Urban Garden System

Designing Efficiente Urban Agriculture Solutions

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Acknowledgement

Today, as I hand in my thesis, I can add one more achievement to the goals I have reached in my life. Looking back, I feel a mixture of nostalgia and joy when remembering everything I have experienced during my time at the university: the moments, the people, the teachings and the achievements obtained in these two years.

I would like to express special thanks to Professor Valpreda and Professor Campanella for their teachings and the support provided during the master's degree and the completion of my thesis. I would also like to thank the Pontificia Universidad Javeriana and the Politecnico di Torino for giving me the opportunity to pursue this double degree.

Last but not least, I would like to thank my family and friends, who were by my side supporting me, advising me and sharing with me this stage of my life, especially my parents and my sister. Today I happily conclude a significant stage of my life and I look forward to the new adventures that the future has in store for me.

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Abstract

01

This project seeks to address the increasing pollution created by **traditional agricultural practices** in a society experiencing constant growth. In addition, this society lives mostly in small places in **urban areas,** creating a disconnect from nature producing not only a lack of experience but also a lack of knowledge about plant care. In response to this reality, an adaptable **agricultural system** was developed for urban spaces, which **promotes and educates on domestic cultivation in these environments.**

Through a **critical analysis**, a product was designed to not only reduce the environmental impact of industralized agriculture but also to reconnect the user with nature in an urban context, strengthening the **link between person, plant, and environment.** This system encourages home cultivation using recycled materials and a semi-automated irrigation system that optimizes water use, making plant care easier and sustainable in the home.

To understand its potential in different contexts, a **holistic analysis** was conducted in 3 cities, considering factors such as **demography, culture, economy, education and waste management**, as well as their relationship with the **product and agriculture.** The cities selected for the study were Bogotá, Turin and New York. This research allowed the formulation of **hypotheses on the behavior and acceptance of the product in each context**, projecting its viability and benefits in different urban environments.

Introduction

02

In today's world, the rapid industrialization of resources and increasing urbanization have created a **growing disconnect between people and agriculture**. This shift has not only led to a **lack of knowledge and appreciation for agriculture** but has also forced the sector to expand its production and operations to meet global demands. However, this expansion has come at a cost, **generating significant environmental impacts, including pollution and resource depletion.** What was once a fundamental solution for human sustenance has now become a contributor to ecological degradation, creating a pressing need for change.

To tackle this issue without compromising the convenience of urban lifestyles, Garub was develope. Garub is more than just a pot; it is a thoughtfully designed solution **aimed at reconnecting individuals with plants while promoting knowledge and awareness about them.** The product is not only a tool for integrating greenery into urban spaces but also an **educational initiative to motivate users toward embracing self-sustainability.** By fostering a deeper connection with nature and empowering individuals to engage with plants, Garub seeks to **create a shift in mindset and behavior.**

The project focuses on developing an **innovative system for plant care and containment** that aligns with the diverse needs of urban users. It considers various environmental and cultural contexts, ensuring that the product is inclusive and relevant across different lifestyles and geographies.

Through a systemic approach, Garub explores how individuals from different parts of the world interact with a single product. This process aims to identify and address cultural, environmental, and practical differences, ensuring that the design remains functional, intuitive, and adaptable. The ultimate goal is to create a **versatile and globally solution** that not only enhances urban living but also contributes to building a more sustainable future.

Methodology & Thesis Question

03

Thesis Question

> How can we incorporate a ***plant containment system*** into urban spaces that is easy to use, adaptable to all types of people and suitable for different environmental and cultural contexts?

Methodology

In the development of this project, **two methodologies** were applied for the development, creation and verification of the project. In the first stage, the **component design methodology** was used, which begins with two key elements: **the identification of a problem and the definition of a potential user.** This methodology allowed us to have a solid and focused starting point in which, with a deep understanding of the situation and the user profile, the first guidelines of the product were established.

Based on the problem and the user identified, a series of **components, functions and forms for the product were developed,** ensuring that each one responded coherently to the challenges posed and contributed to solving the initial situation. During this process, aspects such as **functionality, accessibility and ease of use were considered,** with the aim of making the product not only solve the problem identified but was also intuitive and attractive to the end user.

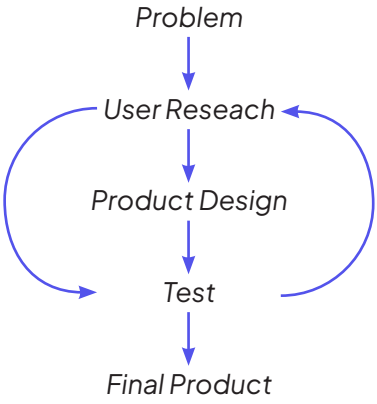
In the final phase, user **tests were carried out to validate the product** as a whole and each of its components. These tests included an evaluation in which users had the opportunity to interact with the product, provide their opinions and express their views regarding the functionality and design of each element. This feedback was key, as it allowed us to identify areas for improvement and confirm that the **product fulfilled both the solution to the initial problem and the satisfaction of the user's needs**, thus ensuring a result that integrates quality and functionality.

In the second stage, the **systemic design methodology** was employed, which, through in-depth research of the **territory as a system,** allowed us to formulate **hypotheses about the user´s behavior in different cities.** This guaranteed that

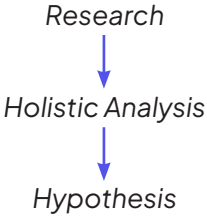
the product was not only functional for a specific niche, but also **adaptable to completely diverse contexts.**

To ensure this versatility, a holistic analysis of the cities of **Bogotá, New York and Turin** was carried out, considering factors such as demographics, education, waste management, economy and agriculture. This detailed information allowed a comprehensive understanding of each context, and from it hypotheses were generated about **how the product could behave in each environment**. This systemic approach ensures that the design is flexible and suitable to **respond to a variety of urban and cultural realities**, contributing to the adaptability and relevance of the product in different contexts.

1st Stage



2nd Stage



Agricultural Problems

04

Industrialization has radically transformed the world since the 18th century, marking a transition from a society focused on **agriculture and crafts to one based on industry and mass production**. This change not only revolutionized the way goods and services were produced but also had a profound impact on the economic structure of societies. The growth of urbanization and the need for increased production led to the development of new innovative technologies, **introducing machinery and mass production techniques**. However, the need to increase production to satisfy a growing urban demand has disconnected basic concepts of society *(Kaczynski, n.d.)*, creating **issues that affect not only society but also the environment and the economy.**

With the rise of machinery and advanced technologies, various sectors have had to drastically implement more **intensive and mechanized systems** to supply products to a society that is **constantly growing** *(Meadows et al., 1972)*. One of the sectors that have been involved and affected by this implementation is the agricultural sector, which, although this has allowed productivity to increase and supply the growing demand for food, has also generated a series of **significant challenges not only for the sector and its workers but also for the environment.** The expansion of monocultures and deforestation has reduced biodiversity and worsened climate change *(WWF, n.d.)*. Additionally, transportation, another key aspect in industrial agriculture, often involves long distances to bring food to markets, creating a considerable carbon footprint due

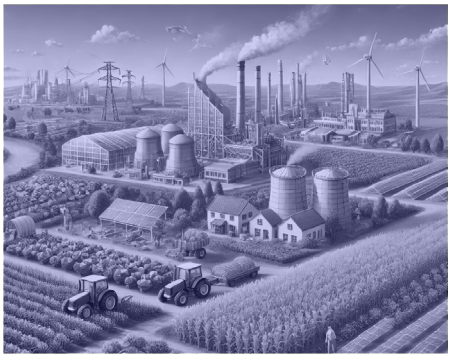


Figure 1. *SAGE University. (n.d.). Agriculture Industry*

to the consumption of fossil fuels *(European Environment Agency [EEA], 2018)*. CO2 emissions from transport and agricultural production contribute significantly to air pollution and global warming. **These problems highlight the need to move towards more sustainable agricultural practices** or perspectives that minimize the negative impact on the environment.

Deforestation

The increasing demand for food has led to massive forest conversion into agricultural land, making agriculture one of the main causes of deforestation. In May 2020, the Food and Agriculture Organization of the United Nations *(FAO, 2020)* reported that approximately **5,000 mega hectares** (1 Mha = 1,000,000 h) - equivalent to **38% of the total land surface** - are being used for agriculture, from which one third is exclusively for crops.

Moreover, the rapid growth of urban populations has increased pressure on the agricultural sector.

Figure 2. *SGK Planet (n.d.). Deforestation by felling trees*

According to FAO data, the world's population doubled between 1961 and 2016, which led to a decrease in the number of hectares per person (ha/cap), from about 0.45 hectares per capita in 1961 to **0.21 hectares per capita in 2016**, pushing agriculture to expand. This expansion has led to the felling of trees to obtain

Figure 3. *Weiser (2023). Forest burning.*

the necessary space for crops, pastures, and plantations, reducing forest cover.

Greenpeace estimated that **80% of global deforestation is directly linked to agriculture** *(Greenpeace USA, n.d.)*, making it one of the sectors with more responsible for environmental degradation. This not only affects soil quality and contributes to pollution but also **destroys the habitats of numerous animal species** that depend on these ecosystems, endangering **biodiversity and forest ecosystems at risk.**

Transportation

Due to the large number of hectares required, crops are mostly located on the **outskirts of cities** or in rural areas, so transportation from these areas to the city is added to the production process. Processes that, due to their **long distances, generate a significant carbon footprint from the consumption of fossil fuels.**

In a country like the United States, the impact of agricultural transport is particularly notable. In 2018, **1.49 billion tons of agricultural** cargo and other primary products were transported mainly by trucks, **representing 71.4% of the total tonnage of goods nationwide** *(S&P Global, n.d.)*. This figure highlights the immense reliance on land transport in the food supply chain, where trucks are the most common method of moving products from farms to urban markets and distribution centers. Furthermore, the fact that this transport covers long distances means that the consumption of fossil fuels is high, which **aggravates the emissions of CO2 and other pollutants.**

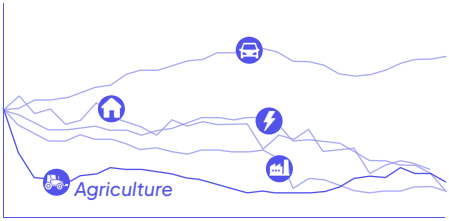


Table 1. Evolution of CO2 emissions in the EU by sector (1990–2019)

The European Parliament *(2019)* has produced a graphic that shows the CO2 emissions generated by transport in various sectors, including agriculture *(Table 1)*. This chart shows how, although agriculture once had lower emissions than other sectors, it has seen a notable increase in recent years. In 2016, this sector was ranked as the **third with the highest CO2 emissions from transport,** surpassed only by domestic transport and trade. This change reflects a worrying trend: while other industries, such as energy and some industries, have managed to reduce their emissions by using **cleaner and more efficient technologies,** agricultural transport has seen an increase in emissions due to the expansion of production and international trade. This rise underscores agricultural transport as a critical factor in the fight against climate change.

Figure 4. *Agrifood Networks (2022). Food transportation*

Waste

The long distances that food must travel from fields to urban areas affect its quality, often preventing it from reaching its final destination in good condition. As a result, in 2019, the FAO's Food Loss Index (FLI) reported that approximately **14% of food worldwide is lost between the post-harvest period and before reaching the points of sale** *(FAO, 2019)*, a percentage that could **feed 1.26 billion people each year** *(FAO, 2022).*

According to Eurostat Statistics Explained, in 2022, an average person generated **132 kg of food waste.** Of this amount, 54% (72 kg per inhabitant) originated in households, while the other 46% was generated

Figure 5. FAO (2022). Food waste

at higher stages of the food chain: 19% came from the manufacture of food and beverage products (25 kg per inhabitant), 11% from restaurants and food services (15 kg per inhabitant), 8% from retail and other forms of food distribution (11 kg per inhabitant) and 8% from primary production (10 kg per inhabitant) *(Eurostat, 2024)*.

Globally, approximately **1.05 billion tons of food waste were generated in 2022.** Of this total, 60% originated from households, 28% from food services and 12% from retail trade. In broader terms, this means that nearly one-fifth (19%) of food available to consumers is wasted in retail, food services, and households, underlining the scale of the problem across the entire food supply chain *(UNEP Food Waste Index 2024)*.

All of this data indicates that food **waste is responsible for 8-10% of global greenhouse gas emissions** *(UNFCCC, 2021)*. This highlights the urgent need to find more efficient methods for people to access their food directly, avoiding the multiple links in the supply chain that contribute to this waste.

CO2

We have identified various problems related to CO2 emissions, but it´s important to note that agriculture not only generates this gas, but also other greenhouse gases, such as **nitrous oxide (N2O) and methane (CH4)**, which are equally harmful to the environment *(Resources for the Future, 2021)*. These gases have a significant impact on global warming, methane is up to **80 times more damaging than CO2** in terms of its ability to trap heat in the atmosphere *(UNEP, 2021),* and nitrous oxide is approximately **300**

times more harmful than CO2 *(Sánchez-Rodríguez, 2019).*
In the United States, **agriculture contributes about 10% of the country's total greenhouse gas emissions** *(Table 2),* which is equivalent to a significant portion of national pollution *(USDA, 2024).* This sector ranks as one of the five largest polluting, along with industry, transportation, electricity generation, and the commercial sector. Agricultural emissions come mainly from activities related to **livestock production, the use of chemical fertilizers, and soil management**, all of which contribute significantly to the release of methane and nitrous oxide.

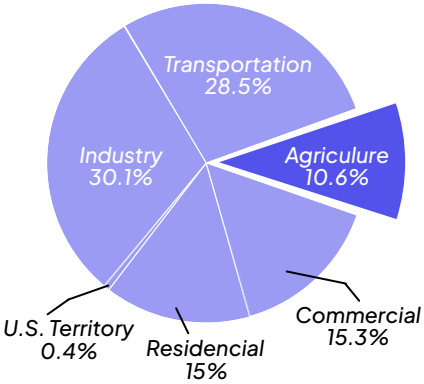


Table 2. *Estimated U.S. greenhouse gas emssion by sector, 2021*

Figure 6. *Sustainability Times, (2021). Pollution caused by pesticides.*

Possible Solutions

Throughout the 21st century, sustainability has become a **global priority**, driving the development of initiatives aimed at creating a world with less pollution and a more responsible use of resources. In this context, agriculture has played a key role in the transformation towards more sustainable models, leading to the creation of large projects that seek to **minimize their environmental impact**. One of the most prominent concepts is the **self-sustaining cities or urban agriculture.**

Figure 7. *Alisea, (2024, June 18). Self-sufficient buildings.*

As the high level of pollution generated by conventional agriculture and its unavoidable importance in producing **basic needs** (food and water) became recognized *(Mok et al., 2013)*, projects aimed at bringing agricultural production closer to urban areas. These initiatives include the development of **urban plots, rooftop gardens, greenhouses integrated into buildings, and plant factory complexes** *(Mok et al., 2014; Weidner et al., 2019)*. This is how concepts such as **"Urban Agriculture"** and **"Self-Sufficient Cities"** were born, with the goal of enabling urban areas to produce enough food for their inhabitants, whether a family, a neighborhood, a city, or even a region, thereby reducing dependence on external resources *(Mok et al., 2013)*. One of these is transportation, as self-sustaining cities integrate agricultural production into urban environments, which not only reduces the need to transport products from long distances, but also decreases

the carbon footprint associated with traditional agriculture *(Goldstein et al., 2016)*. In addition, these initiatives contribute to **food self-sufficiency,** giving people a greater connection with nature and a better understanding of the food production cycle, all within urban spaces.

$$\frac{\text{Vacant Land} \times \text{Yield}}{\text{Consumption}}$$

Table 3. *Grewal & Grewal formula to calculate percentage of self-sufficiency, 2012*

Grewal and Grewal (2012) conducted a study in Cleveland, Ohio, using a simple formula of vacant land multiplied by yield divided by consumption, the authors calculated the **percentage of self-sufficiency for vegetables, fruits, poultry, eggs, and honey** for different land use scenarios in Cleveland *(Table 3)*. Where it was estimated that by dedicating **80% of the city's vacant land to urban agriculture, between 22% and 48% of the local demand for fruits and vegetables** could be covered. This range depends on the farming technique used, which demonstrates the great potential of agriculture in urban areas to contribute to food security. Furthermore, **self-sufficiency could increase to between 46% and 100%** if rooftops and residential lots were also used for food production *(Mok et al., 2013)*.

Currently, many cities are seeking to return to traditional agricultural practices by **combining agricultural and urban living**. Australia, for example, uses **permaculture**, a

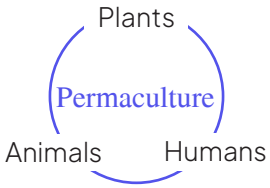


Table 4. *Permaculture strategy, 1978*

strategy in which plants, animals, and humans are integrated into the ecosystem, supporting each other to create a functional and sustainable agricultural system *(Mollison, B. C., & Holmgren, D. (1978). Per-*

maculture 1 a Perennial Agriculture System for Human Settlements. Hobart University of Tasmania. - References - Scientific Research Publishing, 2018). Barcelona, for its part, is moving towards becoming a **Smart City and a self-sustaining city** *(March & Ribera-Fumaz, 2016)*. Thus, many other cities and countries are progressively implementing self-sustainability in food production. However, some foods, such as proteins and cereals, are particularly difficult to produce with nowadays technologies in urban environments, presenting a challenge to achieving complete self-sufficiency in urban areas. However, implementing only fruit and vegetable production in urban areas could contribute to reducing pollution.

Figure 8. *Rosenfield, K. (2020, February 12). Vincent Callebaut's City of Science in Rome.*

Figure 9. *Manos Verdes. (n.d.). Sustainable cities projects.*

Figure 10. *Exacato. (2016, March 15). Singapur an example of sustainable city.*

Figure 11. *eSmartCity. (n.d.). Sustainable cities energy projects.*

User Research

05

One of the fundamental pillars of critical analysis is the creation of products that establish a **connection between the user, the product, the plant and the context in which they are developed.** To achieve a deep understanding of the characteristics and needs of potential users, a survey was carried out focused on getting to know the users.

The objective of this research was to obtain a clear and detailed view that not only covered personal aspects, such as age, type of housing, and nationality but also explored their relationship with plants. Profounding into their past experiences, perspectives on plant care, and general interest in the plant world. Through surveys and interviews, we sought to understand how they interact with plants in their daily lives, what knowledge they have about their cultivation and care, and what barriers they face to becoming more involved in this activity.

Survey

A survey was conducted with **40 people of various ages and nationalities** residing in different parts of the world, in order to gain a broader **perspective on the relationship between users and plants**. The survey includes questions related to the interaction they have with plants and the problems or difficulties they face when having them in their homes.

To facilitate the visualization and organization of the data collected, the survey was divided into three sections. **The first section gathered personal information** of the respondents, including their age, nationality, type of housing, and environment. This allowed for the identification of specific niches within the surveyed population.

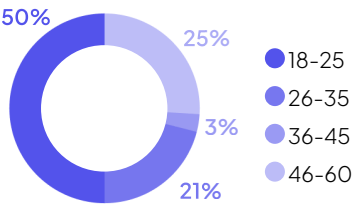
In the second section, questions related to the connection of users with plants were explored. It was asked whether they like plants and whether they usually have them in their apartments or personal spaces. This information was crucial in determining the general interest in caring for and living with plants.

Finally, in the **last section, it was sought to identify whether participants consider having plants to be a challenging task.** If they did, they were asked to share the main difficulties and reasons why they perceived this activity as a challenge. By collecting and analyzing these responses, a deeper understanding of users' perceptions and experiences regarding plant care was achieved.

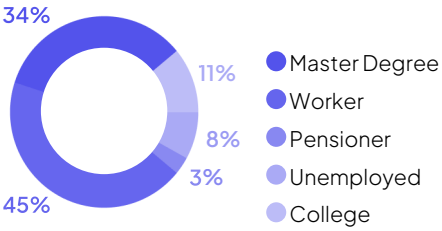
Survey Results

Section 1

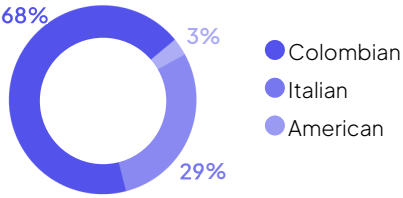
How old are you?



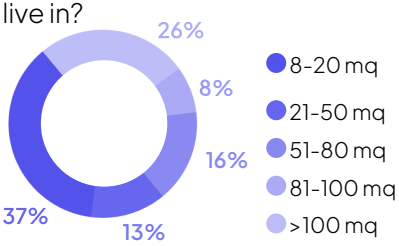
What do you do for a living?



What is your nationality

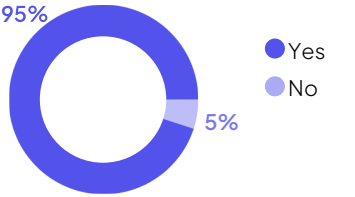


How many square meters do you live in?

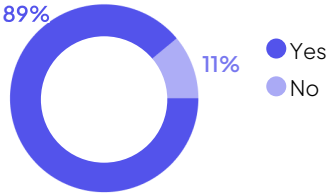


Section 2

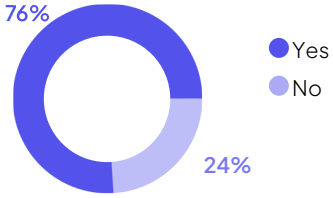
Do you like having plants in you personal space?



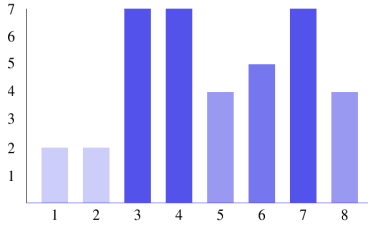
Do you like having plants in you personal space?



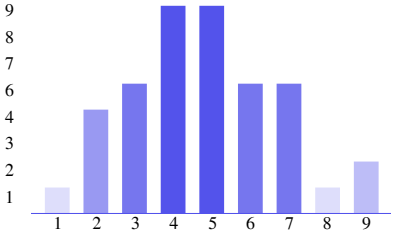
Are you used to have plants in you personal space?



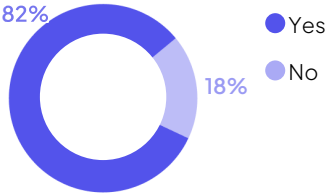
From 1 to 10, what is your knowledge of plants?



From 1 to 10, what is the time you can dedadicate to plants?



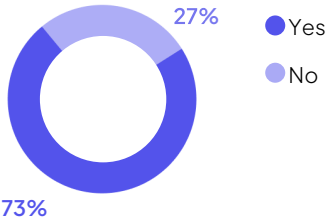
Do you think plants can help reduce stress and anxiety?



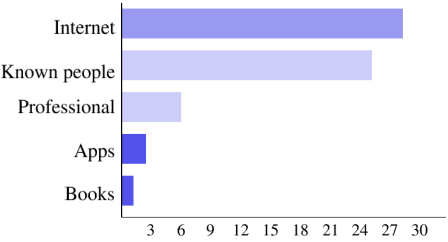
Section 3

Do you think that taking care of plants is difficult?

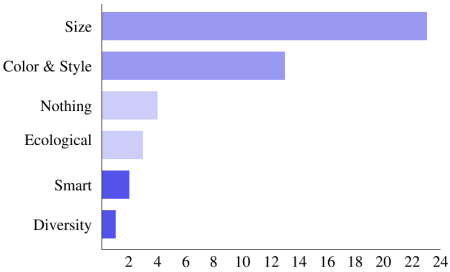
Do you feel that at some point you have limited yourself to having plants in your personal space?



When you see that your plant is sick or has something that you don't know how to solve, who or what do you usually turn to for guidance?



When you buy a pot, what is the first thing you look at?



Conclusions

The surveys revealed an **interest on moste of the participants in having plants in their spaces**. However, this interest was accompanied by a **recurring difficulty**: the lack of knowledge and experience necessary to properly care for them. Many respondents expressed that, although they want to integrate plants into their environment, they feel limited by not knowing how to water them, keep them healthy or even identify the specific needs of each type of plant. This problem highlights the importance of designing **accessible and educational solutions that facilitate plant care**, allowing users to enjoy their benefits without feeling overwhelmed by the demands of maintenance.

Gabriela Cardenas

23 years old

Master student
(Master of science in civil ingeneering)

Lives in Turin in a room with 2 room-mates
(12 mq)

Description

Gabriela is a **Colombian** girl who **lives in Turin** since she is doing a master's degree in the Politecnico di Torino. She lives with 2 roomies in a **house of 60 mq but her room is of 12 mq**. She is a **plant lover** but at her room doesn´t have enough space for a garden.

Time

Knowledge in plants

Space to have plants

Motivations

Having her own orchard helps Gabriela to **avoid buying spices at the supermarket.** As she has had orchards before in Colombia, **she has the knowledge to take care of a plant** but due to the limited time and space she can´t take care of the plants all days.

Frustrations

The **limited space** she has does not allow her to have own garden. Also due to the university commitments, **the time she has free is not enough to fully take care of all plant**.

What she thinks and feels?

- She feels frustated because se can´t have plants in her aparment.
- She feels happy because she is fulfilling a dream.
- She feels a huge connection with plants.
- She thinks plants are important for her life
- She feels relax every time she interact with nature.
- She misses her family

What she sees?

- Social media.
- She sees her friends
- She talk with her family through videocall.
- She go to class and sees the teachers and classmates.
- She sees tha nature aevery day she goes out.

What she hears?

- She hears the pleople arround her *(Roomies, teachers, friends and family)*
- Social media
- Videos about the interaction with plants
- She has classes most of the days of the week.
- She hears her family through videocall all days.

What she says and do?

- She does homework and team work.
- Is a very happy person that love nature.
- She interacts with nature every time she goes out.
- She goes out with friends
- She use to go walking to mos of the parts in that way she can see and interact with nature.

Pain

- The limited space she has does not allow her to have own garden

- Also due to the university the time she has free is not enough take care of plant.

- As she has the knowledge of plants se want to use them in a garden.

- She wants to have her own garden in her apartment.

- Wants a garden to stop buying spices in the supermarket

- A way to do other things than th commitments of the university

- Take advantage of her knowledge in plants

Gain

Ernesto Fernandez

35 years old

Works as architect

Lives in Milan by his girlfrind *(55 mq)*

Description

Ernesto is a **young worker** who **works 8 hours a day** in a job he doesn´t like at all and arrives home very **stressed**. He feels in the plants a way to relax and de-stress, but due to his **lack of knowledge** he prefers to avoid buying them.

Time

Knowledge in plants

Space to have plants

Motivations

Ernesto is highly **motivated to have plants** in his apartment, recognizing their significance for both **physical and mental well-being**. Additionally, he considers that having plants would help him decrease the stress created by work.

Frustrations

His **limited knowledge in plants** prevent him from having plants, as he has tried to buy them before, only to find them dying shortly after purchase.

What he sees?

- He sees her girlfriend everyday .
- He sees his boss and coworkers working.
- He sees how his plants die every time
- He tries to see videos of plants in that way he can learn a little .
- He sees social media
- He sees interviews from famouse architects

What he thinks and feels?

- He feels frustrated because he doesn´t like his job.
- He think plants are important to reduce the levels of stress.
- He feels that due to his lack of knowledge he can´t have plants.
- He wants to become an importante architect.
- He hopes that plants can improve his emotional well-being.

What he hears?

- He hears his boss and coworkers giving him work and instructions
- He hears his girlfriend
- -He hears social media
- He hears interviews of famouse architects
- He hears videos of plants in that way he learns a little about plants
- The opinion of friends and family advising how to manage stress

What he says and do?

- He says plants are importante to reduce the levels of stress
- He says he want to be a famouse architect
- He tries to learn a lot about plants
- He wants to have plants in that way he can learn to manage them
- Achives the work his boss

Pain

- He is working in a job he does like a lot so he arrives home very stressout

- He likes plants but due to his lack of knowledge in it he doesn´t have plant

- Every time he tries to buy a plant it dies shortly after purchasing it.

- He wants to find a job that he really likes

- He wants to know more about plants

- He wants o have plants in his aparte- ment because he knows the importance of it.

- He wants to grow professionaly

Gain

Product Design

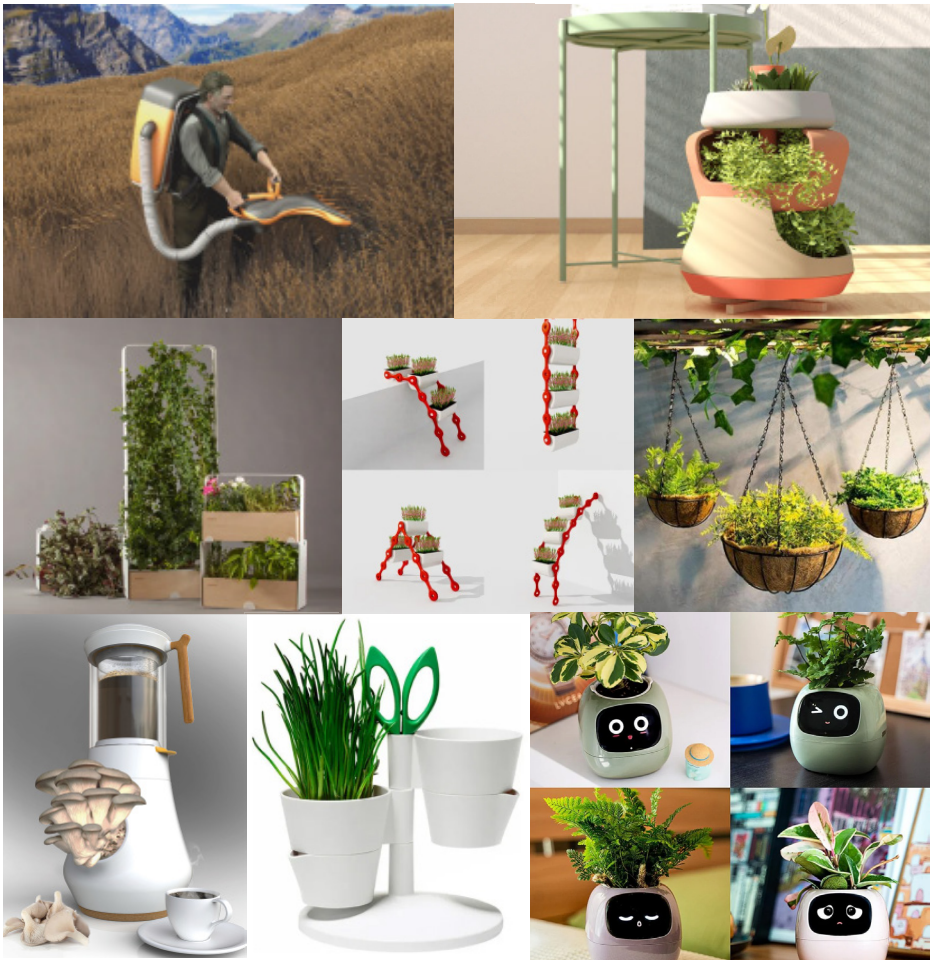
06

Case Studies

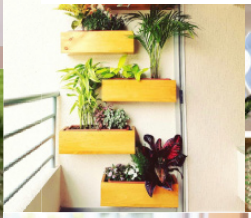
When starting the search for case studies, a variety of pots were identified that not only fulfill specific functions, but also introduce innovations in various contexts. For example, some pots were found stood out for their **technological innovation**, incorporating sensors or automated systems to monitor and maintain plant growth. On the other hand, some pots emerged with **advances in materials**, such as the use of recycled, biodegradable or low environmental impact components, which not only improve their sustainability, but also provide new aesthetic and practical qualities. In addition, pots were found with **functional innovations**, designed to optimize space, facilitate watering or adapt to different types of plants. Finally, some pots were distinguished for their **unique shapes**, which not only respond to a modern aesthetic but also seek to maximize their usefulness in various spaces.

The innovation that is intended to be achieved in the design of the pot focuses on three key aspects: function, form and materials. With these objectives in mind, four types of pots were selected as outstanding case studies, since each one contributes innovative ideas in one or several of these aspects. These examples proved particularly **inspiring in guiding the development of the final product,** ensuring that it meets both the functional needs of the user and responsible and attractive design criteria.

MoodBoard





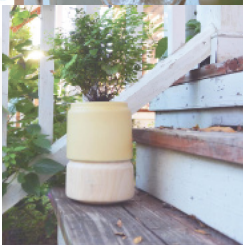


Hydroponic
clean Air









HexaPot

Name: HexaPot, honeycomb structured vertical gardening system

Year: 2013

Designer: Greenamic, Jack Tang

Innovation context: Shape and function

Characteristics

HexaPot is a **modular system** of plants that are **interconnected, not only by the containers but also by a hydraulic system.** The water flows through the upper pots, and once these are filled, the water automatically passes down to the lower pots, continuing this cycle until all the pots are adequately watered.

Why I select It?

The modular system of this case study allows the user not only to **interact and play with the design and form of the system** but also gives the autonomy to **adapt it to different space and to the needs** of each user. In addition, the modular form allows the hydraulic system to be much easier since no matter how many plants you have you will only need to fill one system.

Link

https://issuu.com/greenamic/docs/greenamic_catalogue_2013

Bloom

Name: Bloom

Year: 2016

Designer: Lewis Hunt

Innovation context: Materials and function

Characteristics

Bloom is a **self-watering system** that through **dehumidifying pellets it draws all the moisture it needs form the air.** And once the water is collected it is **absorbed by a wicking string** that will transport the water to the plant.

Why I select It?

Even though the dehumidifying pellets do not collect a huge amount of water, they could help us **save a percentage of water used**. Additionally, the way the water arrives to the plant *(via the string)* could be use to transport water to different plants in a simple way.

Link

https://www.behance.net/gallery/34233693/Bloom-Planter

Muka

Name: Muka

Year: --

Designer: Muka

Innovation context: Materials & Form

Characteristics

Muka specializes in producing plant pots of **various shapes, styles and sizes**, all **made from recycled rubber.** This approach not only offers a wide **variety of aesthetic and functional options**, but also promotes **sustainability** by reusing materials that would otherwise be discarded, thus contributing to the reduction of environmental impact.

Why I select It?

This company was particularly interesting to me because of their **innovative approach to using waste rubber**, giving it a second life in various contexts. One of these is the manufacturing of flower pots, transforming a material that would normally be wasted into **functional and aesthetically appealing products.**

Link

https://www.muka.cl/collections/maceteros-1

Fluidity

Name: Fluidity

Year: 2012

Designer: N.N.

Innovation context: Funtion

Characteristics

This system **automatically waters the plant by utilizing water collected from dishes** after they've been washed. This is made possible by the design of the drainer, which features a container in its lower part to collect water. Simultaneously, there's a pot in which the plant absorbs this water through its roots.

Why I select It?

From a general point of view, the irrigation system presented by this object is a mechanism that not only promotes **water savings by reusing water that we would not have considered using again**, but it also becomes an element with which we **interact day after day in our routine**, creating a closer bond with plants.

Link

https://www.designlibero.com/portfolio/fluidity/

Design Concept

> Living in small spaces limits our ability to have plants or gardens inside our apartment. Therefore, we seek to offer a **comfortable, convenient and original way of organizing plants**, allowing a **close interaction between the user and nature**. This is achieved by designing **simple systems** and considering the interactions between the components and their environment. Our innovative approach integrates **vertical gardening, modular planters and semi-automated irrigation systems**, maximizing the use of available spaces in apartments, whether large, small, or medium-sized. In addition, we incorporate sustainable materials that provide aesthetic and environmental solutions. These systems are designed to be **easy to use**, making it easy for anyone, regardless of gardening experience, to grow and enjoy their own green space. With this, we aim to bring the benefits of nature to urban life, improving well-being and promoting a sustainable lifestyle.

Product Concept

> Design an **urban growing system suitable for small and medium-sized plants that can be easily adapted to both small and large spaces**. This system will allow users to interact with their plants in a **simple and intuitive way**, without requiring extensive gardening knowledge. Our system incorporates **modular components**, allowing for flexible configurations to fit any space, from compact balconies to spacious living rooms. In addition, it includes functions such as **semi-automated irrigation**. The use of sustainable materials and manual technology not only makes the system eco-friendly but also **improves its functionality and user experience**. This innovative approach aims to make urban gardens accessible to all, encouraging a deeper connection with nature and promoting a sustainable lifestyle in urban environments.

Garub

07

Inspiration

When designing the pot, I was inspired by the **swiss cheese plant**, not only because of its distinctive shape, but also because it is a representative plant of the Latin American, region from which I belong, and it is **easy to take care,** a concept I want to reflect on my pot. With this pot, I want to offer a simple and aesthetically pleasing system that allows you to enjoy the experience of having plants without complications. The proposal seeks to combine **beauty and practicality**, making plant care easier for everyone such as the Swiss cheese plant.

Final Design

As a final product, **two pots were developed to adapt to different plant sizes**: one is designed for small plants (with a height between 5 and 15 cm, with 10 to 20 cm foliage) and the other for medium-sized plants (with a height between 15 and 30 cm, with 20 to 40 cm foliage). Each of these pots has a **semi-automated irrigation system** (see page 70) that simplifies the irrigation process, allowing the plants to receive the necessary amount of water without the user having to constantly water them. In addition, it has a **versatile support system** which facilitates its placement in different environments, such as walls or balconies, allowing the user to position the product in the appropriate based on the plant´s needs.

The height and width dimensions of both pots are the same, with a **height of 50 cm and a width of 30 cm** (Technical drawings can be viewed on page 57) However, each pot has specific visual characteristics that help identify the appropriate plant size for each one.

Additionally, these pots are **designed to be modular**, which allows you to organize and combine them in different ways to adapt to the available space where they are located. This modular feature not only helps to **optimize space,** but also it gives the user the power to **decorate and organize their surroundings creatively,** experimenting with different configurations to achieve a unique and aesthetic environment.

Context

Small Plants Pot

Plant height: 5-15 cm
Plant foliage: 10-20 cm

Suitable for plants that prefer tight roots or grow slowly, such as cacti and succulents.

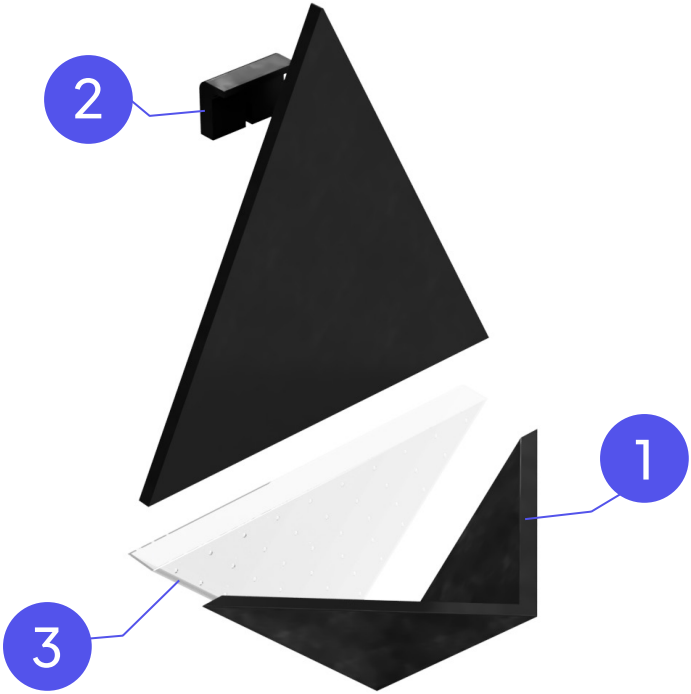
Medium Plants Pot

Plant height: 20-40 cm
Plant foliage: 15-30 cm

Suitable for plants that develop wide or deep roots.

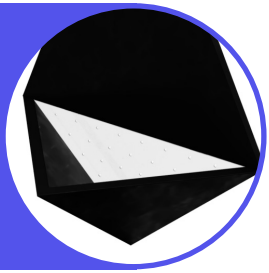
Components

Both pots are made up of **5 essential components**, which are: The space to put the plant, the support, the water container with a lid for opening and closing it, some small holes between the water container and the plant that allow the water to flow from the container to the plant.



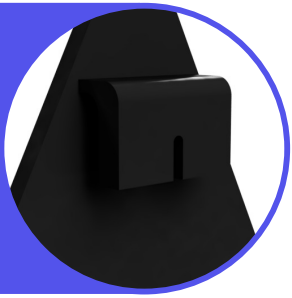
1. Plant Space

At the front of each pot there is a **pyramid-shaped area where the plant and soil are placed.** The user fills this space halfway with soil, places the roots of the plant and then gradually adds soil until reaching a few centimeters below the edge. This approach provides adequate support for the growth of the plant.



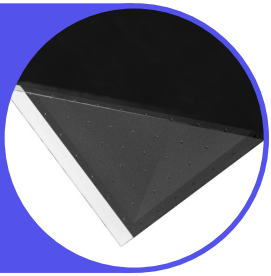
2. Support

Located at the back of the pots is the support which allows the users to place the pots on walls or balconies in an easy and safe way. This **support is L-shaped and has a hole in the middle**. The "L" shape makes it easy to place on balconies through a grip system, while the hole allows the pot to be easily hung using a hook or nail, adding versatility in placement options.



3. Water Container

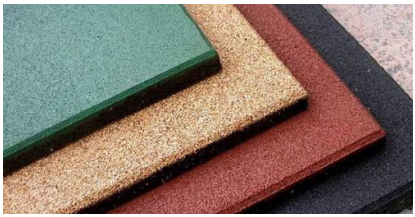
The container has three components: a main body that stores water (562,5 ml for small pots, 1.125 ml for medium), a spill-proof lid for easy filling, and finally, small holes that connect the water container to the plant, **allowing the water to gradually pass from the reservoir to the soil, ensuring efficient, complete, and controlled irrigation.**



Materials

When starting the research on materials, several parameters were considered for their selection. These parameters included that the **materials should be environmentally friendly** and non-polluting, **easy to find and produce in various parts of the world**, easy to reuse, they should **not affect the quality or lifestyle of the plant**, they should be **water resistant** and have a long durability. Keeping these requirements in mind, research was conducted on the available materials and finally two were selected: **recycled glass for the water container and recycled rubber for the rest of the product.**

Recycling Rubber



High durability

Recycled rubber is **resistant to wear and has a good useful life**, it does not have the same resistance as the same virgin material, but its durability is still high.

Sustainable

Using recycled rubber **helps reduce waste** and demand for virgin rubber, contributing to environmental sustainability.

Chemical resistance

Recycled rubber has good **resistance to many chemicals**, including oils and solvents.

Thermal insulator

Recycled rubber is a good thermal insulator, so it will **help protect plants from temperature changes and very high temperatures.**

Weather resistance

Recycled rubber is **resistant to various weather conditions**, including exposure to sunlight (UV), rain, and temperature changes, making it ideal for outdoor applications.

Recycling Glass

Sustainability

Recycled glass is produced from reused glass waste, reducing the need to extract new raw materials. This process **helps reduce energy consumption and CO_2 emissions** compared to manufacturing new glass.

Impermeability

Recycled glass is **impermeable, making it ideal for containing liquids** without the risk of leaks or moisture damage. This property also makes it resistant to corrosion and degradation by chemical agents.

Durability and strength

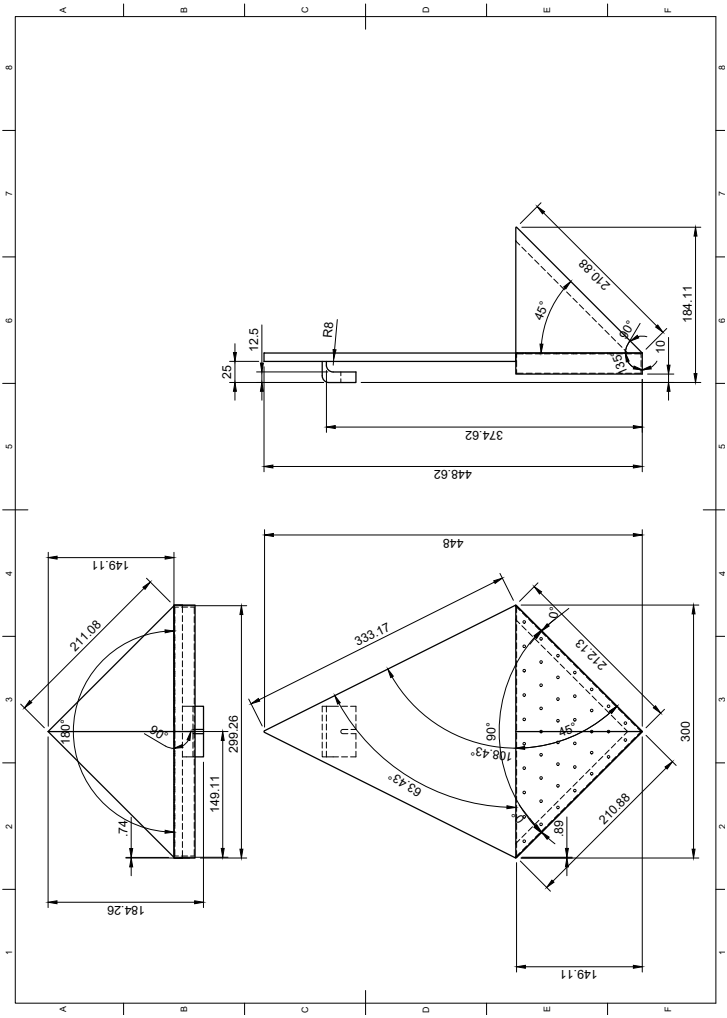
It maintains the same durability and strength as conventional glass. It can withstand variations in temperature and environmental conditions, making it suitable for outdoors and uses that require high resistance.

Transparency

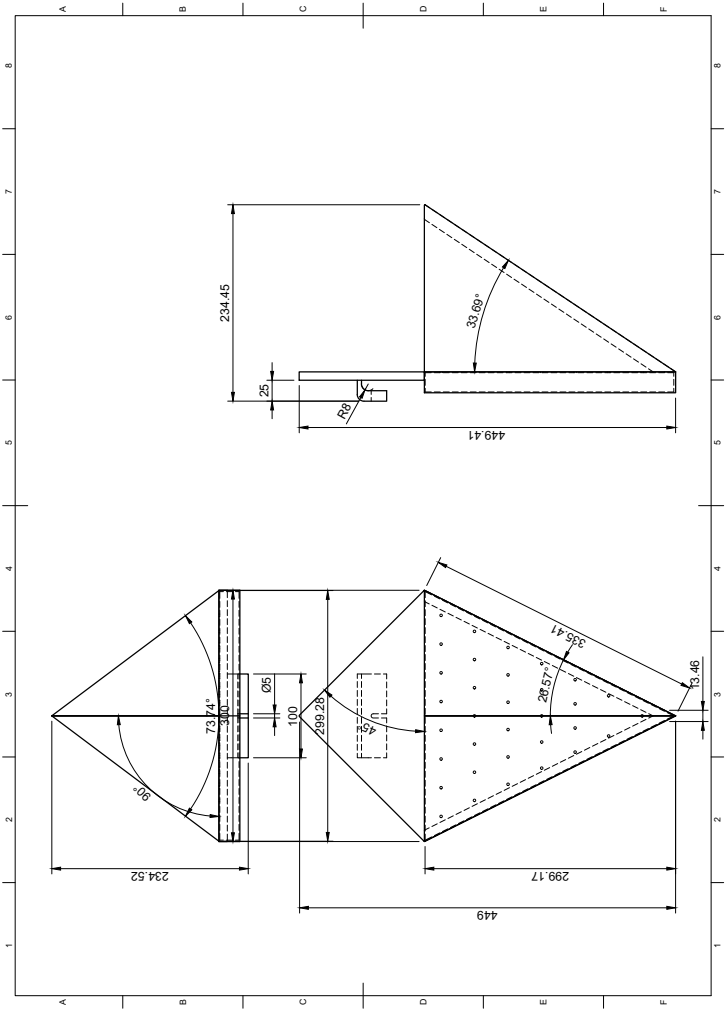
With appropriate recycling processes, recycled glass **can retain or regain its transparency**, allowing visibility of the contents and making it an aesthetically attractive material for decoration or storage.

Measures

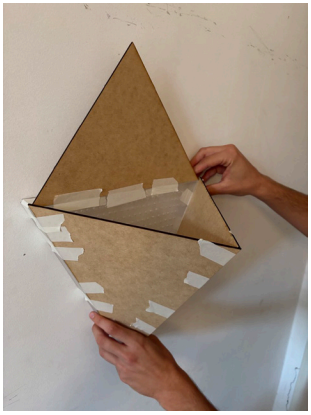
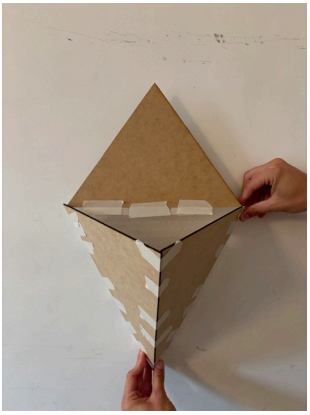
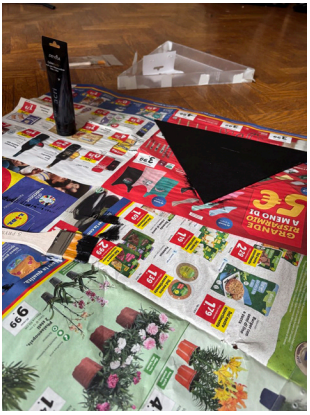
Small Plants Pot

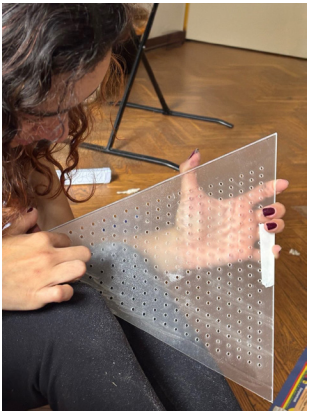


Medium Plants Pot



Prototype




Production Process

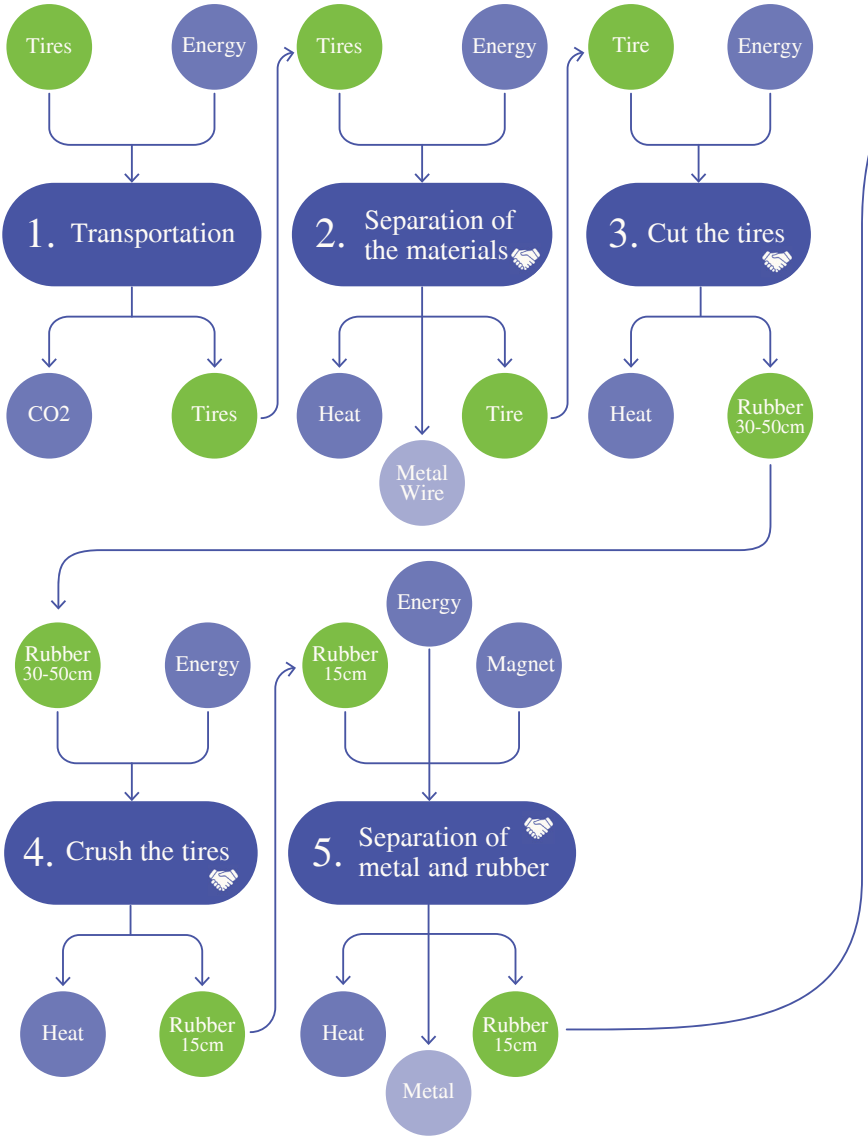
08

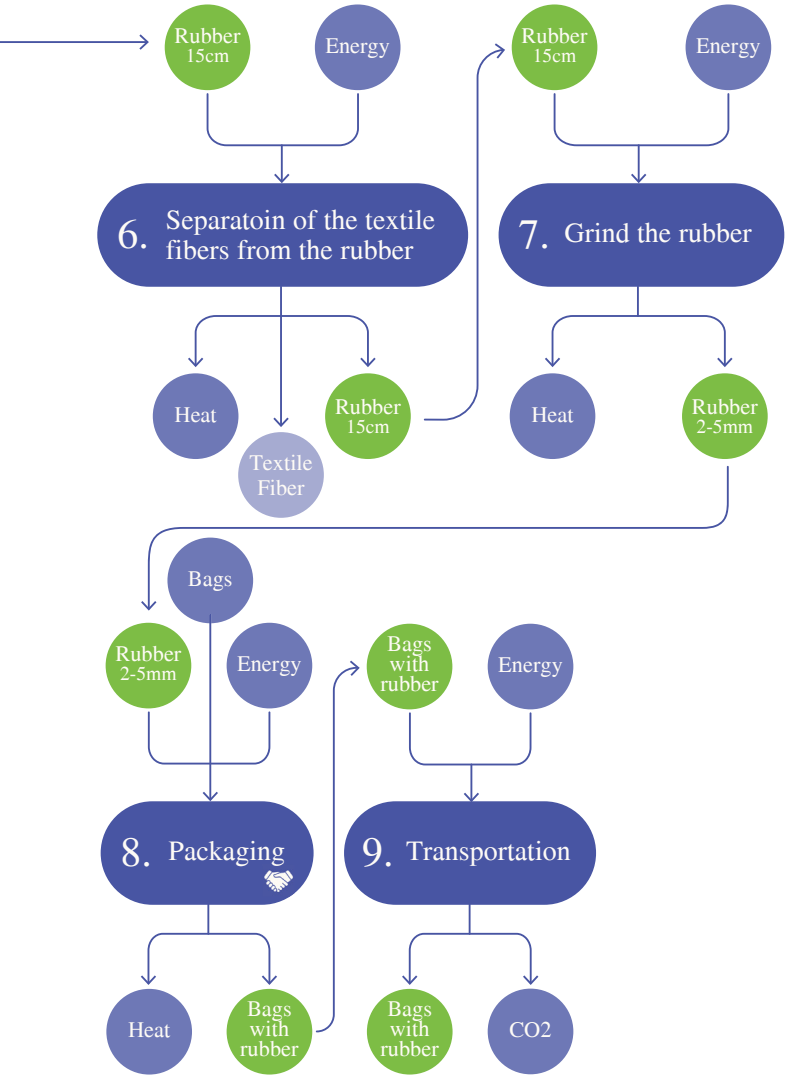
Introduction

A detailed investigation was conducted on the recycling process of both materials to understand the process and challenges associated with it. This included not only **analyzing the primary materials but also identifying additional waste generated throughout the production chain**. Furthermore, steps within the production chain were identified that could potentially be replaced with more **artisanal processes.**

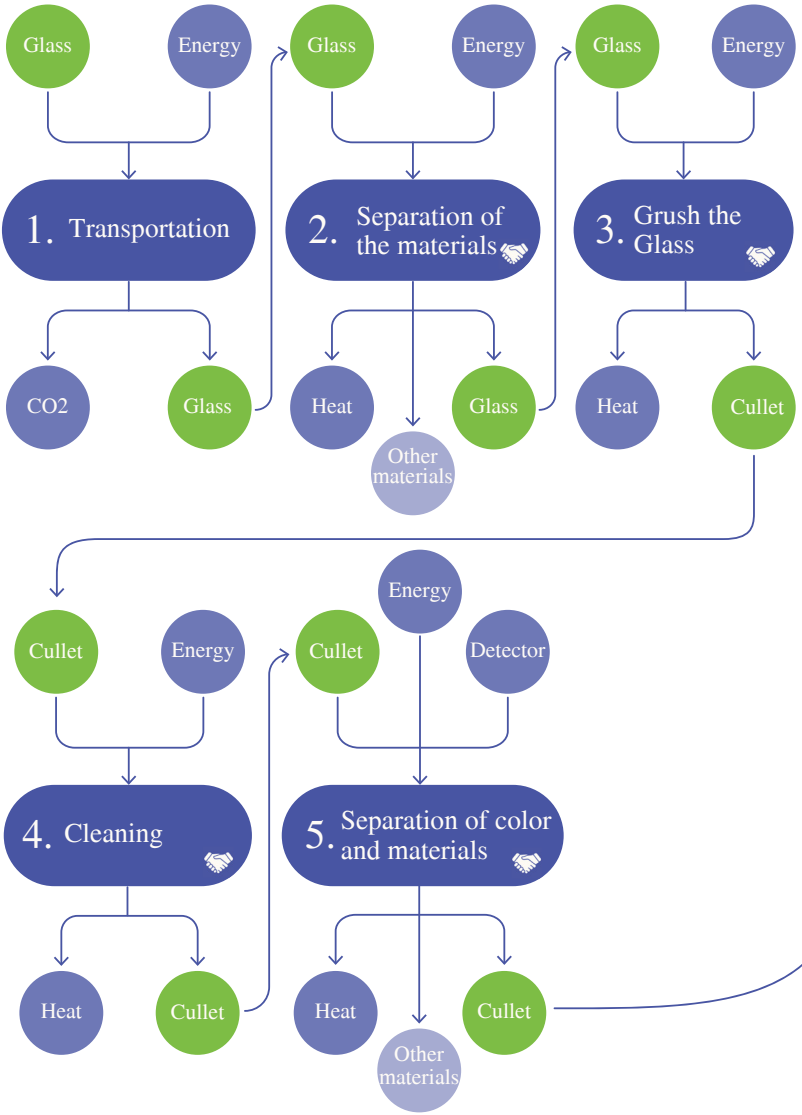
Recycling Rubber Process

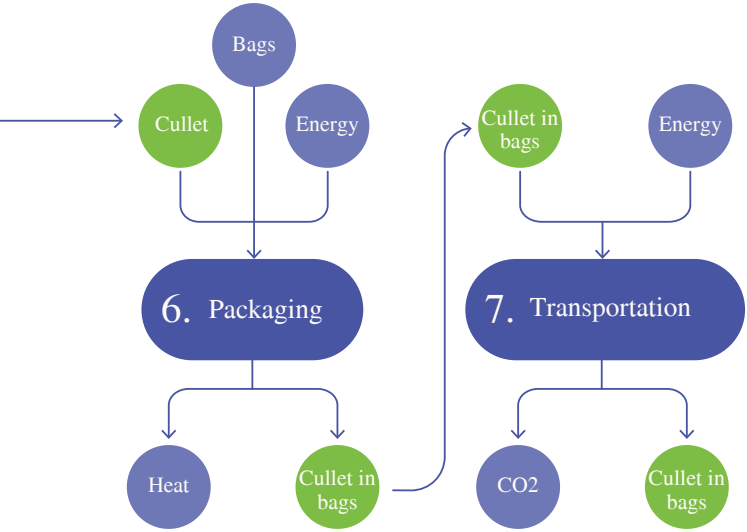
The tire recycling process begins with transporting the material from disposal sites to recycling facilities. First, the metal wires located on the outer part of the tire are removed. Then, the material is cut into pieces measuring 30 to 50 cm, which are subsequently shredded to a size of 15 cm. Next, a magnet is used to remove any remaining metal residues, followed by the extraction of textile fibers found in the material. Finally, the material is shredded a second time to achieve a size of 2 to 5 mm. This material is then packaged into bags of various weights and transported to manufacturers for reuse.


Tires
Energy
1. Transportation
CO2
Tires
Tires
Energy
2. Separation of the materials
Heat
Tire
Metal Wire
Tire
Energy
3. Cut the tires
Heat
Rubber 30-50cm
Rubber 30-50cm
Energy
4. Crush the tires
Heat
Rubber 15cm
Energy
Rubber 15cm
Magnet
5. Separation of metal and rubber
Heat
Rubber 15cm
Metal


Rubber 15cm
Energy
6. Separatoin of the textile fibers from the rubber
Heat
Textile Fiber
Rubber 15cm
Rubber 15cm
Energy
7. Grind the rubber
Heat
Rubber 2-5mm
Bags
Rubber 2-5mm
Energy
8. Packaging
Heat
Bags with rubber
Bags with rubber
Energy
9. Transportation
Bags with rubber
CO2

Recycling Glass Process





The glass production process is simple and efficient. It begins with transporting the material to the recycling plant, where all non-glass elements such as plastics, metals, ceramics, or porcelain are removed. Next, the glass is crushed, becoming what is known as cullet. This material is cleaned without the use of water and then sorted by color. Finally, the cullet is packaged and transported to factories for reuse.

Use

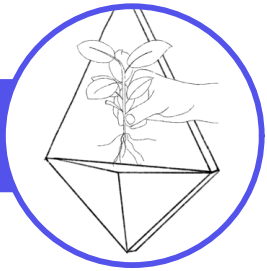
09

Installation

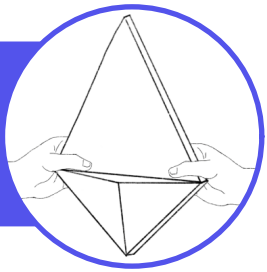
Wall Installation

1. Place the hook or nail in the Wall

2. Place the plant in the pot



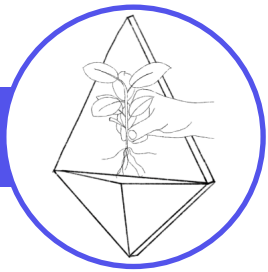
3. Mount the pot on the wall by aligning the hole on the back with the hook.



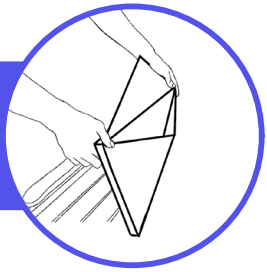
Installation

Balcony Installation

1. Place the plant in the pot

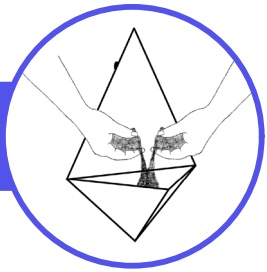


2. Position the L-shaped support along the edge of your balcony.

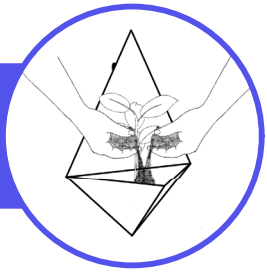


Sequence of Use

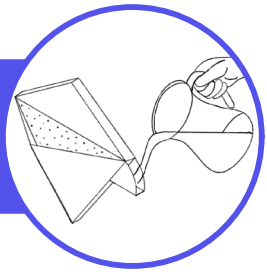
1. Fill the pot halfway with soil.



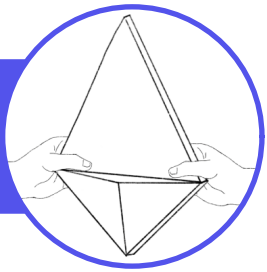
2. Add the plant and then slowly add more soil until the plant is stable.



3. Once the plant is stable, add water to the water container.



4. Finally, place the pot in the most suitable part of your house.



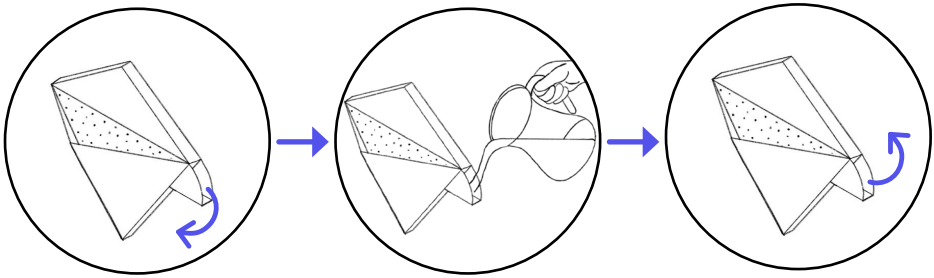
Irrigation Sistem

There are various irrigation systems, each designed to meet the specific needs of plants and crops. Among them, the system I based my design on is **drip irrigation system**, a widely used method known for its water efficiency. This system works by **releasing small, consistent drops of water onto the soil surface**, allowing plants to absorb the water gradually.

However, in the system I propose, the water droplets are not applied directly to the soil's surface but are directed into the soil near the plant's roots. This approach **improves water distribution**, ensuring that the moisture spreads evenly throughout the substrate. As a result, root hydration is optimized, evaporation is minimized, and water resources are used more efficiently, making the irrigation process more **effective and sustainable**.

The product features a water container with small holes on the part in contact with the soil, through which water is released consistently, taking into account the absorption by the roots. This way, the user does not need to water the plant constantly; they simply need to refill the container when it becomes empty. This system simplifies the watering process while maintaining the interaction between the plant and the user, **allowing for more efficient and convenient care without losing the necessary connection.**

Sequence of Use



Possible Configurations

Vertical

Personalize

Horizontal

Balconies

Product Test

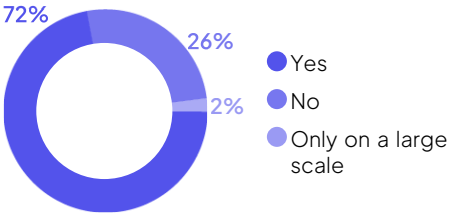
10

A survey was conducted with **55 people** to analyze how they **perceived the components and the overall concept of the product**. The survey was structured into **four sections**, each focusing on a different theme, allowing for a comprehensive assessment of user opinions. These sections explored various aspects of the product, such as **usability, design, and functionality**. The main goal of the survey was to gather insights to determine whether **the potential users found each element of the product clear, intuitive, and easy to use.** By understanding their feedback, we aimed to identify areas for improvement and ensure the product meets user expectations and needs.

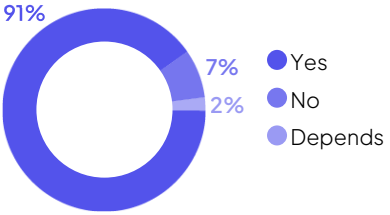
Survey Results

Section 1 - *Product concept*

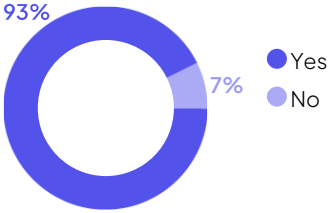
Do you think this product could help to gradually reduce the levels of pollution caused by traditional agriculture?



Beyond its impact on reducing pollution, do you think this product could encourage a new mentality of self-production of food and increase awareness about environmental resources?



Do you think this product can influence people's perception of the possibility of growing plants at home?

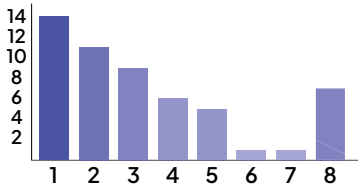


How could people change their perspective on plants in the home?

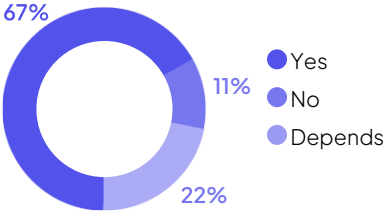
- Making the process of caring for plants easier and more dynamic
- Having plants in their homes by encouraging each member of the family to have and care for plants because of their importance and the positive impact that having them generates.
- To change the perspective, environmental education must be promoted and the diversity of urban flora must be encouraged.

Section 2 - *Sequence use*

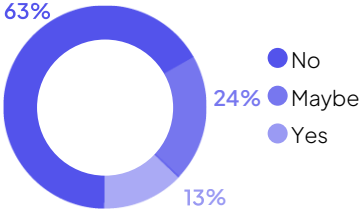
On a scale of 1 to 10, where 1 is very easy and 10 is very difficult, how would you rate the product's ease of use?



Do you think the components of the product make it easier to understand how it works?

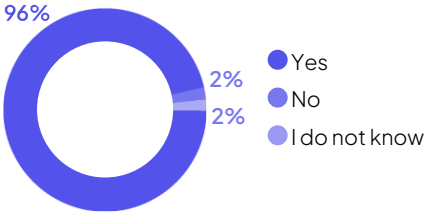


Do you think you would need help or support to use the product?

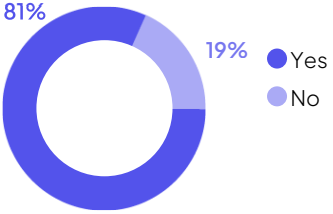


Section 3 - *Material selection*

Do you think the materials selected were the most suitable for this product?

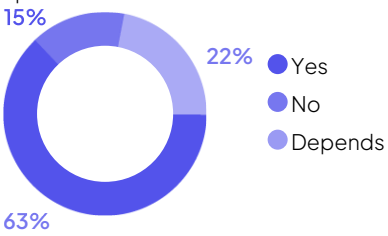


Do you think the selection of materials influences the aesthetics and design of the product?



Section 4 - *User aceptance*

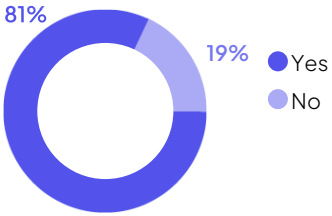
Now that you know the product, do you think it would be a product you would buy for your apartment?



Is there any feature or component you would like to add or modify in the product?

- Add a technological and automated system
- A meter that indicates the amount of water or when it needs to be refilled
- It is inconvenient to pour water into that tank

Would you like to have the possibility of customizing and assembling your own urban pot using a kit that includes all the necessary elements?



If so, how?

- Different sizes
- Being able to put it together would make it more inclusive to the customer.
- More variety of colors
- Different forms
- Having the possibility to build like a lego

Product in Context

Then a test was conducted with **5 users**, presenting the product without offering extensive explanations or details. The objective of this test was to **hypothesize how they might behave and use the product**, evaluating whether it was clear and easy to use or whether, on the contrary, it required additional support for its correct understanding. The test began with a brief presentation to the user about the problem and possible solutions, providing the necessary context of the situation that was sought to be addressed. Subsequently, the product was delivered with an explanation of the actual materials used. Finally, 5 open questions were posed, designed for users to express in detail their emotions, perceptions, uses and actions related to the product.

Questions

- How would you use the product, whether during installation or in the planting process?

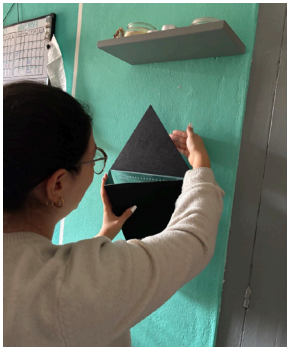
- Thinking about your daily context, where would you place it?

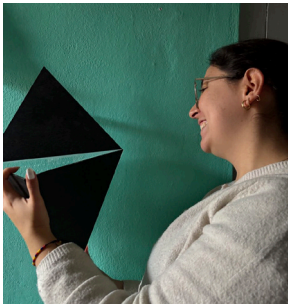
- What is your opinion about the product's usage and design?

- Does this product encourage you to have plants in your home?

- Compared to other products available on the market, what do you think about this product?

Laura Sofía Granados



Age: 25 years old
Location: Turin, Italy
M²: 50 m²
Plant Knowledge: Medium

Laura Sofía, when observing the product, perceived it as **versatile and decorative**, considering it an excellent element to beautify her home. When it was installed, she realized that it would be more practical if **the holder had a hole to allow it to be hung in the wall**. She was fascinated by the water-related functionality, although she expressed some concern about the **possible moisture it could generate**. Appreciated that the pot was adaptable for both indoor and outdoor. However, their main concern was the **stability and security**

Juan Gabriel Pieschacón

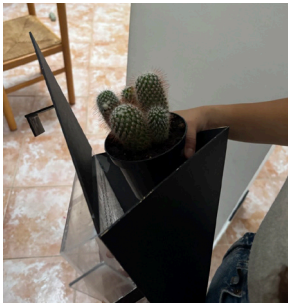



Age: 28 years old
Location: Turin, Italy
M²: 44 m²
Plant Knowledge: Basic

Juan Gabriel associated the product only with its use in **outdoor,** since he did not see elements for its installation on the wall. He is a person who has never had plants at home, as he feels that it is a **responsibility he prefers to avoid**; therefore, the product **did not motivate him to consider having them.** Proposed that the stand be adjustable to fit different spaces. Also, although he found the irrigation system interesting, he suggested adding a **measuring mechanism** to know how much water is remaining.

Lina María Medina



Age: 29 years old
Location: Turin, Italy
M²: 75 m²
Plant Knowledge: High

At first, Lina did not fully understand the irrigation system but after a careful examination she understood it and expressed concern about whether this **system is functional for all types of plants.** She envisioned the product more as an option for **wall installation**. With the product, she feels comfortable having plants in her home, **appreciating its attractive and decorative design** that complements the apartment. Compared to other pots, consider that this product has both decorative and functional functions. Finally, she commented that she would like the pot to have **more technological features**.

Felipe Suarez

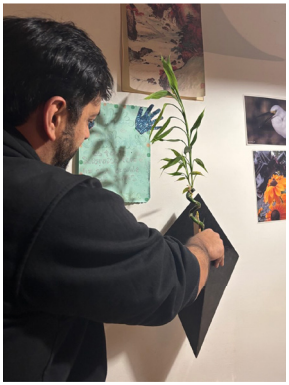



Age: 29 years old
Location: Turin, Italy
M²: 62 m²
Plant Knowledge: Medium

Felipe had **difficulty understanding the functioning of the irrigation system**, but once he understood it, he felt that it could make taking care of his plants easier. He currently have many plants on his balcony floor, and he thinks this product would help him save space and organize them more efficiently. He was curious by the triangular shape of the design and suggested that more figures could be included. Ultimately, he believes that this product could incorporate more plants into his home thanks to its easy care.

Carlos Perez






Age: 41 years old
Location: Turin, Italy
M²: 45 m²
Plant Knowledge: High

Carlos found the pot design interesting, highlighting the **advantages of rubber as the main material** and mentioning he would install it on walls, suggesting the addition of a more stable wall-mounting element, as well as **stones in the container to improve water circulation.** Although he expressed some concern about the container's transparency and the potential influence of the shape on nutrient distribution, he did not see it as a significant issue. Carlos, a fan of outdoor plants, stated he would use the product outdoors, mounting it on walls, and appreciated **the opportunity to experiment with the pot's shape**.

Conclusions

After conducting the surveys, a **great interest was identified on the majority of the respondents**. Many pointed out that, regardless of the level of knowledge each person has about plant care, **the pot facilitates an activity** that is generally perceived as complicated, making it simpler and more accessible. This led me to hypothesize that the product **could capture the market's attention** thanks to its design, functionality and versatility.

In addition, respondents showed particular interest in the possibility of **customizing and creating their own pot.** This preference opens the opportunity to develop, in the future, a **kit that allows people to design their personalized pot**, offering options to choose both the shape and the colors, and encouraging a more interactive, personalize and creative experience for the user.

Systemic Design Perspective

11

Introduction

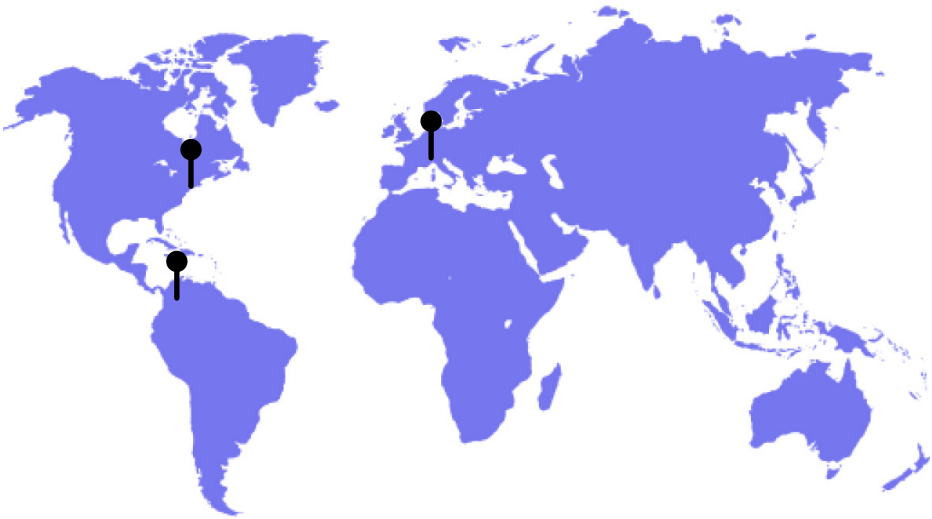
Throughout the master, it has been possible to see how a product can evolve from a traditional design into a systemic one, a change achieved by **considering not only the individual functionality of the product but also the relationship between its components, the environment in which it is inserted and the users who interact with it.** By focusing on these connections, it is possible to design effective products, solving complex problems holistically and sustainably, minimizing negative impacts, and maximizing value for both users and the environment.

This approach seeks to understand the impact that the product will have throughout its life cycle in one or multiple contexts. This includes **the extraction of raw materials and the manufacturing process to the use, maintenance, and eventual disposal or recycling of the product.** Ultimately, a systemic product is defined by its ability to contribute to a larger system, responding to multifaceted challenges and providing solutions that last over time.

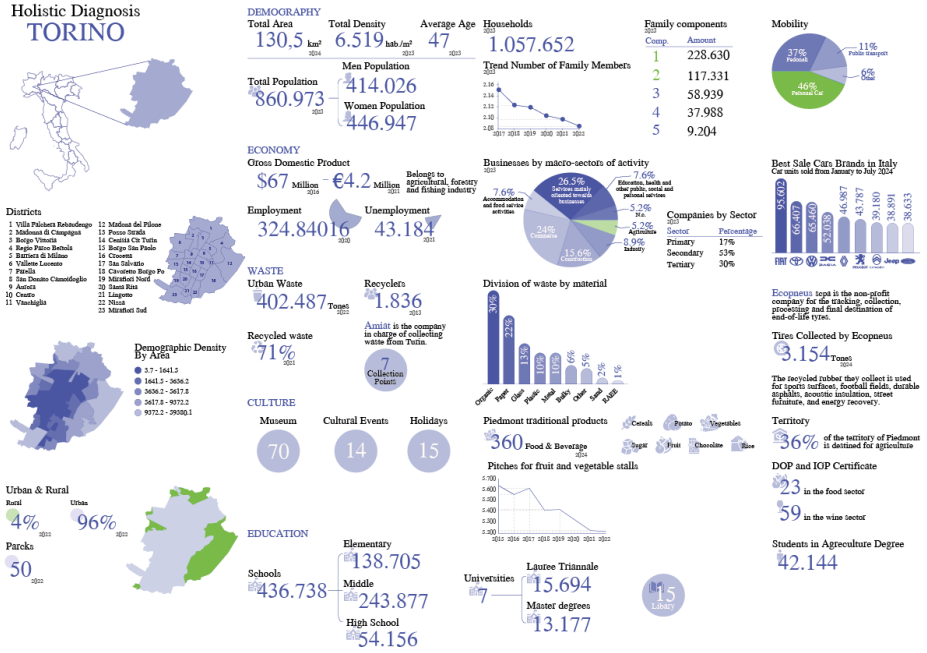
Garub has a systemic approach because it is designed to encourage people to grow food in small spaces while integrating into a wider context that considers urban agriculture's environmental and social impact. By allowing people to start changing their perspective and start growing their food at home, you will **reduce reliance on industrial agriculture and minimize carbon footprint**. It also uses **recycled materials**, promoting sustainability and the circular economy. This holistic approach fosters a culture of self-production, helping users to be more aware of their consumption habits and their impact on the environment, turning the act of cultivating into a tool for social and environmental change.

Holistic Analysis

The product was not designed to be used in a single context, so an analysis was carried out to explore **how it could be adapted to different environments.** Bogotá, New York, and Turin, were selected for this purpose, as each one of these cities has **completely different cultural, economic, and geographical characteristics.** To assess whether the product was suitable in different contexts, a holistic analysis of these three cities was carried out, which allowed me to have an integrated view of **how people in different environments interact with the product,** considering not only the individual characteristics of users but also external factors such as culture, economy, education, among other aspects. In addition, this analysis included research on the materials used in the product and how they are integrated into each context, considering aspects such as sustainability, availability of raw materials, and possibilities for reuse.



Turin, Italy



For a better visualization of the holistic analysis scan the Qr code

In carrying out the holistic analysis of Turin, it was identified that it is a city in which **96% of its territory is urban** (*Table 5*), but that is located

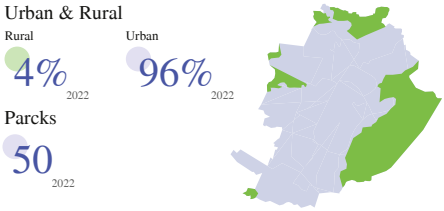


Table 5. Representation of the urban and rural area in Torino, 2022

in the region of Piedmont, a region known for its traditional products and whose **36% of the territory is devoted to agriculture, making it have a deep link with the sector.** Over time, food products have

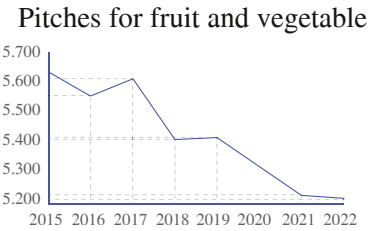


Table 6. Pitches for fruits and vegetable stalls in Torino from 2015 to 2022, 2023.

been marketed in the city through plots of land to cultivate fruits and vegetables, so that citizens can eat more naturally and healthily. However, **the number of these plots has been decreasing progressively,** leading people to rely on supermarkets and industrialized stores to buy their food (*Table 6*).

Family components
2023

Comp.	Amount	Comp.	Amount
1	228.630	4	37.988
2	117.331	5	9.204
3	58.939		

Table 7. Representation of the family components in Torino, 2023

As for Turin's demographics, there has been a trend towards a **reduction in the size of families,** with one or two people being the main household (*Table 7*). This shift has led to a decrease in the sizes of the apartments, presenting challenges for the efficient use of space in urban housing. In addition, this phenomenon is linked to the presence of a **significant percentage of foreign students** who come to study in Turin, which in many cases leads peo-

ple to live in smaller spaces such as single rooms, further limiting the space available in dwellings.

Finally, as regards raw material, it was identified that **mobility in Turin is mostly linked to the use of**

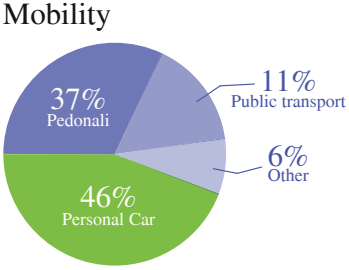


Table 8. Mobility in Turin.

private cars, resulting in a high volume of tires discarded each year *(Table 8)*. In this context, the company **Ecopneus** stands out, which collects used tires and gives them a second life in other areas; in **2024, it managed to collect approximately 3,000 tires.** As for glass, the waste segregation in households includes this material along with cans in the recycling plan, making **glass the third most discarded type of waste in the city** *(Table 9)*. Therefore, it can

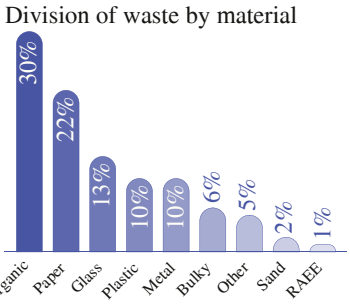


Table 9. Waste material division in Turin

be concluded that the two materials used in Garub are easily accessible and reusable in Turin.

After analyzing Turin and evaluating the different scenarios and contexts, I believe that Garub has the potential to connect deeply with the identity of this city. Turin is a city that, although it has experienced a high degree of urbanization, has

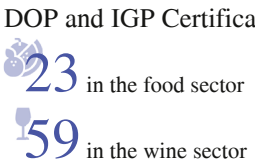


Table 10. DOP and IGP certificates in Piedmont

always been historically linked to agriculture, especially in the region of **Piedmont where traditional local products have been very important** (*Table 11*). Over time, due to urban expansion and the reduction of habitable space, agricultural practices have decreased considerably in the daily life of the Torinese. However, there is a **cultural background that appreciates these products** and may be interested in reconnecting with these practices.

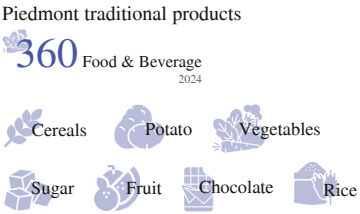
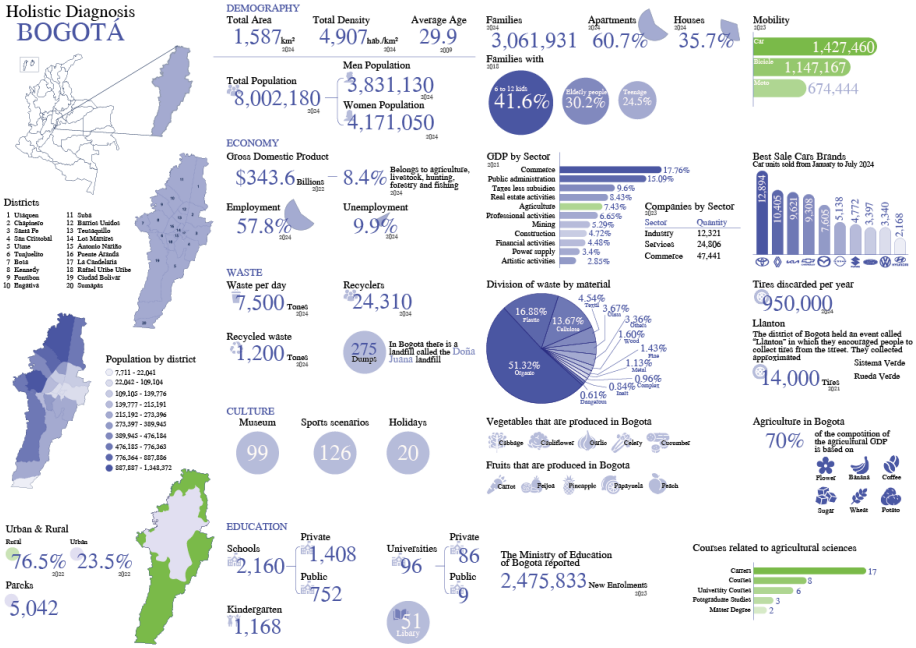


Table 11. *Traditional crops and products in Piedmont*

Garub could fit into this context by offering a solution that would allow the inhabitants of Turin, even those living in small spaces or apartments, **to regain that connection with land and food production**. In addition, the growing trend towards sustainability and environmental awareness in the city could reinforce acceptance of a system that allows urban cultivation in small spaces, **returning citizens to the possibility of self-producing food efficiently**, without compromising living space or the environment. Thus, the product not only responds to a practical need of those living in small spaces but can also be aligned with a **cultural desire to keep agricultural traditions alive in a modern and urban environment**.

Bogotá, Colombia



For a better visualization of the holistic analysis scan the Qr code

A holistic analysis of Bogotá identified that, despite its **urban development that grows annually, much of its environment is rural** *(Table 12)*, as the Sabana de Cundinamarca and Boyacá surround it. This gives Bogota a significant territorial extension, positioning it as one of the largest cities in the world in terms

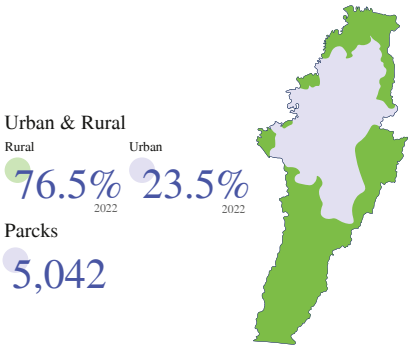


Table 12. Representation of the urban and rural area in Bogota, 2022

of area. **Due to this proximity to rural areas, agriculture plays a crucial role in the local economy** *(Table 13)*, being the fifth sector with the highest contribution to the city's GDP. This connection between urban and rural highlights the importance of agriculture in the development of the region.

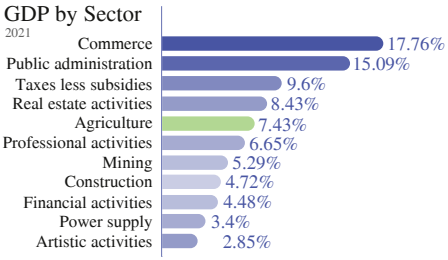


Table 13. Growth domestic product diveded by sector in Bogota, 2021.

When analyzing the demographics of Bogota, it was observed that **most residents live in apartments** *(Table 14)*, which considerably reduces the space available per person. This restriction limits the possibility

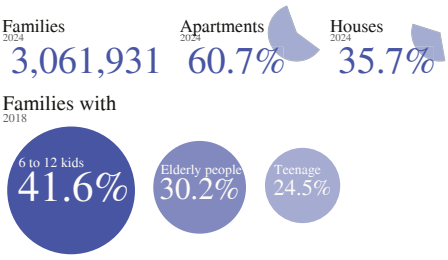


Table 14. Representation families with its components

of growing plants or crops indoors using traditional pots. In addition, it was also identified that **many families have children between 6 and 12 years of age, a crucial stage for learning and habit-forming** *(Table 14)*. If a new perspective towards agriculture and home farming is encouraged during this period, it could positively influence future generations, generating significant change in this sector in the long term.

As for the raw material, it was identified that **mobility in Bogotá is mainly based on three means of**

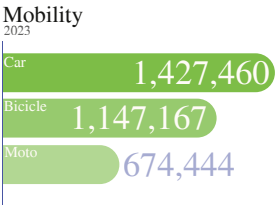


Table 15. Representation of the mobility in bogota in 2023

transport: cars, bicycles and motorcycles, all equipped with rubber tires (Table 15). However, due to the lack of an efficient waste management system, many citizens choose to dispose this tires in the streets, contributing to pollution. To address this problem, the Mayor of Bogotá launched a program called **"Llantón", whose objective is to collect tires discarded in the street.**

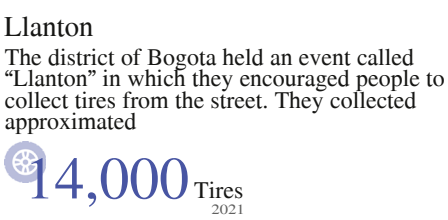


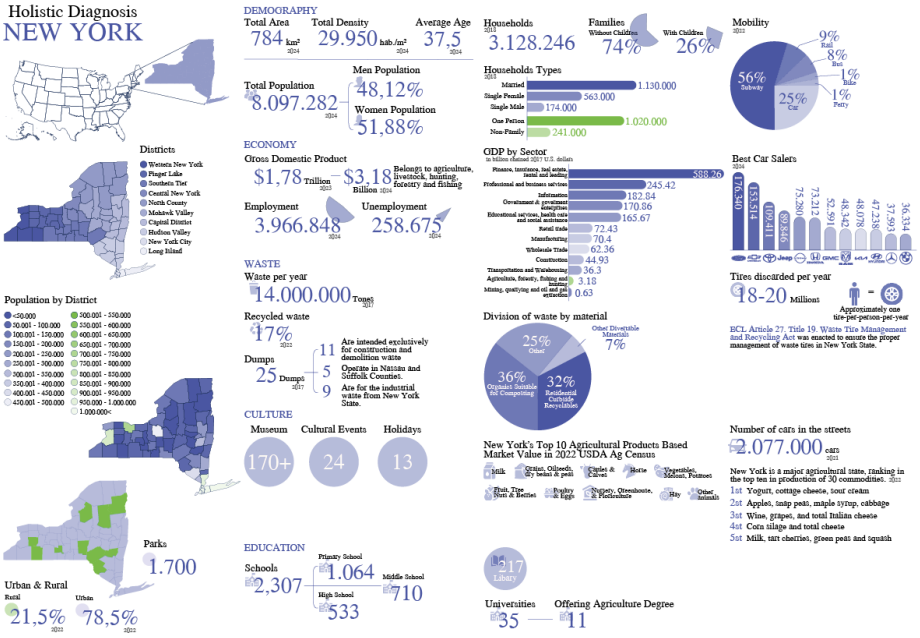
Table 16. "Llanton" and tires recollectes in 2021 by the company.

In 2021, around 14,000 tires were recovered *(Table 16),* which were then transported to foundations such as **Sistema Verde and Rueda Verde, responsible for processing and giving them a new service life.** Referring **to glass, it was identified as the fifth most discarded material in Bogotá,** which opens up the possibility of using this recycled resource in the project.

In the context of Bogota, Garub would **not only offer families the**

possibility to grow plants or small gardens in apartments or small spaces, but it would also have a crucial role in the education of the new generations. By incorporating this option into their homes, children and youth pleople living in apartments would have the opportunity to **learn about sustainability and food production from an early age,** thus fostering a deeper ecological awareness. This practical learning would change the way we interact with nature and agriculture, driving **self-sufficiency even in densely populated urban environments.** Also, being a product designed to fit into limited spaces, it offers an **accessible and efficient solution to reconnect people with agriculture, a sector that has always been linked to the culture and economy of Bogotá**. Thus, the product allows for agricultural practices to be continued in a more urban-friendly way, promoting sustainable and safe interaction with the environment.

New York, USA



For a better visualization of the holistic analysis scan the Qr code

Table 17. Representation of the agricultural area in the total area of New York, 2021

As New York is one of the most influential and economically developed cities, **agriculture does not play a major role in its GDP, representing only 3.18% of the total.** However, the interesting thing is that despite its urban character and focus on sectors such as finance, commerce and technology, **about 20% of the city's area is devoted to agriculture** *(Table 17)*. This space is mainly used for the cultivation of a variety of key agricultural products, such as grains, fruits, vegetables, and animal husbandry.

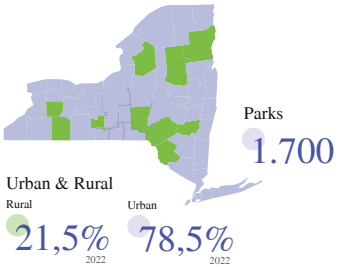


Table 18. Representation of the urban and rural area of New York, 2022

In terms of demography, New York is **the most populous city in the United States**, with a great cultural and ethnic diversity that makes it a global center for social and economic exchange. **Households are predominantly composed of married couples without children or people living alone** *(Table 19)*, reflecting a trend towards smaller family structures in line with the rapid way of urban life and high costs of living in cities. In addition, **78.5% of its territory is urban** *(Table 18)*, with a large number of areas occupied by skyscrapers and emblematic high-rise buildings that represent the impor-

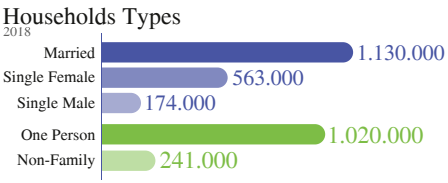


Table 19. Representation of the household types in New York.

tance of New York as a **financial, technology and cultural epicenter worldwide.** This predominance of urban areas highlights the challenge of integrating sustainable solutions in a high population density environment where **space is limited and living in small apartments is the daily life of citizens.**

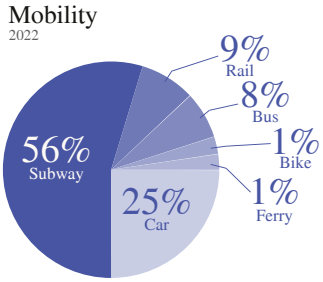


Table 20. *Representation of the mobility in New York, 2022*

As for raw material, public transport, especially the subway (*Table 20*), is the main means of mobility in New York due to heavy traffic, especially in the central areas of the city. However, despite the extensive public transport system, **there is a large number of cars in the city**, which generates considerable waste

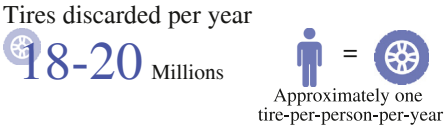


Table 21. *Tires discards representation per year in New York*

production, especially tires. It is estimated that, on average, **each citizen of New York contributes one scrap per year** (*Table 21*). This situation has led the authorities to establish specific measures for managing this type of waste. One of these measures is the **"ECL Article 27, Title 19: Waste Tire Management and Recycling Act"** (*Table 22*), which

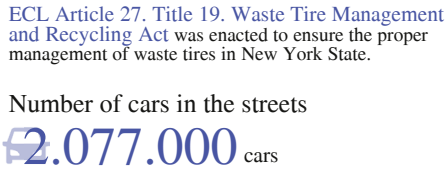


Table 22. *Recicling car tires article and number or cars in the streets in New York.*

was designed to ensure proper collection and recycling of discarded tires. This regulation aims not only to reduce the amount of tires that

ends up in landfills, but also to **encourage the use of recycled materials in the manufacture of new products or projects.**

New York, as the most populous and predominantly urban city in the US, **faces a huge demand for food that must be grown and transported from other regions,** which contributes significantly to pollution levels. Garub could offer a solution which, although low in initial impact, would contribute progressively to **reducing this demand and consequently the pollution rates**. In addition, its role would be not only practical but also educational, teaching people to grow their own food within their homes. Designed to fit in small spaces, Garub fits into the New York lifestyle where apartments are often cramped. This not only promotes self-sufficiency, but also a sustainable alternative for urban life.

Conclusions and Next Steps

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Conclusions

The project led to several important conclusions. First and foremost, a **notable interest in the product was observed among most participants**, suggesting its potential appeal to a broader audience. However, given that the surveys and testing were conducted with a relatively small group of individuals, it is necessary to approach this finding with caution. Until further studies are carried out with a larger and more diverse sample size, **the product's overall acceptance remains a hypothesis to be validated**. Another critical aspect identified is the need for **visual support materials,** such as instructional manuals or diagrams, to guide users effectively. Certain components and functions, particularly the semi-automated irrigation system, are not entirely self-explanatory, which could hinder ease of use without additional guidance.

Regarding the irrigation system itself, while it offers a **practical and efficient solution for most plants**, **it is not universally suitable**. Some plant species are highly sensitive to excess water and could suffer or even die if submerged for prolonged periods. Therefore, it becomes essential **to conduct further research to identify these specific plant types and provide clear recommendations to users on compatible species.** Another noteworthy conclusion is the product's potential to act as a tool for **reconnecting individuals with nature, particularly within urban environments.** Its compact size, versatility, and ease of use make it an excellent option for incorporating greenery into apartments or small spaces. Moreover, its design provides an easy and stress-free way for beginners to care for plants, making it perfect for those new to gardening or with little experience in plant care.

Additionally, the product demonstrated a high level of **adaptability to different geographic, cultural, and demographic contexts.** This flexibility eliminates the need for

region-specific redesigns, as the product's design can seamlessly integrate into a wide variety of environments. This feature not only increases its functionality but also broadens its market potential. Lastly, the findings revealed significant interest among users in **personalizing their pots.** Many expressed a desire to **customize the product's colors, shapes, and styles**, allowing them to custom the design to their individual tastes and preferences. This customization capability not only enhances the product's appeal but also adds a creative and personal dimension to its use, further increasing its value in diverse markets.

Next Steps

As the next steps for the project, a broader test will be conducted with a more diverse group of people, **including individuals of different ages, nationalities, and levels of knowledge about plant care.** The aim of this research is to gather a more comprehensive understanding of the product's acceptance, **ensuring the expectations and needs of the audience.** By conducting this evaluation with a broader user base, we will obtain **more accurate data and strengthen the validation of both the design and functionality of the product.**

Additionally, an analysis will be carried out to **identify plant species that are not suitable for the semi-automated irrigation system** in the pot. This step will involve specific tests and studies to determine which types of plants do not tolerate this irrigation system propuose. With this information, an alternative proposal or a modified version of the product will be developed, maintaining the original design principles but **adapted to meet the particular needs of these more sensitive plants or those with special requirements.**

Finally, a **customization kit will be developed for users who wish to personalize their pots**. This kit will allow users to create their own pots by choosing from a variety of **colors, shapes, and styles,** offering them the opportunity to have a unique product tailored to their tastes. The customization process will be simple and accessible, ensuring that even users with no design experience can create a pot that perfectly fits their preferences and needs, while also enhancing their interaction with the product.

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