CBI4AI Final Report: Swiss Cheezers Team 2

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1. Project Context

1.1. Project Introduction

Our project focused on the challenges faced by the residents of Vereda Granizal, an informal settlement located in Medellin, Colombia. These residents lack access to accessible, affordable, and safe housing infrastructure, which has a significant impact on their quality of life. In our efforts to tackle this problem, we sought to empower the residents to utilize local resources and low-cost materials to build their own housing solutions, fostering a sense of ownership and pride in their community.

Through our project journey, we conducted thorough desk research and engaged in interviews with experts and community members. These activities allowed us to gain valuable insights into the specific needs and aspirations of the residents of Vereda Granizal. Notably, during our interview with Esteban, a designer with experience working closely with the community, we deepened our understanding of their challenges and the importance of involving local stakeholders in the solution-finding process

By addressing the housing infrastructure issues in Vereda Granizal, we hope to enhance the residents' living conditions and foster a stronger sense of community. Our project aligns with the objectives of SDG 9, as it strives to build resilient infrastructure, promote inclusivity, and leverage innovation to address real-world challenges. In the subsequent sections of this report, we will delve into our proposed solutions and the insights gained from our interview, presenting a comprehensive overview of our project's progress and potential for impact.

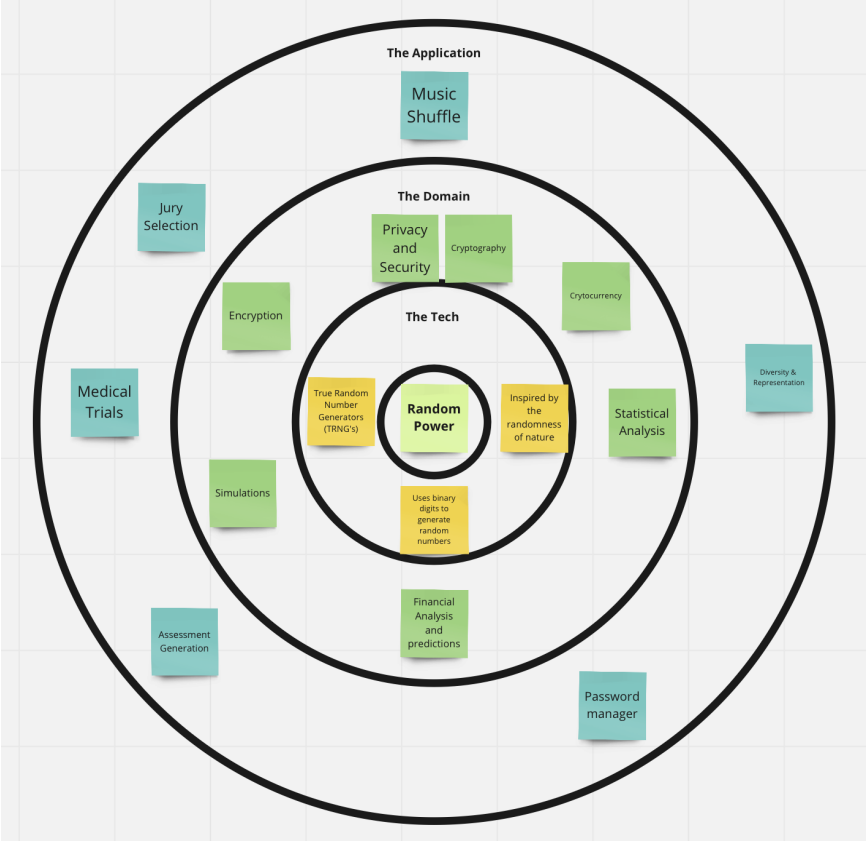
1.2. Understanding SDG9

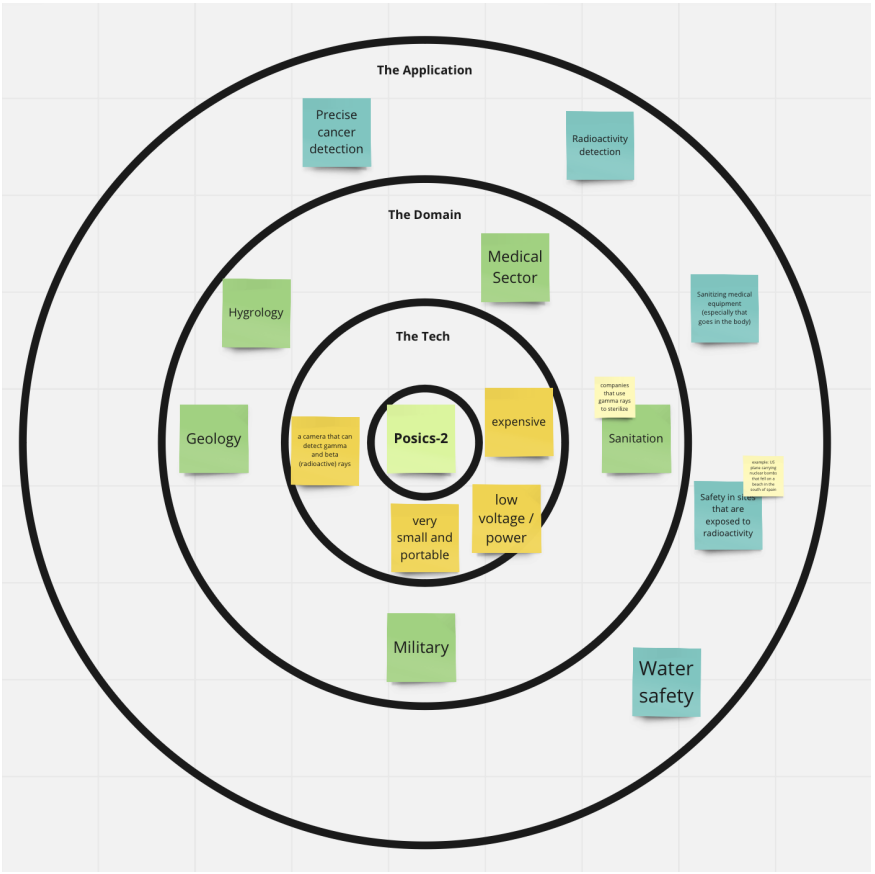
SDG 9, defined by the United Nations, aims to create resilient infrastructure, promote inclusive and sustainable industrialization, and foster innovation. Its key objectives include:

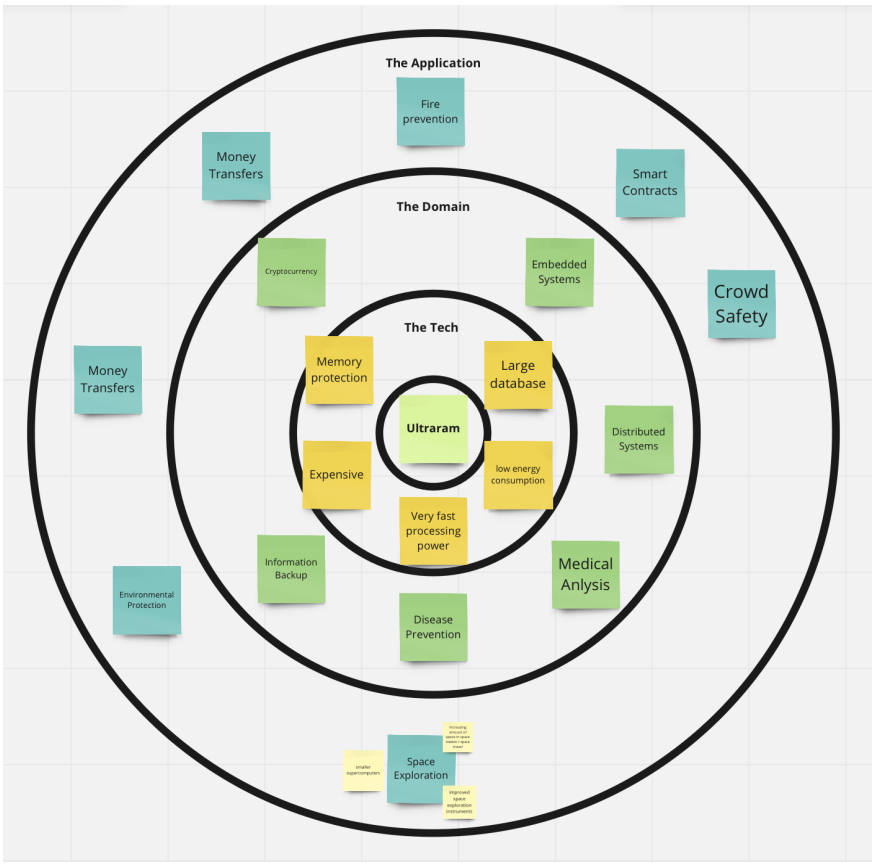
- Increasing investment in research and development to drive technological advancements.
- Upgrading and retrofitting existing infrastructure and industries to align with sustainability principles.
- Promoting sustainable and resilient infrastructure in developing countries.
- Enhancing access to information and communication technologies, especially in underserved areas.
- Facilitating the growth of small and medium-sized enterprises to foster economic development.

1.3. Understanding the ATTRACT Technologies

We spent three days in CERN learning about what CERN does and received answers to some intriguing existential questions. We also learned in depth about the three technologies: Random Power Generator, UltraRAM, and Posic2 Camera. We were able to explore these 3 technologies and learn how we might utilize these technologies in our project boosting the project's impact. We explored what each technology is, their domain and potential use cases. Below is a summary of our learnings and understanding of the three technologies.



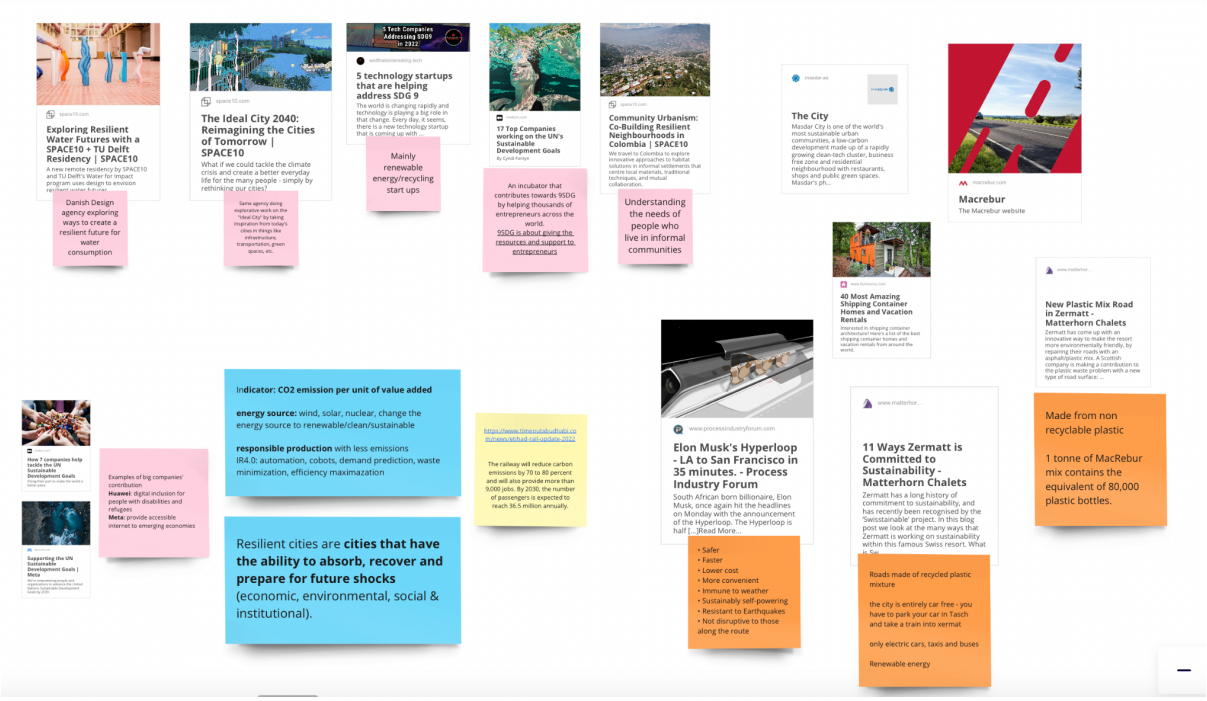

The Application
Precise cancer detection
Radioactivity detection
The Domain
Medical Sector
Hygrology
Sanitizing medical equipment (especially that goes in the body)
The Tech
companies that use gamma rays to sterilize
Geology
a camera that can detect gamma and beta (radioactive) rays
Posics-2
expensive
Sanitation
Safety in sites that are exposed to radioactivity
low voltage / power
very small and portable
Military
Water safety


The Application
Fire prevention
Money Transfers
Smart Contracts
The Domain
Cryptocurrency
Embedded Systems
Crowd Safety
The Tech
Money Transfers
Memory protection
Large database
Ultraram
Distributed Systems
Expensive
low energy consumption
Very fast processing power
Information Backup
Medical Anlysis
Environmental Protection
Disease Prevention
Space Exploration

2. Conceptual Development

2.1 Initial ideation process

During the initial ideation process, we explored various issues related to SDG 9. Our brainstorming sessions covered topics such as insufficient water transport, lack of internet access, road maintenance, food waste, and inadequate housing. After careful consideration, we narrowed down our focus to the three most compelling ideas: Dog Poop Problem, Food Waste, and Inadequate Housing.



2.1.1. Dog Poop Problem

The city of Barcelona, with a dog population of approx 180,000, has faced the problem of uncleared poo on the streets for several years. The government has tried to implement fines to encourage owners to pick up, but this was not as lucrative.

Our idea aimed to tackle the issue of dog waste on the streets of Barcelona by collecting it and converting it into either fertilizer or methane energy. The idea had several advantages, making it a potentially beneficial solution for the city:

1) Environmental Benefits: By collecting and recycling dog waste, the project aimed to reduce the environmental impact of dog waste, which can contribute to water pollution and greenhouse gas emissions. The conversion of waste into fertilizer could have improved soil quality and reduced the need for chemical fertilizers.
2) Public Health Improvement: The initiative aimed to enhance public health by protecting small children and dogs that can become in contact with an infested waste. By effectively collecting and processing the waste, the project aimed to minimize the risk of contamination.

However, after careful consideration, the team decided not to proceed with the dog waste recycling project. Several factors influenced this decision:

1) Technological Challenges: The conversion of dog waste into fertilizer or methane energy posed significant technological challenges. Developing efficient and cost-effective methods for collection, processing, and conversion required substantial research and development.
2) Economic Viability: Assessing the economic viability of the dog waste recycling project raised concerns. The costs associated with collection, transportation, and processing of the waste, along with the necessary infrastructure and equipment, were substantial.
3) Weak connection to SDG 9: Evaluation of this project idea lead us to a conclusion that this project has no direct impact on the infrastructure, industry or innovation, three main topics included in SDG 9.

Considering these factors, we made the decision to pursue an alternative project that presented a more feasible and impactful solution.

2.1.2. Food Waste

Each year about 1.2 billion tonnes of food is wasted WorldWide. The majority of this waste is found at the end of the supply chain during consumption. Our conversation about this problem revolved around preventive rather than reactive. Our idea was to leverage AI technology to predict instances of food waste in restaurants and redirect the excess food to more meaningful causes. Besides bringing efficiency in waste reduction, this project would also create social and environmental impact.

However, after thorough discussions, we decided not to pursue this project idea. Here are the reasons:

1) Existence of Solutions in the Market: In big cities, like Barcelona, where there is a high density of restaurants, there are many solutions available to the public, e.g. apps like “Too Good To Go” address the problem of food waste.
2) Different SDG: There is a different sustainable development goal (SDG 2: Zero Hunger) that is directly related to the project, so we decided to explore alternative ideas instead, that are closely related to SDG 9.

2.1.3. Inadequate housing

Inadequate housing refers to a situation where a country or locality experiences a shortage of available housing in relation to the demand. This shortage does not imply a complete absence of vacant homes, but rather a lack of housing options that are suitable in terms of affordability and cater to the diverse economic groups in need of housing.

We explored how inadequate housing plays a role in these following situations:

Refugee Camps

A refugee camp can be described as a designated area where people are accommodated in informal housing arrangements, such as tents or temporary structures, often arranged in dormitory-style layouts. These housing solutions are intended for temporary use, as the length of stay is typically undefined. Refugee camps provide a provisional shelter for individuals and families, offering basic living conditions and minimal amenities to address their immediate needs in a situation of displacement or refuge.

Daddab Refugee Camp

Through research we found the Daddab Refugee camp which is located in eastern Kenya, it is home to about 219,000 refugee asylum seekers from South Sudan, Somalia, Ethiopia, Eritrea, Democratic Republic of Congo, Burundi and Rwanda. These are people who have fled their home countries due to conflict, persecution or other forms of violence or instability. There are several problems that are experienced by the camp and their residents. They have a lack of durable and resilient housing and many residents live in makeshift shelters from basic materials such as mud, sticks and plastic sheeting. This region of Kenya is also prone to natural disasters such as flooding, droughts and fires. We found that about 15% of the refugees in the camp suffer from physical disabilities exacerbating this housing issue. As a consequence of the natural disasters the residents have to frequently rebuild their shelters. Resources and labor are expensive and this overall creates the problem of overcrowding and unsanitary conditions.

Here we understood how inadequate housing can play a role in a living situation with an undefined time period. Utilizing design thinking processes we explored solutions to resolve these issues. We wanted to encourage these camps to maintain more long term housing solutions while being aware of the political implications of this. We wanted these homes to take into account the personal situations of each family and accommodate them appropriately. So how might we build more low cost and customized housing to create more resilient neighborhoods at refugee camps in Kenya?

Our thought was based on creating a resource allocation system that optimizes the housing for customization. Currently the homes are not customized for the sizes of families, disabilities and pets. We thought we could create an AI algorithm that would help determine the most optimized resource allocation for land, material etc based on the information about the families including size, age, gender, etc.

Disaster related inadequate housing

Inadequate housing in disaster-prone areas refers to the insufficient availability of safe and secure housing options that can withstand the impact of natural disasters. Temporary housing in disaster-prone areas refers to the provision of short-term shelter solutions for individuals and communities affected by natural disasters. These temporary housing structures are designed to quickly accommodate displaced individuals until more permanent housing solutions can be implemented. Temporary housing often takes the form of

prefabricated or modular units, tents, or emergency shelters that can be rapidly deployed in response to disasters.

We explored this issue through the lens of the housing situation in the Philippines. We learned that the Philippines ranks as the third most disaster-prone country in the world based on the World Risk Index and 70 million people live in substandard housing. These numbers are projected to grow by 113 million people by 2030. The country is located in areas of high seismic risk and each year experiences approximately 20 typhoons. Our discussions revolved around finding solutions that allowed resilient homes to be built in short turn over times to rapidly accommodate the sudden shortage.

Informal settlements

Informal settlements can be characterized as a form of inadequate housing. These settlements typically emerge in urban or peri-urban areas, often unplanned and lacking proper legal recognition or infrastructure. Informal settlements are characterized by the presence of makeshift or self-constructed dwellings, which may consist of temporary materials like scrap metal, cardboard, or tarpaulins. These settlements are typically established by marginalized populations who are unable to afford formal housing due to economic constraints or exclusion from the formal housing market.

One of the main characteristics that define an informal settlement are the self constructed nature of the communities. This is what eventually inspired our final project proposal.

Verada Granizal

Vereda Granizal is an informal housing settlement located on the outskirts of Medellin, Colombia. People originally migrated to Vereda Granizal from their hometown in rural Colombia due to the armed conflict in the 1990's. Many thought their stay would be temporary while they looked for something more permanent in the city. However, 30 years have passed and many of the residents are still living there today.

The problem is that because the city of Medellin doesn't recognize Vereda Granizal as officially part of the municipality, the community lacks access to basic services such as water, energy, sewage, and waste management. Because many residents imagined their stay to be temporary, they only recently began investing in creating these services for themselves on their own.

"Such temporariness affects not only people's health and well-being but their ability to earn and income, and quality and safety of their home"
(*Community Urbanism: Co-Building Resilient Neighborhoods in Colombia,* Space10)

Residents of the community have a collaborative method for developing their community called the "Combite". During this process residents get together with a community development objective in mind over a local soup called "Sancocho". They share a meal together and work towards the defined objective. This bottom-up approach puts the residents at the center of the decision making when deliberating on how to make forward progress in the community.

The people of the community built their homes over time by purchasing resources or acquiring them locally. Having learned this we were inspired to create solutions around aiding this community. We wanted to provide them with solutions that educate them to efficiently use their resources and knowledge while designing spaces and products that could create a sense of permanence within the community.

During the initial stages of our project, we encountered various challenges within the broad scope of inadequate housing. However, as part of our research efforts, we had the opportunity to connect with a designer who has been actively engaged with the community. Recognizing the invaluable insights and firsthand experience he could provide, we made a collective decision to focus our efforts specifically on addressing the needs and aspirations of the Verada Granizal community. This strategic shift allows us to gain a deeper understanding of the community's unique context, enabling us to develop a more targeted and impactful solution. By leveraging the expertise and insights shared by the designer, we were confident that our project would be better equipped to address the pressing housing issues faced by the community in a meaningful and sustainable manner.

Figure 1. Photo of Verada Granizal Community

2.2. Initial Solution Proposal

While deciding which specific housing issue to focus on we explored different solutions that could resolve the problem of inadequate housing. We were exploring ideas of how to build homes that were quick to erect and are resilient in nature. 3D printing homes was a solution that we explored in depth. [1]

[1] https://space10.com/project/community-urbanism/

3D printed homes

During our ideation process, we considered the potential of 3D printed homes as a solution for the housing challenges. The concept intrigued us due to the speed and cost-effectiveness of 3D printing technology[2], which could enable faster and more affordable home construction. We explored possibilities of how Ultra Ram could possibly aid in speeding up the building process and maybe reduce the power usage.

However, upon further research and analysis, we found several reasons why 3D printed homes might not be feasible or affordable. Firstly, the initial investment required to acquire the necessary 3D printing equipment was too costly for the community's resources. Additionally, the lack of trained personnel skilled in operating and maintaining 3D printers posed a significant challenge.

Moreover, the availability of affordable and sustainable construction materials suitable for 3D printing in the local context was limited. Transportation costs and difficulties in sourcing specialized materials further hindered the viability of this solution.

Finally, the community is located on a steep hill with some sections reaching up to 40% grades making it extremely difficult to get the printers in position to print

Considering these factors, we collectively decided to explore alternative approaches that utilized local resources and low-cost materials, ensuring the affordability and sustainability of housing infrastructure.

2.3. Problem Validation: Interview with Esteban

Through desk research we found a design and research lab called “Space10” that focuses on exploring ways for creating “a better everyday life for people and the planet”. On their website we discovered their “Community Urbanism” project which is centered around an informal settlement called Vereda Granizal on the outskirts of Medellin, Colombia. The project aims to explore innovative approaches to habitat solutions in informal settlements that centre local materials, traditional techniques, and mutual collaboration. It was led by their in-house designer and prototyper – Esteban Gomez Ramirez.

We reached out to Esteban asking for an interview to learn more about his multiple visits to the community in recent years to better understand the problems the residents of the community are experiencing.

[2] https://cobod.com/advantages-and-disadvantages-of-a-3d-printed-house

After speaking to Esteban we learned three important pieces of information that drove our decision making during our ideation and prototyping. They were:

1. **Vereda Granizal thrives on co-building:** they employ a collaborative process for community building called the “combite”. This is a tradition in which residents get together with a community development objective in mind. Everyone contributes what they can whether it be knowledge, labor, or materials. They celebrate their efforts over a traditional soup called “Sanchoco”.
2. **Residents are open to progressive forms of construction:** many men in the community work in construction and often combine traditional techniques with modern processes
3. **Residents collect plastic in garages around the community to sell to recycling facilities**

This got our project thinking about how we might continue to empower the residents of this community to combine their local knowledge and materials to build their territoriality at a low cost.

3. Final Solution

3.1. The Solution

After conducting thorough research on the community and gaining valuable insights from Esteban, we were inspired to make a focused decision to empower the home-building process of the specific community in Medellin through low-cost technology. Through our interview, we discovered that the local residents are open-minded and willing to embrace new construction methods. Furthermore, local residents have abundant access to plastic materials.

Recognizing the potential of utilizing recycled plastics, particularly in furniture production, we have identified a critical gap in the process. We found a company, Precious Plastics, that provides resources to communities and people to upcycle their plastic waste using two simple machines. One is a shredder that shreds recycled plastic into chips and the second is a heat press that compresses these chips into sheets of plastic that can then be used to create functional and purposeful objects.

Our solution also involves leveraging AI to optimize the cutting plan, taking into account the available backlog of materials. By analyzing the shapes and sizes required for furniture components, our algorithm will minimize waste and maximize the use of plastic resources. This approach ensures efficient utilization of materials while providing the community with affordable and accessible furniture solutions.

Through this innovative solution, we aim to empower the residents of the community by enabling them to create functional and sustainable furniture using local resources. But also encouraging them to create aesthetic objects for their community. This would allow them to create more public spaces fostering a sense of community and permanence. By combining

technology, local materials, and community engagement, we strive to enhance the living conditions and promote a sense of pride and ownership within the community.

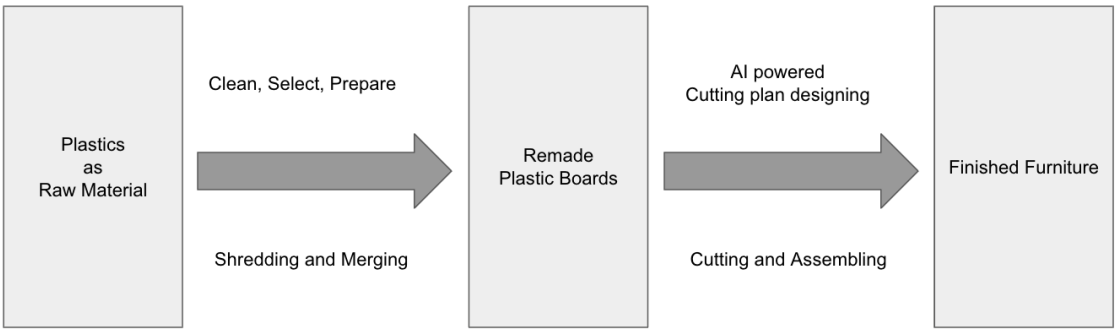


Figure 2. Process Flow of the Solution.

3.2. The Technological Approach

2.3.1. Artificial Intelligence

AI plays a crucial role in our solution by leveraging cutting-edge technologies to optimize the cutting plan and effectively manage the inventory of materials. We draw inspiration from industry leaders such as IKEA, who have successfully implemented AI-driven systems to optimize production processes and material utilization. These companies utilize AI algorithms to analyze furniture designs, calculate the most efficient cutting patterns, and minimize waste.

Additionally, innovative inventory management systems, like those employed by PQR Industries, utilize AI to track and manage material stocks, ensuring timely availability and efficient utilization. Taking cues from these industry examples, our solution aims to incorporate similar AI-powered capabilities, enabling us to optimize the cutting plan for plastic boards and effectively manage the backlog of available materials. By harnessing AI technology, we empower the community in Medellin to build functional and sustainable furniture with minimal waste and maximum resource utilization.

2.3.2. ATTRACT Technology

After exploring and assessing the three technologies we delved into during our research—random power generator, Posics 2 radiation-detecting camera, and UltraRAM—we have made the decision not to incorporate them into our project for optimizing the cutting plan and managing inventory materials in the community. While these technologies showcase great potential across various industries, we have determined we wanted our focus to be in benefit of our selected cause. The random power generator, although promising, does not significantly enhance our AI algorithm training process due to the manageable size of our training data. Similarly, the improved speed offered by UltraRAM is not a critical factor for our project's success. Furthermore, the Posics 2 camera, while impressive in radiation detection, does not offer tangible user value within the context of our solution. Therefore, our project's focus remains on addressing the social problem at hand and providing a practical, accessible, and user-friendly solution for the community.

3.3. Prototyping

We prototyped a program that the residents could use to determine the optimized cutlines for the recycled plastic sheet that they have produced using the precious plastic machinery. The program would use an AI algorithm to determine the optical cut lines for a backlog of projects the residents want to create. Through a simple UI design users are prompted to insert their

project details such as the shapes they need to build their project, the number of pieces required and the size. The users are then prompted to add this information to a backlog of other projects they would like to build and then eventually use the backlock to determine the most optimized cut lines that reduce material waste.

4. Key Challenges and learnings

4.1. Challenges faced during the project

Throughout the course of this project, we encountered several notable challenges that tested our abilities and required us to find effective solutions.

1. **Setting direction of the project**

   We initially faced limitations in understanding the specific social problems to focus on and determining the scope of our project. However, by actively seeking guidance from professors and drawing inspiration from past projects, we were able to overcome these limitations and gain clarity on our project direction.

2. **Working in a diverse team**

   Working in a diverse team presented its own set of challenges. As we navigated through the project, we encountered frictions and differences in opinions, particularly when there was a lack of progress or a clear definition of the problem. Managing team dynamics and fostering effective communication became crucial in resolving conflicts and ensuring collective progress.

3. **Project management skills**

   Project management, particularly with regards to time, posed challenges. Balancing individual schedules and finding common meeting times proved to be a hurdle, resulting in occasional delays in progress. However, through effective coordination and open communication, we were able to navigate these time constraints and keep the project moving forward.

These challenges served as valuable learning experiences, allowing us to develop skills in problem-solving, teamwork, and project management. By addressing these obstacles head-on, we were able to overcome them and strengthen our collaboration, ultimately leading to the successful execution of the project.

4.2. Key learnings and takeaways

1. **Communication is Key**

   Firstly, we discovered that effective communication is essential for project success. We learned the significance of asking for clarifications and seeking guidance when faced with uncertainties or limitations. By actively engaging in open and transparent communication, we fostered a collaborative environment that encouraged idea-sharing, problem-solving, and continuous improvement.

2. **The power of Artificial Intelligence**

   Our project also allowed us to explore the vast potential of AI and its applications in various fields. However, we also recognized that implementing AI solutions comes with considerations such as cost, feasibility, and ethical implications. Through our research and exploration, we gained a deeper understanding of how AI can be harnessed to address real-world problems. For instance, we examined industry examples where AI is used to optimize cutting plans in manufacturing processes, such as the case of IKEA, which utilizes AI algorithms to minimize material waste and enhance efficiency.

3. **The importance of diversity in teams**

   Lastly, our diverse team composition proved to be a significant asset. The diverse backgrounds, perspectives, and skill sets within our team fostered an environment of innovation and creativity. We embraced the value of diversity, recognizing that it brings forth a range of ideas and approaches that ultimately lead to better outcomes. Our collaboration allowed us to leverage our individual strengths and learn from one another, ultimately enriching our problem-solving capabilities.