Report

Foldable Disaster Shelter

Author(s):

- Eduardo Jorge Canossa Pereira
- Daniela-Andreea Popescu
- Gabriel Jean-Louis Robert Givanovitch
- Jelte Bakker
- Vladimir Dukoski
- Lore Pauwels

Acknowledgement

Team 3 would like to express their deepest gratitude to Instituto Superior de Engenharia do Porto (ISEP) and to the European Project Semester (EPS) organizers and teachers that are giving us their time and the chance to have an amazing opportunity to be involved in a project that challenges us and allows us to grow both at a personal and professional level, not only as individuals but also as a team.

Glossary

Abbreviation	Description
EPS	European Project Semester
ISEP	Instituto Superior de Engenharia do Porto
BIS	Beautiful International Students
WBS	Work Breakdown Structure
UNHCR	United Nations Commissioner on Refugees / The UN Refugee Agency
ICRC	International Committee of the Red Cross
IFRC	International Federation of Red Cross and Red Crescent Societies

Abbreviation	Description
RCMRS	Reusable, Customizable, Modular, Reliable and Structure(from nature)

1 Introduction

This report thoroughly describes Team 3's work and progress during the European Project Semester at Instituto Superior de Engenharia do Porto in the second semester of the academic year 2019/2020. In the chapter, “Introduction”, the team will be introduced and a short overview of the entire project will be provided.

1.1 Team introduction

BIS (Beautiful International Students) consists of six students, all with different backgrounds of education and all from different countries. We are spending the spring semester of 2020 in Porto working at ISEP on our European Project Semester.

The team members:

- Eduardo Jorge Canossa Pereira (Automotive Engineering) from Portugal
- Daniela-Andreea Popescu (Industrial design) from Romania
- Gabriel Jean-Louis Robert Givanovitch (Structural Material Engineering) from France
- Jelte Bakker (Applied Physics) from the Netherlands
- Vladimir Dukoski (Digital Business Informatics) from Macedonia
- Lore Pauwels (Product Development) from Belgium

1.2 Motivation

The purpose to enroll in the European Project Semester was similar for every member of the group. The main goal was to learn to work with different cultures, fields, personalities and different ways to think.
Our main objectives are:

- Challenge ourselves to manage different situations
- Gain knowledge about different subjects
- Learn to work with different cultures and different fields
- Work in an international environment
- Get out of comfort zone
- Learn how to work in groups to achieve a common goal in a project
- Improve communication skills

During this semester, BIS members want to contribute to devise solutions for people inhabiting in disaster-affected areas by designing an innovative shelter.

1.3 Problem

Natural disasters are extreme, sudden events caused by environmental factors that injure people and damage property. Earthquakes, windstorms, floods, and other disasters that strike anywhere on Earth, often without warning. As examples, we have chosen these disasters that have occurred around the world throughout history so we can analyze what has happened so far, wishing to create a conducive environment for the affected people.
In many countries around the world, at one point, a disaster occurred, either environmental or because of wars or other problems, so that a huge number of people were affected, as were the buildings.
Some examples of disasters are explained below:

1. Country: In the USA, San Francisco;
   Disaster: Earthquake and fire;
   Disaster date: April 18th, 1908;
   No. of houses damaged: 28,000 buildings and 500 city blocks – one-quarter of the city of San Francisco;
   No. of people homeless: 225,000.
2. Country: Malawi;
   Disaster: Earthquake;
   Disaster date: December 6th and 20th, 2009;
   No. of houses damaged: 6,000;
   No. of people affected: 24,000.
3. Country: Haiti;
   Disaster: Earthquake;
   Disaster date: January 12th, 2010;
   No. of houses damaged or destroyed: 180,000.
4. Country: Romania;
   Disaster: Heavy rain and flooding in 24 counties of Romania;
   Disaster date: June, July 2010;
   No. of houses damaged: Over 800 houses completely destroyed and more than 7,000 houses damaged;
   No. of people displaced: 15,000.

There are a lot of such disasters that have taken place worldwide, so there are a lot of solutions on the market to make up for the disaster. So, to create the safe environment that is needed, the BIS team intends to place the shelters in the Equator area as it is an area with fewer risks, being an area with high temperatures and a pleasant environment.
Hurricanes tend not to form on the Equator, and only rarely a few degrees north and south of it, because that area is not sufficiently affected by the Coriolis force of the rotating Earth to give the generating winds the spin necessary to form hurricanes.
Hurricanes tend not to form farther North and south of the 25-degree latitudes because the climate is too cold to provide the heat energy they need.
In disaster impacted areas it is not always possible to shelter all the affected people. To minimize the damage to the troubled families it is important to have a shelter at your disposal as soon as possible. For this reason, it is important to create a portable shelter which is easy to bring to disaster-impacted areas.

Some considerations that the team must face are:

- The limited budget for the project

- The short time frame (two months) to propose a feasible solution
- The reduced possibilities to explore different properties of materials
- The required response time frame to meet the target audience's needs
- Locating adequate areas to install a large number of shelters
- Constrains considering the folding system and transport:

1. The shelter folding system so that it occupies the least space as possible.
2. The appropriate transport for the shelter packages, considering the transport harsh conditions.

1.4 Objectives

The main objective of this project is to develop a foldable disaster shelter considering the materials and the energy used and the procurement processes so that the concept of sustainability is respected. During the project, the marketing perspectives, the environmental issues, and the ethical side need to be scaffolded and applied to fulfill the requirements.
The purpose of the project is to create an easy-to-use product, user-and-environmentally friendly, to be fully functional, customizable and maintained for a long time on the market.
Shelters are used to provide private and secure places for people to live who have left or lost their usual accommodations as a result of some form of disaster.
SafeBIS shelters not only provide immediate and short-term shelter for the victims of a disaster, but they also help them to recover from the trauma of a disaster as well as provide a base to start the process of rehabilitation.

1.5 Requirements

We define the requirements to ensure that the shelter will meet the desired goal. On the basis of some subcategories, the requirements are:

Initial requirements:

- Use low-cost hardware solutions;
- Comply with the following EU Directives:
    - Machine Directive**[1]**;
    - Electromagnetic Compatibility**[2]**;
    - Low Voltage Directive**[3]**;
    - Radio Equipment Directive**[4]**;
    - Restriction of Hazardous Substances (ROHS) in Electrical and Electronic Equipment Directive**[5]**;
- Mandatory adoption and use of the International System of Units**[6]**;
- Use open-source software and technologies.

Usability requirements:

- ease of use and assembly;
- quick folding;
- ease of cleaning and maintenance.

Functional requirements:

- to protect people against disasters;

- to be foldable;
- to include a fixing system to ensure the shelter to be fixed on the desired location;
- to be light enough to be easily handled;
- to include the necessary elements to support life inside.

Environmental requirements:

- the product is made out of materials which ensure a long lifespan/sustainability;
- the production is not harmful to the environment;
- use of natural, renewable resources, low energy consumption.

Limitations:

- to use a maximum budget of 100 € to build a prototype, low-cost hardware solutions and open-source software.

1.6 Functional Tests

During the process, a prototype will be produced. The prototype will help to eliminate uncertainties that are still in the picture and to evaluate the design of the shelter. The evaluation exists out of a few functional tests. The main objective of these tests is to find problems not detected during the theoretical part of the project so they might be corrected and have a functional product, ready to be placed on the market. The tests to be performed are as follows:

Structure safety
-A first test examines if the shelter is strong enough to protect the victims during extreme weather conditions.
-The second test is set up to examine if the shelter stays fixed to the desired location during extreme weather conditions.
All tests need to be done in simulation software to simulate bad weather conditions and the forces to which it is applied.
Usability
- In this test will be checked if the shelter can be folded/unfolded individually in a very short time. For this test, the prototype is invoked.
Material analysis
-Sustainable and good insulating materials will be used to keep the temperature and humidity inside the shelter in normal parameters so as to create favorable conditions for living safely.
These materials will be tested with forces and tensions in the software used to obtain the strengths and weaknesses which will then be remedied.

1.7 Project Planning

The project is coordinated according to agile project management in terms of Scrum methodology. “Scrum addresses the complexity of software development projects by implementing the inspection, adaptation, and visibility requirements of empirical process control with a set of simple practices and rules” **[7]**.

“SCRUM is a management, enhancement and maintenance methodology for an existing system or production prototype” **[8]**.

Software product releases are planned based on the following variables:

- Customer requirements - how the current system needs enhancing
- Time pressure - what time frame is required to gain a competitive advantage
- Competition - what is the competition up to, and what is required to best them
- Quality - what is the required quality, given the above variables
- Vision - what changes are required at this stage to fulfill the system vision
- Resource - what staff and funding are available

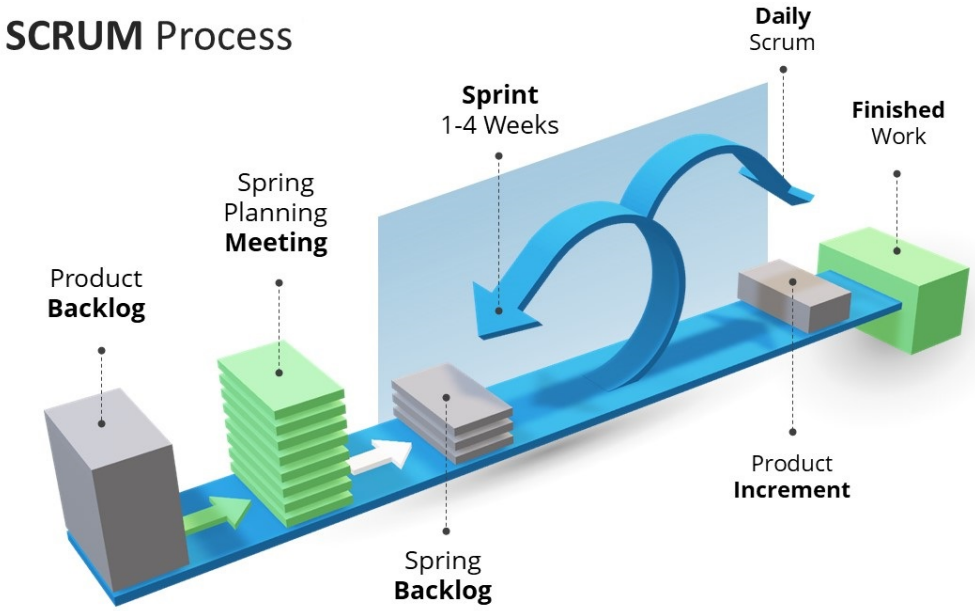


Figure 1: Scrum Process[9]

Table 1 provides an overview of our planning, mainly considering the initial tasks, the project course, the specific planning including the schematics, the decision on materials to use, and the communication channels.

Table 1: Planning Table

Task	Team Member
Initial Planning	
Task Allocation	The Team
Project Proposal	The Team
Gantt Chart	Lore
Initial Budget Planning	The Team
Project Leading	
Existing products	The Team
Technical Research	The Team
Marketing Research	Vladimir
Design Research	Andreea, Lore, Jelte, Gabriel
Project Management	Andreea, Lore
Eco-Efficiency and Sustainability	Jelte
Ethical and Deontological Concerns	Andreea, Lore
Specific Planning	

Task	Team Member
Initial Planning	
Schemes and Diagrams	The Team
Schematics	
Drafts	Andreea, Lore, Gabriel
3D Drafts	Eduardo
Materials	
List	Andreea
Providers	The Team
Communication	
Wiki	Andreea, Lore
PPT	Andreea
Manual	
Video	
Report	
Interim	
Presentation	Gabriel
Report	The Team
Upload Interim Report and Presentation	Andreea, Lore
Upload Refined Interim Report	
Complete List of Materials	
Construction	
Assembly	
Test	
Functional Tests	
Upload Functional Test Results	
Final	
Final Report & Presentation	
Poster, Paper, Video, Manual	
Upload the Wiki	
Prototype and Demonstration	

1.8 Report Structure

This report is organized into eight chapters which are described in Table 2.

Table 2: Report Structure

Chapter	Title	Purpose
1	Introduction	to introduce the team and the project with its objectives and requirements, defining the topic and the possible expectations
2	State of the Art	to analyze the current state of the market; State of the Art is not a one-way road, is a step to demonstrate the novelty of your research results.

Chapter	Title	Purpose
3	Project Management	to comprise the documentation of the progress including all the tasks and all the available resources
4	Marketing Plan	to identify the target of the product and to build a long-term marketing strategy that can be applied for incipient solutions
5	Eco-efficiency Measures for Sustainability	to identify the optimum constructive variants from a social, economic and environmental point of view and to identify the necessary components following tests to maximize the sustainability
6	Ethical and Deontological Concerns	to analyze the ethical challenges and limitation in order to find their solutions
7	Project Development	to present the steps that the team has defined throughout the whole project, taking into account all the suggested aspects and problems, analyzing the final results that can be implemented in a complete and functional prototype
8	Conclusions	to sum up the result and the achievements and to present the possibility of implementing the prototype in a functional product

2 State of the Art

2.1 Introduction

In this chapter, the objective is to present the initial research in order to better understand what is required from a foldable disaster shelter before starting the development of a product and/or solution. Therefore, this chapter will focus on the basic principles that define a shelter, its main functions, existing designs and the possible features and functions that can be added.
The team started doing a brief market study for existing products in different categories, from emergency to animal shelters, in order to determine what type of shelter would be best suited for our project. This study also allows us to determine what kind of situations the shelter could be deployed for and in that way determine an effective way to develop a product that will have a meaningful impact on the market and be able to set itself apart from others.
Furthermore, this shelter is intended not only to be original and innovative in its design but also to have a very low carbon footprint by using sustainable/recycled materials preferably sourced locally so it also supports the local economy and its inhabitants as well as being an optimum lowcost solution that can be easily acquired, stored, maintained and deployed when needed.

2.2 Disaster Shelter

In order to understand what an emergency shelter should be like, what purpose it must serve, first it is necessary to understand what it really is. For that, the UNHCR created the Emergency Handbook, a guide to humanitarian responses. Most of the information present in this chapter was obtained from this organization since they are the authority in emergency responses **[10]**.

The following standards are present in *The Sphere Handbook 2018* and they represent the minimum internationally recognized quantifiable standards applicable throughout all operational stages.

2.2.1 Emergency Shelter Standard

According to UNHCR, “A shelter is defined as a habitable covered living space providing a secure and healthy living environment with privacy and dignity” and therefore it should be adequate for every situation. It should serve as a protection from the elements, as a space to live and somewhere to store belongings and it should give a sense of privacy, comfort and emotional security.

In addition, family shelters should be preferred to communal accommodations due to the fact that the previous provides the privacy and psychological comfort, the security for the people and their possessions in times of turmoil and it also aids to preserve or rebuild family unity.

Despite of the type of emergency shelter that is necessary, there is a common thread of basic requirements that every shelter should follow:

- Protection from the elements, space to live and store belongings, privacy, and emotional security.
- Blankets, mats, and tarps must be provided as needed.
- Be culturally and socially appropriate and familiar where possible. The use of local materials is preferred.
- Be adequate regardless of seasonal weather patterns, if not, it should be adapted accordingly.
- Wherever possible, empower refugees to build their own shelter, provide the necessary organizational and material support. This helps to ensure that dwellings meet their occupant’s needs thus generating a sense of ownership and self-reliance while reducing costs and construction time considerably.

As for the “architecture” of an emergency shelter, its needs can be best met by using materials and designs that persons of concern or the local population would normally use. Materials should not be imported unless adequate local materials cannot be obtained quickly or in an environmentally responsible manner. The simplest structures and the least labour-intensive building methods are preferable.

The fifth requirement mentioned above can only be followed if the adequate amount of materials and tools can be locally and easily obtained. Otherwise, in case of emergencies with a high volume of displaced people and local constructions that cannot meet the immediate shelter needs, it is advised that the shelters and/or the necessary materials be brought into the country.

One of the key features of a shelter design is to allow, if possible, modifications by its occupants in order to better suit their individual needs.

Shelter Standards

There are standards for the minimum amount of space and height that shelters must-have. Those requirements are as follows:

For warm climate deployment

- Minimum of 3.5 m^2 for covered living space per person in tropical or warm climates, excluding cooking facilities or kitchen (assuming cooking will take place outside).
- Minimum height of 2 m at the highest point.

For cold climate deployment

- Minimum 4.5 m² to 5.5 m² covered living space per person in cold climates, including kitchen facilities as more time will be spent inside the shelter (cooking, eating, and livelihood).
- Maximum ceiling height of 2 m to reduce the heated space.

Cold Climate Considerations

In cold climates, where cold weather with rain and/or snow is prevalent, there is a different set of requirements that needs to be considered for the shelter due to the amount of time people will spend inside it. There might even be a need for dedicated heating and enclosed space in each shelter in order to maintain adequate temperature.

A downside to this is that shelters that can withstand these harsh conditions need a higher standard of build quality and that entails a more complex and, therefore, more expensive shelter. There are special considerations that need to be made in the design of this type of shelter regarding:

- Structural stability - in the event of strong winds and snowfall;
- Protection from debris;
- Protected and heated kitchens and sanitary facilities;
- Provision for heating.

To help the refugees survive and have somewhat of a comfortable living despite the situation and the cold weather, the shelter should focus on a few different areas.

Individual survival

It is extremely important to protect the human body from heat loss. Particularly during sleep, it is of the utmost importance for one to be able to keep warm by retaining body heat, if necessary, with the use of blankets, sleeping bags, clothing and shoes. Heat can be generated by providing food with high calorific value or with the use of a heating element.

Living space

It is very important to concentrate on limited living space and to ensure that cold air can be kept out from it. This can be done by sealing the room with plastic sheeting and sealing tapes. Windows and doors should be covered with translucent plastic sheeting and secured on window and door frames. Walls, ceilings, and floors of the living space should be designed to insulate from cold air and to retain warm air as efficiently as possible.

Heating

Keeping the inside of a shelter at a comfortable temperature (15 to 19 °C) depends to a large extent on the outside temperature, the type of construction, the quality of the insulation, the orientation of the building, and on the type and capacity of the stove. Depending on conditions, a stove with 5 to 7 kW performance should have the capacity to heat a space with a floor area of 40 to 70 m² in most cold areas. When the stove for heating is used for cooking as well, special attention should be given to its stability.

Also, where there are daily extremes of temperatures, lack of adequate shelter and clothing can have a major adverse effect on the protection and well-being of refugees, including health and nutritional status.

Longer-term standard

As it was previously mentioned and emphasized, these remain as the minimum standards. In case it is necessary to maintain a shelter for a longer period of time, it is imperative to consider the next steps of the sheltering process as soon as possible. The followed approach should bridge the gap between emergency, temporary, and permanent shelter but also link relief, rehabilitation, and development.

For this kind of situations, where a longer stay is necessary, it is expected that the shelter provides the refugees with the possibility to make adjustments in order to find a long-lasting solution. Shelter solutions need to be adapted and contextualized according to the elements presented in the target location. Elements such as:

- Geographical context
- Climate
- Cultural practice and habits
- Local availability of skills
- Access to adequate construction materials

The standards that are to be applied to temporary and/or permanent shelters depend on the situation and they need to be defined by the shelter partners and in close coordination with government authorities and development partners.

The lifespan of an erected canvas tent depends on the length of storage before deployment, as well as the climate and the care given by its occupants. Where tents are used for a longer duration, provisions for repair materials should be considered. In general, tents are difficult to heat as walls and roof provide limited insulation and can be an expensive item if not in stock (airlifting cost).

2.2.2 Shelter Solutions

Now that the fundamental concepts and requirements for emergency shelters are established, it is necessary to delve into possible shelter solutions to better understand what is necessary to design one.

On this matter, the UNHCR **[11]** presents some other characteristics and concerns that should be considered when designing a shelter as well as an *Emergency Shelter Catalogue* **[12]**.

According to the overview of this page, it is important to mention that the location will impact the response, therefore, the specific characteristics of an urban shelter differ from those of one needed in rural areas. It is of the utmost importance that shelter responses need to be adapted to take account of the local context and climate, cultural practices and habits, local skills, and available construction materials.

Rarely does one shelter solution fit all the needs of the displaced populations. It is best practice to provide the widest palette of options possible. Which may include cash assistance, rental support, construction materials, transitional shelter, shelter kits, plastic sheeting, tents, among others.

The table below summarizes the various settlement options with their most associated shelter solutions:

Table 3: Types of shelters **[13]**

Settlement	Most frequently used shelter Solutions
Planned and managed camps	Tents; Shelter kit; Plastic sheeting; Transitional/Temporary shelters; Local construction materials
Hosting villages	Shared accommodation or shared property - Plastic sheeting; Shelter kit; Local construction (one room); Cash assistance
Dispersed self-settlement without legal status	Tents; Plastic sheeting; Shelter kit; Cash assistance
Short-term land, house, apartment, or room tenant	Individual or shared accommodation - Cash assistance; Plastic sheeting; Shelter kit; Local construction
Collective centres, non-functional public building, transits centres	One room accommodation - Plastic sheeting; Shelter kit; Local construction (adaptation)

Also, on this page, it is possible to take out a few other points that are important for the safety and well-being of the refugees. Those points are as follows:

2.2.3 Protections Risks

As recognized by Article 25 (1) of the Universal Declaration of Human Rights the principle: “Everyone has the right to adequate housing” is applicable to all stages throughout the displacement cycle and is relevant to every single person that is displaced, independent of gender or age. Adequacy of housing includes security of tenure, availability of services, materials, facilities, and infrastructure, affordability, habitability, accessibility, location, and cultural adequacy.

- Displaced unaccompanied children, especially child-headed households, are particularly exposed to protection risks due to a lack of appropriate shelter, including trafficking and various forms of violence, abuse or exploitation.
- Refugees can be at greater risk of harassment, assault or exploitation if they live in shelters without proper walls, partitioning or the possibility to lock the shelter doors.
- Unaccompanied older persons **[14]** might have difficulties constructing their own shelters or might need to share the shelter with others. Unless they receive targeted support, they can find themselves in a precarious and undignified situation of dependency. Older persons heading households and/or caring for children have specific needs requiring targeted support.
- Those with disabilities also need to receive specific attention, and shelter must be adjusted to their specific needs.
- During conflict, ethnic or religious minority groups might be unwelcomed among the host population or within the displaced population itself and, consequently, may experience difficulty finding shelter.

2.2.3.1 Other risks

- Shelter solutions should take into consideration hazards in the area such as earthquakes, floods, landslides and others. In dispersed settlements and spontaneous camps, persons of concern may find accommodation in high-risk areas and informal settlements which are hazard-prone.
- Conflict may arise with the host community if the presence of refugees increases strain in local

services and makes access to resources such as water more difficult.

It is likely that any operation will require a combination of approaches to meet the needs of the displaced population. Deciding which options to provide will be a key determinant in the quality of life refugees are able to achieve during their displacement.

The following table provides some guidance on the advantages and disadvantages of several types of shelter solutions.

Table 4: Types of shelters - Advantages and disadvantages **[15]**

Shelter solution	Pros	Cons
Family tents	Traditional relief tent; lightweight; proven design; good headroom; can be winterized; large production capacities.	Canvas rots; inflexible; may be unstable in high winds or heavy snow, difficult to heat. Where tents are used for long durations, provisions for repair materials should be considered.
Plastic sheeting	Most important shelter component in many relief operations; UV-resistant; heavy-duty; lightweight, flexible; large production capacities.	Collecting wood for shelters' support frames or stick skeletons can considerably harm the environment if collected from surrounding forests. It is therefore important to always consider sustainable sources of framing material which is sufficient to support the plastic.
Materials and tools for construction (shelter kits)	Suitable local materials are best, if available, and must be suitable for variance in the seasons, culturally and socially appropriate and familiar.	Required time and training.
Prefabricated shelter and containers	Permanent or semi-permanent structures; long-lasting.	High unit cost; long shipping time; long production time; transport challenges; assembly challenges; inflexibility; disregard cultural and social norms.
Rental subsidies	Greater sense of independence; greater integration in a community; an influx of income to host community.	Difficult to monitor that shelter meets standards; competitive market may result in exploitation and abuse; inflation and speculation may occur; upgrades or repairs may be needed.

2.3 Recreational shelter

The Recreational Shelter is a common shelter that comes in many shapes and sizes. A total of four different shelters were selected because each of them holds an interesting characteristic that may be useful to consider and apply in our project. The chosen shelters are the rooftop tent, an inflatable shelter, a regular tent, and an origami shelter. The considered features are the transportability, shape and structure, design, maintenance and the price of the shelter. The only requirement is being transportable.

An analysis regarding the strengths and weaknesses, and also the considerations of transportability, shape, structure, design, maintenance, materials and price will be performed for each type of shelter from this research for the chapter State of The Art in the Tables 5, 6, 7 and 8.

2.3.1 Rooftop shelter

The Rooftop shelter is a nifty design that is attached to the roof of a vehicle, in most cases a car. This design was chosen because it is easy to transport it by car and the tent is on a higher level so there will not be any inconvenience by animals. The bottom of the tent is made of a solid flat area that promotes sleeping on the contrary to a normal tent that needs a flat area without gravel and bumps. The best thing about the rooftop tent is that you can literally sleep everywhere. The rooftop tent's construction can be set up in a matter of minutes and has one of the fastest assemblies on the market. If the rooftop tent is bought without extra utilities the room available is just enough to sleep. One of the best rooftop shelters on the market right now is the Front runner rooftop shelter which has one of the lowest weights of all the rooftop shelters, around 43 kg **[16]**.

An example of a rooftop shelter is illustrated in Figure 2.

Figure 2: Rooftop tent

Table 5: Rating the rooftop tent

Research objects	++/- -	Reason
Transportability	+/-	The shelter is fixed to the roof of a car so it is really easy to transport it. Unfortunately, a car is the only vehicle that can transport it because it is built for it.
Shape, Structure	+/-	The structure on the roof of the car is really steady and will not break easily. The weight of the entire structure is really high so if you buy this you first have to check the strength of the frame of your car. The size of the Rooftop tents is only built for 2 people. The tent is for sleeping only but you can buy extra utilities to increase the size of the tent.
Design	+	The design of the rooftop tents allows you to have nothing bungling behind the car and to sleep high away from snake bites and pointy gravel. A disadvantage of the rooftop tent is that there will be no place for extra baggage on the roof. The rooftop tent is built with comfort in mind.

Research objects	++/- -	Reason
Maintenance	+/-	The rooftop tent can be easily detached from the roof of the car but it is incredibly heavy. To lift the tent of the roof of the car at least 2 people are needed. The maintenance itself is kinda tricky as well. Small problems can be solved easily but because the tent consists of multiple items it will be hard to disassemble.
Materials	+	The tent body is constructed of water-repellent, durable poly-cotton ripstop fabric. While the tent base is made of aluminum.
Price[€/m²]	-	The rooftop tent is worth around 1260 €, that is alright but considering the size of the shelter(which is 1.3 m by 2.4 m), it is not the best price to get on the market. The price per Square meter is 403.84 €.
Conclusion		
In conclusion, the rooftop tent is an excellent choice to do road trips with 1 or 2 friends. The tent can be set up everywhere and it will be set up in a couple of minutes and is made to be as comfortable as possible. Unfortunately, the price is really high and the disassembly progress takes skill that can only be learned over time.		

2.3.2 Inflatable shelter

The inflatable shelter, in most cases a tent, is the future of tents. The inflatable tent does not need a metal or other solid objects to be able to stand straight. It uses a smart design of tubes as a skeleton of the tent that holds the entire tent together. The weight of the tent is extremely low because the only thing that is necessary is a fabric. Unfortunately, the tent can not be shipped off alone. To fill the tent with air a pump is necessary **[17]**.
As for the design, the Vango Capri 500 XL Tent was chosen because of the size and represented in Figure 3.

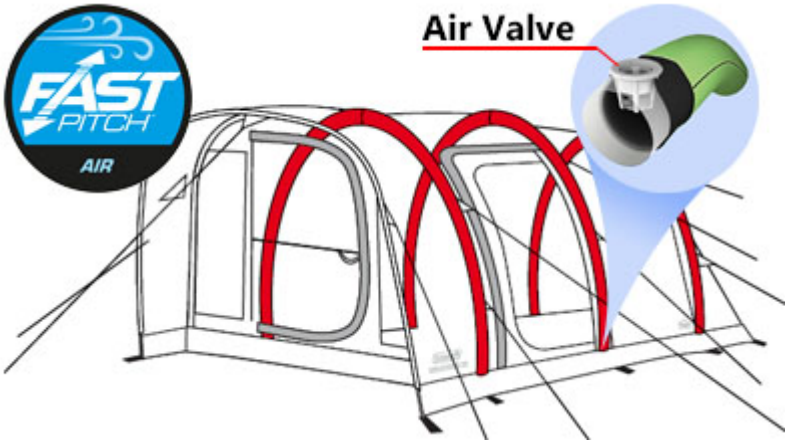


Figure 3: The Vango Capri Tent

Table 6: The Vango Capri Tent

Research objects	++/- -	Reason
Transportability	+	The shelter has a low weight, of course, it will depend on the size of the tent, especially with the extra pump. Because of the light model of the shelter, it is possible to transport it with a bike.
Shape, Structure	+	The structure of the tent makes it available to live with more than 5 people in the tent, this, of course, depends on the size of the tent. The design in the image has an extra room that can serve as a living room. The shape will be a simple rectangle hold together by ropes and tent pins. The size is limited it will not be smaller than a tent for 2 people because the area that the inflatable tubes fill makes it expensive to build tents for only one person. The volume the tubes filled with air fill is a lot bigger than the metal/aluminum sticks in regular tents.
Design	+	The design of the inflatable tent makes it really lightweight and easy to set up if compared to a normal tent the inflatable tent only needs to be thrown on the ground, get the tubes filled with air and be stabilized with ropes and tent pins.
Maintenance	+	The inflatable tent is one of the easiest shelters to repair, or be checked. if there is a hole in the fabric it can easily be repaired. if there is a hole in the inflation tubes fabric can be used as well, it has to be able to withstand strong pressure because of the air in the tubes.
Materials	+	The entire tent is made of polyester(Vango Protex® 70 denier polyester flysheet, 4000 mm HH). It has a dark inner side to stay dark during mornings without absorbing to much heat.
Price[€/m²]	+	The inflatable tent is around 580 € and it is a little bit more expensive than other tents in the same category. The price per square meter is 30 €.
Conclusion		
In conclusion, an Inflatable tent is an excellent option if you want to bring a big tent with you without bringing a lot of weight. The tent is easy to repair and the price range falls within the range of common campers. It has the same problem as regular tents, it needs to stand on flat ground. Overall it is a good tent that will improve the bigger it gets.		

2.3.3 Instant tent

The instant tent is one of the most common tents on the market. It is made in multiple shapes and structures. The Instant tent is different from the other tents by that it is packed compact and is easily set up by opening the bag. It is one of the easiest shelters to manufacture. The instant tent is supported by metal/aluminum sticks and held to the ground by tent pins. This causes the instant tent to be stable in most areas with grass or dirt. Another requirement for the tent spot is the angle and roughness of the terrain. Because the bottom of the tent is only one layer of fabric changes in terrain are noticeable. This time the Zomake tent was chosen because of its quick set up time of only 30 seconds**[18]**.
The Zomake tent is illustrated in Figure 4.

Figure 4: Zomake tent**[19]**

Table 7: Zomake tent

Research objects	++/- -	Reason
Transportability	++	The shelter has a low weight. Everything can be carried in a bag. It will have extra aluminum poles.
Shape, Structure	+	The shape and structure is similar to the inflatable tent. The inflatable tent is supported by pipes filled with air and the regular tent is supported by a skeleton of metal/aluminum sticks. which makes the regular tent heavier if it is the same size. But because of the thin pipes, an entire spectrum of designs is possible.
Design	++	The design of the regular tent is quite genius. The thin sticks in the tent can be made into an entire spectrum of designs so even the weirdest tents can be built.
Maintenance	+/-	The regular tent has 2 main points that will need repairment, the fabric, and the metal/aluminum rods. Because of the pressure that will be put on the tent by the sticks, tiny cracks in the fabrics are unavoidable and if the sticks break it is necessary to buy new ones.

Research objects	++/- -	Reason
Materials	+	The tent is made of 210D water-resistant k-oxford fabric and has a couple of aluminum poles that hold the tent together.
Price[€/m²]	++	The Zomake tent is a cheap tent at the price of 75 € with the size of 220 cm by 220 cm it makes the Instant tent the cheapest tents in this category with the price per square meter of 15.50 €.
Conclusion		
The Instant tent, as one of the more common tents in the world, is one of the best choices to take with you on a short camping trip. The tent needs a couple of materials like aluminum sticks and tent rods but it is still one of the safest choices to chose for camping. The tent's weight is lower than the average shelters in the market and it is pretty easy to repair. The reason why most people will still choose this shelter is that the time it takes to set up the shelter is around 30 seconds.		

2.3.4 Origami shelter

Cardborigami is an origami tent that wants to provide a long-term plan for unsheltered homeless people.
The cardboard structure requires no tools to assemble and can be compacted easily and stored. The origami shelter improves the idea of Clean Technology, which represents: products, processes, or services that reduce waste and require as few non-renewable resources as possible**[20]**.
Cardborigami tent is shown below, in the Figure 5.

Figure 5: Cardborigami-homelessness crisis **[21]**

Table 8: Origami shelter

Research objects	++/- -	Reason
Transportability	+	The folds and cardboard material give it high structural integrity that a tent does not have. Ease of transport due to the use of lightweight material. The fact that the tent folds gives great ease in storage and transportation.

Research objects	++/- -	Reason
Shape, Structure	+/-	It stands up to wind much better than a tent, also due to its structural design. Cardboard is naturally insulative. Camping tent material lets heat pass in and out easily. The shape allows it a good integration into space and good adaptability for the area to be installed. It does not have a very high strength compared to other materials.
Design	+	It is aesthetically attractive, it is made of minimum 50% recycled content, and is recyclable. Outside sound is significantly dampened when inside, so the person inside is less disturbed by ambient noise. This is very important for promoting a sense of privacy.
Maintenance	+/-	A non-toxic, food-safe treatment is applied to the cardboard which makes it water-resistant to light rain. There is not yet an effective version against rain, and the material can be damaged after exposure to rain for a long time.
Materials	+	Cardboard treated with non-toxic substances. There is a wide range of materials and colors that can be used to design an origami shelter.
Dimensions		When open: 183 cm depth (long) x 122 cm width x 107 cm height; Weight: 7.9 kg / When closed: 25 cm depth (long) x 91 cm width x 107 cm height; Weight: 7.9 kg.
Price[€/m²]	+	It costs $ 100 to build one Cardborigami. The price per square meter is 44.80 €.
Conclusion		
Cardborigami shelters are lightweight and provide privacy and protection from the elements with no assembly required. In one shelter can sleep 2 adults up to 6 feet tall and it can come pre-assembled and can be deployed immediately to provide instant, private space. The treated cardboard is insulative, water-resistant, and eco-friendly, reducing both the impact of weather conditions and on the environment. In conclusion, it is a suitable shelter for people in need.		

2.3.5 Conclusion

After looking at the designs, the inflatable shelter, the instant shelter, and the Cardborigami stood out the most. They were the lightest designs per square meter and do not need any extra items to support the structure. The Cardborigami does not need anything at all. Both designs have their pros and their cons but they can be solved by implementing some new strategies. Like the Cardborigami does not have enough space to stand and the Inflatable shelter's tubes take up to much space. The goal of the project is to design a disaster shelter so the rooftop shelter will not be possible to implement. The regular tent is always a good last option because it can go every way.

2.4 Animal shelter

Research for animal shelters was done as well because animals also get affected by disasters. Designing an animal shelter would be a possible opportunity to create since it can also become a “foldable disaster shelter”. In order to this section, different types of shelters will be compared. Makeshift shelters and Animal shelters are examples of places where animals that were victims of a

disaster would get shelter. In addition to the temporary shelters, research about common animal houses was done because delving into foldable variants could be a great source of information to use later during the design process.
An analysis regarding the strengths and weaknesses, and also the considerations of transportability, shape, structure, design, maintenance, materials and price will be performed for each type of shelter from this research for the chapter State of The Art in the Tables 9, 7, and 11.

2.4.1 Makeshift

This type of shelter is temporary and of low quality. The makeshift implies an inferior (less valuable) expedient adopted because of urgent need. Often the makeshift is made out of old equipment. During the extreme bushfires in Australia, makeshifts were used to shelter koalas.

The Makeshift shelter is illustrated in Figure 6.

Figure 6: Makeshift **[22]**

Table 9: Makeshift

Research objects	++/- -	Reason
Transportability	++	They are easy to transport because they exist of a minimum of material, they are foldable and lightweights (1.1 kg).
Design	+	They are available in all types and shapes because most of the time it is just a creation made out of old equipment and invented by a human or it is something cheap and low budget which is manageable very quick.
Period of use	+	It will only be used in the ultimate necessary period. Most of the time the usage is maximum 7 days.
Materials	-	Fiber, nylon
Dimensions	-	73x73x43 cm
Price [€/m²]	+	The price differentiates between 2,5 € and 9/m² € **[23]**.
Conclusion		

Research objects	++/- -	Reason
The advantages of the makeshift are the lightweight, the ease of setting it up and the fact that you can transport it very easily. On the other hand, the material which is used is a big drawback. Nylon will not protect an animal against bad weather conditions and it is really fragile which makes it easier to damage.		

2.4.2 Animal shelter

This is the most known shelter for animals. It is a place that is divided into several smaller spaces by fences. These shelters are supposed to shelter animals without a home. Most of the times they contain dogs or cats. This type of shelter is not foldable.
One type of animal shelter is shown in Figure 7.

Figure 7: Animal shelter **[24]**

Table 10: Animal Shelter

Research objects	++/- -	Reason
Transportability	- -	There is no possibility to transport an animal shelter. It is a building that is divided by fences. Only by disassemble all the fences, transportation of the different parts of the shelter is possible.
Design	-	A shelter exists out of several quadrangular spaces. It only provides the necessary needs of space for an animal. Building an animal shelter requires making a series of decisions unique to animal-housing facilities such as choosing safe caging materials and selecting appropriate floor coatings. They have flat roofs, although flat roofs are convenient for accommodating HVAC equipment, they are more prone to leaks and may collapse under heavy ice and snow build-up **[25]**.
Period of use	+	The shelter is maintained by employees or caretakers. After +/- 20 years the shelters had to be replaced. It is a shelter which is used daily by animals without a home.

Research objects	++/- -	Reason
Materials	-	**Types:** *Modular runs:* Aluminum or stainless-steel frame with solid in-fill or cage “rod” in-fill panels. *Panelized kennel fencing:* A smooth chain link with a galvanized metal frame (material is electro-galvanized, not hot-dipped) This fencing is more difficult to clean than solid walls. **Requirements of materials in animal shelters:** The perfect surface would have these characteristics: Pleasing visual impact, Durable, Easily cleanable, Resilient, Nonabsorbent to liquids and odors, Prevents microbial growth, Sound absorbent. *Cleanliness:* Appropriate flooring materials are vital to maintaining a clean facility in which microorganisms and odors are minimized. Poured floors with a minimum of seams are best. *Noise control:* 1) Absorption of sounds: porous, sponge-like materials (carpet, drapery, foam rubber, acoustic ceiling tile, sprayed-on fibers). Sound-absorbing materials (good for durability and cleanliness): - mylar-faced ceiling baffles - NRC 0.95; - quilted blankets/banners hung from ceiling- NRC 1.10; - fabric-wrapped wall panels - NRC 0.90; - sound block (concrete block with slots and foam inside) - NRC 0.35. 2) The Second way who they controlling noise is isolating the area by using a wall or ceiling assembly that has a high mass. Typical forms are: - 3 ½“ steel stud wall with gypsum drywall both sides - 47 STC; - two wythes (layers) of 4“ brick with plaster - 59 STC. 3) Keeping noise outside by: By using double panes of glass separated by at least 4” of air space (windows), use tight-fitting, solid core wood doors or hollow metal doors with insulation (doors), foam spacers, Barium Loaded Vinyl (A heavy-duty rubber between multiple layers of drywall in a wall), masking by using muzak (The Muzak (background music) effectively covers the barking without significantly increasing the sound level) **[26]**.
Dimensions	-	For Cats: 1,8-2,8 /m² per cat (with higher ceilings for more places to climb), for dogs: 5,5-11 /m² **[27]**.
Price [€/m²]	/	The price is indefinite because the purchase- /rent costs and maintenance costs should be charged at the price. It is not a one-time-purchase but a lifetime cost. An estimated cost: Renovation/new construction ranged from 13,5 - 17 €/m² not including land.
Conclusion		

Research objects	++/- -	Reason
The animal shelter is divided into several quadrangular spaces which are very compact. Because of this, space will be used optimally. Using metal fences for a disaster shelter for humans is a bad idea, but getting inspiration out of the materials they use as walls that have noise control or provide cleanliness is not. Porous, sponge-like materials (carpet, drapery, foam rubber, acoustic ceiling tile, sprayed-on fibers) are materials that are noise absorbers and which could be used for the disaster shelter as well. Invoking Muzak, like they use to do in some animal shelters, is also a technique that can be used during the Shelter project.		

2.4.3 Animal house

This type of “shelter” is comparable with the recreational shelter for humans. Customers buy them to shelter their pets at home. The animal houses are available in all kind of sizes, colors, and prices. Reflecting on the “foldable” disaster shelter, examples which are foldable are elucidated here. Some types of animal houses are shown in Figures 8, 9, and 10.

Figure 8: Animal house **(1)** **[28]**

Figure 9: Animal house **(2)** **[29]**

Figure 10: Dog Cage **(3)** **[30]**

Table 11: Animal House

Research objects	++/- -	Reason
Transportability	+	Easy to transport because the whole is made to assemble/disassemble easily. When disassembling the whole to a package of all the separated parts transport is possible. Example 2 and 3 are lightweights. Example 2 has a weight of 2.2 kg, example 3 has a weight of 6 kg.
Design	+	Foldable, sliding all the parts together to get the whole, a common point is that all the designs are waterproof. They are all made to assemble/disassemble easily without having to use tools.
Period of use	+	The average life-span of an animal house is 5 to 10 years.
Materials	-	**1.** MDF material, weather-resistant; **2.** EVA board, Ultra-Soft Plush, water-resistant; **3.** metal. Common for the used materials is that they are all easy to clean.

Research objects	++/- -	Reason
Dimensions	-	**1.** 52x38x53 cm; **2.** 56×48×80 cm; **3.** 61x46x53 cm.
Price [€/m²]	-	**1.** 26 €/m²; **2.** 29 €/m²; **3.** 22 €/m² .
Conclusion		
There are plenty of types of animal houses, three of them were selected to explain in the report because of their interesting way of being “foldable”. When working with hard materials, the slide technique (example 1) is interesting because it is easy to assemble and will provide much stability. Animal houses 2 and 3 are examples of folding mechanisms, by folding and clicking the parts into each other, they create a strong structure. The advantages of animal houses are that there water resistant because they are made to stay outside and easy to clean.		

2.4.4 Conclusion

Hexagonal and quadrangular spaces are easy to use as shapes for shelters. The biggest advantage of the quadrangular is the fact it has 4 rectangle walls, which makes it easier to provide a compact interior. An advantage of the hexagonal form is that it is very modular and aesthetic to fill up a bigger space. Because there is no heavy ice or snow in areas located nearby the equator, a flat roof can be used. It will not have bad effects on the quality or the reliability of the shelter. Noise control can be provided in the shelter by using specific materials like carpet, drapery, foam rubber, acoustic ceiling tile, sprayed-on fibers. Muzak can be used to distract the affected people of unpleasant background noises.

2.5 Conclusion

By looking at different shelters on the market a decision can be made. To make this decision, the most important aspects were viewed. The most important aspect is the shape of the disaster shelter. A honeycomb shape was chosen because it is important to place multiple tents in a small area without losing extra space and the shape is a shape of nature that will improve the appearance of the shelter. Another very important choice to make was the technique that is used to hold up the tent. One of the goals of this project is to build a shelter that does not need extra materials. So a couple of techniques like inflation, pipes and a hardshell outer layer are the main options. For the final disaster shelter, a combination of hardshell and pipes will be used to get great stability with the added bonus of foldability. The materials used will provide some insulation, of relatively lightweight and which are friendly to the environment and the manufacturing method so we can use a combination of polymeric materials or fabric that can be customized.

3 Project Management

3.1 Scope

The goal of this project is represented by a strong desire to create a disaster shelter for people that comes from damaged areas. The concept revolves around many things, so we want to innovate this shelter so that it conforms to some technical norms and is suitable for everyone. The disaster shelter

will be focused on warm areas(around the Equator) and it has to be a shelter that hosts disaster struck people that do not have a home to return to. The biggest danger is gone. The shelter has to be foldable and compact so it is easy to place multiple tents in a shelter enclosure. The focus of the shelters will be on the safety and the feelings of the victim.

For the adequate functioning of the project, to properly organize all the tasks and to follow the evolution of the project, it is necessary to set the goal, the scope, so that the whole team can take all the steps necessary to fulfill all the requirements.
It is used a simple hierarchical structure of all tasks and deliverables which are necessary to accomplish the final project outcome, thus we adopted the Work Breakdown Structure (WBS), in which the scope is divided into sections with details. “The work package represents the list of tasks or “to-dos” to produce a specific unit of work” **[31]**.

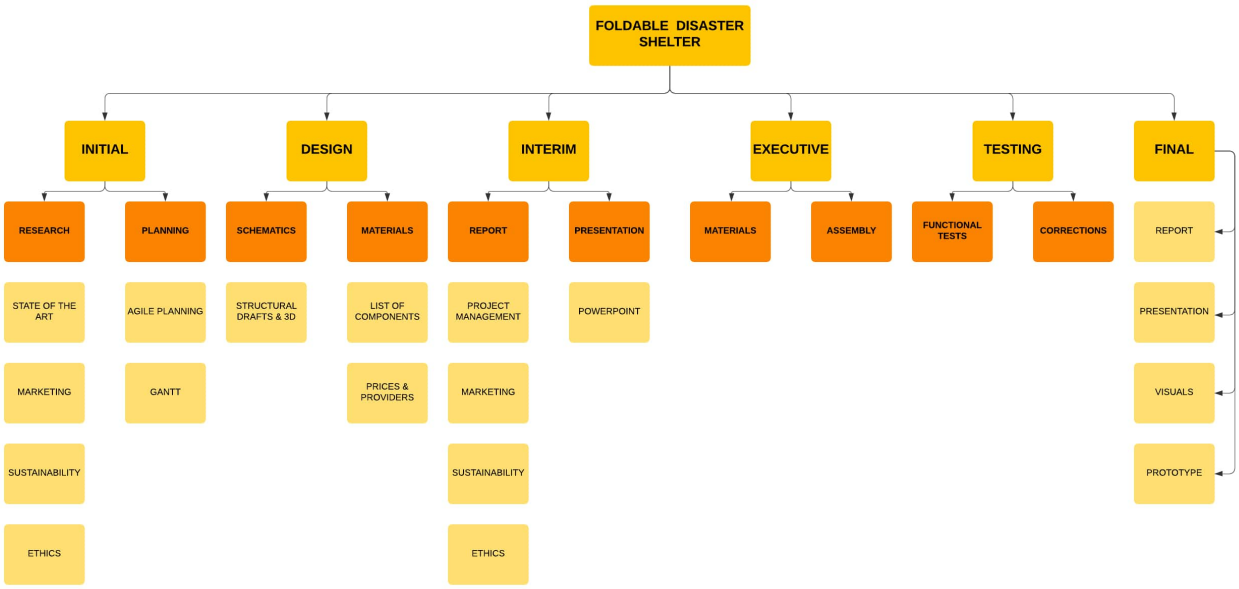
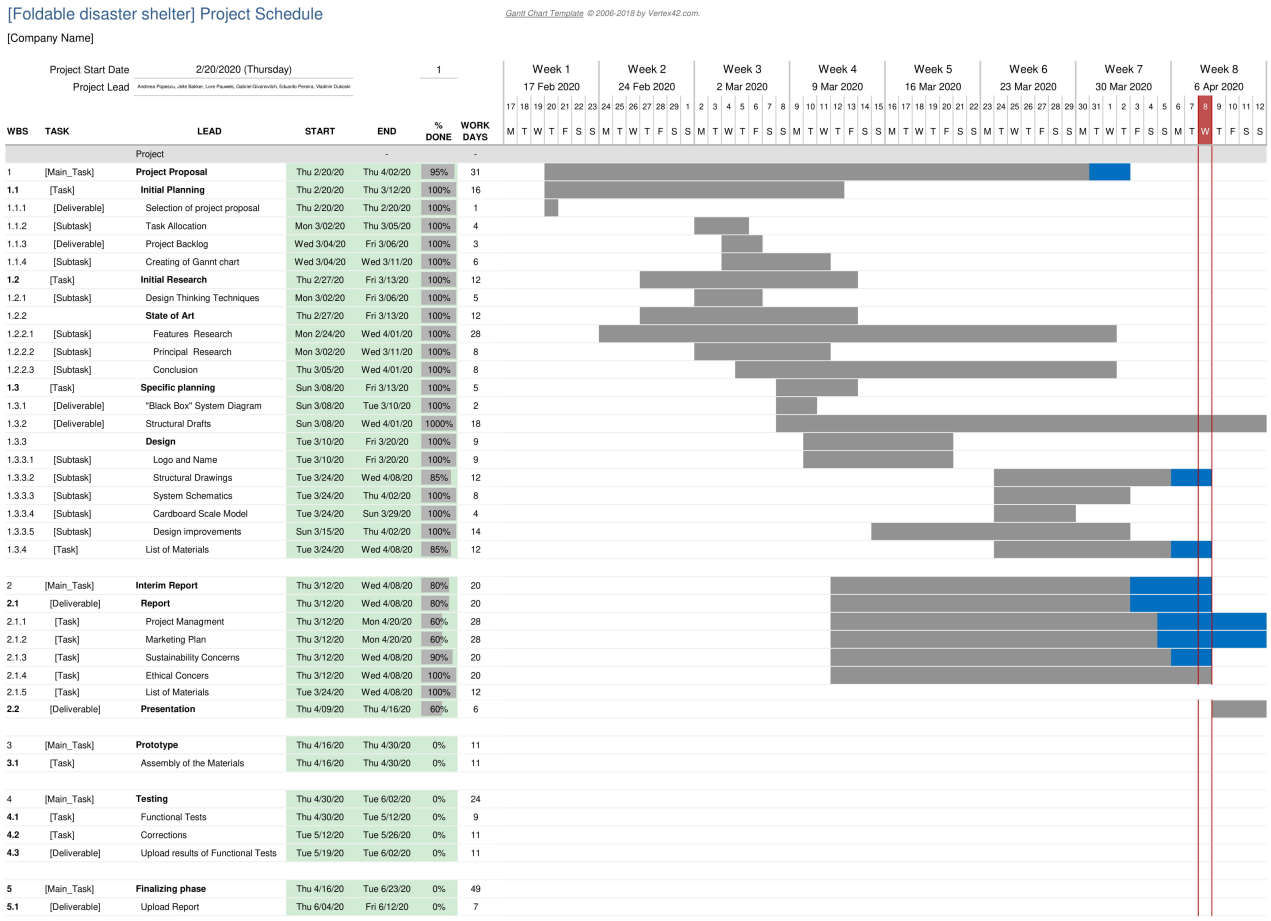


Figure 11: Work Breakdown Structure (WBS)

3.2 Time

3.2.1 Gantt Chart

The following Figure 12 contains the Gantt Chart of SafeBIS project.



WBS	TASK	LEAD	START	END	% DONE	WORK DAYS
		Project		-		-
1	[Main_Task]	**Project Proposal**	Thu 2/20/20	Thu 4/02/20	95%	31
1.1	[Task]	**Initial Planning**	Thu 2/20/20	Thu 3/12/20	100%	16
1.1.1	[Deliverable]	Selection of project proposal	Thu 2/20/20	Thu 2/20/20	100%	1
1.1.2	[Subtask]	Task Allocation	Mon 3/02/20	Thu 3/05/20	100%	4
1.1.3	[Deliverable]	Project Backlog	Wed 3/04/20	Fri 3/06/20	100%	3
1.1.4	[Subtask]	Creating of Gannt chart	Wed 3/04/20	Wed 3/11/20	100%	6
1.2	[Task]	**Initial Research**	Thu 2/27/20	Fri 3/13/20	100%	12
1.2.1	[Subtask]	Design Thinking Techniques	Mon 3/02/20	Fri 3/06/20	100%	5
1.2.2		**State of Art**	Thu 2/27/20	Fri 3/13/20	100%	12
1.2.2.1	[Subtask]	Features Research	Mon 2/24/20	Wed 4/01/20	100%	28
1.2.2.2	[Subtask]	Principal Research	Mon 3/02/20	Wed 3/11/20	100%	8
1.2.2.3	[Subtask]	Conclusion	Thu 3/05/20	Wed 4/01/20	100%	8
1.3	[Task]	**Specific planning**	Sun 3/08/20	Fri 3/13/20	100%	5
1.3.1	[Deliverable]	"Black Box" System Diagram	Sun 3/08/20	Tue 3/10/20	100%	2
1.3.2	[Deliverable]	Structural Drafts	Sun 3/08/20	Wed 4/01/20	1000%	18
1.3.3		**Design**	Tue 3/10/20	Fri 3/20/20	100%	9
1.3.3.1	[Subtask]	Logo and Name	Tue 3/10/20	Fri 3/20/20	100%	9
1.3.3.2	[Subtask]	Structural Drawings	Tue 3/24/20	Wed 4/08/20	85%	12
1.3.3.3	[Subtask]	System Schematics	Tue 3/24/20	Thu 4/02/20	100%	8
1.3.3.4	[Subtask]	Cardboard Scale Model	Tue 3/24/20	Sun 3/29/20	100%	4
1.3.3.5	[Subtask]	Design improvements	Sun 3/15/20	Thu 4/02/20	100%	14
1.3.4	[Task]	List of Materials	Tue 3/24/20	Wed 4/08/20	85%	12
2	[Main_Task]	**Interim Report**	Thu 3/12/20	Wed 4/08/20	80%	20
2.1	[Deliverable]	**Report**	Thu 3/12/20	Wed 4/08/20	80%	20
2.1.1	[Task]	Project Managment	Thu 3/12/20	Mon 4/20/20	60%	28
2.1.2	[Task]	Marketing Plan	Thu 3/12/20	Mon 4/20/20	60%	28
2.1.3	[Task]	Sustainability Concerns	Thu 3/12/20	Wed 4/08/20	90%	20
2.1.4	[Task]	Ethical Concers	Thu 3/12/20	Wed 4/08/20	100%	20
2.1.5	[Task]	List of Materials	Tue 3/24/20	Wed 4/08/20	100%	12
2.2	[Deliverable]	**Presentation**	Thu 4/09/20	Thu 4/16/20	60%	6
3	[Main_Task]	**Prototype**	Thu 4/16/20	Thu 4/30/20	0%	11
3.1	[Task]	Assembly of the Materials	Thu 4/16/20	Thu 4/30/20	0%	11
4	[Main_Task]	**Testing**	Thu 4/30/20	Tue 6/02/20	0%	24
4.1	[Task]	Functional Tests	Thu 4/30/20	Tue 5/12/20	0%	9
4.2	[Task]	Corrections	Tue 5/12/20	Tue 5/26/20	0%	11
4.3	[Deliverable]	Upload results of Functional Tests	Tue 5/19/20	Tue 6/02/20	0%	11
5	[Main_Task]	**Finalizing phase**	Thu 4/16/20	Tue 6/23/20	0%	49
5.1	[Deliverable]	Upload Report	Thu 6/04/20	Fri 6/12/20	0%	7

Figure 12: Gantt Chart

3.2.2 Deadlines & Deliverables

The management time management is a necessity and is the key to success, and the observance of the temporary parameters leads to the development of the project in a systematic and efficient way.

To manage the correct time, the team receives deadlines to be on time with any task, thus approaching the weekly plans (Sprint Plan), estimating the time required for each task, assigning each member of the team a topic, at the same time monitoring the present tasks but also taking the next ones into consideration, ensuring continuous work and productive operation.

The entire time management regarding the step-by-step organization of the project is included in the Gantt Chart, which monitors all tasks concerning the deadlines imposed.
In case that some tasks require a longer time and are not performed in time, the whole time management may be affected, thus organizing the time must be done very well from the beginning, and each member must fulfill these tasks in order to could take on another attribution dependent on it.

The deadlines and the deliverables of the project are illustrated in Table 12:

Table 12: Project Deadlines & Deliverables

Date	Task
2020-02-24	Project Proposal
2020-03-05	Project Backlog, Global Sprint Plan, Initial Sprint Plan, Gantt Chart
2020-03-10	Black Box, System Diagrams, Structural Drafts
2020-03-27	System Schematics, Structural Drawings, 3D Modelation, Cardboard Model
2020-04-01	List of Materials (what & quantity)
2020-04-08	Upload Interim Report and Presentation
2020-04-16	Interim Presentation, Discussion and Peer, Teacher and Supervisor Feedbacks
2020-04-23	List of Materials (provider, price, quantity, including VAT and transportation)
2020-04-30	Final video of the 3D Model
2020-05-06	Refined Interim Report (based on Teacher & Supervisor Feedbacks)
2020-05-13	Packaging Solution
2020-06-02	Results of Prototype or Simulation Functional Tests
2020-06-12	Final Report, Presentation, Video, Paper, Poster and Manual
2020-06-16	Final Presentation, Individual Discussion and Assessment
2020-06-19	Final Deliverables
2020-06-23	Demo of Prototype or 3D Model, Simulation and Companion Applications

3.3 Cost

From this point of view, we can define our project as a unique collection of resources.
This collection is different from project to project, depending on the used resources, resources that can be classified in human, material and so on. Our project involves the use of time, money, people and materials resources, all of which are interconnected so that classification will be made in 2 major categories: work and material resources.

Human resources play a key role in every company because they have a great impact on its performance and the achievement or not of its goals .
Human resources of a company have several important features:

- Skills
- Experience
- Qualification
- Geographic Location
- Time Availability

Material resources include everything a company needs to accomplish the project and to build the final prototype.

3.3.1 Work Resources

A budget is a financial plan for a specific period and depends on the time and the number of workers involved in the project, so this cost is calculated according to the hours worked and the cost imposed per hour.
In developing the project, we need to calculate this, even if it is a theoretical one, in order to visualize

the costs from this point of view, at the level of the necessary resources.
Each team member is involved in the development of the project, so that certain tasks are assigned weekly, following the Sprint Plans and the Gantt Chart, considering the time limits imposed for obtaining results.
For people to be motivated, rewards are usually generated, this reward consisting of the monthly payment, so that for every hour worked and the task accomplished, for our team a budget is needed to be allocated in this regard.
Thus, as considered in the 3.5 People, tasks are assigned differently, so the costs for each person differ depending on the involvement. Although it is ideal for each member to work and cooperate in order to maximize their performance together, it does not really happen that way. In the Figure 13, the optimal workload is illustrated, but which in reality is different due to the differences in how each one assigns his / her own tasks and also because of the studies every member has done before. The diagram with the workload of the team is shown in Figure 14.

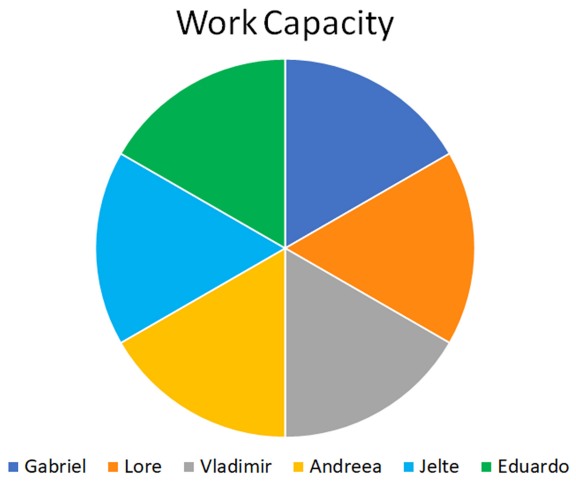


Figure 13: Optimal Workload for the Team

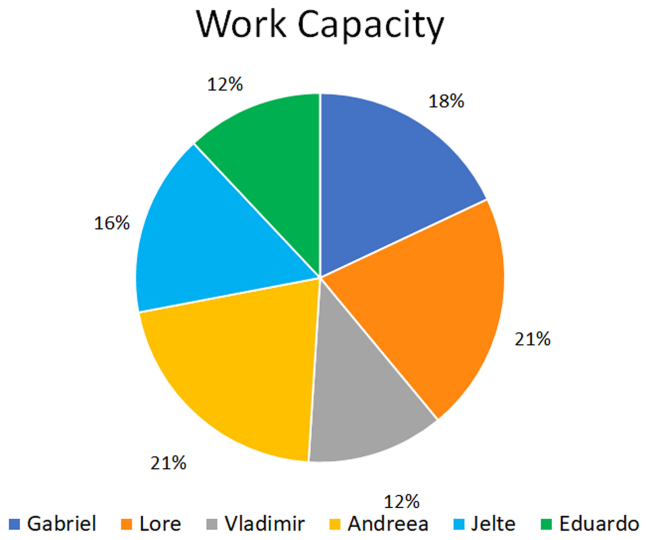


Figure 14: The Workload for the Team

Considering that in Porto, an engineer earns on average between 500 and 4000 € per month **[32]**, we will estimate the cost for the labor in the Table 13.

Table 13: Working Cost

Name	Salary/Month [€]	Cost/Year [€]
Gabriel	1200	14400
Lore	1200	14400
Andreea	1200	14400
Jelte	1200	14400
Eduardo	1200	14400
Vladimir	1200	14400
Total cost : 86400 €		

3.3.2 Material Resources

In table 14 are displayed the resources needed and the costs to build the prototype. The prototype is built on a 1:4 scale.

Table 14: List of materials and components for the prototype

Nr.	Item	Part of SafeBIS	Provider	Dimensions	Quantity	Unit	Unit Price [€]	Item Cost [€]
1	Laminated Oak wood beams	Walls	Valgerlemn	0.02×0.02×0.575 0.02×0.02×0.66 0.02×0.02×0.75	2 2 2	m	0.35 0.40 0.45	0.70 0.80 0.90
2	Laminated Oak wood beams	Roof	Valgerlemn	0.02×0.02×0.581	6	m	0.35	2.10
3	Laminated Oak wood beams	Roof resistance	Valgerlemn	0.03×0.01×1.025	2	m	0.46	0.92
4	Solid wood panels - Spruce class	Floor	Valgerlemn	1×1.18×0.01	1	m	8.85	8.85
5	Stainless Steel Door Hinge-90 degree stop	Floor	Alibaba	45x45X1.2	6	mm	0.50	3.00
6	Self Adhesive Cork Sheet Roll	Floor	Ebay	0.48X1X0.001/roll	0.86 m² or 3 rolls	m	7.39/roll	22.17
7	Cotton Canvas Fabric	Walls	fibre2fashion	1.83	2.30	m²	3.24-4.17 €/m²	7.45-9.59
8	Cotton Canvas Fabric	Roof	fibre2fashion	1.83	0.90	m²	3.24-4.17 €/m²	2.92-3.75
9	Slotted Flat Head Machine Screws with Hexagon Nuts	To attach the hinges	Dedeman	M5x40 mm	24	pieces	0.87 €/8 pieces	2.61
10	Connectors to attach the shelters together	Walls	/	/	12	/	/	/
11	Clips/fabric fasteners	Walls	/	/	12	/	/	/

Nr.	Item	Part of SafeBIS	Provider	Dimensions	Quantity	Unit	Unit Price [€]	Item Cost [€]
12	Clips/fabric fasteners	Roof	/	/	16	/	/	/
13	Support for beams	To fix on the floor	/	/	6	/	/	/
14	Zipper	Doors and Windows	/	/	5	/	/	/
Total cost : 55.39 €								

In table 15 are displayed the resources needed and the costs to build the product on a 1:1 scale.

Table 15: List of materials and components for the product

Nr.	Item	Part of SafeBIS	Provider	Dimensions	Quantity	Unit	Unit Price [€]	Item Cost [€]
1	Laminated Oak wood beams	Walls	Valgerlemn	0.08×0.08×2.3 0.08×0.08×2.65 0.08×0.08×3.0	2 2 2	m	22.08 25.44 28.80	44.16 50.88 57.60
2	Laminated Oak wood beams	Roof	Valgerlemn	0.08×0.08×2.33	6	m	22.33	133.98
3	Laminated Oak wood beams	Roof resistance	Valgerlemn	0.10×0.05×4.1	2	m	30.75	61.50
4	Solid wood panels - Spruce class	Floor	Valgerlemn	4×2.3×0.02	1	m	138.00	138.00
5	Solid wood panels - Spruce class	Floor	Valgerlemn	4×1.14×0.02	2	m	68.40	68.40
6	Stainless Steel Door Hinge-90 degree stop	Floor	Alibaba	45x45X1.2	10	mm	0.50	5.00
7	Cork Roll	Floor	Corklink	15X1X0.004/roll	13.74 m²	m	3.68 €/m²	50.56
8	Cotton Canvas Fabric	Walls	fibre2fashion	1.83	36.57	m²	3.24-4.17 €/m²	118.48-152.49
9	Cotton Canvas Fabric	Roof	fibre2fashion	1.83	18.72	m²	3.24-4.17 €/m²	60.65-78.06
10	Slotted Flat Head Machine Screws with Hexagon Nuts	To attach the hinges	Dedeman	M5x40 mm	40	pieces	0.87 €/8 pieces	4.35
11	Connectors to attach the shelters together	Walls	/	/	12	/	/	/

Nr.	Item	Part of SafeBIS	Provider	Dimensions	Quantity	Unit	Unit Price [€]	Item Cost [€]
12	Clips/fabric fasteners	Walls	/	/	24	/	/	/
13	Clips/fabric fasteners	Roof	/	/	24	/	/	/
14	Support for beams	To fix on the floor	/	/	6	/	/	/
15	Zipper	Doors and Windows	/	/	5	/	/	/
Total cost : 793.56 €								

3.4 Quality

- Employee & Team Work Quality
- Product Quality
- Material & Component Quality
- Time Quality

3.5 People

An essential thing in the good organization and functioning of a collective, and then of carrying out a project and obtaining the desired product consists in assigning the appropriate tasks to all members of a team to accomplish them.
The team is responsible to allocate tasks according to each member's skills and knowledge.

Effective management of people and their skills is necessary because if it is done correctly, very good results can be achieved, both during and at the end of the project.
In this way, each of the team members knows who is responsible for a particular task, who is responsible if some things are delayed or malfunctioning, they can address them to remedy the situation and lead the project on the right path.

One way to define each team member’s role is to use the Responsibility Assignment Matrix (RAM). It is a charting system that illustrates the task’s goal and the required action for each person.
This assists with reducing confusion on expectations, in turn, increasing project efficiency.
In this context, decisions are made more quickly, accountability is clear and workload is evenly distributed **[33]**.

Table 16 displays who is responsible for the tasks in the team.
Description of the abbreviations used in table **[34]**:

- R = Responsible (Person who does the work to complete the task).
- A = Accountable (Person who ensures that prerequisites of the task are met and who delegates the work to those responsible).
- C = Consulted (Those whose opinions are sought, typically subject matter experts, and with whom there is two-way communication).
- I = Informed (Those who are kept up-to-date on progress, often only on completion of the task or deliverable, and with whom there is just one-way communication).

Table 16: Responsibility Assignment Matrix

Project Tasks	Gabriel	Lore	Andreea	Jelte	Eduardo	Vladimir	Supervisors
Task Identification and Allocation	P	P	P	P	P	P	C/I
Project Backlog		R		P			C/I
Global Sprin Plan		R					C/I
Sprint Plan		R		P			C/I
Gantt Chart		R		P			C/I
Black Box			R				C/I
Introduction	P	P	P	P	P	P	C/I
State of the Art		P	P	R	P		C/I
Technical Research	P	P	P	P	P	P	C/I
Project Management		P	P				C/I
Marketing Plan	P		P			R	C/I
Eco-efficiency Measures for Sustainability	P			R			C/I
Ethical and Deontological Concerns		R	R				C/I
Project Development	P	P	P	P	P	P	C/I
List of Materials		P	R				C/I
Budget planning	P	P	P	P	P	P	C/I
Logo			R				C/I
Leaflet		P	P				C/I
Flyer		P	P				C/I
Sketches	P	P	P				C/I
3D Model					R		C/I
Interim Presentation	P	P	P	P	P	P	C/I
Animation							C/I
Paper							C/I
Poster							C/I
Video							C/I
Prototype							C/I
Packaging							C/I
Manual							C/I
Final Presentation	P	P	P	P	P	P	C/I
Conclusions	P	P	P	P	P	P	C/I

3.6 Communications

In order to achieve the best possible result for the project, in a group, communication is essential. It facilitates the flow of information and understanding between different people through different media using all the channels and networks.

This flow of information is vital for managerial effectiveness and decision making in general. Thus helps understand people better-removing misunderstanding and creating clarity of thoughts and expression. It also educates people.

Communication brings people together, closer to each other and is an important management function closely associated with all other managerial functions. It bridges the gap between individuals and groups through the flow of information and understanding between them. Information is the most vital aspect of communication **[35]**.

Being in a team with 6 different members, we all have to create good communication between us, to ensure that the team members and the stakeholders are informed so that all the participants of the project are involved, know what are the tasks and constraints of time but also resources, so that good understanding is also achieved to obtain good results.
All projects are fluid and the members need to prepare themselves for the challenges that they will face from the start until the project completion or end. To ensure effective communication throughout the whole project and team, a communication plan needs to be developed at the start – planning stage.

The communication plan will contain the type of communication required during specific meetings, who needs to be communicated with, the frequency of communication needed, and the needs to be communicated.
The communication was made both between the team members to carry out the project tasks, as well as between the team and the supervisors to receive feedback and to continue with the new tasks.

Adapting the project to the current situation, the meetings with the teachers were held every Thursday, as usual, using the Microsoft Teams application but at the same time, the mail is also used for any questions or for receiving helpful materials. Most of the means of communication used, taking into account the current situations worldwide, involve the online environment:

- Oral communication
- Microsoft Teams
- Zoom
- OneNote
- Whatsapp
- Google Drive

The allocation of the main means of communication is represented in the Figure15.

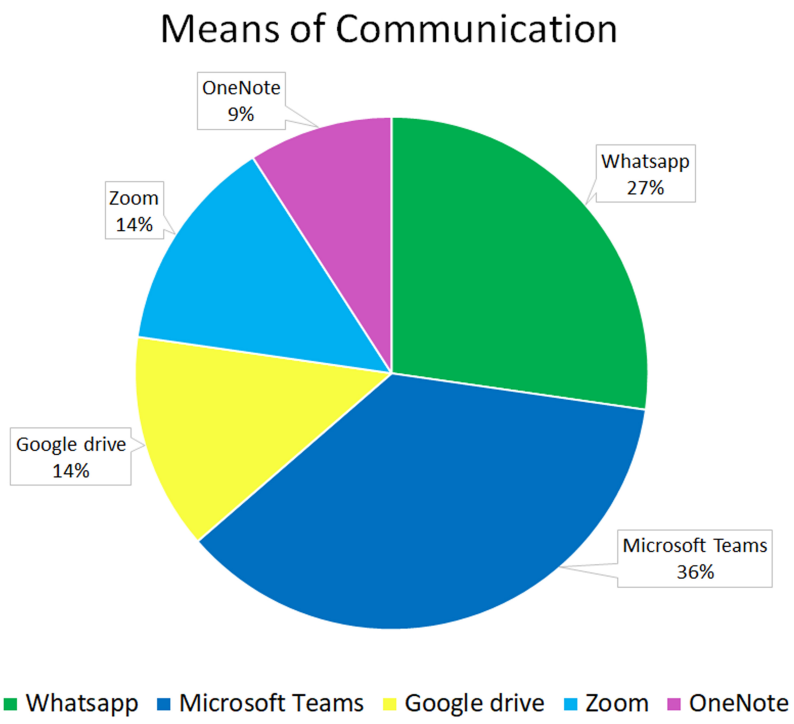


Figure 15: Allocation of the main means of communication

The communication matrix is displayed in Table 17.

Table 17: Communication Matrix

What?	Why?	Who?	When?	How?
Deliverables	Development of the project	Responsible person	On the specific deadlines	Presenting to the supervisors and to the responsible teachers/ Uploading to Wiki
Brainstorming	Development of ideas to find the proper solutions/ Doing research and discussing ideas with the team	Team BIS	Before beginning the development of any topic	Online counseiling
Daily Scrum	Short communication what each team member had done the last day and what he is planning to do the next day	Team BIS	Daily	Online counseling
Sprint planning	To add tasks to the Project Backlog, to divide the tasks to the team members, and to assign a deadline for each task	Team BIS	Weekly	Online counseling

What?	Why?	Who?	When?	How?
Sprint review	To determine which tasks were done and to see what tasks should be worked on in the next Sprint	Team BIS	Weekly	Online counseling
Agenda	To establish topics for the meeting with supervisors	Team BIS	24 hours before the weekly meeting with the supervisors	Uploading to Wiki
Weekly Team Meeting	To update each other about the progress of the project and to establish new objectives	Team BIS	Weekly	Online counseiling
Weekly Supervisors Meeting	To update the progress of the project and to proceed with the next steps	Team BIS	Weekly on Thursday	Face-to-face with a presentation/ Microsoft Teams
Interim Presentation	To present the current state of the project and to get feedback from the supervisors	Team BIS	2020-04-16	Microsoft Teams

3.7 Risk

Identify key risks (product and project level), evaluate them and define how they should be handled (responses) and monitored.

3.8 Procurement

Document your procurement management strategy including make vs buy decisions, materials/services to be acquired, sources, costs, timings, etc.

3.9 Stakeholders Management

Define how you will manage stakeholders to keep them engaged.

3.10 Sprint Outcomes

As BIS team is using the Scrum method to organize the tasks for the project, representing the sprint tables and making efficiency calculations is a big part of the project managment. Table 18 illustrates how efficient the past sprints were going, calculated on the basis of the work capacity, available capacity and sprint velocity. The team’s work capacity shows the number of hours per day that one member can work, multiplied by the number of team members and thereafter multiplied by amount of days a member works during one week. BIS team choose for a normal work week of 5 days and 8 hours a day. Therefore, the total work capacity is 240 hours. The available capacity reflects the work capacity subtrachted by the total hours of classes that occur in that week, multiplied by the number of members. This calculation is important because the team needs to focus on the class as well. The

sprint velocity is the summation of all the completed tasks in one sprint. Following formule shows how to obtain the weekly work efficiency:

$$\begin{equation} Efficiency =100*\frac{Velocity}{Capacity_{available}}\equiv 100* \frac{Hours_{CompletedTasks}}{(Amount_{Days} * Hours_ {Working} * Amount_{Team members})-Hours_{Classes}} \end{equation}$$

Table 18: Sprint Capacities & Velocities

Sprint	Work Capacity	Available Capacity	Sprint Velocity	Efficiency
1	240 h	228 h	42 h	18.4 %
2	240 h	54 h	52 h	96.3 %
3	240 h	112 h	52 h	46.3 %
4	240 h	204 h	19 h	9.3 %
5	240 h	174 h	59 h	33.9 %
6	240 h	144 h	51 h	35.4 %
7	240 h	210 h	64 h	25,7%

Table 18 shows relatively diverse efficiencies throughout the sprints. The efficiency of the first sprint seems very low, this can be explained easily as this week represents the introduction between the members and the subject. The intensive Design Thinking classes leads to less available capacity, which is showed extremely in the efficiency of week two. The arrival of the COVID-19 explains why the efficiency of the fourth sprint is very low, half of the members of the BIS team went back to their home country, the sprint was accompanied by many uncertainties. In the following sprints a greater efficiency get achieved again, but it is still not optimal. This is explained by the difficulties with which the team get faced by only having online conversations. Reaching all the members online is harder than in real life.

Beginning from table 19 all details concerning the tasks of each sprint are described in tables. Below every sprint table, points of criticism about that sprint are cited.

Table 19: Sprint 1 Review

Sprint 1 20/02 - 26/02					
Task name	Responsible	Duration	Completed	Not completed	Notes
ID04 selection of the project proposal	whole group	2h	x		
ID05 features research	Andreea, Lore			x	this task will take time until the 4th sprint
features research week1	Andreea, Lore	20h	x		
ID06 pricipal research	Jelte, Gabriel			x	this task will take time until the 3th sprint
principal research week1	Jelte, Gabriel	15h	x		
ID02 teambuilding resport (individual)	whole group	2h	x		
ID01 weekly report	Eduardo	1h	x		
ID03 classes	whole group	2h	x		
Sprint Velocity		42h			

Stop doing:

- Working all on the same tasks without having a good overview

Start doing:

- Look at agenda’s and wiki's of the other years to see what the teachers expect from us and to

get inspiration
- A meeting with the team on Monday or Tuesday to add the agenda

Keep doing:

- Making decisions as a team
- Listen to all the members

Table 20: Sprint 2 Review

Sprint 2 27/02 - 4/03					
Task name	Responsible	Duration	Completed	Not completed	Notes
ID11 defining target group (Field indication)	whole group			x	this task will take time until the 3th sprint
defining target group week 1	whole group	2h	x		
ID05 features research	Andreea, Lore			x	this task will take time until the 4th sprint
features research week2	Andreea, Lore	6h	x		
ID06 principle research	Jelte, Gabriel			x	this task will take time until the 3th sprint
principal research week2	Jelte, Gabriel	6h	x		
ID13 gantt chart	Lore	3h	x		
ID08 weekly agenda & minute	Andreea	30'	x		
ID12 Backlog, sprint plan (project managm.)	Lore	3h	x		
ID07 weekly report	Eduardo	30'	x		
ID10 design thinking (classes)	whole group	12h (3x4h)	x		3 of the 4 DT courses were given during this sprint period
ID09 classes	whole group	19h	x		
Sprint Velocity		52h			

Stop doing:

- Vladimir: not coming to the classes
- Be to late at the meeting with the teachers

Start doing:

- Communicate better about the tasks that have to be done
- Motivate some members to start focusing on the project
- Try to get a good overview of which tasks are done yet and which aren't

Keep doing:

- Be prepared well for the meeting with the teachers
- Meetings are really a good way to have an overview

Table 21: Sprint 3 Review

Sprint 3 5/03 - 11/03					
Task name	Responsible	Duration	Completed	Not completed	Notes
ID18 structural drafts	Gabriel, Andreea, Lore	5h		x	
ID19 black box diagram	Andreea, Jelte	3h	x		
ID11 defining target group (Field indication	whole group	3h	x		
ID05 features research	Andreea, Lore			x	this task will take time until the 4th sprint
features research week3	Andreea, Lore	8h	x		
ID06 principle research	Jelte, Gabriel	10h	x		
ID10 design thinking (classes)	whole group	4h (1x4h)	x		
ID17 classes	whole group	15h	x		
ID16 weekly sprint plan	Lore	2h	x		
ID20 marketing (4.1)	Vladimir	6h	x		
ID15 weekly agenda & minute	Lore	30'	x		
ID14 weekly report	Andreea	30'	x		
Sprint Velocity		52h			

Stop doing:

- Vladimir: not coming to the classes

Start doing:

- Make a powerpoint presentation for the group meeting on Thursday
- Social activity with the team members to get to know each other better

Keep doing:

- Meeting on Tuesday with the whole group
- Meetings are really a good way to get a clear overview

Table 22: Sprint 4 Review

Sprint 4 12/03 - 18/03					
Task name	Responsible	Duration	Completed	Not completed	Notes
ID26 leaflet & flyer	Andreea	8h	x		
ID25 design logo & brand name	Andreea	4h	x		
ID27 shelter design	whole group	10h		x	this task was postponed to sprint 5 because of COVID-19
ID05 features research	Andreea, Lore			x	this task was postponed to sprint 5 because of COVID-19
features research week4	Andreea, Lore	8h		x	
ID23 weekly sprint plan	Lore	2h		x	
ID24 classes	whole group	6h	x		This was the first week we had to stay home because
ID22 weekly agenda & minute	Andreea	30'	x		of COVID-19, some courses got cancelled
ID21 weekly report	Andreea	30'	x		
Sprint Velocity		19h			

Stop doing:

- Not showing up at the meeting with the teachers (some members)

Start doing:

- Reminding everybody about the meeting with the teachers on Thursday
- Find a good way to communicate with all the members while everybody is staying home (COVID-19)
- Find a way to motivate all the members to work for the project

Keep doing:

- Make a powerpoint presentation for the meeting on Thurday

Comment:
ISEP got closed since 12/03/2020 because of COVID-19. So far it is unclear how long the university will stay closed, as long as it is closed all the members will work from home. Weekly online meetings will take place to ensure good communication between the members from now on. Sprint 4 was not done properly as there were a lot of uncertainties. During the next sprints BIS-team will try to catch up to ensure that no other deadlines will be missed.

Table 23: Sprint 5 Review

Sprint 5 19/03 - 25/03					
Task name	Responsible	Duration	Completed	Not completed	Notes
ID27 shelter design	Andreea, Lore	10h	x		this task was postponed to sprint 5 because of COVID-19
ID05 features research	Andreea, Lore			x	
features research week4	Andreea, Lore	8h	x		this task was postponed to sprint 5 because of COVID-19
ID33 improve design logo & brand name	Andreea	2h	x		
ID18 structural drafts	Lore	5h	x		
ID36 sustainability	Jelte	5h	x		
ID34 marketing (until 4.5)	Vladimir	6h		x	
ID37 ethics	Andreea, Lore	6h	x		
ID35 SWOT analysis	Gabriel	2h		x	
ID31 classes	whole group	11h	x		
ID30 weekly sprint plan	Lore	2h	x		
ID29 weekly agenda & minute	Andreea	30'	x		
ID32 update gantt chart	Lore	1h	x		
ID28 weekly report	Andreea	30'	x		
Sprint Velocity		59h			

Stop doing:

- Not feeling responsible to do tasks because of COVID-19 (some members)

Start doing:

- Divide the tasks very clear so everybody knows their job
- Ask team members for help in the Whatsapp group when you are struggling with something

Keep doing:

- A weekly big meeting with the team, using the Teams application
- Try to motivate the members to keep working for the project

Table 24: Sprint 6 Review

Sprint 6 26/03 - 01/04					
Task name	Responsible	Duration	Completed	Not completed	Notes
ID43 List of Materials	Whole team	3h		x	
ID44 material research	Andreea, Lore, Gabriel	10h	x		
ID05 features research	Andreea, Lore	8h	x		
ID42 cardboard	Lore	6h	x		
ID45 CAD model	Eduardo	10h		x	
ID48 ventilation system	whole group	2h		x	
ID47 update sustainability	Jelte	3h		x	
ID34 marketing (until 4.5)	Vladimir	6h		x	
ID46 project managment	Andreea	8h	x		
ID41 classes	whole group	16h	x		
ID40 weekly sprint plan	Lore	2h	x		
ID39 weekly agenda & minute	Lore	30'	x		
ID38 weekly report	Andreea	30'	x		
Sprint Velocity		51h			

Stop doing:

- Not feeling responsible to do tasks because of COVID-19 (some members)

Start doing:

- Making shorter deadlines for everybody to get a better view on what everybody is doing

Keep doing:

- Divide the tasks very clear so everybody knows their job
- Ask team members for help in the Whatsapp group when you are struggling with something
- Meetings are really a good way to have an overview
- Motivate some of the members to keep working for the project

Table 25: Sprint 7 Review

Sprint 7 02/04 - 08/04					
Task name	Responsible	Duration	Completed	Not completed	Notes
ID54 Strength of Shelter	whole team	4h		x	
ID59 Improve leaflet & flyer	Lore	6h	x		
ID43 List of Materials	Andreea	3h	x		
ID45 CAD model	Eduardo	10h	x		
ID48 ventilation system	whole team	2h		x	
ID57 research paintable cotton	Jelte	5h		x	
ID55 add mechanisms (chapter 7)	Lore, Andreea	8h		x	
ID60 material research (chapter 7	Lore, Andreea	6h	x		
ID47 update sustainability	Jelte	3h	x		
ID56 materials (chapter 5)	Gabriel	1h	x		
ID34 marketing (until 4.5)	Vladimir	6h	x		
ID35 SWOT analysis	Gabriel	2h	x		
ID58 project managment	Andreea, Lore			x	this task will take time until the 9th sprint
project managment 3.3-3.6, 3.10	Andreea, Lore	8h	x		
ID51 weekly sprint plan	Lore	2h	x		
ID52 classes	whole team	5h	x		in the middle of this sprint the easter break started
ID50 weekly agenda & minute	Lore	30'	x		
ID53 update gantt chart	Lore	2h	x		
ID49 weekly report	Andreea	30'	x		
Sprint Velocity		64h			

Stop doing:

- Not feeling responsible to do tasks because of COVID-19 (some members)

Start doing:

- Use the Microsoft planner and One Note
- Work together as a team

Keep doing:

- Making shorter deadlines for everybody to get a better view on what everybody is doing
- Divide the tasks very clear so everybody knows their job
- Ask team members for help in the Whatsapp group when you are struggling with something
- Motivate some of the members to keep working for the project

3.11 Sprint Evaluations

Include the summary of all the sprint retrospectives, including any actions implemented as part of the team's continuous improvement strategy.

3.12 Conclusion

Provide here the conclusions of this chapter and introduce the next chapter.

4 Marketing Plan

4.1 Introduction

The aim of marketing is to understand the market and the customer’s requirements as well as possible, to be able to design a product to meet the necessary conditions. Marketing is based on the fact that we need to fulfill a necessity and to make a profit. In this chapter, the marketing plan for the Foldable Disaster Shelter can be found. The marketing plan consists of a Market analysis; a Strengths, Weaknesses, Opportunities, and Threats (SWOT) analysis; the Strategic objectives including the Specific, Measurable, Attainable, Relevant and Time based (SMART) principal; Market Segmentation; Positioning strategy; Adapted Marketing-mix; a Budget and a Strategy control.

Our purpose is to create the ideal product in the event of an imminent disaster so that it will fit the customers and be a useful and innovative product so that the created design can be maintained for a long time in the market. Later in this the marketing part of the project we will make a detailed analysis of who our costumers and how can we promote our solutions to attract the right people that will require our solution/ product. We do not just offer a product but we offer a solution. At least this is our goal, which is very important to know where we are going if we want to reach there. Another way to define marketing: targeted and target group-oriented lining up of a company to the needs of the market. Thus, marketing is much more than advertisement or sales which most people associate with it. In the development process of a new product, marketing has a significant role in success. Processes should always be verified to be important for the customer. The balance between demand-pull and technology-push has strongly shifted toward demand-pull in recent years **[36]**. Therefore, the benefit for the customer should always be in the focus during the development process. It is absolutely necessary to know the customer, the market and especially the future customer.
At the end of this chapter, the team wants to have a proper market and customer analysis to have the opportunity to create a solid Marketing Mix where either price, product, place or promotion are defined.

4.2 Market Analysis

It serves as a basis for decision-making. Information is collected and evaluated by suppliers and buyers to make purchases or sales decisions. Furthermore, you can evaluate your current market or view new markets. “A comprehensive market analysis forms the basis of the development of a marketing strategy and concrete marketing measures” **[37]**.
When entering a new business it is crucial to understand your new environment, if you want to enter and win in some new game you need to know the players, the rules and the environment, in other work you need to gather information and be prepared.
Here is where market analysis comes, we gather information about the players (competitors), rules (regulations, laws, requirements) and finally, you need to know the surroundings of the business. In other words, we will call this competitive environment and Porter's Five Forces model acts as a framework for analyzing a company’s competitive environment **[38]**.
The threat of new entrants porter’s 5 forces explained is one of the factors to consider when analyzing the structural environment of an industry.

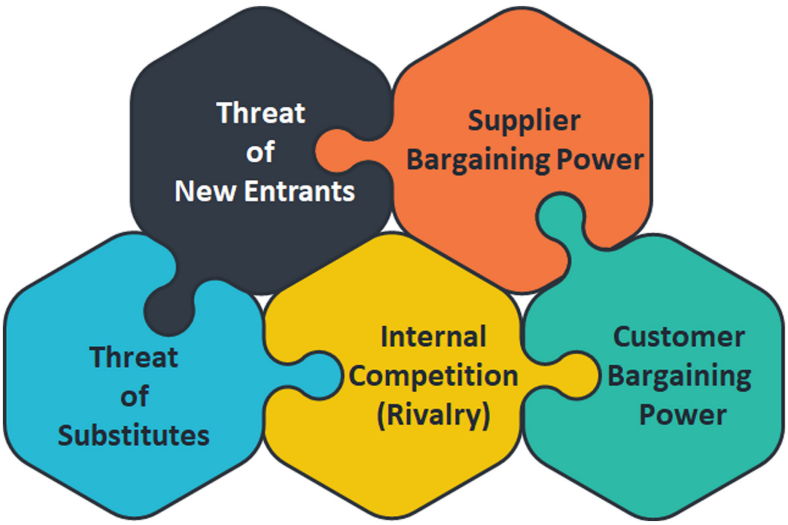


Figure 16: Porter's Five Forces **[39]**

Threats of new entrants

There always exists the threat of a new entrant in the market and if you are not properly positioned in the market, it can be challenging. New competitors entering the marketplace can either threaten or decrease the market share and profitability of existing competitors and may result in changes to existing product quality or price levels.
This is the reason that our team will cover some of the major benefits that will help the product to be well-positioned pretty considering the benefits and all the strengths we bring.
Although launching our new product can be a challenge for other competitors, at the same time it is a challenge for us to maintain our position, so thinking ahead and designing the product so that it respects all the necessary conditions and brings an extra through the unique design, we will be able to maintain the shelter in something that is called “trending” making the product's life a long one.
Reusable (sustainable), customizable, modular, reliable and structure that appears in nature (RCMRS).
The integration of an easy-to-use product that uses sustainable materials, an innovative and accessible mechanism and at the same time a customizable and modular design becomes a pleasant product for the people who will use it, the people who have been brought to safe places from affected and damaged areas, thus the shelter becomes a necessity and at the same time a product that promises entertainment through its design.
Moreover, we will go one extra step to both the end-user and the customer, which in our example the effected people by disasters are the end-users and the costumers are organizations and individuals and companies that want to help the end-users of the disaster shelter.

Suppliers Bargaining Power

The power exerted by suppliers in the form of price, volume limitations, shifting costs to customers **[40]**. When doing business with suppliers quantity has a big effect on price and due to our focus on costumers and end-user, the quantity will either be 0 or 5-digit numbers. This will help our suppliers give us a more affordable price.
When doing an analysis of supplier power in an industry, low supplier power creates a more attractive industry and increases profit potential as buyers are not constrained by suppliers. High supplier power creates a less attractive industry and decreases profit potential as buyers rely more heavily on

suppliers.
There are five major factors when determining the bargaining power of suppliers:

1. Number of suppliers relative to buyers;
2. Dependence of a supplier's sale on a particular buyer;
3. Switching cost (switching costs of supplier);
4. Availability of suppliers for immediate purchase;
5. Possibility of forwarding integration by suppliers **[41]**.

The Bargaining Power of Suppliers is high when the buyer relies heavily on sales from suppliers, when substitutes are unavailable, when there is a small number of suppliers relative to buyers and the threat of forwarding integration is high.
The Bargaining Power of Suppliers is low at that moment when the buyer does not rely heavily on sales from suppliers, substitutes are available, when there is a large number of suppliers relative to buyers, switching costs of suppliers are high and the threat of forwarding integration is low.

Costumers Bargaining Power

Customers can have the power to influence price, quality, and services/features **[42]**. In this part, the project has an advantage because our main focus is on costumer with big buying power like big organizations, government agencies, world charity associations, and our secondary focus will be individuals with less purchasing power.
By addressing to companies with greater influence power, we make our product to be easily integrated into the market because through the target we set we can help people who have been subjected to environmental disasters, and launch the shelter on the market, ensuring his usability.

Internal Competition

This Force refers to the number of competitors and their ability to undercut a company. The more competitors along with the number of equivalent products/services they offer the less power a company has in the market. Competition can drive prices down, similarly, if the rivalry is low then the company has more power to charge higher prices. Competition drives innovation to remain competitive in the market **[43]**.
Disaster shelters are not a new idea on the market, therefore the competition is much higher, and the innovations that will be brought will add more value to the product compared to the other products on the market, so the thing that will distinguish us is how we position ourself on the start and how we market the product. For this reason, we have the RCMRS with a focus on both customer and end-user.

Threats of substitute

Substitute goods and services that can be used in place of a company's products or services pose a potential threat. Companies that produce goods or services for which there are no close substitutes will have more power to increase prices **[44]**. The team will adopt several measures to protect the project's success, such as unique shape, customizable and intentions of satisfying the end-users and costumers before making high profits.
Designing a product that wants to protect people, hosting them in safe and even pleasant and customizable places to make their lives easier, increases the confidence of the buyers, therefore our

product receives credits in terms of attracting the attention of our buyers.

PORTER'S FIVE FORCES - SafeBIS

The 5 parts of the Porter's Five Forces Diagram in the case of the SafeBIS-Foldable Disaster Shelter are analyzed below.

1. Threats of New Entrants
Threats of New Entrants:

- Not much specialized knowledge required (some for materials and mechanisms);
- Production and labor cost is relatively lower in some cities;
- Low customer loyalty for non-established brands, making it easy for a buyer to switch to alternatives;
- Increased bargaining power of suppliers.

2. Supplier Bargaining Power
Supplier Power:

- The whole industry relies on few suppliers.

3. Customer Bargaining Power
Customer Power:

- Buyers are sensitive to price change;
- Buyers are not willing to spend much;
- Buyer can compare different alternatives easily with information on the Internet.

4. Internal Competition
Competitive Rivalry:

- High competition between on-line and off-line companies;
- Large advertising expense;
- High customer loyalty to established brands;
- Most competitors have strong financial support;
- Some competitors have a government background.

5. Threat of Substitutes
Threat of Substitution:

- There are many products with the same functionality and some are cheaper.

4.3 SWOT Analysis

The S.W.O.T. analysis or matrix is a business strategy tool for determining the options offered in a strategic area of activity.
It aims to clarify the objectives of the company or project and to identify the internal and external factors favorable and unfavorable to the achievement of these objectives. SWOT has been described as a proven tool for strategic analysis.
The letters stand for Strengths, Weaknesses, Opportunities, and Threats.
In the following figures is illustrated the analysis of S.W.O.T. for the product 17 and the representative one for the BIS team 18.

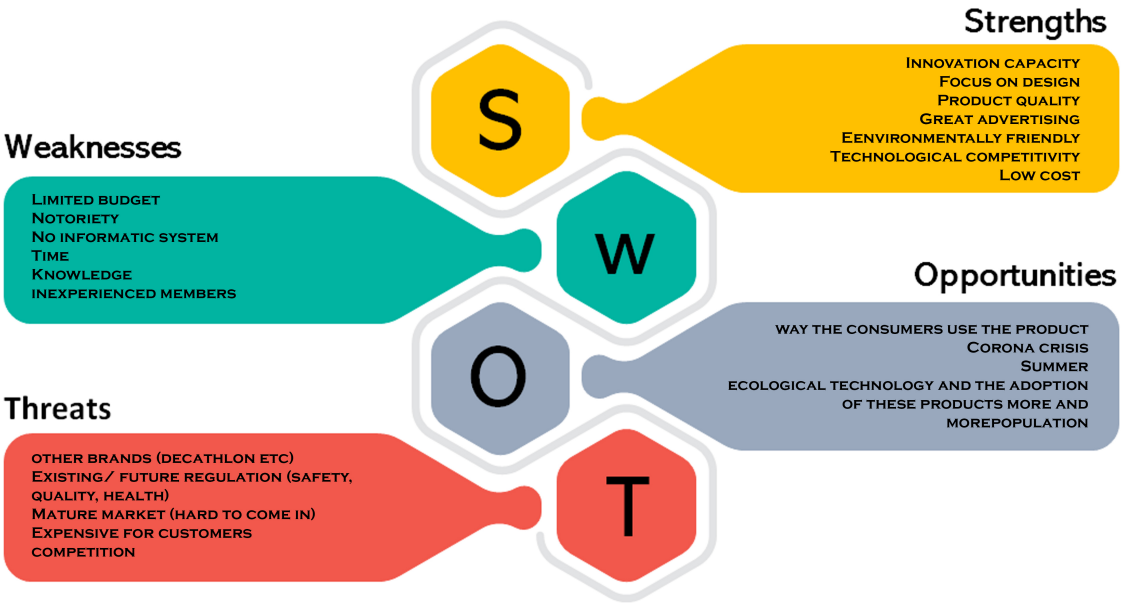


Figure 17: S.W.O.T. Analisys

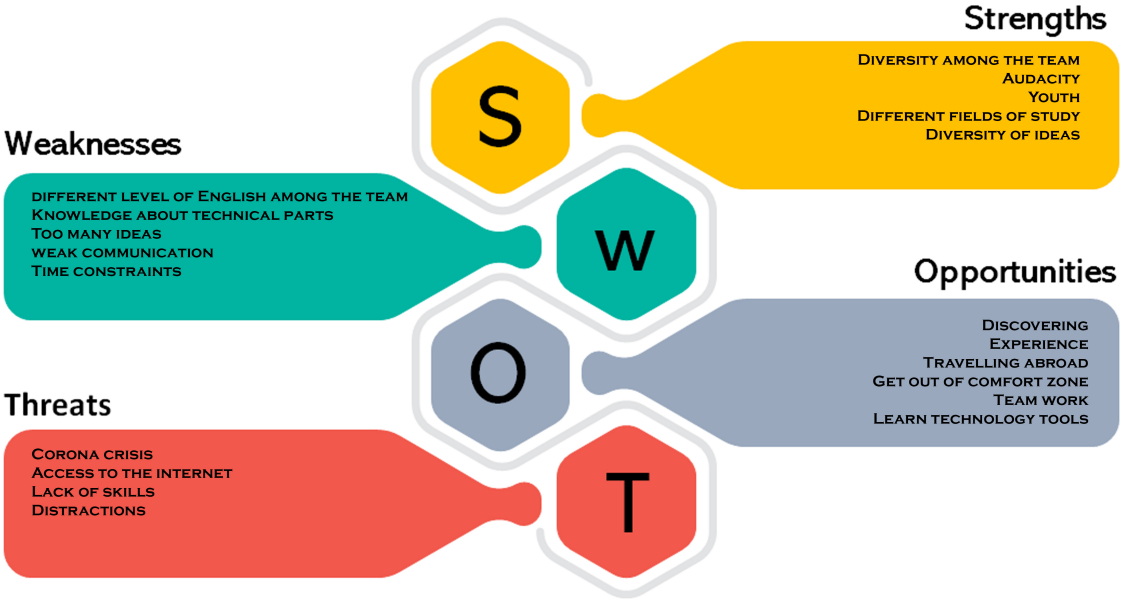


Figure 18: Team S.W.O.T. Analisys

4.4 Strategic Objectives

Goal setting is among the most important things in life and business. They serve as a light that guides our path because without that light we are lost. They help us to visually embrace what we want out of life, enabling us to provide some measurable metrics to the progress that we make along the way. Thus, setting our goals is the way to pour a concrete solid foundation about the things that we want and about our vision, because it is very important to guide ourselves according to our own aspirations and current needs. Knowing all these things and wanting to create a product in systematic steps, we approach this method so that our entire course is well organized.
We will use the S.M.A.R.T.E.R. method of setting goals for this purpose **[45]**. This method is illustrated in the picture 19.

Figure 19: S.M.A.R.T.E.R. Goals

“S” – Specific
The goal must be easy, clear and exact to be easy to understand by everyone. It can lead to confusion and uncertainty which will end up with a loss of time resource.
So the more specific we are about our goals, the better and more able you will be to accomplish them no matter what method you use.
Our main objective is to compensate for great damage and to help people affected by disaster both emotionally and physically, offer them temporary shelter where they will feel at ease and safe, offering them a reliable structure.
Our team does not have a specific objective and for this reason, we decompose it (ie. project planning):

- Make a reusable sustainable eco-friendly shelter.
- Make it customizable. This gives the end-user (people affected by the disaster) a way to change his mind out about what happened and calm the people as well as giving them the feeling like they did not lose everything and that they still have something that is theirs and they can feel comfortable and protected in it.
- Modular so that it can fit more people depending on the need, creating a community for all families.
- Reliable shelter to provide safety and to provide safety and protection against bad conditions.
- Make a structure that appears in nature. Considering market analysis, one of the strongest and biggest buildings in the world found their inspiration from nature.

“M” – Meaningful
When your goals have a deep enough meaning to you, you will do whatever it takes to achieve them. This does not have to do with vanity or superficial reasons, but more profound and life-altering reasons why you want to achieve something.
In order to achieve the proposed objectives, a strong justification is needed to define the attributions we give to our product.
This justification is summed up in one word - “why”.

- Why Reusable?

There are numerous products that are completely recyclable, partially or not at all, so those non-recyclable waste must be stored somewhere or subject to certain processes that are more or less

harmful to the environment.
In today's world, we have more trash that we are supposed to deal with, because of the business models we have followed in the past.
The US alone produces 250 million tons of trash per year **[46]**. This is a very worrying thing for everything around us.
In the end, that trash has to go somewhere. That’s why we want to contribute to society and our planet, by changing the old methods by adopting an eco-friendly and reusable solution.

- Why Customizable?

Starting from the image of an imminent disaster: an earthquake has happened, you lost your home, your possession, you feel like you do not have anything and your life and dreams are compromised.
Our team, during our brainstorming sessions and discussions, saw that this is a real and important problem that the people face.
So, we thought of a solution.
It includes human psychology and is about investing in yourself, in feelings and customs, participating in the creation of a pleasant environment in which to feel the feeling of belonging. And when you have this place that you created and you feel comfortable there it can be called your place in which you can live **[47]**. For this reason, we will add a customizable feature such as paintable fabric.

- Why Modular?

When a catastrophe happens, there are different numbers of families and a number of people affected.
We create the idea of community that we have set ourselves, by participating in the formation of a pleasant environment in which people live close to their united families and in safety.
At the same time, by making it modular we can use less material and have less loss of resources by making the shelter meet the demand and the needs of the group of people.

- Why Reliable?

By the purpose we created, we place people's safety first, as well as the necessary opinions and requirements.
Thus, by creating a product that can do all these things, trust is gained by itself, so the word “reliable” becomes part of this product.

- Why Natural Structure?

Nature is beautiful and this structure is something that deserves to be exploited in this regard. Also, it has been proven throughout the history of humankind that the most wonderful looking buildings that require a strong shape have been inspired by nature.
The industry is moving towards a more “environmentally nature-inspired understanding” of how nature responds to its environment and how humans can do the same **[48]**.
Adopting a natural structure, that is honeycomb, is a feature of our product that gives it both strength and pleasant design and very easy to attach to create the community of shelters, reducing the used space, in the same time the hexagon shape gives extra resistance to the structure.

“A” – Achievable
The art of choosing a goal. It can be small, easy but not motivating or it can be a really big and important one but hard to achieve. With the first one, you will not actually do anything remarkable and the second one will be hard and you will have a tendency to give up. That’s why you have to choose a goal that is big enough to motivate you but small enough that you believe you can get. In

the same time you Thus we chose to build a shelter that will be focused both on the costumer the planet and the end-user. This is a unique solution that is affordable, user-friendly, beautiful and the end-user will not just find it useful but also love it.

Achievable goals put things in perspective. They ensure that our team has the right focus. To set achievable goals, we need to make our goals smart. Or maybe even smarter and for this reason, we followed the S.M.A.R.T.E.R. method.

“R” – Relevant Every disaster foldable shelter has been focused on being useful and it is not based very much on creating a pleasant, friendly space with people in need, focusing more on utility than on entertainment and missing the element about how the affected people feel about it.
“T” – Time-Bound In the context of the EPS program, we have deadlines to respect (ie. Gantt chart). That is why our first real model will be ready and operational at the end of June.
For the SafeBIS product the following objectives are defined:

- Create the leaflet and flyer before 8th April 2020;
- Finish the project report before 12th of June 2020;
- Create a packaging solution for the product until 12th May 2020;
- Build the prototype before June 2020;
- Creating a website for the customers until 12th of June 2020;
- Obtain funding to start production by the end of 2020;
- Start sales to our clients in January 2021;
- Invest 5% of the profit in innovation before 1 July 2021;
- Invest 5 % of sales in the advertisement before December 2021;
- Achieve a wealthy net sales growth between 5-8% annually.

“E” – Evaluate
In this kind of big project, it is necessary to evaluate our progress and quality after each task. If the whole project is organized and monitored at every step, everything will go according to expectations, finally achieving a good result.
“R” – Readjust
The final step in setting goals with the S.M.A.R.T.E.R. method is to readjust our approach. If, for example, we find ourselves pursuing a goal but continuously hitting a brick wall, readjust our method and techniques. An Example: We really loved the modular honeycomb idea and placing one on top of another but that was hard and maybe not attainable with the budget, knowledge, and deadlines we had. That’s why we readjusted and made the honeycomb idea by fixing the hexagonal shape on the ground and then attaching the other shelter one by one to another.

4.5 Strategy/Targeting/Positioning/Brand

SafeBIS primary focus will be dealing with businesses, organizations, and governments around the globe and secondary focus will be individuals that want to help affected areas and to donate. Since our market is dealing with disasters, and this is a subject that can not be expected, we will be dealing with the global market from various national and cultural backgrounds. There are three criteria of segmentation we will analyze:

- Geographic
- Demographic
- Psychological

Geographic

Although there are natural disasters happening worldwide, we can not focus everywhere. Looking at the picture 20 we can see that there are four major areas that most of the events are focused, apparently, for some reason, Russia seems to be immune to natural disasters.
The four areas are the following:

- First around Japan, China, and Korea.
- The second area is around India.

For these two areas, we can collaborate with Chinese manufacture that will manufacture and ship the shelters. The reason for this is lower manufacturing and shipping costs due to the distance between the affected area.

- The third area is around central Europe, the most suitable country for manufacturing regarding expenses and shipping costs would be Serbia or Poland. More research is needed regarding this matter.
- The fourth area is the US and Mexico, more specifically the area around the Gulf of Mexico. We can say that the south-east part of North America. We all know that America is pretty costly and we will use something that already is working in the world. For the supply of America, we can use the already established production in China and ship it from there.

To summarize, the four major areas of natural disasters occurrence: southeast Asia, India, central Europe, and southeast North America.
There are two strategical areas we can have manufacturing which is Serbia or Poland and China. China would supply three major areas which would be good for an expansion opportunity after the one in central Europe.

Figure 20: World map of the 50 major loss events 2016 **[49]**

Demographic
SafeBIS has a primary and secondary marketing focus. As we mentioned in previous chapters our primary focus are business organizations and governments, but our secondary focus is individuals

who want to donate. The demographic segmentation will be done for our secondary focus. According to the data published by The Guardian **[50]** on how much individuals donate, people in their 60s are donating twice as much as the people younger than 30 are doing this fact.

Percentage of households giving – by age group
Click heading to sort table. Download this data

Ageband	1980	1990	2000	2010
<30	23.2	17.2	15.2	15.6
30-44	33.7	28.8	27.6	24.8
45-59	39.1	34	29.9	26.5
60-74	30.7	29.9	32.1	32.7
75+	27.4	27.8	30	31.1

Source: Mind the Gap by CAF and Bristol University

Figure 21: Percentage of households giving

As we can see from that Figure 21 the older people are, the more they tend to donate. Everyone likes simplicity and for our example, we will separate the age range in 3 groups: Youth, Mature and Wise. To explain the percentage, a diagram was made 22:

- Youth (5%) is the age range < 30. The percentage is quite low and this will have our lowest priority focus. Due to the limitations of these individuals which is primary finances they are not able to donate that much and because of their beliefs and youth they want to spend their money on other things, and they have other priorities at that age.
- Mature (22%) group is the age range from 30 – 60. This group is starting to mature and accumulate more wealth than they can allow themself to donate. Moreover, this group starts to understand and learn that taking care of others, helping, is something that those who can.
- Wise (73%) group. The reason this group is called wise is that they are wise and the place that they are allows them to donate and give to the people. They have accumulated some wealth and build, they have what they need and feel that they should give back to the world. Therefore Wise. They are our group with the highest priority.

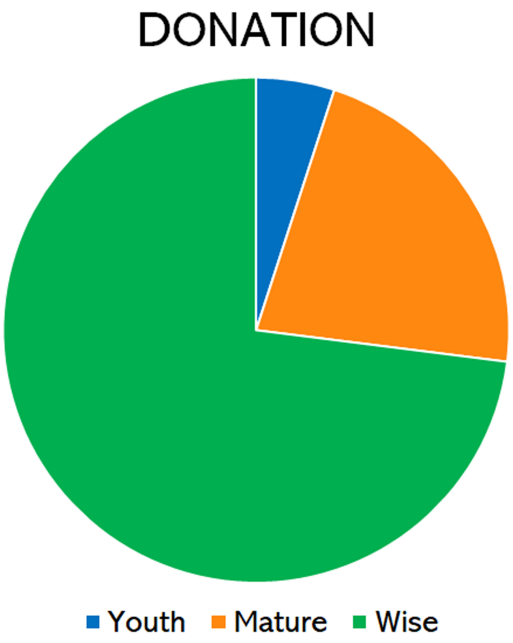


Figure 22: Donation Diagram

Psychological
Concerning the Psychological, we have already cover that for our secondary marketing focus in the demographics part. Now we will cover the psychological part for our primary market target. Why do organizations buy shelters in the first place, they have to and they want to, that's their job. What influences their decision in choosing a product? Usually, it goes on a tender, and suppliers offer their price and if it meets their requirements and has a low price, they get the tender. Another side is they chose one product because of the benefits as well as sustainability and eco-friendly.
There are also a lot of other reasons and situations but this will be our main objective, objectives we can actually change and influence.
SafeBIS has implemented a couple of benefits and good solutions, not to mention the eco-friendly part.
Moreover, the strategical locations for manufacturing the product will help us to cut down on the price drastically.

4.6 Adapted Marketing-Mix

4.7 Budget

4.8 Strategy Control

4.9 Conclusion

Provide here the conclusions of this chapter and introduce the next chapter.

Based on this market/economic analysis, the team decided to create <*specify the type of product*> intended for <*specify the market niche*> because … Consequently, the team decided to create a product with <*specify the features*>.

5 Eco-efficiency Measures for Sustainability

5.1 Introduction

In the current age, it grows more and more important to make your products sustainable. In this chapter, the focus will be on making the shelter and the environment of the shelter more sustainable. In the case of the disaster shelter, there will be a focus on the materials and the adaptation to the environment.

The pillars of sustainability

The concept of sustainability can be reached by looking at the environment, the social aspect, and the economical aspect. To achieve the highest level of sustainability each of the three pillars should be taken seriously. The environment pillar is related to natural resources, water, and air quality, energy conservation, and land use. The Social pillar deals with the community, education, equity, social resources, health, well being and quality of life. The Economical pillar deals with the bottom line and

the cash flow **[51]**.

The environmental pillar

Global warming is a big problem during the current days. A lot of companies are committing a lot of resources on this problem. Unfortunately, the measures that are taken can be considered soft or in the wrong direction. That's why the disaster shelter wants to prevent this and go with an environmental approach. The environmental pillar in the case of the disaster shelter can be separated into two aspects: Materials and the location. To create the optimal shelter, materials are needed. These materials need to be able to survive harsh weather circumstances while being good for the environment. The location of the shelter is really important as well because there will always be a footprint of society. If this is in a location that is easy to reach, the garbage and broken materials can be transported to nearby dumps quite easily. The location should not endanger the environment in any way. In the optimal case, the shelters should be buildable with materials on hand in the disaster-struck areas so there are no transport costs. This will not work in the case of most disaster-struck areas so the focus should lie on the weight and size of the shelter together with the kind of material used to make the shelter to keep the transport as low as possible **[52]**.

The economical pillar

The shelter is not meant to earn money because human lives are at stake. This does not mean that there will not be done everything to keep the price of the shelters as low as possible **[53]**. It is important to create shelters that are not that expensive because they will be used in huge numbers to help the unfortunate. In the case of the disaster shelter, it is incredibly important to save as much as possible on the materials and size while limiting the damage to the environment. An easy way to do this is by limiting the number of materials used in the shelters. If the fabric is broken or not usable anymore it will not be as bad for the environment as with a shelter that uses a lot of fabric. The kind of fabric is incredibly important of course. In the case of the disaster shelter, it is important to have a material that can withstand high amounts of sun and drought while staying ventilated. If this is not the case the materials need to be replaced more often.

The social pillar

An important aspect of our social structure is to not do bad things to accomplish something good. In the case of the disaster shelter, the emission for the production for the shelter should be low. Another aspect is that the environment should not be polluted. In the case of the disaster shelters, this will mainly be caused by leftover trash and loose equipment that stays in the environment after the temporary camp is deserted. We do not want to destroy someone else’s property. The shelter camp should be in a location that is easy to reach from an urban environment, The shelters should be built as a single object, the shelters should be robust and the shelter's materials should not be too harmful to the environment (a natural material like cotton would be a good step in the right direction). Of course, the main objective of this project is to help the victims of major disasters so the environment will be second to the safety of the victims.

Sustainable development goals

The sustainable development goals are 17 goals that are set for the 2030 agenda. It is created to seek peace and prosperity for the planet and its people. The disaster shelter can be described by two of the sustainable development goals as seen in Figure 23.

- 3: Good health and well being;
- 11: Sustainable cities and communities **[54]**.

Figure 23: Sustainable Development Goals **[55]**

Sustainable cities and communities

The goal of the disaster shelter is to create a shelter that can shelter multiple victims without splitting them from loved ones and friends. The shelters are built in a way that is incredibly sustainable. All the materials that make up the shelter are natural and 100% recyclable. The shelter is robust and can survive in harsh environments. The entire shelter is built in a way to keep the pollution as low as possible. One of the more pressing problems with building a shelter is that the shelters are built to be temporary while the truth is that it is sometimes necessary to live in the shelter for multiple years. This can be solved by using good easy to replace materials **[56]**.

Good health and well being

While sheltered it is important to keep the inhabitants healthy. That is why it is important to look at the design of the shelter. Because the shelters that we built are mainly focussed on the areas around the equator we chose to use materials that can keep the sun out while keeping the inside cool. This will improve the living conditions of the victims and by making their stay more comfortable we can improve their mental health **[57]**.

5.2 Life Cycle Analysis

In an ideal world, the production process is a cycle it will go from resources to a product and back to resources. Of course, this is in most cases, not the case. During this project, efforts will be made to work in a cycle. The life cycle of a product is seen in figure 24. All the stages will be observed and explained with the shelter in mind.

Figure 24: Life Cycle Analisys **[58]**

Resources, Materials
The disaster shelter is almost entirely built out of fabric. In the case of the shelter, it will help to use materials that can be recycled from old shelters or other products. The material should be resistant to drought, rain, and the sun. One of these materials is cotton. Cotton is a natural material and can be recycled. But it is not super good at keeping water out. Another option is nonwoven polypropylene which is a material that is 100% recyclable and it waterproof. Of course, both options have their pros and cons. besides the fabric the shelter uses a big plate of cork as a bottom for comfort.

Manufacturing, Production
The manufacturing process should be limited to as few components as possible. The product should be produced in Portugal or in the disaster-struck areas to limit the emissions by not moving the resources needed oversees.

Assembly
The assembly process should be as easy as possible. The disaster shelter is built in a way that it is only possible to create a tent shape in one possible way. And by using multiple components that are the same, like the sticks and the fabric, it will be easy to build the shelter. The shelter will not use complicated designs because these designs often have more components in them and more components have a higher chance of breaking. This product is created with the plan to use it multiple times so all the designs are easy to disassemble as well.

Retail, Distrobution
The importance of this product is huge, it needs to be transported quickly to the place where it is needed. That is why the package should be lightweight and the size should be limited. The plan is to use health organizations like the Red Cross to transport them to the place that needs help the most.

Use
The shelter should provide a regular living environment that provides enough privacy with the intent to protect the inhabitants. The shelter should be able to withstand a lot of impacts it should be robust and when it breaks it is repaired easily. The shelter should be able to do everything itself, it should not be necessary to get extra waterproof spray to make the shelter waterproof, to limit emission.

Recycle
An important aspect of the disaster shelter is the recyclability. In the case of the disaster shelter, it is important that if the shelter is left behind in an area because of an unforeseen danger it will not damage the environment. So the materials of the shelter should be Nature-based or easy to absolve in nature. In the case that the shelter is damaged beyond repair the materials should be easy to separate from each other.

5.3 Conclusion

Sustainability is a big part of the creation of shelters. To achieve our goal to create a shelter for the less fortunate victims it is important to design a product that is long-lasting. By using natural materials and choosing the right location for the shelter it will be possible to keep the impact on the environment as low as possible.

6 Ethical and Deontological Concerns

6.1 Introduction

Ethical theories are to be useful in practice, they need to affect in a good the way human beings behave **[59]**.
Philosophers nowadays tend to divide ethical theories into three areas:

1. **Metaethics**: deals with the nature of moral judgment. It looks at the origins and meaning of ethical principles.
2. **Normative ethics**: concerned with the content of moral judgments and the criteria for what is right or wrong.
3. **Applied ethics**: consider controversial topics like war, animal rights, and capital punishment.

There are several reasons why it is important to adhere to ethical norms in research. First, norms promote the aims of the research, such as knowledge, truth, and avoidance of error. For example, prohibitions against fabricating, falsifying, or misrepresenting research data promote the truth and avoid the error. Second, since research often involves a great deal of cooperation and coordination among many different people in different disciplines and institutions, ethical standards promote the values that are essential to collaborative work, such as trust, accountability, mutual respect, and fairness. Finally, many of the norms of research promote a variety of other important moral and social values, such as social responsibility, human rights, animal welfare, compliance with the law, and health and safety **[60]**.

6.2 Engineering Ethics

Engineering ethics focuses on:

1. The study of the moral topics and judgments regarding people and societies belonging to the engineering field **[61]**,**[62]**,**[63]**;
2. The study of correlated concerns referring to the moral principles, figures, guidelines, and interactions of people and companies concerned with technical actions. Engineering Ethics also highlights the ethical responsibilities of the engineers due to their professional grade. It is a guideline of how engineers should behave in certain circumstances especially in their professional life **[64]**.

Jayakumar summarizes the following three elements regarding work ethics:

1. Interpersonal skills;
2. Initiative;
3. Being dependable.

This work ethic hypothesis embraces trustworthiness, dependability, and punctuality. If engineers are not reliable, they are considered to be redundant in the company because of the wasted time and funds their conduct exposes. Engineering ethics might be regarded as the identification, training and solving of ethical difficulties which can come about in the engineering career, but can also be functional for other people who intend to get involved in technical initiatives, for example, experts, mechanics, technical critics, production personnel, administrators, sales personnel, doctors, legal representatives, and common members of the community. Engineers have the right to complain and disclose such situations that commonly regard severe deficiencies and misconduct, for instance, reduced quality or monetary fraud. And if engineers really reveal such situations, then we can say that they are obviously morally authorized to perform such actions **[65]**.

The Fundamental Principles:
Engineers uphold and advance the integrity, honor, and dignity of the engineering profession by:

1. Using their knowledge and skill for the enhancement of human welfare;
2. Being honest and impartial, and serving with fidelity their clients (including their employers) and the public;
3. Striving to increase the competence and prestige of the engineering profession **[66]**.

As this team consists of 6 engineers, in our process of creating the desired product to help many people, we will respect these considerations of engineering ethics.

6.3 Sales and Marketing Ethics

The 10th principles of fair trade are shown in Figure 25.

Figure 25: 10 Principles of Fair Trade **[67]**

Ethical marketing refers to the process by which companies market their goods and services by focusing not only on how their products benefit customers but also how they benefit socially responsible or environmental causes. It consists of everything from ensuring advertisements are honest in building strong relationships with consumers through a set of shared values.
Modern sales management is a complex and disciplined mix of marketing skills, professional selling and negotiation skills, people management skills, sales strategy, and tactical planning skills.
Sales and Marketing Ethics is an important factor for a company and these ethical guidelines must be considered, thus our team has set itself to put these considerations on the foreground, in order to relate in an efficient and ethical way with both clients and competition. Our team wants to create a unique product so that we adhere to all the rules, laws, developing a marketing strategy that will place the product on the market in a pleasant way, taking into account the needs of customers, wishes, trends, all in the ethical sphere.
We will produce a product using a limited budget, sustainable materials and green energy, create the image of our company and aspire to positive results and profit.

6.4 Environmental Ethics

Figure 26: Environmental Ethics **[68]**

Environmental ethics is about searching for a good balance between the living creatures in our society. The creatures include humans, but also plants and animals. Searching for a good balance between there 3 is important because there are all considered a functional part of a human's life. This is why it is very important to use morals and ethics when dealing with these creatures.

As the increase of the population is going to extremely fast, the consumption of natural resources keeps increasing like never before. This causes a big pressure on the capacity of the planet because the consumption of resources is going at a faster rate than they can naturally replenish. Problems like global warming, climate change, deforestation, pollution are a few examples of what humans created by not paying attention to the value and moral status of the environment **[69]**. As a company nowadays, it is essential to take environmental ethics into consideration while developing our product and to do our part in keeping the environment safe and unfarmed.
SafeBIS will strive for this goal by doing the next things:

1. All the used materials are environmentally friendly;
2. SafeBIS strive to a maximal production efficiency with minimal energy consumption;
3. Our products reach the highest possible lifetime, which means that the shelters will be part of the circular economy. When discarding the shelter, every single part will be reused or recycled.

In addition to developing an eco-friendly disaster shelter, it will also be important for our company to focus on the area where the shelters will be placed. For a period of 2 weeks, the disaster shelters will stay on a fixed spot. The surface of what they are placed must be handled with care and be respected. After breaking down the shelters, no signs of damage may have been done to the surface.

6.5 Liability

As a company is responsible for the safety of the consumers while using their product, optimizing the safeness is very necessary. Every possible hazard needs to be avoided. In order to avoid hazards, SafeBis will manufacture components that are of high quality and reliable. The team strives to optimal safety by choosing suppliers who are legitimate and certified.
During the development of the product, EU Directives concerning liability have to be taken into account. For the disaster shelter, there are no directives that apply. The disaster shelter will not include mechanical components as the construction of shelter is completely manual.
Therefore no recourse to the Machine Directive is required. As the shelters are not provided with electricity, the Low Voltage Directive does not apply to the project. No electronic devices will be implemented in the shelter, sequential the Electromagnetic Compatibility Directive and the Restriction of Hazardous Substances (ROHS) in Electrical and Electronic Equipment Directive do not apply either. The Radio Equipment Directive applies to all of the equipment in the EU market which uses radio-electric technology (Bluetooth, Wi-Fi, NFC.). Our company will not provide radio-electric technology in shelters **[70]**.

Despite the fact that no general directives of the European Commision apply, important guidelines to take into account are the Humanitarian Shelter and Settlements Guidelines. These guidelines take care of European Civil protection and Humanitarian aid Operations (ECHO) **[71]**.

6.6 Conclusion

Ethical concerns need to be respected in order to protect the environment, to provide the highest quality to customers and to create a good and reliable reputation for SafeBIS.
They help us to deliver a safe and environmentally friendly product that will add value to society.

With regard to the marketing of our product, the team strives towards an honest and transparent attitude and aim to be ethical towards the customers and also competitors.
The main concern is environmental ethics, as SafeBis strives to provide a completely circular service

in which almost no waste will be produced and production efficiency will be optimized without spilling energy. When using components of suppliers, SafeBIS will make sure that the partners follow the standards and are certified.
Concerning the area on what the shelters will be placed, will be handled with respect, our team takes care of the fact the used area stays intact after the use of the disaster shelters.

7 Project Development

7.1 Introduction

Provide here the summary of this chapter.

7.2 Architecture

In this chapter, we will observe the evolution, and improvements brought along the way to achieve the final product. Here is shown the scheme of a black box, which includes the inputs and outputs which summarily define the structure of the shelter and its results.

Following the definition of shelter, that is a place giving temporary protection from bad weather or danger, and our goal is to provide protection, safety, and a friendly shelter both with the user and with the environment by adopting sustainable methods, ethical considerations and following a well-organized marketing plan, we set out to create a shelter with a hexagonal base and roof that promises all the things listed above.

Black Box Diagram
Considering that for the construction of the SafeBIS shelter we intend to use very easy to recycle materials, easy to assemble components and because we have not integrated any electrical or electronic part in the structure of this product, the Black Box represented in Figure 27 illustrates the necessary requirements that the team follows properly to achieve the initial goal.
The input is based on the integration into the shelter component of 6 parts that result in 6 other parts as follows:

- Folding Mechanism

The folding system gives the shelter, in the case of good design and in the case of choosing an optimal system, good portability, and efficiency in storage and assembly.
Thus, the better this system is made, the more SafeBIS is more user friendly, reducing the space needed for transport, storage and at the same time becomes a favorite product.

- Sealing System

The sealing system refers to the hermetic closure between the component parts so that the heat is not lost or a temperature balance between the inside and outside space is maintained. At the same time, it is necessary to consider good insulation in adverse weather conditions that can endanger the life and health of people and at the same time, the materials and components of the shelter can be damaged.
In the case of SafeBIS, natural materials have been chosen, mostly wood, cork, and cotton canvas, which are environmentally friendly, do not pollute, are fully recyclable and very resistant. Attaching

the wood fabric will be done by means of fasteners.

- Ventilation

Ventilation is a very important factor that must be taken into account in any type of room. To achieve the recirculation of the air it is necessary a ventilation system, or the simplest, it is adopted the creation of a window in the fabric, so that both the light and the air enter and leave the shelter.

- Thermal Protection

Thermal protection is achieved by choosing the cotton canvas which is a very good insulator, at the same time, for the floor is used wood covered with a layer of cork. The properties of the cork material are incomparably very good, giving good isolation, comfort to the touch and at the same time an impeccable appearance.

- Attachment System

The attachment system mainly refers to the method by which we want to create a community of shelters for people who have been through a disaster.
Thus, the shelters will be attached according to the number of members in a family, helping to keep them in good condition, helping them to be happy and to recover together. The shelters will be attached by means of fasteners existing on the market or that we ourselves will create using a 3D printer.

- Customizable

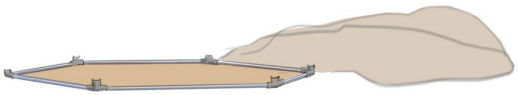
This part is the SafeBIS team's imprint on the shelter, to create entertainment so that people can customize their shelters according to their preferences. In this way, we create our own design which will be a valuable addition to the market exposure. The shelters have cotton canvas that can be painted in different colors and the environment is not affected.
In the Figure 27 is illustrated the Black Box Diagram for the project.

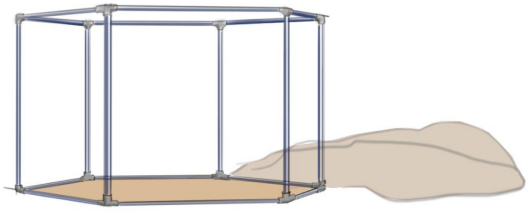
Figure 27: Black Box Diagram

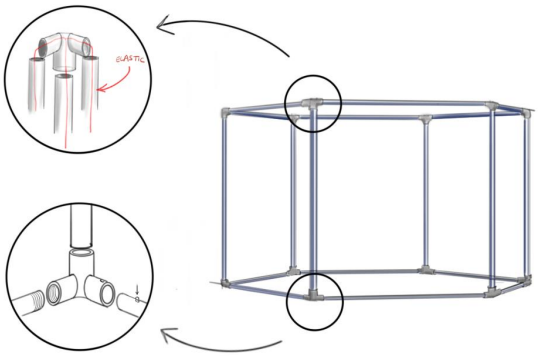
7.2.1Foldable Disaster Shelter-Sketches

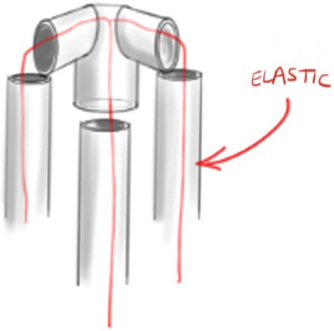
Folding Method 1

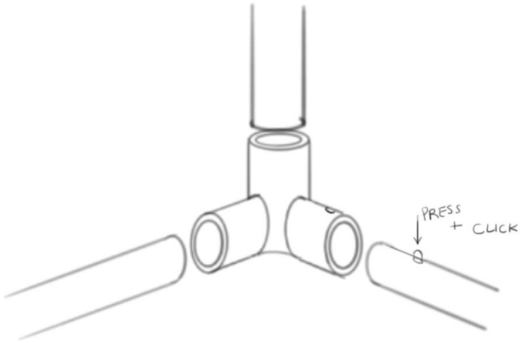
For this variant will be used bars that will be attached to each other through a corner with 3 branches. The shelter's skeleton can be assembled by attaching 3 to 3 components by: simple connection by push, by the mechanism similar to the umbrellas or by screwing.

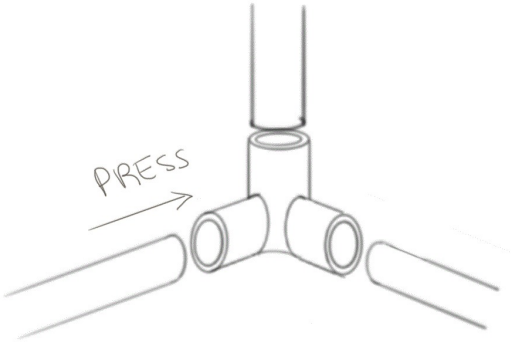


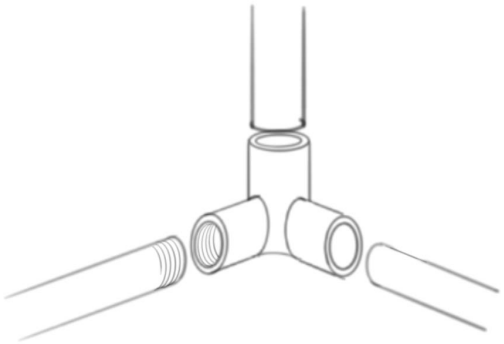





ELASTIC

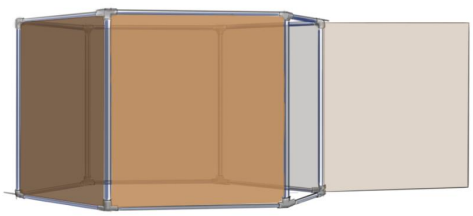


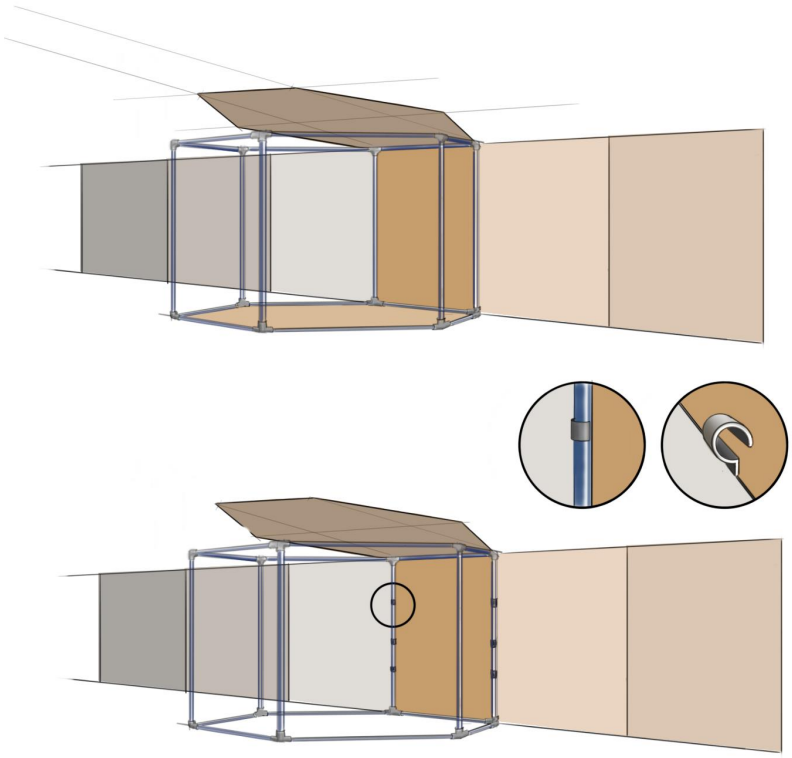


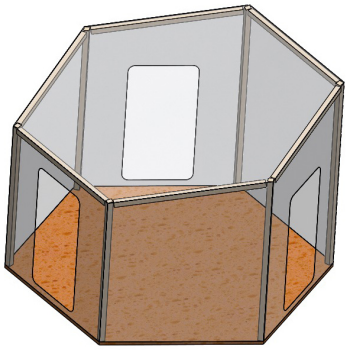


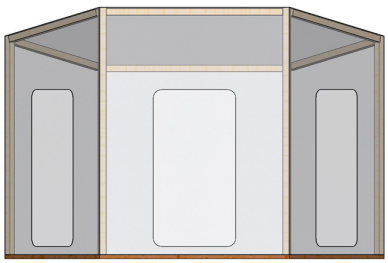
Folding Method 2

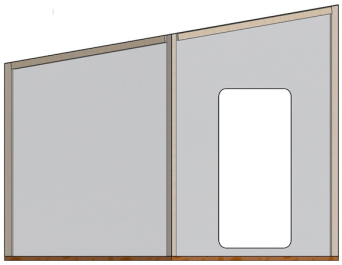
The second method refers to the attachment of each wall to the bars of the skeleton so that they are folded over each other in a compact group with the final dimensions as those of a wall or folded as in the last image. Instead of clips, we can use hinges to stabilize the walls and allow easy folding.



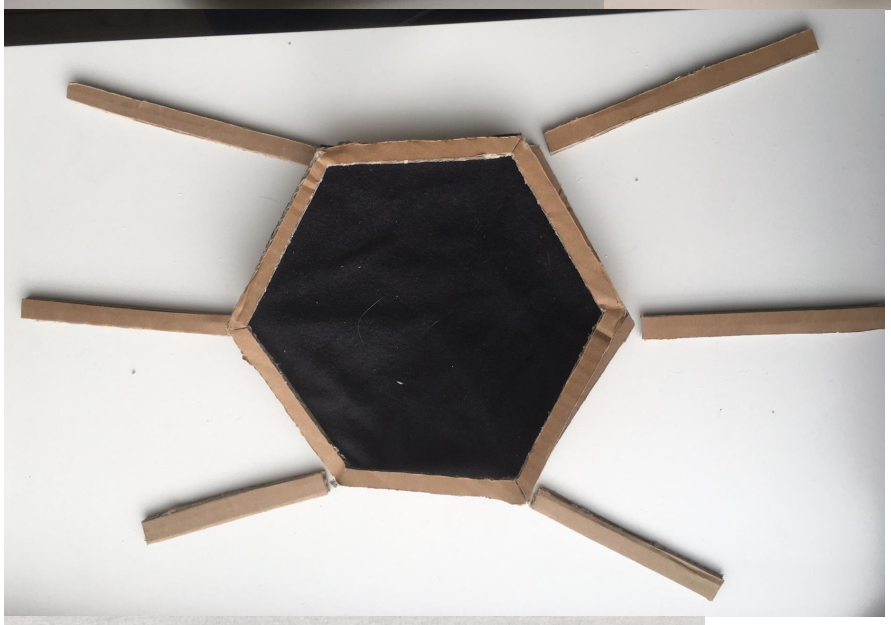


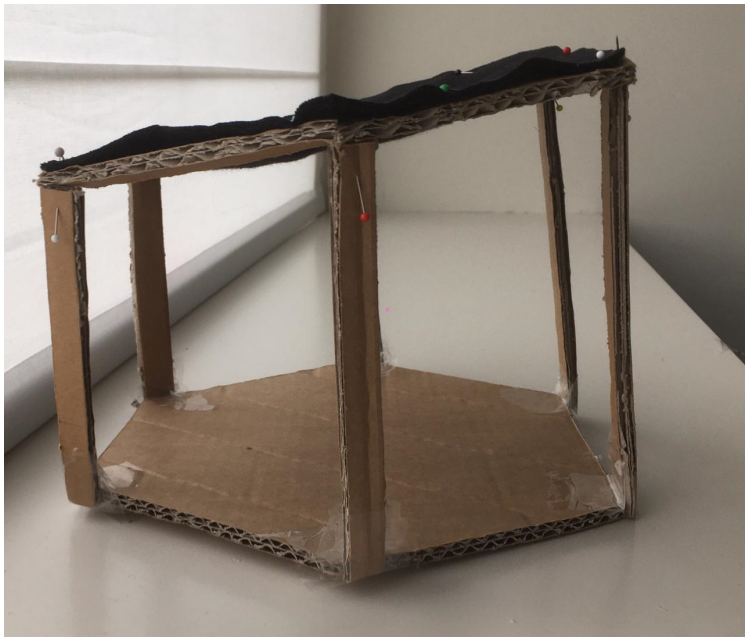






7.2.2 Cardboard model





7.3 Components

7.3.1 Components comparison

A comparison of several canvas considerations is illustrated in the Table 4.

Table 26: Canvas Comparison

Name	Sustainability	Price	Thermal properties	Area	Cons	Lifetime
Cotton	++	++	Very good ventilation and isolation	-Almost everywhere -Better in warm area	-Mold if moisturized -Need to keep dry	8-10 years
Poly-Cotton	+	+	Very good ventilation and isolation		Not as good as pure cotton under UV lights	6-8 years
polymer (polyester)	+	-	Good isolation	Better in temperate climate	Bad under UV	5-7years \ Less if Strong UV

7.3.2 Construction materials

As a building material, wood was predominantly used, namely laminated oak wood which has superior quality properties.

- **OAK WOOD**

Oak wood is a type of hardwood that derives from the oak tree native to the northern hemisphere. There are around 600 species of oak, both deciduous and evergreen. North America has the most,

with around 90 species being found there. Oak wood has been used as a hardwood timber for thousands of years, yet it takes up to 150 years before the wood from an oak tree can be used for construction **[72]**.

Properties and qualities

Oak wood is exceedingly strong, heavy and durable. It is an attractive light color with a prominent grain and is resistant to fungal attack, thanks to its dense constitution and long-living nature, which must equip the tree for its long lifetime.

Water Resistance

White oak wood has small pores that allow less absorption of water, while red Oak wood has large pores that absorb water. Hence in conditions where water contact is obligatory, white oak wood must be preferred.

Maintenance and Cleaning

It requires low maintenance and is very easy to clean. Regular dusting and wiping with a wet cloth will preserve the shine of the surface. However, stains are to be removed with caution **[73]**.

In conclusion, oak wood is popular due to its less cost and high durability.

- **LAMINATED OAK WOOD**

Laminated products are well known for their durability, reliability and high quality. The surface resists scratches and stains, and can last an entire lifetime.

This process provides stronger dimensional stability and is less likely to warp or crack, maintaining the solid oak quality, without the dangers associated with solid wood.

The purpose of the wood stratification is to eliminate the internal stresses within the wood fiber, stresses that most often cause changes in the structure of the wood, leading to bending, bending and loss of initial dimensions. Thus, this process gives the beams the best qualities.

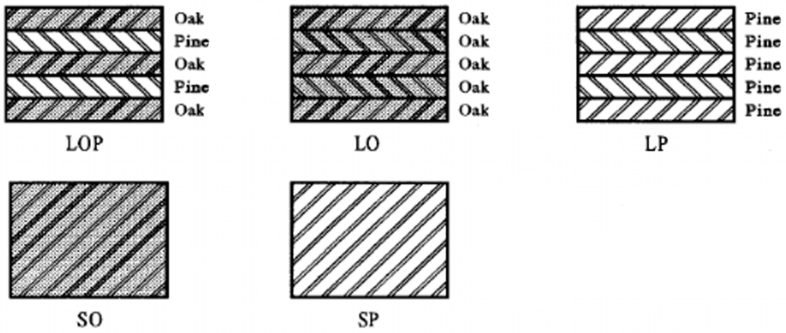
Advantages of laminated wood construction [74]:

- The glued laminated wood has insulating properties and helps to eliminate thermal bridges from structures and sub-structures;
- It is a renewable and environmentally friendly resource;
- The applications are diverse and can be produced easier than most of the materials used in the structure;
- The glued laminated wood adds resistance, structure, and majesty to any design;
- It is durable and robust. It offers increased fire resistance and provides safety and integrity to structures. It is chemically stable and recommended for wet and aggressive environments;
- The glued laminated wood is fully recyclable.

According to TS EN 386 **[75]**, the laminated wood material can be defined as a structural member that was made of wood fabricated from laminations of timber glued parallel to the longitudinal axis. The moisture content should be uniform between laminations. According to TS EN 386 and DIN 68140 **[76]**, the moisture content of adjacent laminations should not vary by more than 4 %. This limit is essential to avoid the development of internal stresses.

The moisture content should be uniform between laminations. To see the structure of the laminated oak some samples are chosen. The samples consisted of 5 layers and the overall dimensions of the samples were 780 mm long, 70 mm wide and 20 mm deep. Also, similar samples were made of solid oak and pine for comparison in Figure 28.

These samples are subjected to tests under varying conditions for resistance testing, are subjected to different temperatures until they reached the equilibrium moisture content of 12 %.



LOP : Laminated oak and pine wood, LO : Laminated oak wood, LP : Laminated pine wood, SO : Solid oak wood, SP : Solid pine wood

Figure 28: Solid and laminated wood samples **[77]**

Test results to find out the technological properties of the samples were summarized by using descriptive statistics such as the maximum, minimum, mean and standard deviation. Descriptive statistical values of tested technological properties of samples were given in Figure 29.

Process	Values	Air-Dry Density g/cm^3	Bending Strength ($\perp$N/mm^2)	Modulus of Elasticity ($\perp$N/mm^2)	Compression Strength (//N/mm^2)	Shear Strength (//N/mm^2)
LO (Laminated Oak Wood)	Mean	0.639	109.026	10985.705	70.027	11.373
	Std. Dev.	0.020364	2.089111	193.736290	2.638545	0.918164
	Variations	0.000415	4.364385	37533.7503	6.961921	0.843025
	Min	0.607	105.39	10676.92	66.46	10.06
	Max	0.678	112.55	11293.02	75.93	12.93
	N	11	11	11	11	11
SO (Solid Oak Wood)	Mean	0.611	106.050	10742.727	67.177	10.161
	Std. Dev.	0.012713	2.697243	265.97996	2.102289	0.474675
	Variations	0.000162	7.275120	70745.340	4.419621	0.225316
	Min	0.595	102.37	10065.69	64.92	9.22
	Max	0.631	109.81	11051.68	70.67	10.84
	N	11	11	11	11	11

Figure 29: Descriptive statistical values of technological properties **[78]**

Technological properties (air-dry density, bending strength, modulus of elasticity in bending, compression strength, shear strength) of laminated and solid wood materials concerning table are as follows:

- Air-Dry Density (g/cm³): SO=0.611; LO=0.639;
- Bending Strength (N/mm²): SO=106.05: LO=109.02;
- Modulus of elasticity in Bending (N mm-2): SO=10742.727; LO=10985.705;
- Compression Strength (N/mm²): SO=67.17; LO=70.02;
- Shear Strength (N/mm²): SO=10.16; LO=11.37.

Examination of overall results showed that laminated oak samples showed was the best properties, however, it was found the lowest value in the solid pine.
Technological properties of laminated oak were higher than that of solid wood samples (air-dry density value 4.5 %, bending strength 2.8 %, modulus of elasticity in bending 2.2 %, compression strength 4.4 %, shear strength 11%).
Technological properties of laminated wood materials and solid wood materials differences between may result from the cohesion force of the adhesive.
According to these results, laminated wood materials, more superior values than solid wood materials which were representing their kinds.

7.3.3 Covering material

7.3.4 Floor materials

For the floor of the shelter, the team decided to use cork. Cork offers a range of good properties that match perfectly with the requirements and the vision of SafeBIS. The most important properties are shown in the list below **[79]**.

- impermeable to liquids and gases;
- excellent thermal, acoustic and vibration insulator;
- Resistance to biological corrosion (decay resistance: highly resistant to moisture);
- Cork retains neutrality of taste and odor and does not absorb odors;
- flame retardance;
- 100% biodegradable, recyclable and renewable;
- durable;
- warm appearance.

As cork is flexible and the young modulus and tensile strength are not high when using a cork plank with a density of 210 kg/m³ and a thickness of 10 mm, we have to make it stronger **[80]**. The bottom plate is very important because it will serve as the box for the other parts and has to protect these parts. To make the floor more strong and resistant for fractures and damage, there are 2 possible solutions. The first one is to thicken the thickness of the plate and to choose for a type of cork with a higher density, the second solution is to add a plate made out of another strong material.

The following characteristics of the shelter have to take into account while considering the materials which will be used for the bottom plate. The shelter has to be: as light as possible, sustainable, durable, strong, cheap.

Continuing on the first solution (only cork), calculations will be made to clear out if this is the best option to use for the shelter. The cork plate will have a thickness of 30 mm instead of 10 mm. The highest density found for cork is 250 kg/m³ **[81]**.
For a surface of 13.74 m², the weight is (13.74 m²x0.04×250) 137.4 kg. A disadvantage of this solution is that even with a thickness of 40 mm, there's no certainty that the floor is resistant to fatigue and fractures. As the floor will be used as the storage box for the other parts, a big force will be exerted on the bottom part of the box. This part is 4 m long and has a width of 1 m. The problem with cork is that the tensile properties of cork, namely fracture stress and strain, depend on the irregularities that are present in the cork structure and their specific characteristics. Fracture starts at a pore and propagation depends on the occurring defects. The elastic behavior is related to the density and, to a lesser degree, to the coefficient of porosity. The tensile properties of cork vary in the plank from the inner part to the outer part, with a trend of decreasing strength, and also vary with the cork plank quality, with higher tensile strength for good quality corks **[82]**.
Doing more research about the quality of different types of cork and setting up a test to examine the qualities will not be able as company visits are not possible. In the second solution will be explained how more certainty about the strength of the floor can be obtained.

For the second solution, a second material will be added to the cork plate. Adding a bottom plate made out of a strong different material will ensure a greater total strength of the floor. In the comparison table below, different materials will be compared to see how to create the lightest bottom plate possible that is still strong. The density, the Young modulus, and the yield point will be charged. The density is necessary to decide the weight, the yield strength defines the resistance to plastically

deformation and the modulus of rupture shows the flexural strength.

The research was done about multiple species of would, also aluminum was compared. Aluminum got eliminated very fast because the weight of it in comparison with the wood species was way bigger. It also did not fit in the 'nature' look that the team wants to pursue.
Marine Plywood, Ash wood, and Spruce wood were the three species that fitted the best in our 'shelter picture'. Spruce wood was chosen as it is the lightest of them all and still has good strength properties. The density of Spruce wood is 450 kg/m³ **[83]**, for the floor a plate of 20 mm will be used.

For the shelter, the bottom plate will exist out of one upper layer which will consist out of cork. As the cork layer does not have to catch all the forces, we can choose for an expanded cork **[84]**. The expanded cork has the same good properties but is more light because the density is 180 kg/m³ instead of 210-250 kg/m³. The upper layer will have a thickness of 4 mm. For a surface of 13.74 m², this layer with a thickness of 4 mm, will have a weight of (13.74 m²x0.004×180 =) 9.9 kg.

The weight of the bottom layer, namely the spruce wood plate is (13.74 m²x0.02 mx450 =) 123.6 kg. This makes a total weight of 133.5 kg for the floor.

7.3.5 The skeleton

7.3.6 Shelter modules

7.3.7 Ventilation

7.3.8 3D Model

7.4 Functionalities

7.5 Tests and Results

7.6 Conclusion

Provide here the conclusions of this chapter and introduce the next chapter.

8 Conclusions

8.1 Discussion

Provide here what was achieved (related with the initial objectives) and what is missing (related with the initial objectives) of the project.

8.2 Future Development

Provide here your recommendations for future work.

Bibliography

Will be added automatically by citing, in the body of the report, entries specified in BibTeX format and stored in the http://www.eps2020-wiki3.dee.isep.ipp.pt/doku.php?id=refnotes:bib file

PS - *If you have doubts on how to make citations, create captions, insert formulas, etc. visit this page with examples and select "Show pagesource" to see the source code.*

---

[1] Paul DE TROCH. *Internal Market, Industry, Entrepreneurship and SMEs, Machinery.* European Commission [Accesed in March 2020].
[2] European Commission. *Electromagnetic Compatibility (EMC) Directive.* European Commission [Accesed in March 2020].
[3] European Commission. *The Low Voltage Directive (LVD).* European Commission [Accesed in March 2020].
[4] European Commission. *Radio Equipment Directive (RED).* European Commission [Accesed in March 2020].
[5] European Commission. *Restriction of Hazardous Substances in Electrical and Electronic Equipment.* European Commission [Accesed in March 2020].
[6] B. N. Taylor, B. N. Taylor, Ambler Thompson. *Guide for the use of the International System of Units (SI).* National Institute of Standards and Technology [Accesed in March 2020].
[7] Ken Schwaber. *Agile project management with scrum.* Microsoft [Accesed in Febr 2020].
[8] Ken Schwaber. *SCRUM Development Process.* Business Object Design and Implementation [Accesed in Febr 2020].
[9] SlideModel. *3D Animated Scrum Process PowerPoint Template.* SlideModel [Accesed in March 2020].
[10] United Nations High Commissioner for Refugees. *Emergency shelter standard.* EMERGENCY HANDBOOK[Accesed in March 2020].
[11], **[13]**, **[15]** United Nations High Commissioner for Refugees. *Shelter Solutions.* EMERGENCY HANDBOOK[Accesed in March 2020].
[12] United Nations High Commissioner for Refugees. *SHELTER DESIGN CATALOGUE.* UNHCR Shelter and Settlement Section[Accesed in March 2020].
[14] United Nations High Commissioner for Refugees. *Emergency Handbook.* Older persons [Accesed in March 2020].
[16] Runner Front. *Roof Top Tent - by Front Runner.* Front Runner [Accesed in Febr 2020].
[17] Attwoolls Outdoors. *Vango Capri 500XL Airbeam Tent 2019.* Attwoolls Outdoors [Accesed in Febr 2020].
[18], **[19]** Amazon. *ZOMAKE Automatic Camping tent 2 3 Person - 4 Season Backpacking Tent Portable Dome Quick Up Tent.* Amazon [Accesed in Febr 2020].
[20] TINA HOVSEPIAN. *SHELTERS.* Upswell [Accesed in Febr 2020].
[21] UPSWELL. *Cardborigami: A pop-up solution to reshaping the LA homelessness crisis.* Upswell [Accesed in Febr 2020].
[22] 2020 The Animal Club January 9. *Rescue sets up makeshift koala shelter in school gym after Australian bushfires.* Johan Rikner [Accesed in Febr 2020].

[23] HangZhou TianYuan. *Speedypet High Quality Wholesale Custom Cheap Pet House Foldable Dog Bed.* Alibaba [Accesed in Febr 2020].
[24] Escambia County Florida. *Animal Services.* My Escambia [Accesed in Febr 2020].
[25], **[26]** The Humane Society of The United States. *Welcome to Animal Sheltering.* Animal Sheltering.
[27] ARQ Lucinda Schlaffer & ARQ Paul Bonacci. *Design for Shelter Animals.* Maddie's Fund [Accesed in Febr 2020].
[28] Amazon. *Wooden Pet House.* Amazon [Accesed in Febr 2020].
[29] Amazon. *PUPPY KITTY Cat House Insulated Foldable Pet House.* Amazon [Accesed in Febr 2020].
[30] Shopee. *Cage for dogs Collapsable-Pet Crate Brand.* Shopee [Accesed in Febr 2020].
[31] Work Breakdown Structure. *Work Breakdown Structure (WBS).* Work Breakdown Structure.com [Accesed in March 2020].
[32] Glassdoor. *Salary: Engineer in Porto.* Glassdoor [Accesed in April 2020].
[33] Jose Maria Delos Santos. *Understanding Responsibility Assignment Matrix (RACI Matrix).* PM [Accesed in March 2020].
[34] wikipedia. *Responsibility assignment matrix.* Wikimedia Foundation [Accesed in March 2020].
[35] Your Article Library. *Communication: Meaning, Purpose, Importance and Principles.* Your Article Library [Accesed in April 2020].
[36] Ann Handley. How to Repel the Wrong Customers -- and Attract the Right Ones. *Entrepreneur [Accesed in Febr 2020]*.
[37] Startup Guide IONOS. *Market analysis: definition.* Startup Guide IONOS [Accesed in 2020].
[38], **[39]**, **[40]**, **[42]**, **[43]**, **[44]** Disruptiv Nation. *Drive Business Strategy & Competitiveness with Porter's Five Forces " Disruptiv Nation.* DRIVE BUSINESS STRATEGY & COMPETITIVENESS WITH PORTER'S FIVE FORCES [Accesed in March 2020].
[41] Corporate Finance Institute. *Bargaining Power of Suppliers - Factors that Give Suppliers Power.* Corporate Finance Institute [Accesed in March 2020].
[45] Wanderlust Worker. *Setting S.M.A.R.T.E.R. Goals: 7 Steps to Achieving Any Goal.* Wanderlust Worker [Accesed in April 2020].
[46] Randy Olson, Liang Sen, Daniel Leal-Olivas. *How People Make Only a Jar of Trash a Year.* National Geographic Society [Accesed in April 2020].
[47] Julie Beck. *The Psychology of Home: Why Where You Live Means So Much.* Atlantic Media Company [Accesed in April 2020].
[48] Michelle Douglass. *Earth - Nine incredible buildings inspired by nature.* BBC [Accesed in April 2020].
[49] MUNICH RE. *World map of the 50 major loss events 2016: Munich Re.* MUNICH RE [Accesed in April 2020].
[50] Guardian News, Media. *Charitable giving - how does it differ by age?.* Guardian News and Media [Accesed in April 2020].
[51] FutureLearn. *The four pillars of sustainability.* Futurelearn [Accesed in April 2020].
[52], **[53]**, **[56]**, **[57]** Sophia Apel. *THE ROLE OF SUSTAINABLE DESIGN IN THE CURRENT REFUGEE CRISIS.* Greenofficevu [Accesed in April 2020].
[54] Division for Sustainable Development Goals-United Nations. *Transforming our world: the 2030 Agenda for Sustainable Development.* United Nations [Accesed in April 2020].
[55] Unilever Nederland. *UN Sustainable Development Goals.* Unilever Nederland [Accesed in April 2020].
[58] Vietnambiz. *Phân tích vòng đời sản phẩm (Life Cycle Analysis – LCA) là gì? Lợi ích.* vietnambiz.vn [Accesed in April 2020].
[59] Larry Alexander, Michael Moore. *Deontological Ethics.* Stanford University [Accesed in March 2020].
[60] David B. Resnik. *What is Ethics in Research & Why is it Important?.* National Institute of Environmental Health Sciences [Accesed in March 2020].

[61] Gail D. Baura. *Engineering ethics: an industrial perspective.* Academic Press [Accesed in March 2020].
[62], **[64]** W. RICHARD. BOWEN. *ENGINEERING ETHICS: challenges and opportunities.* SPRINGER [Accesed in March 2020].
[63] Charles B. Fleddermann. *Engineering ethics.* Prentice Hall [Accesed in March 2020].
[65] Jay D. Humphrey, Jeffrey W. Holmes. *Style and ethics of communication in science and engineering.* Morgan & Claypool [Accesed in March 2020].
[66] ASME. *ASME Code of Ethics.* MAFIADOC.COM [Accesed in March 2020].
[67] World Fair Trade Organization. *10 PRINCIPLES OF FAIR TRADE.* World Fair Trade Organization [Accesed in March 2020].
[68] Civilsdaily. *The Ethics of Environment is Environmental Ethics.* Civilsdaily [Accesed in April 2020].
[69] Rinkesh Kukreja. *What are Environmental Ethics?.* Conserve Energy Future [Accessed in March 2020].
[70] European Commision. *Internal Market, Industry, Entrepreneurship and SMEs.* European Commision [Accessed in March 2020].
[71] European Commission. *Humanitarian Shelter and Settlements Guidelines.* European Commission [Accesed in April 2020].
[72] URBANARA. *Oak Wood.* URBANARA [Accesed in April 2020].
[73] Kavisha Desai. *Complete Guide on Oak Wood: Strong and Durable Hardwood!.* GharPedia [Accesed in April 2020].
[74] Valger Lemn. *Lemn Stratificat - Grinzi Lemn Stratificat.* Valger Lemn [Accesed in April 2020].
[75], **[76]**, **[77]**, **[78]** Hakan Keskin. *Technological properties of laminated wood materials made up with the combination of European oak wood and Scotch pine wood and possibilities of using them. Gazi University.* ResearchGate [Accesed in April 2020].
[80], **[81]** kurk. *Ondervloeren in Kurk en Rubberkurk.* kurk [Accesed in April 2020].
[82] M. Emília Rosa Helena Pereira Ofélia Anjos. *Tensile properties of cork in axial stress and influence of porosity, density, quality and radial position in the plank.* HAL [Accesed in April 2020].
[83] Cedarstripkayak. *Wood Density Chart.* Cedarstripkayak [Accesed in April 2020].
[84] CorkLink. *Cork rolls for underlay / insulation - CorkLink - cork products direct from Portugal.* CorkLink [Accesed in April 2020].