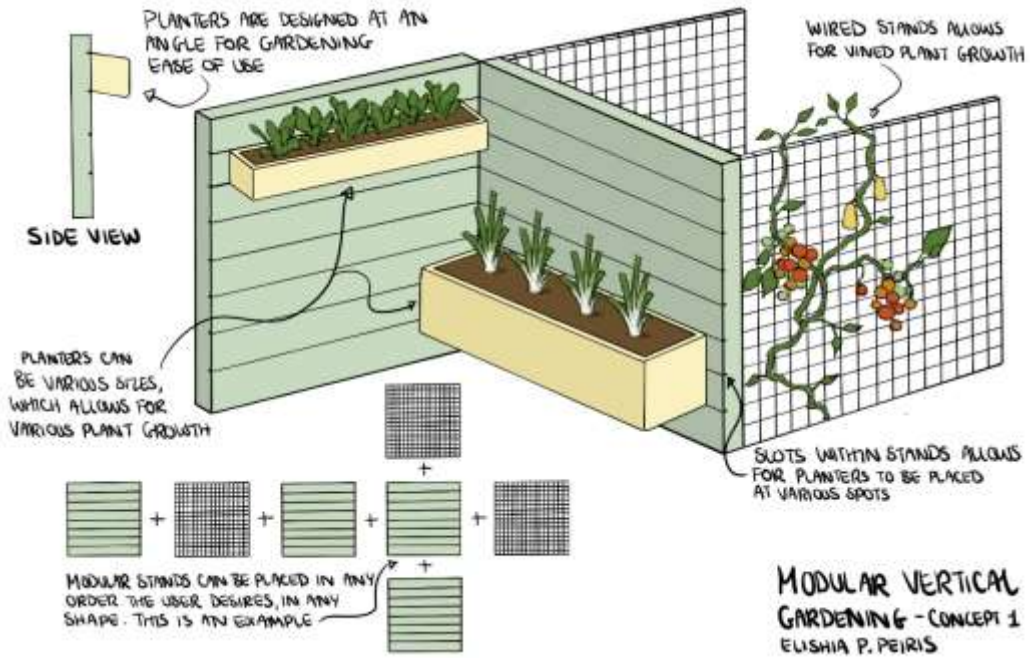
**BELONGROUND**



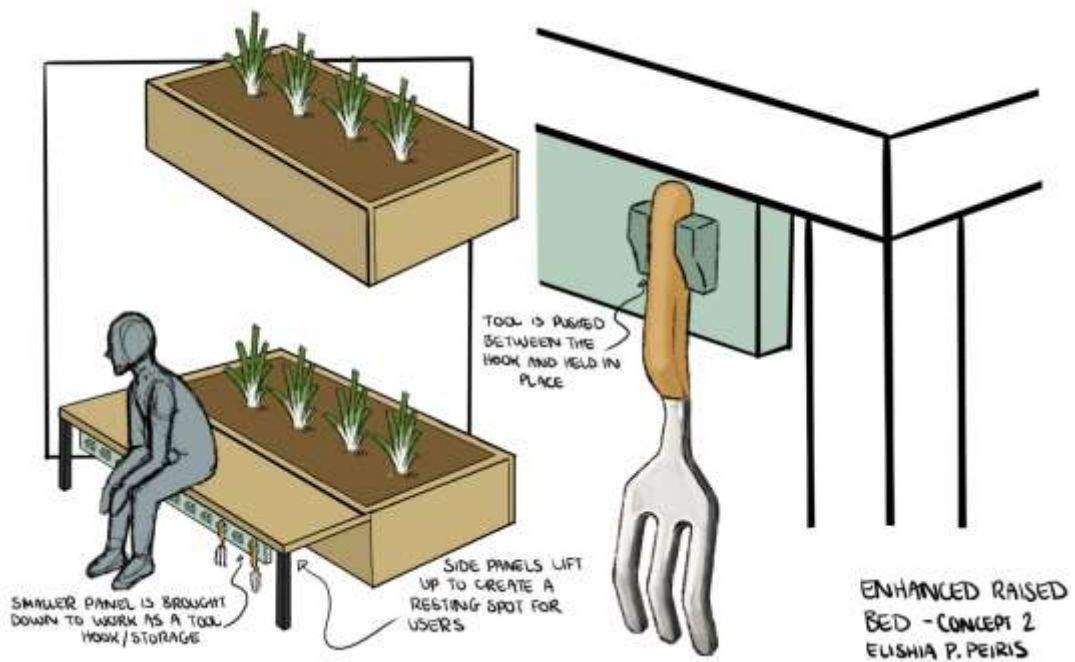


## 4.2 Concept Exploration

### 4.2.1 Concept One

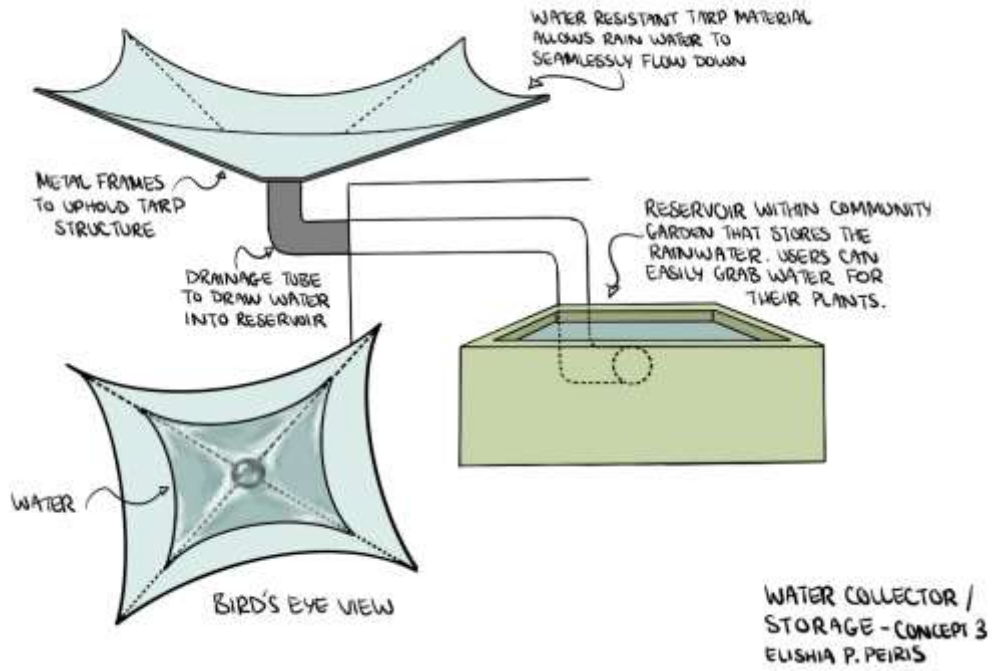


### 4.2.2 Concept Two



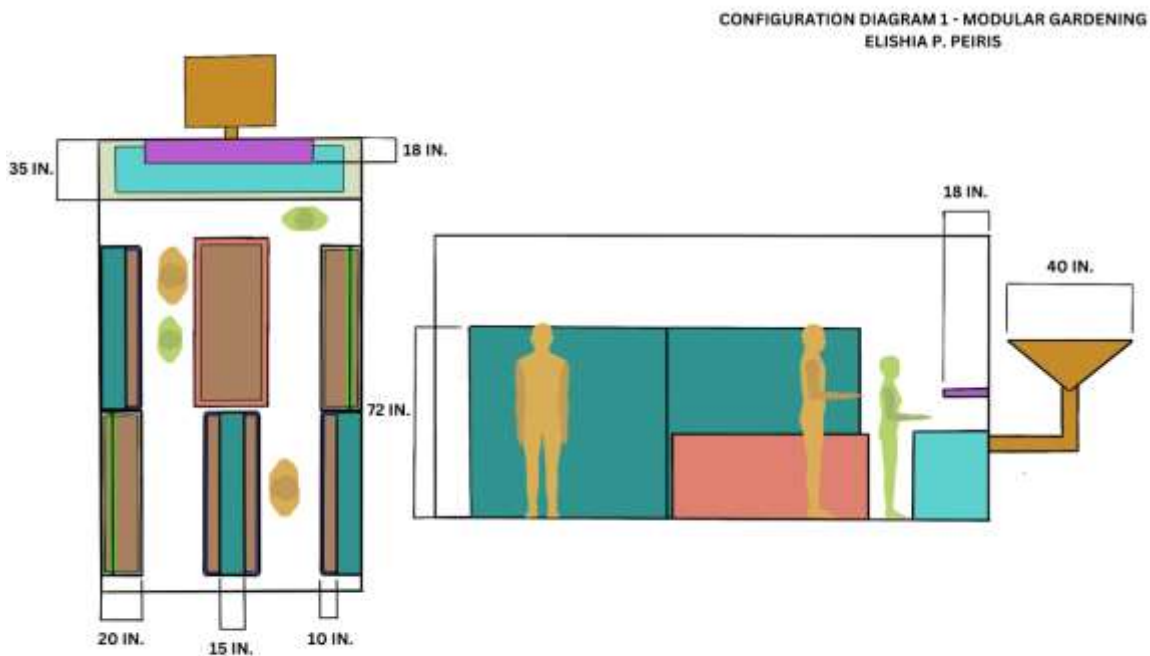
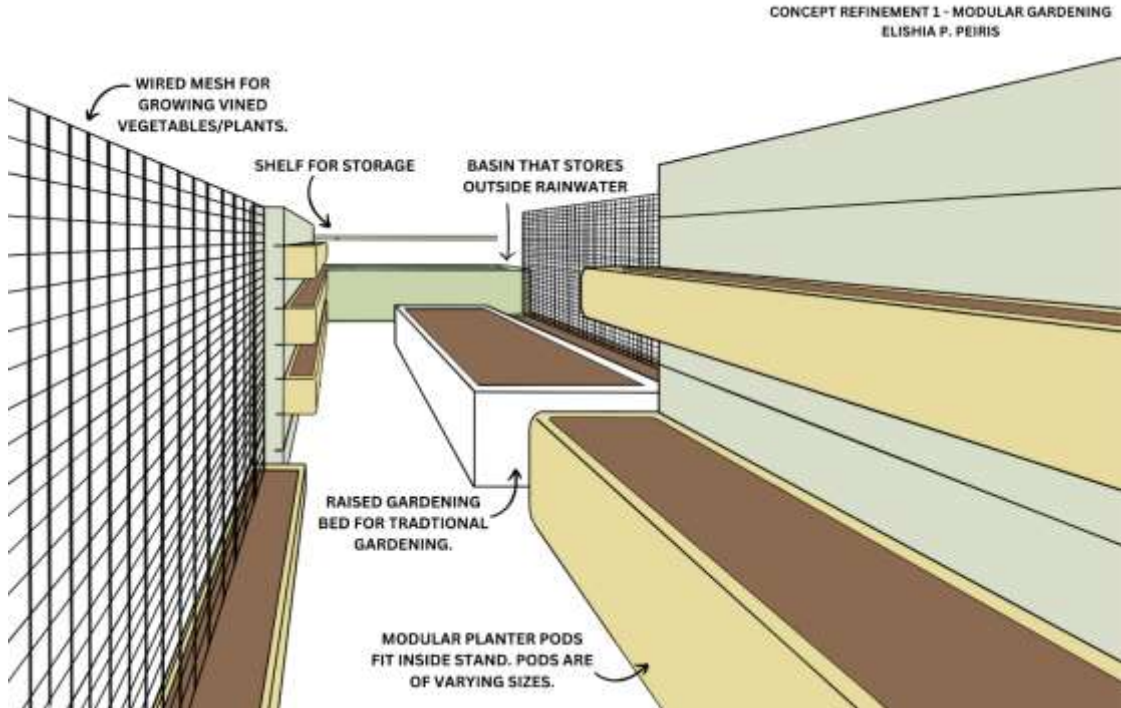


### 4.2.3 Concept Three



### 4.3 Concept Strategy

#### 4.3.1 Concept Direction and Product Schematic One

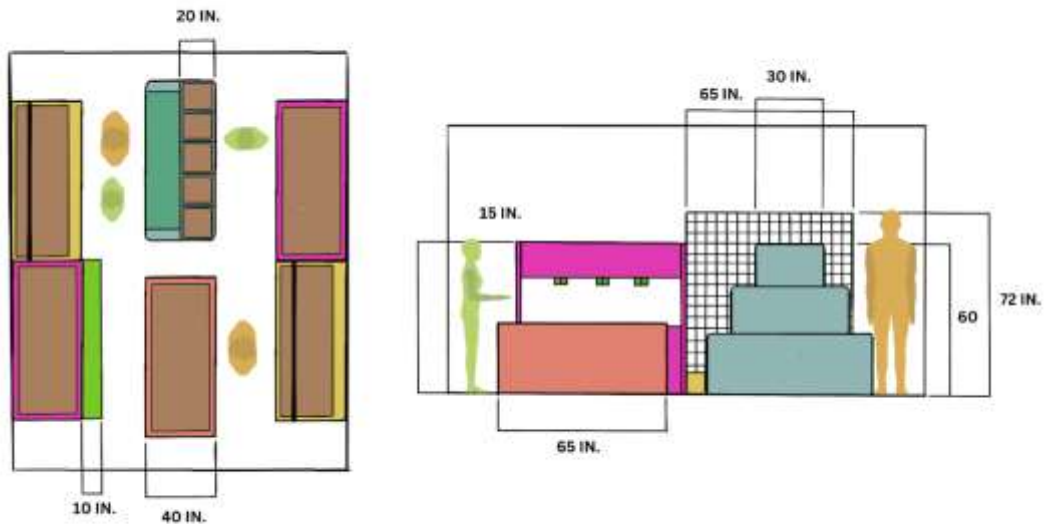


### 4.3.2 Concept Direction and Product Schematic Two

CONCEPT REFINEMENT 2 - HYDROPONIC GARDENING  
ELISHIA P. PEIRIS



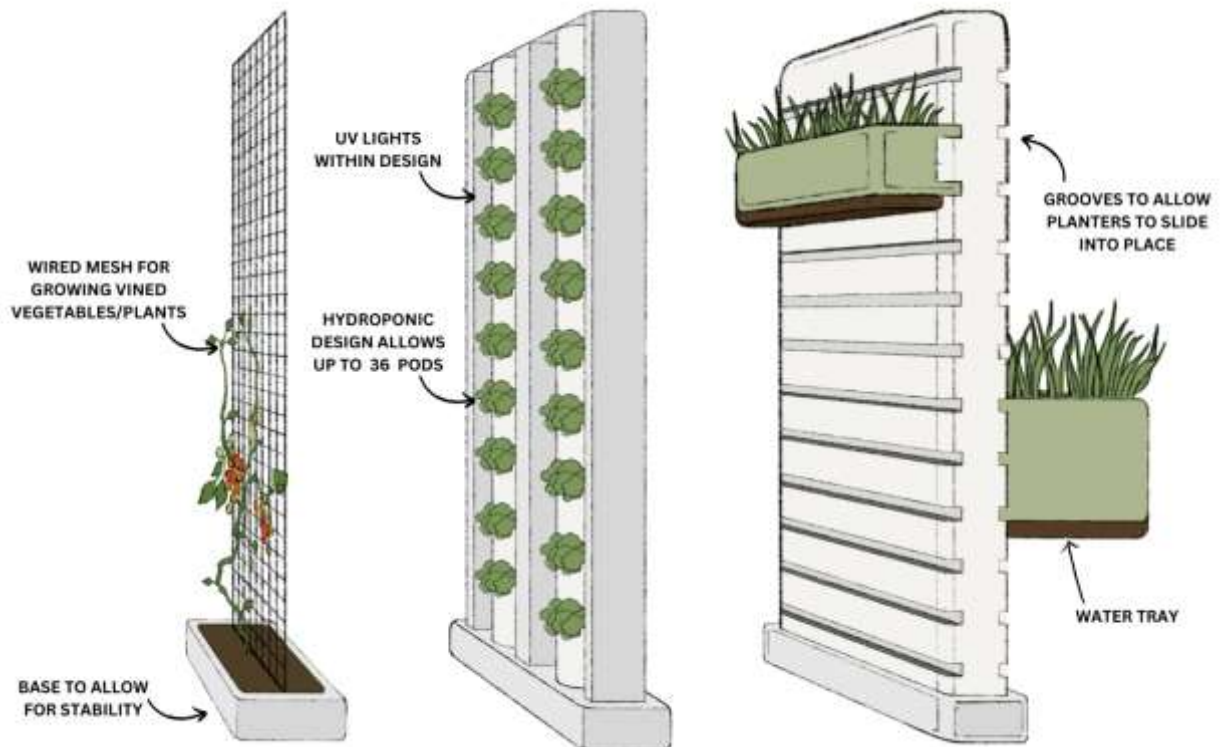
CONFIGURATION DIAGRAM 2 - MODULAR GARDENING  
ELISHIA P. PEIRIS



## 4.4 Concept Refinement and Validation

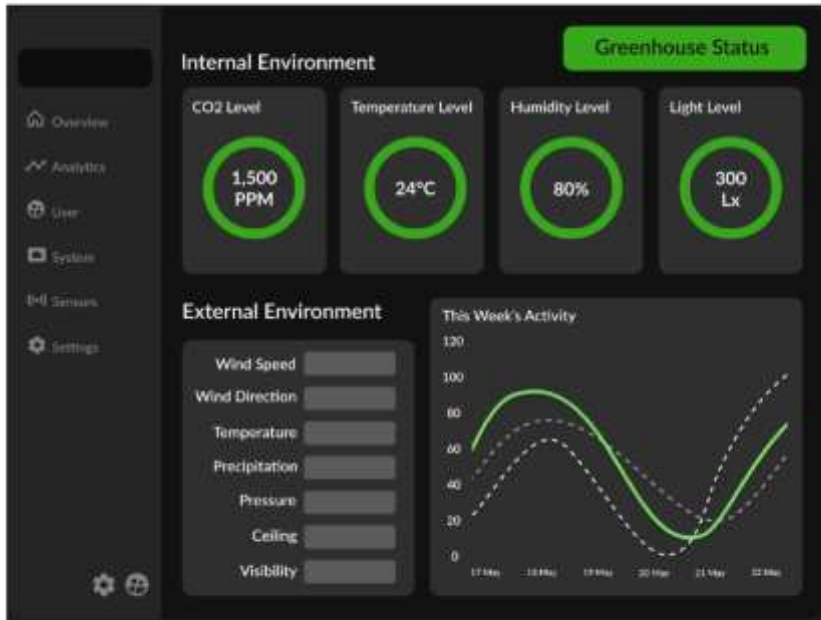
Following a thorough examination of various concepts, Concept Direction One was identified as the most promising and practical solution for gardeners. This concept was selected for further exploration of design aesthetics and refinement of details to validate the final solution. The focus of the concept refinement process is to ensure that the characteristics of the final design are molded in a way that creates a consistent and cohesive design language, while still maintaining a recognizable aesthetic that is consistent with conventional gardening planters. The end goal is to establish a new brand image for planters and plant stands.

### 4.4.1 Design Refinement



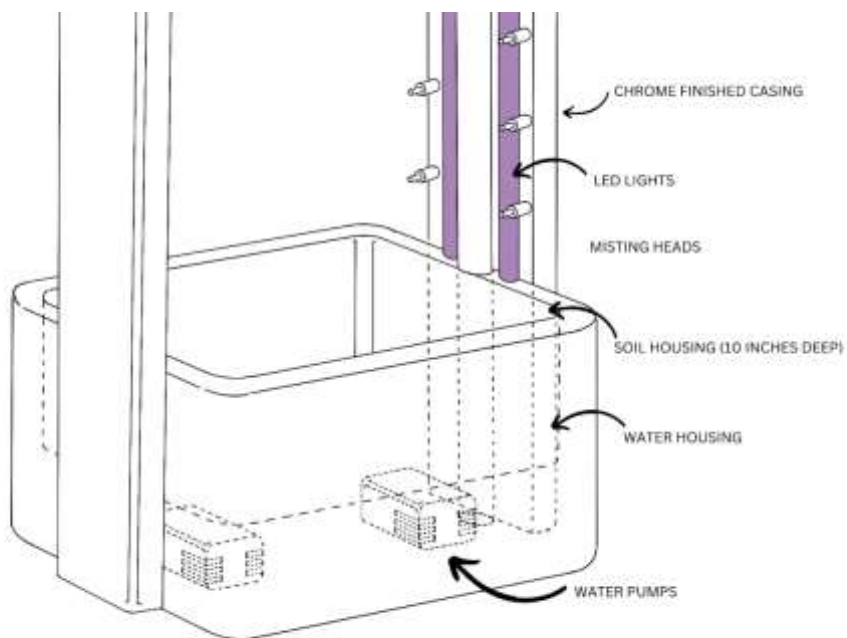
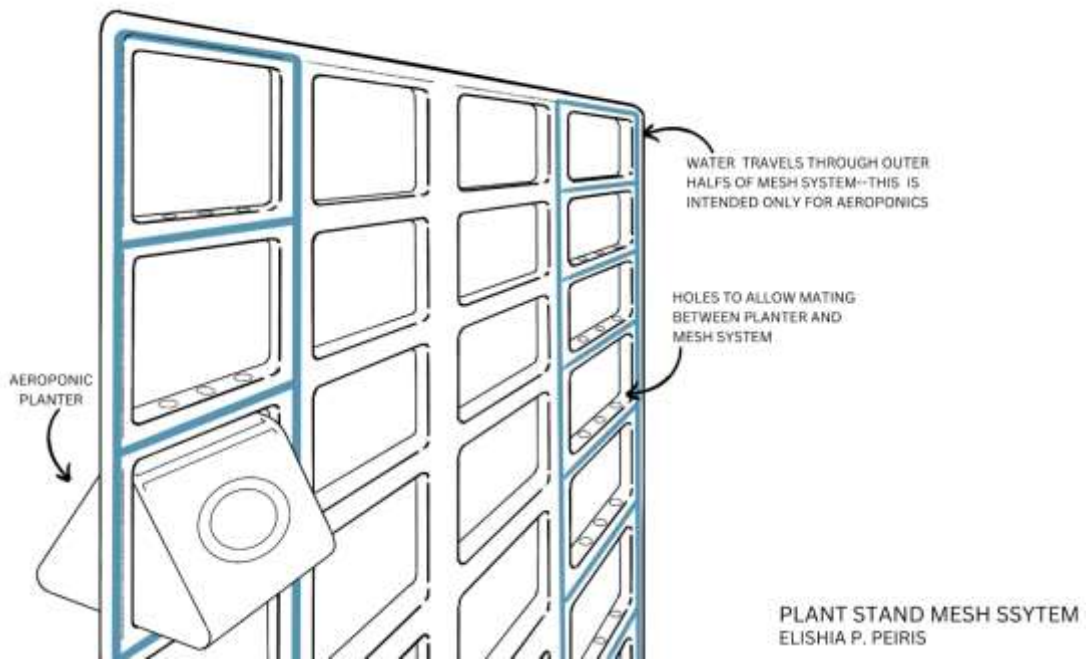
### 4.4.2 Detail Development

GREENHOUSE/PLANT STANDS APP DESIGN  
ELISHIA P. PEIRIS

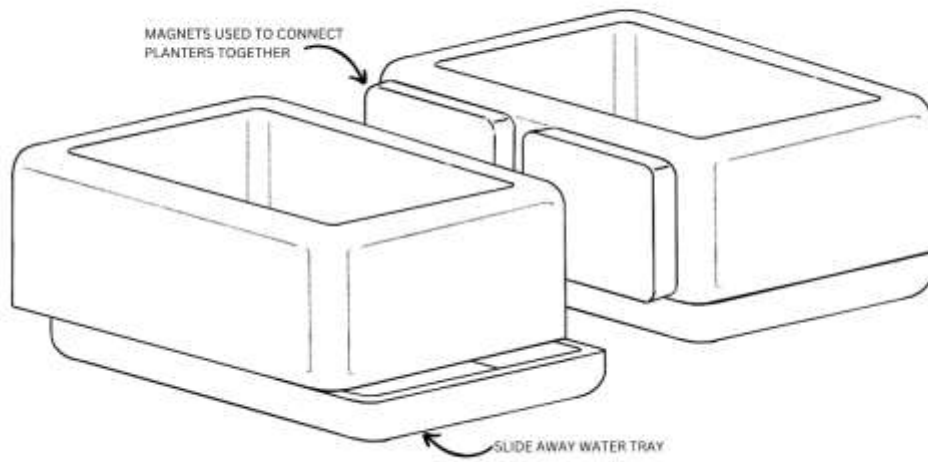


- THE APP MEASURES BOTH INTERNAL AND EXTERNAL READINGS OF THE GREENHOUSE
- THE INTERNAL ENVIRONMENT IS AFFECTED BY THE EXTERNAL ENVIRONMENT
- INTERNAL READINGS DISPLAY CO2, TEMPERATURE, HUMIDITY, AND LIGHT LEVELS
- EXTERNAL READINGS DISPLAY WIND SPEED, WIND DIRECTION, TEMPERATURE, PRECIPITATION, PRESSURE, CEILING, AND VISIBILITY

Once the styling and design language had been settled upon, attention turned towards integrating the various details into a single plant stand. This shift in focus facilitated the development of the final design and made it possible to create a versatile gardening stand that could serve multiple purposes.

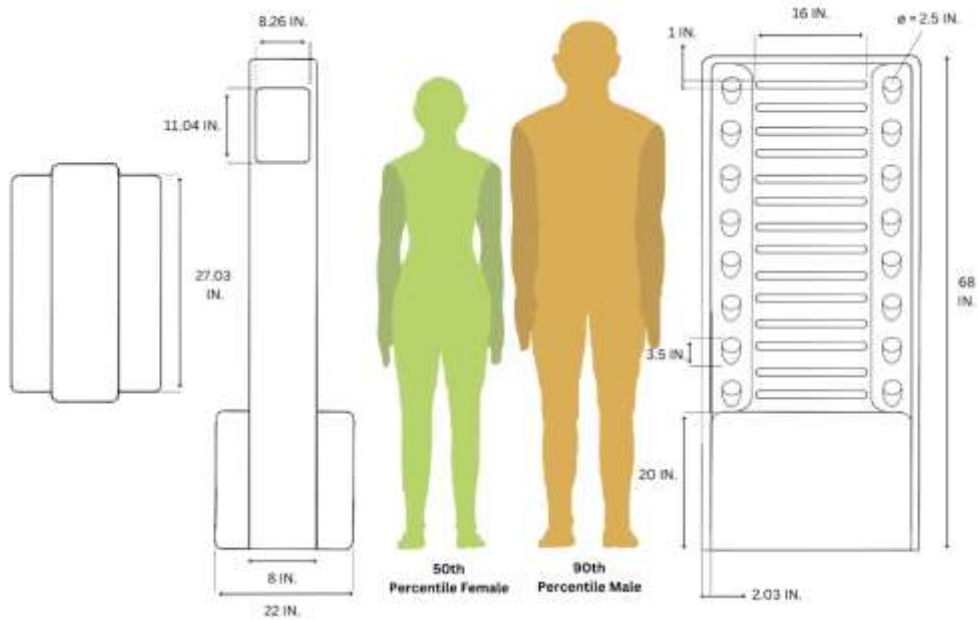




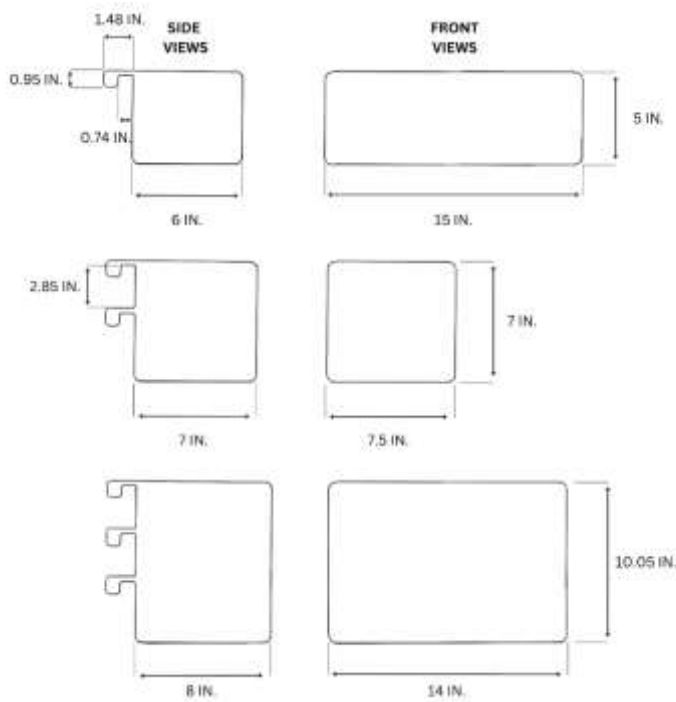


PLANT STAND PLANTERS  
ELISHIA P. PEIRIS

#### 4.4.3 Refined Product Schematic and Key Ergonomic







#### 4.5 Concept Realization

During this phase, several final modifications were implemented in the design, including the development of the form, refinement of exterior detailing, and adjustments to internal aspects. This phase served as the basis for the commencement of the CAD process, which presented the final opportunity to make any necessary changes before model fabrication begins. It also offered a chance to fine-tune the finer details of the design, from selecting appropriate materials to ensuring optimal functionality of each feature.

#### 4.5.2 Physical Study Models

To gain a deeper understanding of the proportions, interior ergonomics, and overall layout of the various features, a sketch model was constructed at a 1/6th scale. Pink foam was predominantly used to construct the model, along with smaller amounts of other materials. This model proved instrumental in identifying potential issues that could arise during the CAD modeling process, leading to some necessary revisions to the design.



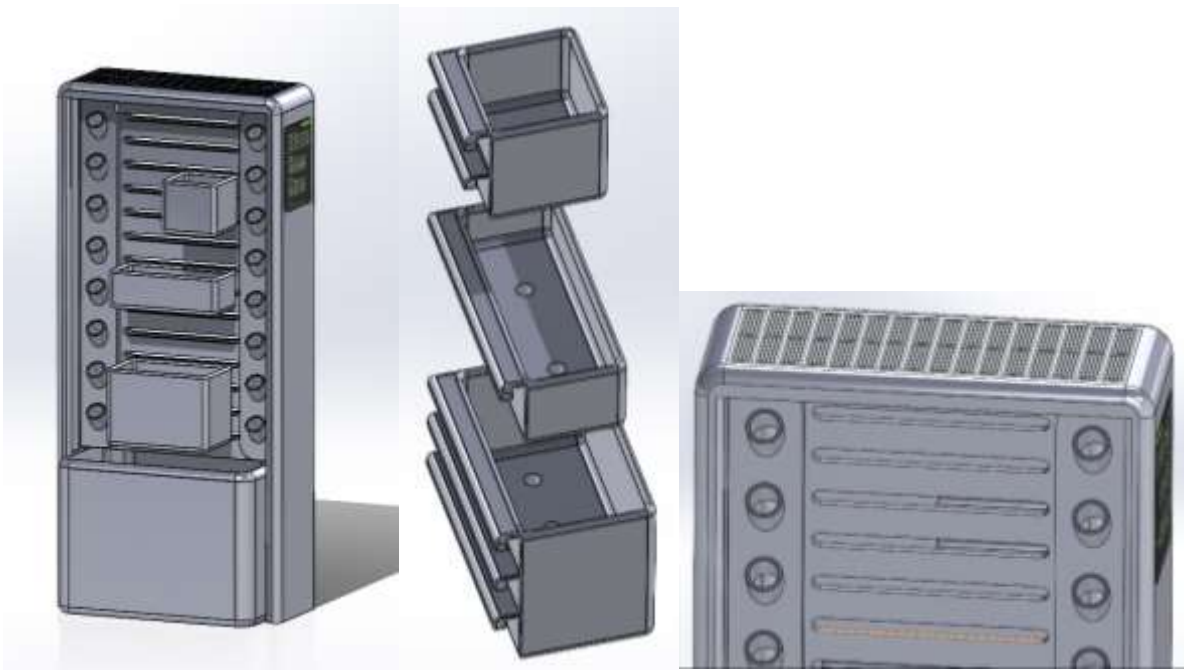
#### 4.6 Design Resolution

Kōen's final design prioritizes the essential needs and desires of gardeners, whether they operate within community gardens or limited living spaces. The plant stand's versatility allows for traditional, vertical, and aeroponic gardening, which leads to increased crop yields and a greater likelihood of gardening success. Kōen comes equipped with an accompanying app and digital touchscreen that permits the user to regulate various aspects of the stand. Internal sensors provide diagnostics for pH, CO<sub>2</sub>, lux, and moisture/humidity levels. For novice gardeners, the app serves as a guide and instructor, while experienced ones may use it as a log and reminder. Kōen is manufactured from environmentally-friendly materials, making it 95% eco-friendly, and its

energy source is solar-powered, including a solar battery. The aesthetic of Kōen emphasizes sleek, utilitarian design elements that enable it to fit into small spaces, and its color choices were selected to exude a serene and comforting vibe.

#### 4.7 CAD Development

With the design form and functionality of Kōen finalized, the next step was to transition to Solidworks to begin developing the prototype model. This process aimed to provide a better comprehension of the design and expose any issues that may not have been evident in the earlier 2D sketches or rough models. The CAD model will eventually be used to produce the final prototype through 3D printing and will be employed for generating renders used in visual presentations.



## Chapter 5 – Final Design

### 5.1 Summary

Kōen represents an urban gardening solution explicitly tailored for individuals operating within community gardens or small living spaces. Kōen's design prioritizes functionality in condensed areas and locations with limited sunlight, allowing individuals to engage in both traditional and aeroponic gardening practices. The platform offers a comprehensive range of educational and informational resources, enabling gardeners to maximize their yields and ensure optimal outcomes, regardless of their level of experience.

#### Description

Community gardens are a common occurrence amongst urban living. It allows users who can't garden in their own homes to rent a plot within their local community garden and grow their own plants. Currently, these gardens are at full capacity and their waitlists only increase. In Coquitlam, B.C., for one instance, individuals are waiting up to seven years to get their own plot (Norman, 2022). However, these gardens are not able to keep up with such a high demand as they do not have the required space to do so. Furthermore, these individuals who desire community gardens do not have sufficient space or lighting within their own homes to garden. They also are in a society that is in an economic recession, with inflation increasing the costs of living and decreasing the quality of it. Due to this, these individuals are further pushed towards community gardening as it is not only a solution for typical gardening but also an economic and societal solution.

#### Explanation

Kōen offers a viable solution to the issues outlined above, providing gardeners with the capacity to adapt to their surroundings and engage in gardening activities effectively. The technology integrated into Kōen maximizes gardening success rates and crop yields, directly addressing the core concern of this thesis project; namely, inadequate space within community gardens.

### **Benefit Statement**

Kōen represents an urban gardening solution that encompasses a highly ergonomic and productive gardening workspace, optimized for user comfort and efficiency. Featuring a range of intelligent features and tools incorporated into the frame and interior of its planter, Kōen is designed to enhance and maximize the overall experience of the gardener.

## **5.2 Design Criteria Met**

### **5.2.1 Full Bodied Interaction Design**



### **5.2.2 Materials, Processes, and Technology**

Many gardening materials are not eco-friendly, however, Kōen addresses this issue. To minimize environmental impact, Kōen primarily employs galvanized steel, a type of steel that has a relatively low environmental footprint because it uses natural resources efficiently. Additionally, the zinc coating on galvanized steel makes it suitable for outdoor use. The plant stand is also constructed with high density polyethylene (HDPE), which is recognized as the most

environmentally stable plastic. HDPE is produced using recycled materials and is fully recyclable, requiring minimal energy to manufacture. Kōen also houses a waterpump, digital touchscreen, and sensors all within its plant stand and planters.

### 5.3 Final CAD Rendering







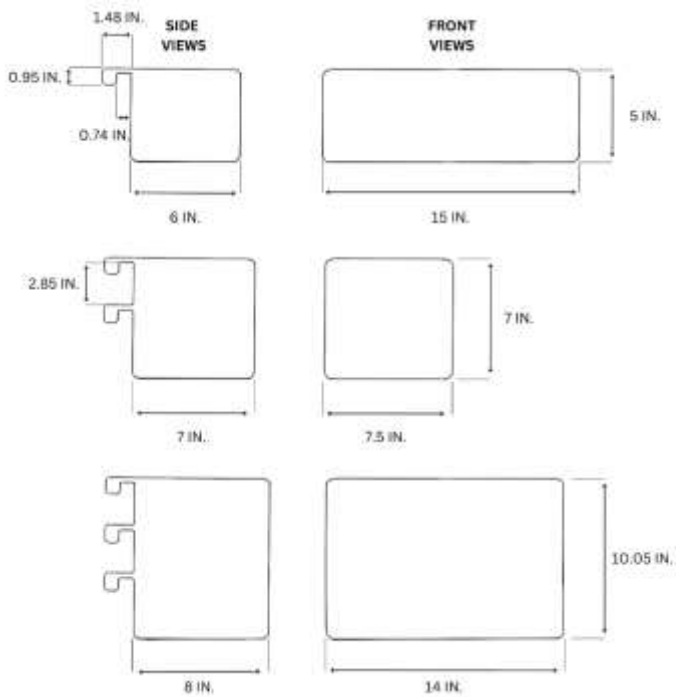
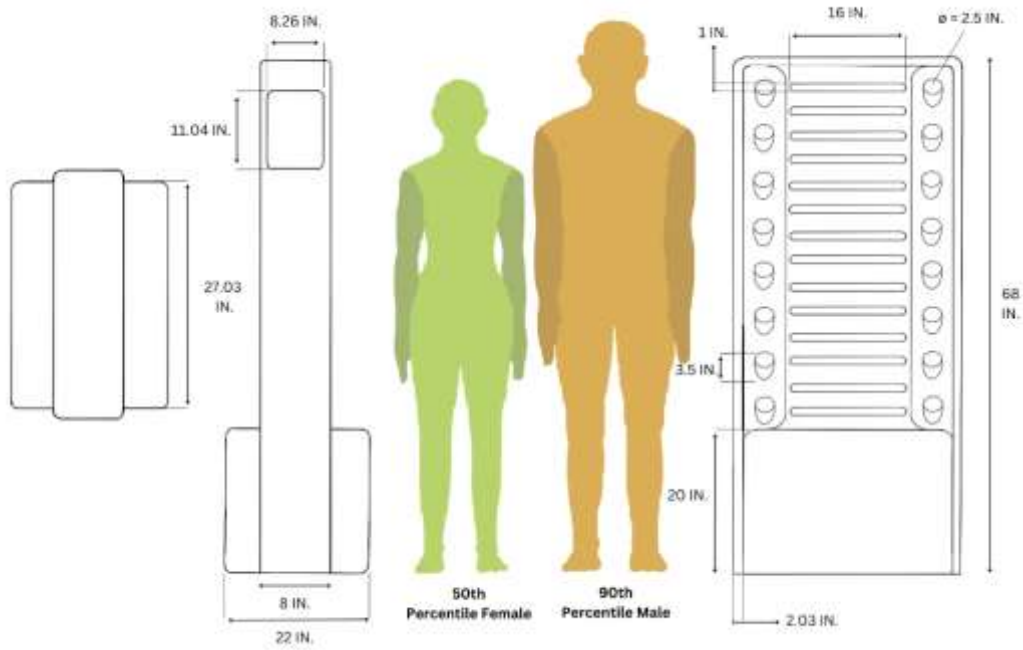




### 5.4 Physical Model



### 5.5 Technical Drawings



## 5.6 Sustainability

Awareness of sustainability has become a critical need in modern society, encompassing concerns relating to the environment, materials, wildlife, and humanity. Sustainability represents a foundational pillar for both this thesis project and the broader industrial design community, as it continues to evolve. Without due consideration for sustainable factors in Kōen's final design, this project cannot be deemed viable for the future world. The design successfully incorporates sustainable features, materials, and methods throughout every element of its design, including sustainable power sources, recycled/upcycled materials, and greener manufacturing processes. The result is a design that fulfills all user requirements without having a negative impact on the environment.

## Chapter 6 – Conclusion

Kōen's final design prioritizes the essential needs and desires of gardeners, whether they operate within community gardens or limited living spaces. The plant stand's versatility allows for traditional, vertical, and aeroponic gardening, which leads to increased crop yields and a greater likelihood of gardening success. Kōen comes equipped with an accompanying app and digital touchscreen that permits the user to regulate various aspects of the stand. Internal sensors provide diagnostics for pH, CO<sub>2</sub>, lux, and moisture/humidity levels. For novice gardeners, the app serves as a guide and instructor, while experienced ones may use it as a log and reminder. Kōen is manufactured from environmentally-friendly materials, making it 95% eco-friendly, and its energy source is solar-powered, including a solar battery. The aesthetic of Kōen emphasizes sleek, utilitarian design elements that enable it to fit into small spaces, and its color choices were selected to exude a serene and comforting vibe.

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## Appendix A – Discovery

1

### FTA-4 RESEARCH PLAN & ADVISOR INITIATIVES

<b>Student Name:</b>	Elishia P. Peiris
<b>Topic / Problem Definition:</b>	How may we facilitate community gardens in city living conditions?

#### Introduction

The purpose of this research plan is to gain insight and understanding into individuals who community garden and who are also within city settings. The plan will be executed through advisor interviews, participant interviews/surveys, user observational studies, secondary research, and literature reviews. This plan will act as the foundation for design ideation and concept development, in order to allow for a design solution for the chosen topic.

#### Research Plan

Various research elements will be applied into this research plan. Product benchmarking will be used in order to better understand the most important features/aspects of current products. Furthermore, better understanding the user and their profile will be conducted through user observational research, activity mapping, and journey mapping. By doing so, I will be able to evaluate the everyday situations and interactions of users of community gardens.

This research plan will be executed primarily through expert interviews of people related to the topic, and literature research from academic sources. The expert interviews will be conducted in-person and online, when necessary. Advisor interviews will follow a similar methodology. I will also look into relevant statistics regarding gardening and community gardens. Furthermore, I will analyze videos and similar Reddit forums that provide further knowledge.

#### Potential Interview Questions:

1. How did you acquire your plot at this community garden?
  - a) You were selected
  - b) It was given to you
  - c) You share it with someone else
  - d) Other - please explain
2. Why do you choose to garden in this style?

## Appendix J – Approval Forms

Elishia P. Peiris

**FTA-2 (A) SELECTED TOPIC APPROVAL**


**THESIS TOPIC APPROVAL:**

Student Name:	Elishia Polwattage Peiris
Topic Title:	How may we facilitate community gardens in city living conditions?

**TOPIC DESCRIPTIVE SUMMARY (PRELIMINARY ABSTRACT):**

Research has shown that those who grow vegetables are more conscious about maintaining a healthy diet. By doing so, it can also provide a cheap and effective method towards healthy eating. However, not every individual is able to garden. Some live in apartments or other small living conditions that do not offer enough space. Others simply do not have a place to call home. That is where the benefit of community gardening comes into play; community gardening allows individuals to have their own plot to garden and grow produce. However, the demand for community gardening has skyrocketed in Toronto and similar cities. The ratio of available plots to people wanting a plot is more than 1:6, with only 5% of plot owners choosing to give up their plots yearly. Due to the current structure of community gardening, it is offered only from April-October of each year—leaving some individuals to fend for themselves. With ever increasing inflation leaving individuals with less income, the solution to these issues might come from facilitating community gardens within city living conditions. Changing these community gardens will not only benefit the user economically, but also mentally. It is scientifically proven that gardening can aid in mental health and reduce stress. However, none of this can happen without increasing availability and changing the current primitive design within community gardens. This thesis provides an in-depth study on societal factors and issues that relate to community gardening by the use of data collection methods such as interviews, observational studies, and surveys. By doing so, a one-to-one scale model will be developed to understand ergonomics, human factors, and determine the feasibility of the design. A solution will be developed in order to aid those related to community gardens.

**Student Signature:** *Elishia P. Peiris*  
**Date:** 2022/10/11

**Instructor(s) Signature:**   
**Date:** 13 October 2022

## Appendix K – Advisor Meetings and Agreements Form

**IDSN 4002 / 4502**  
SENIOR LEVEL THESIS ONE & THESIS TWO

 **HUMBER**  
Faculty of Applied Sciences & Technology  
Bachelor of Industrial Design / FALL 2022 & WINTER 2023

**INFORMATION LETTER**

**Conditions of Participation**

- ✓ I understand that I am free to withdraw from the study at any time without any consequences.
- ✓ I understand that my participation in this study is confidential. (i.e. the researcher will know but will not disclose my identity)
- ✓ My identity will be masked.
- ✓ I understand that the data from this study may be published.

I have read the information presented above and I understand this agreement. I voluntarily agree to take part in this study.

Joy Reid



2022-10-16

Participant's Name

Participant's Signature

Date

**Project Information**

Thank you very much for your time and help in making this study possible. If you have any queries or wish to know more about this Senior Level Thesis project, please contact me at the followings:

Phone: = 647-906-2312 =

Email: = Elishia.peiris@hotmail.com =

My supervisor is:

Prof. Catherine Chong, [catherine.chong@humber.ca](mailto:catherine.chong@humber.ca)

**PARTICIPANT INFORMED CONSENT FORM**

**Research Study Topic:** Community Gardens in City Living Conditions  
**Investigator:** Elishia Polwattage Peiris / 647-906-2312 / Elishia.peiris@hotmail.com  
**Courses:** IDSN 4002 & IDSN 4502 Senior Level Thesis One & Two

I, Joy Reid, have carefully read the Information Letter for the project on community gardens in city living conditions, led by Elishia Polwattage Peiris. A member of the research team has explained the project to me and has answered all of my questions about it. I understand that if I have additional questions about the project, I can contact Elishia Polwattage Peiris at any time during the project.

I understand that my participation is voluntary and give my consent freely in voice recording, photography and/or videotaping; with the proviso that my identity will be blurred in reports and publications.

**Consent for Publication: Add a (X) mark in one of the columns for each activity**

ACTIVITY		YES	NO
<b>Publication</b>	I give consent for publication in the Humber Library Digital Repository which is an open access portal available to the public	<input checked="" type="checkbox"/>	<input type="checkbox"/>
<b>Review</b>	I give consent for review by the Professor	<input checked="" type="checkbox"/>	<input type="checkbox"/>

**Privacy**

All data gathered is stored anonymously and kept confidential. Only the principle investigator /researcher, « insert student Name here » and Prof. Catherine Chong or Prof. Frederick Matovu may access and analyze the data. All published data will be coded, so that visual data is not identifiable. Pseudonyms will be used to quote a participant (subject) and data would be aggregated.

I also understand that I may decline or withdraw from participation at any time, without negative consequences.

I understand that I can verify the ethical approval of this study, or raise any concerns I may have by contacting the Humber Research Ethics Board, Dr. Lydia Boyko, REB Chair, 416-675-6622 ext. 79322, [Lydia.Boyko@humber.ca](mailto:Lydia.Boyko@humber.ca) or « insert student Name /Phone Number /Email Address ».

**Verification of having read the Informed Consent Form:**

I have read the Informed Consent Form.

My signature below verifies that I have read this document and give consent to the use of the data from questionnaires and interviews in research report, publications (if any) and presentations with the proviso that my identity will not be disclosed. I have received a copy of the Information Letter, and that I agree to participate in the research project as it has been described in the Information Letter.

Joy Reid

Participant's Name



Participant's Signature

2022-10-16

Date

**Project Management:**

**Interview 1**

Date: Sept 29, 2022

Duration: 1 hour

Method: In Person

Topics Covered: Basic user profile, user behavior, community gardening basics

**Interview 2**

Date: Oct 21, 2022

Duration: 1 hour 30 minutes

Method: In Person

Topics Covered: In depth on community gardens and the societal impacts/impairments

**Interview 2**

Date: Nov 1, 2022

Duration: 1 day

Method: Via Text Message

Topics Covered: Discussion on current design solutions and their feasibility

