

# 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     |
| RCMRS        | Reusable, Customizable, Modular, Reliable and Structure(from nature) |

| Abbreviation | Description                                       |
|--------------|---------------------------------------------------|
| SWOT         | Strengths, Weaknesses, Opportunities, and Threats |
| CFD          | Computational Fluid Dynamics                      |
| GDP          | Gross Domestic Product                            |

# 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** consists of six students, all with different backgrounds of education and all from different countries. This spring semester of 2020 the team will be 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 enrol 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 developing solutions for people inhabiting in disaster-affected areas by designing an innovative shelter.

## 1.3 The 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 disasters like these 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 that were not detected during the theoretical part of the project. After correcting the founded problems, a fully working product will be developed, this will be ready to place on the desired market. The tests to be performed are as follows:

**Structure safety tests**

- 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 test**

- In this test will be checked if the shelter can be folded/unfolded easily and will be tested how long it takes to do this. For this test, the prototype is invoked.

**Material analysis test**

- Sustainable and good insulating materials will be used to keep a good temperature inside and humidity outside the shelter. The selected materials have to create favorable conditions for living safely. The materials will be tested by simulating forces and tensions on it. By doing this simulation, an overview of the strengths and weaknesses of the materials will be obtained.

## 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

## SCRUM Process

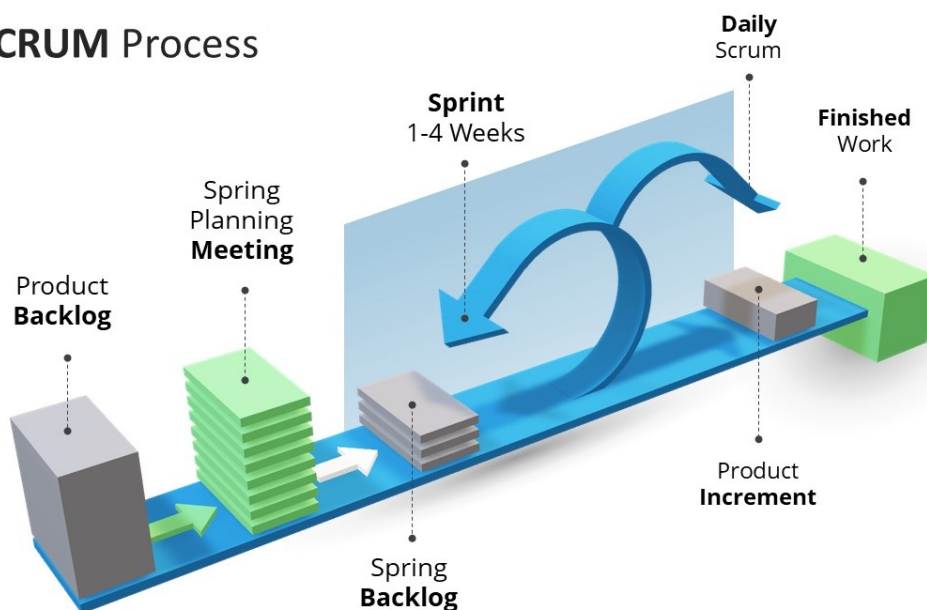


Figure 1: Scrum Process[9]

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 |
|-------------------------|-------------|
| <b>Initial Planning</b> |             |
| Task Allocation         | The Team    |
| Project Proposal        | The Team    |
| Gantt Chart             | Lore        |
| Initial Budget Planning | The Team    |
| <b>Project Leading</b>  |             |
| Existing products       | The Team    |
| Technical Research      | The Team    |
| Marketing Research      | Vladimir    |

| <b>Task</b>                            | <b>Team Member</b>            |
|----------------------------------------|-------------------------------|
| <b>Initial Planning</b>                |                               |
| Design Research                        | Andreea, Lore, Jelte, Gabriel |
| Project Management                     | Andreea, Lore                 |
| Eco-Efficiency and Sustainability      | Jelte                         |
| Ethical and Deontological Concerns     | Andreea, Lore                 |
| <b>Specific Planning</b>               |                               |
| Schemes and Diagrams                   | The Team                      |
| <b>Schematics</b>                      |                               |
| Drafts                                 | Andreea, Lore, Gabriel        |
| 3D Drafts                              | Eduardo                       |
| <b>Materials</b>                       |                               |
| List                                   | Andreea                       |
| Providers                              | Lore                          |
| <b>Communication</b>                   |                               |
| Wiki                                   | Andreea, Lore                 |
| PPT                                    | Andreea                       |
| Manual                                 | Gabriel                       |
| Video                                  | Jelte                         |
| Report                                 | The Team                      |
| <b>Interim</b>                         |                               |
| Presentation                           | The Team                      |
| Report                                 | The Team                      |
| Upload Interim Report and Presentation | Andreea, Lore                 |
| Upload Refined Interim Report          | Lore                          |
| Complete List of Materials             | Andreea                       |
| <b>Construction</b>                    |                               |
| Assembly                               | The Team                      |
| <b>Test</b>                            |                               |
| Functional Tests                       | Eduardo, Lore                 |
| Upload Functional Test Results         | Andreea                       |
| <b>Final</b>                           |                               |
| Final Report & Presentation            | The Team                      |
| Poster, Paper, Video, Manual           | The Team                      |
| Upload the Wiki                        | Andreea, Lore                 |
| Prototype and Demonstration            | The Team                      |

## 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.                                                                                  |
| 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 defines 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<sup>2</sup> 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 m<sup>2</sup> to 5.5 m<sup>2</sup> 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 m<sup>2</sup> 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. |

| Research objects                                                                                                                                                                                                                                                                                                                               | + +/- - | Reason                                                                                                                                                                                                                                                                                                                                                                         |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 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.                                                                                 |
| 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 aluminium.                                                                                                                                                                                                                                                 |
| Price[€/m <sup>2</sup> ]                                                                                                                                                                                                                                                                                                                       | -       | 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 €.                                                                                                                                                              |
| <b>Conclusion</b>                                                                                                                                                                                                                                                                                                                              |         |                                                                                                                                                                                                                                                                                                                                                                                |
| 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

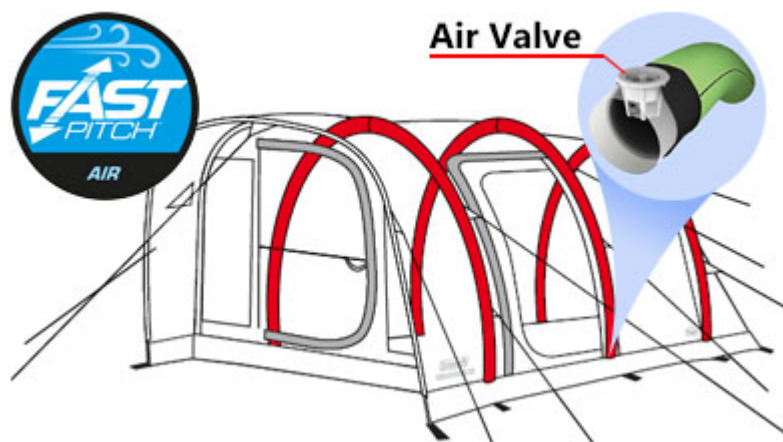


Table 6: The Vango Capri Tent

| 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/aluminium 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.                                                                                                                                                                                                                                                                                                                                                                                                      |

| Research objects                                                                                                                                                                                                                                                                                                                                                         | ++/- - | Reason                                                                                                                                               |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|------------------------------------------------------------------------------------------------------------------------------------------------------|
| Price[€/m <sup>2</sup> ]                                                                                                                                                                                                                                                                                                                                                 | +      | 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 €. |
| <b>Conclusion</b>                                                                                                                                                                                                                                                                                                                                                        |        |                                                                                                                                                      |
| 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/aluminium 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 aluminium poles. |



| Research objects                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | ++/- - | Reason                                                                                                                                                                                                                                                                                                                                 |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 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/aluminium 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/aluminium 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.                                                       |
| Materials                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | +      | The tent is made of 210D water-resistant k-oxford fabric and has a couple of aluminium poles that hold the tent together.                                                                                                                                                                                                              |
| Price[€/m <sup>2</sup> ]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | ++     | 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 €.                                                                                                                                       |
| <b>Conclusion</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |        |                                                                                                                                                                                                                                                                                                                                        |
| 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 aluminium 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.                                                                                                                 |
| 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[€/m <sup>2</sup> ]                                                                                                                                                                                                                                                                                                                                                                                                                                                              | +      | It costs \$ 100 to build one Cardborigami. The price per square meter is 44.80 €.                                                                                                                                                                                                                                                                    |
| <b>Conclusion</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |        |                                                                                                                                                                                                                                                                                                                                                      |
| 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                                                                                                                                                                                                        |



| Research objects                                                                                                                                                                                                                                                                                                              | ++/- - | Reason                                                              |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|---------------------------------------------------------------------|
| Dimensions                                                                                                                                                                                                                                                                                                                    | -      | 73x73x43 cm                                                         |
| Price [€/m <sup>2</sup> ]                                                                                                                                                                                                                                                                                                     | +      | The price differentiates between 2,5 € and 9/m <sup>2</sup> € [23]. |
| <b>Conclusion</b>                                                                                                                                                                                                                                                                                                             |        |                                                                     |
| 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                 | -      | <p><b>Types:</b><br/> <u>Modular runs:</u> Aluminium or stainless-steel frame with solid in-fill or cage "rod" in-fill panels.<br/> <u>Panelized kennel fencing:</u> 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.</p> <p><b>Requirements of materials in animal shelters:</b><br/> The perfect surface would have these characteristics: Pleasing visual impact, Durable, Easily cleanable, Resilient, Nonabsorbent to liquids and odors, Prevents microbial growth, Sound absorbent.</p> <p><u>Cleanliness:</u><br/> 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.</p> <p><u>Noise control:</u><br/> 1) Absorption of sounds: porous, sponge-like materials (carpet, drapery, foam rubber, acoustic ceiling tile, sprayed-on fibers).<br/> Sound-absorbing materials (good for durability and cleanliness):<br/> - mylar-faced ceiling baffles - NRC 0.95;<br/> - quilted blankets/banners hung from ceiling- NRC 1.10;<br/> - fabric-wrapped wall panels - NRC 0.90;<br/> - sound block (concrete block with slots and foam inside) - NRC 0.35.</p> <p>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:<br/> - 3 ½" steel stud wall with gypsum drywall both sides - 47 STC;<br/> - two wythes (layers) of 4" brick with plaster - 59 STC.</p> <p>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].</p> |
| Dimensions                | -      | For Cats: 1,8-2,8 /m <sup>2</sup> per cat (with higher ceilings for more places to climb), for dogs: 5,5-11 /m <sup>2</sup> [27].                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Price [€/m <sup>2</sup> ] | /      | 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 €/m <sup>2</sup> not including land.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| <b>Conclusion</b>         |        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |

| 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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | -      | <ol style="list-style-type: none"> <li>1. MDF material, weather-resistant;</li> <li>2. EVA board, Ultra-Soft Plush, water-resistant;</li> <li>3. metal.</li> </ol> Common for the used materials is that they are all easy to clean.                                        |
| Dimensions                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | -      | <ol style="list-style-type: none"> <li>1. 52x38x53 cm;</li> <li>2. 56x48x80 cm;</li> <li>3. 61x46x53 cm.</li> </ol>                                                                                                                                                         |
| Price [€/m <sup>2</sup> ]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | -      | <ol style="list-style-type: none"> <li>1. 26 €/m<sup>2</sup>;</li> <li>2. 29 €/m<sup>2</sup>;</li> <li>3. 22 €/m<sup>2</sup>.</li> </ol>                                                                                                                                    |
| <b>Conclusion</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |        |                                                                                                                                                                                                                                                                             |
| 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 they are 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.

Following chapter will explain the Project Management approach of SafeBIS.

## 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].

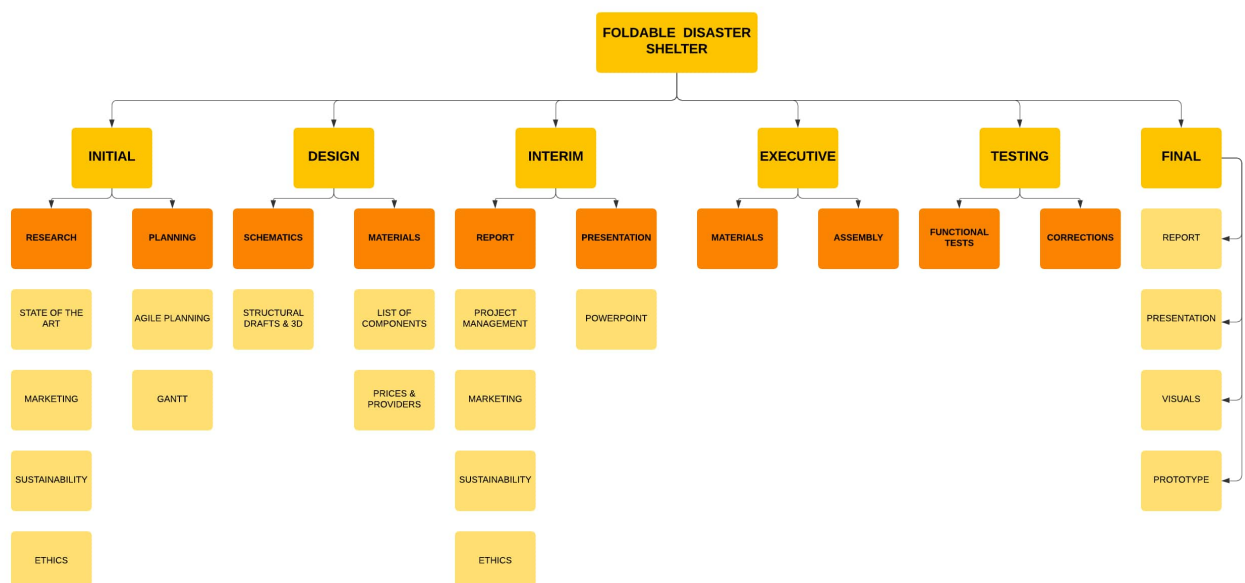


Figure 11: Work Breakdown Structure (WBS)

## 3.2 Time

### 3.2.1 Gantt Chart

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



Figure 12: Gantt Chart

### 3.2.2 Deadlines & Deliverables

The 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)                                    |



| Date       | Task                                                                            |
|------------|---------------------------------------------------------------------------------|
| 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 in which the involvement and work capacity of each team member made for the first period of the semester, up to the intermediate presentation (17.02-16.04), is illustrated in Figure [14](#), and the representative diagram for the second period (17.04-16.06) is shown in Figure [15](#).

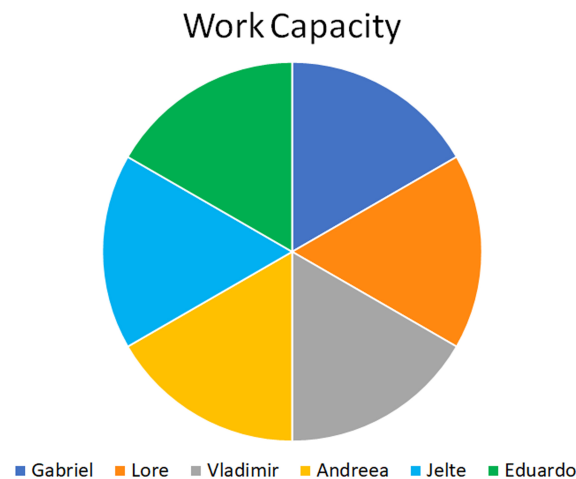


Figure 13: Optimal Workload for the Team

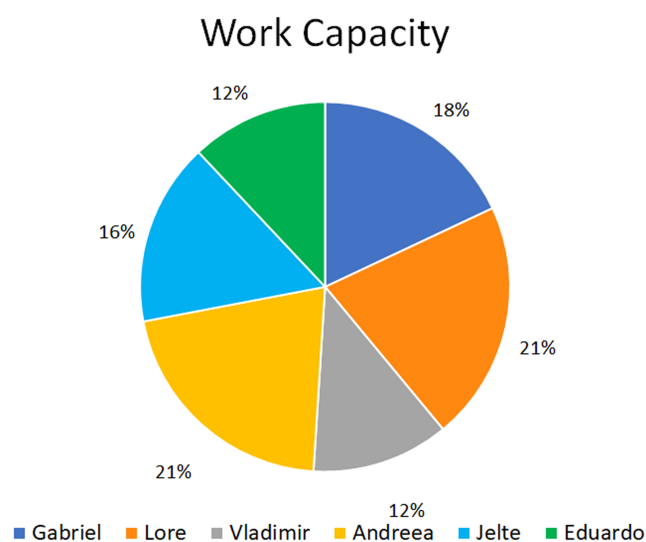


Figure 14: The Workload for the Team (17.02-16.04)

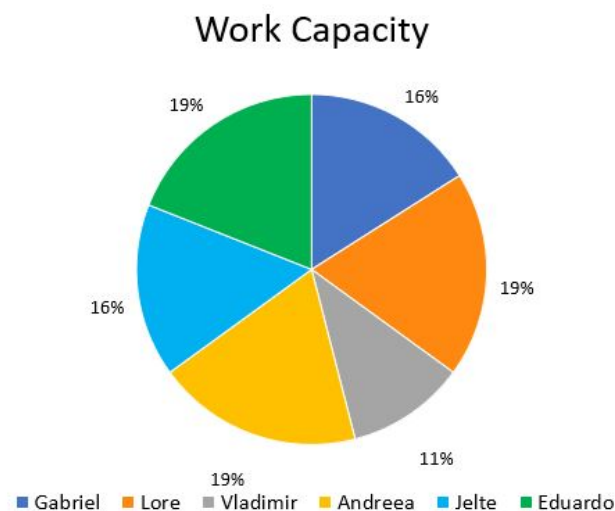


Figure 15: The Workload for the Team (17.04-16.06)

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         |
| <b>Total cost : 86400 €</b> |                  |               |

### 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 | 0.02×0.02×0.625 | 2        | m    | 0.38           | 0.76          |
|     |                                  |                 |            | 0.02×0.02×0.66  | 2        |      | 0.40           | 0.80          |
|     |                                  |                 |            | 0.02×0.02×0.75  | 2        |      | 0.45           | 0.90          |
| 2   | Laminated Oak wood beams         | Roof            | Valgerlemn | 0.02×0.02×0.625 | 6        | m    | 0.38           | 2.28          |
| 3   | Laminated Oak wood beams         | Roof resistance | Valgerlemn | 0.03×0.01×1.082 | 2        | m    | 0.62           | 1.24          |
| 4   | Solid wood panels - Spruce class | Floor           | Valgerlemn | 1.08×1.25×0.01  | 1        | m    | 10.13          | 10.13         |

| Nr.                         | Item                                       | Part of SafeBIS     | Provider      | Dimensions        | Quantity                        | Unit           | Unit Price [€]             | Item Cost [€] |
|-----------------------------|--------------------------------------------|---------------------|---------------|-------------------|---------------------------------|----------------|----------------------------|---------------|
| 5                           | Self Adhesive Cork Sheet Roll              | Floor               | Ebay          | 0.48X1X0.001/roll | 1.015 m <sup>2</sup> or 3 rolls | m              | 7.39/roll                  | 22.17         |
| 6                           | Cotton Canvas Fabric                       | Walls               | fibre2fashion | 1.83              | 2.45                            | m <sup>2</sup> | 3.24-4.17 €/m <sup>2</sup> | 7.94-10.22    |
| 7                           | Cotton Canvas Fabric                       | Roof                | fibre2fashion | 1.83              | 1.1                             | m <sup>2</sup> | 3.24-4.17 €/m <sup>2</sup> | 3.56-4.59     |
| 8                           | Connectors to attach the shelters together | Walls               | Unknown       | Unknown           | 12                              | Unknown        | Unknown                    | Unknown       |
| 9                           | Clips/fabric fasteners                     | Walls               | Unknown       | Unknown           | 12                              | Unknown        | Unknown                    | Unknown       |
| 10                          | Clips/fabric fasteners                     | Roof                | Unknown       | Unknown           | 16                              | Unknown        | Unknown                    | Unknown       |
| 11                          | Support for beams                          | To fix on the floor | Unknown       | Unknown           | 6                               | Unknown        | Unknown                    | Unknown       |
| 12                          | Zipper                                     | Doors               | Ebay          | Unknown           | 8                               | Unknown        | Unknown                    | Unknown       |
| <b>Total cost : 58.70 €</b> |                                            |                     |               |                   |                                 |                |                            |               |

The materials listed up in table 14 were the ones that the team needed to build a prototype of our first version of the shelter. The materials changed later during the development to pursue lightness and more strength. No research was done to find the new materials for making the prototype as the team was not able to make a prototype as a result of the pandemic. To compensate for this problem encountered, the team designed the maquette of the shelter to get the general idea of the shelter and to validate the functionality of the folding system.

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   | Cotton Canvas                        | Roof                 | fibre2fashion | 13.388              | 13.388           | m <sup>2</sup> | 3.24-4.17 €/m <sup>2</sup> | 43.37         |
| 2   | Cotton Canvas                        | Outer Layer          | fibre2fashion | 35.42               | 35.42            | m <sup>2</sup> | 3.24-4.17 €/m <sup>2</sup> | 114.76        |
| 3   | Cotton Canvas                        | Inside Tent          | fibre2fashion | 58.78               | 58.78            | m <sup>2</sup> | 3.24-4.17 €/m <sup>2</sup> | 190.45        |
| 4   | Connectors                           | To attach the hinges | Unknown       | Unknown             | 36               | items          | Unknown                    | Unknown       |
| 5   | ALU Panel- Aluminium Composite Panel | Floor/Packaging      | GEPLAST       | 16.69 (10 mm thick) | 16.69            | m <sup>2</sup> | Unknown                    | Unknown       |
| 6   | Aluminium Square Profile Beams       | Structure            | DEPO          | 0.05×0.05×0.003     | 45.15 m/ 8 items | m              | 46.63/6 m                  | 373.04        |
| 7   | Cork Roll                            | Floor                | Corklink      | 15x1x0.004 m        | 16.69            | m <sup>2</sup> | 3.68 €/m <sup>2</sup>      | 61.42         |

| Nr.                           | Item             | Part of SafeBIS | Provider      | Dimensions              | Quantity | Unit    | Unit Price [€] | Item Cost [€] |
|-------------------------------|------------------|-----------------|---------------|-------------------------|----------|---------|----------------|---------------|
| 8                             | Steel Plate      | Legs            | Unknown       | 28x28x0.4 cm            | 8 items  | Unknown | Unknown        | Unknown       |
| 9                             | Zipper           | Doors           | Ebay          | 3 m                     | 8        | items   | 9.10           | 72.80         |
| 10                            | Fabric fasteners | Walls           | Snowl/Alibaba | 18 cm                   | 24       | items   | 0.45           | 10.8          |
| 11                            | Steel Cable      | Roof            | WebsiLor      | 7x7AA04G (4mm diameter) | 15       | m       | 0.6 €/m        | 9.00          |
| 12                            | Tent Pegs        | To fix the legs | Multivers     | 30 cm                   | 7        | items   | 1.2            | 8.4           |
| 13                            | Hinges           | Structure+Floor | Unknown       | Unknown                 | 36       | items   | Unknown        | Unknown       |
| <b>Total cost : ~884.04 €</b> |                  |                 |               |                         |          |         |                |               |

### 3.4 Quality

Quality assurance includes two principles:

- “Fit for purpose”- the product should be suitable for the intended purpose;
- “Right first time”- mistakes should be eliminated.

Quality assurance includes management of the quality of raw materials, assemblies, products and components, services related to production, and management, production, and inspection processes. The two principles also manifest before the background of developing (engineering) a novel technical product: The task of engineering is to make it work once, while the task of quality assurance is to make it work all the time [33].

As the company SafeBIS is a business based on the production of shelters with the role of maintaining the safety and health of people, quality plays a very important role once these products are directed to use. These shelters aim to follow certain legislation and comply with certain requirements so that the livelihood and the good coexistence are ensured.

In terms of certain important factors that a business has and must comply with quality standards are:

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

Getting the employees to adopt a quality mindset is the real key for producing high-quality products and services. Employees must feel a sense of ownership. They must feel responsible for the outcome of anything connected with the product. One always takes better care of something that they own as opposed to something that they do not. With ownership, employees will feel a sense of pride when hearing that their product or service has the highest reputation in the market place. To instill a sense of ownership, employees must feel that they play an important role in the success of the product. This is done through teamwork. A team is defined as a collection of individuals who rely on group collaboration to achieve specific goals and objectives. Team members contribute their individual thoughts and expertise to the team and bear different responsibilities in the fulfillment of the team's objectives. Teambuilding is a process that takes time, training, and perseverance. Successful teamwork requires the right attitudes and a firm commitment from all involved [34].

In terms of product quality, as long as the requirements are met, it can be said that it is a product that satisfies users. As the shelters provide more needs and, in addition, introduce the term of innovation and bring more entertainment, it becomes a desirable product on the market.

In order for the quality of the product to be fulfilled, it must comply with certain conditions such as the selling price of the final product, and actual end use of the product; the dimensional specification;

reliability and life of the product; the production conditions required for the manufacture of the product, and maintenance objectives and related costs. The quality of the design and the quality of conformance must be considered [35].

Regarding materials and components, the Bis team wants to adopt for the design of the shelter the best materials, sustainable, with low impact on the environment, the choice of natural materials, minimizing the amount of non-renewable materials used.

All the chosen materials are recyclable, being widely used aluminium, cotton fabric, and steel. The resulting shelters aim to ensure human needs, providing safety against external factors and, at the same time, have the role of encouraging the use of renewable natural materials as little as possible, but for long-term usable products.

Time is the most important factor in carrying out a project. In close accordance with the purpose and budget, the quality in terms of time factor is dependent on all other aspects. If the goal is well set and the budget is assured, time is the guideline for the project. Thus, if the time management is achieved and respected, the project will be carried out in good parameters, at the same time, it is very important the time aimed at making and fixing the shelters in the specially arranged places. Time efficiency is the key to meeting the target.

It may be concluded that quality is a key attribute that consumers use to evaluate products or services. Thus it is everything to everyone involved in a business, to satisfy the total needs of every consumer/user whoever that customer may be, and is driven by the market conditions, by the competition and especially by the consumer.

### 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 [36].

Table 16 displays who is responsible for the tasks in the team.

Description of the abbreviations used in table [37]:

- 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).
- P = Participant (Those who have contributed to the accomplishment of a certain task).

Table 16: Responsibility Assignment Matrix

| <b>Project Tasks</b>                       | <b>Gabriel</b> | <b>Lore</b> | <b>Andreea</b> | <b>Jelte</b> | <b>Eduardo</b> | <b>Vladimir</b> | <b>Supervisors</b> |
|--------------------------------------------|----------------|-------------|----------------|--------------|----------------|-----------------|--------------------|
| 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                                  |                |             |                |              | R              |                 | C/I                |
| Paper                                      |                | P           | P              |              |                |                 | C/I                |
| Poster                                     | R              |             |                |              |                |                 | C/I                |
| Video                                      |                |             |                | R            |                |                 | C/I                |
| Prototype                                  | P              | P           | P              | P            | P              | P               | C/I                |
| Packaging                                  |                |             | R              |              |                |                 | C/I                |
| Manual                                     | R              |             |                |              |                |                 | 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 [38].

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 Figure16.



## Means of Communication

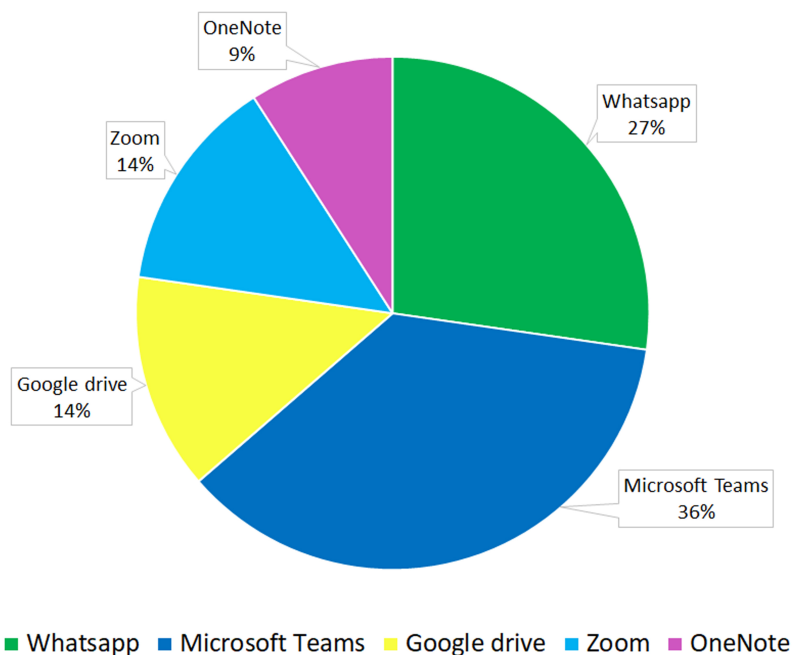


Figure 16: Allocation of the main means of communication

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/<br>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 counselling                                                                  |
| 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 counseling                                 |
| 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

The traditional view of risk is negative, characterizing risks as “threats” with adverse consequences on project objectives. But current risk thinking includes the possibility of “upside risk” or “opportunity,” which could have a beneficial effect on achieving objectives. Despite this theory, most applications of the risk process still concentrate on managing threats, and approaches to opportunity management remain patchy and reactive [39].

Developing a solid risk management plan is one of the most important things our company needs to consider. Some companies do not succeed all the time and there can be many problems, they consider that the “economy” or other unforeseen circumstances are the problems, but everything is about risk management and good organization. Risk management is about being prepared for as many of these adverse events as possible so that we can ride out storms that make our competitors go under.

Disaster can still wreck the best-laid plans, of course, but taking risk management seriously will certainly increase our chances of long-term success. There are some steps that must be taken into account [40].

For the whole process, to work in normal parameters, from the company level to the production of a product and its distribution in places specially arranged for people who have gone through natural disasters, it is essential to develop and follow a plan so that every step to meet expectations.

1. Make a Plan;
2. Decide How to Handle Each Risk;
3. Monitor;
4. Next Steps.

## 1 Make a Plan

- A list of individual risks;
- A rating of each risk based on likelihood and impact;
- An assessment of current controls;
- A plan of action.

## 2 Handle Risks

Treating risks involves working through options to deal with unacceptable risks to your business. Unacceptable risks range in severity; some risks will require immediate treatment while others can be monitored and treated later.

Our risk analysis and evaluation will help us prioritize the risks that need to be treated. To develop a plan for treating the risks, we must consider the:

- Method of treatment;
- People responsible for the treatment;
- Costs involved;
- Benefits of treatment;
- The likelihood of success;
- Ways to measure the success of treatments.

It is important to review our plan regularly to take into account any new risks associated with changes in business or improvements in techniques for treating risks.

The next step is to decide what to do about each risk so that we can manage them best. In the world of risk management, there are four main strategies:

1. Avoid it;
2. Mitigate it;
3. Transfer it;
4. Accept it.

Each strategy has its own advantages and disadvantages. Sometimes it may be necessary to avoid a risk, and other times to reduce it, transfer it, or simply accept it.

## 3 Monitor

A good risk management plan must be a living document, constantly referred to and updated to reflect new situations, new risks, and the effectiveness of our actions.

There is a problem here and that means that a lot of time is spent to initially prepare a topic, and when certain questions arise, there is no longer the same involvement as at the beginning to want to solve and resume the whole initial process.

There is a responsibility for each task, so he will have the duty to lead and perform the assigned task

and will be responsible according to its evolution.

## 4 Next Steps

The steps that we will follow must protect our business from many of the pitfalls that will come our way.

After taking into consideration the risk management and follow exactly the steps created and the plan, our business will be a successful one because we will have all the necessary knowledge to control the inevitable situations.

After all these considerations, our action plan has a clear timeline and a person responsible for implementing it, and we have made a commitment to monitoring the success of our actions and updating the plan as necessary.

We have evaluated the effectiveness of the controls we currently have in place, and come up with an action plan for either avoiding, reducing, transferring, or accepting the risk.

Table 18 displays the team's Risk Management, with possible causes, impact and the strategies to deal with certain risks.

- Avoid - Eliminate the cause and the threat.
- Mitigate - If the risk cannot be eliminated, reducing its impact.
- Transfer - Transfer the risk to someone else.
- Accept - Accept the risk, make a backup plan.

Note:

- Low impact = 1, Medium impact = 2, Strong impact = 3.
- The Rank number comes from the multiplication of the Probability and the Impact. Rank is used to identify which risks could influence the project more and which ones less.

Table 18: Risk Management

| Risk identification               | Risk category | Cause                                           | Effect                                             | Probability | Impact | Rank | Strategy                                                                                                    |
|-----------------------------------|---------------|-------------------------------------------------|----------------------------------------------------|-------------|--------|------|-------------------------------------------------------------------------------------------------------------|
| Disagreement between team members | Internal risk | Misunderstanding. The problem of communication. | Lost of time. Efficacy of the work. Delay of work. | 2           | 3      | 6    | Mitigate by establishing good communication.                                                                |
| Team member absent                | Internal risk | Sickness, accident, irresponsibility.           | Less working capacity, less diversity of opinions  | 3           | 2      | 6    | Mitigate by motivating the team members or Transfer the responsibility of the tasks to another team member. |
| Bad time management               | Internal risk | Low involvement. The inefficiency of the work.  | Not finishing in time.                             | 3           | 3      | 9    | Avoid and create a good plan to motivate the members to achieve the goals.                                  |

| Risk identification                            | Risk category  | Cause                                                                     | Effect                                                         | Probability | Impact | Rank | Strategy                                                                                                                                         |
|------------------------------------------------|----------------|---------------------------------------------------------------------------|----------------------------------------------------------------|-------------|--------|------|--------------------------------------------------------------------------------------------------------------------------------------------------|
| The components are non-functional              | Technical risk | Bad component quality. Broken component. Inappropriate component.         | The product will not work. Impact on the time delay and costs. | 1           | 3      | 3    | Mitigate by negotiating with the suppliers and claim the guarantee to replace the defective component. Transfer by having alternative suppliers. |
| Folding and unfolding the shelter easily       | Technical risk | The weight of materials. The need for more people to set out the shelter. | More time and persons required.                                | 1           | 2      | 2    | Mitigate                                                                                                                                         |
| Injuries caused to the customer by the product | Technical risk | Breaking / damaging certain components of the shelter.                    | Manufacturing error. Incorrect installation of the shelter.    | 1           | 3      | 3    | Avoid                                                                                                                                            |
| Late delivery of materials                     | External risk  | Delay for the delivery time. Transportation strike. Out of stock.         | Time delay and difficulties in the development of the product. | 2           | 3      | 6    | Avoid                                                                                                                                            |
| Incorrect components are delivered             | External risk  | Verification of the components                                            | Problems in developing the prototype/ product. Time and costs. | 1           | 3      | 3    | Mitigate by sending back incorrect components.                                                                                                   |

### 3.8 Procurement

The procurement is the process of acquiring and buying products, goods and services from external suppliers. This process is essential as the team has to find local suppliers who can provide SafeBIS with the best possible price and high quality for the needed goods. The production of the BIS shelters exists of making minor adjustments to the received goods and assembling all components. In other words, no parts will be produced by the SafeBis team. The team made the decision not to produce their own elements because all needed goods were available in standard formats. Buying the elements instead of producing them is time- and moneysaving for us. Considering to the fact that SafeBIS won't produce any component, the quality and price of our shelter is totally dependent of all our external suppliers.

Knowing that sustainability is an important factor that the team takes into account, the team must search for suppliers that attach importance to sustainability and try to minimize the number of supplier companies. The number of suppliers is especially important in order to save costs and transportation pollution.

The SafeBIS team chose to build the warehouse in Romania. This decision was made because the supplies are cheaper and have a good quality. Romania offers a large number of suppliers, the suppliers are easy accessible for the team as one member of the SafeBIS team has its origin in Romania. Fibre2fashion and Dedeman are the two most important suppliers to produce the shelters. Fibre2fashion is our Romanian provider for all the needed goods made out of fabric. Despite the big amount of manufacturers, international suppliers are nevertheless called upon, namely Alibaba and Ebay. In [7.3 Components](#) the complete list of components with their suppliers, costs and dimensions is available.

### 3.9 Stakeholders Management

The stakeholders' analysis is a structural approach allowing the understanding of a system, **by precisizing the interests, the needs and the concerns of the organisms concerned**. This tool is thus useful to help decision making when the different stakeholders have opposite interests when resources are limited and the needs of the different parts have to be balanced precisely. It can also be used to value a different scenario.

In 4 steps the method of the stakeholders' management will be defined:

#### 1. Identify the stakeholders

- List the stakeholders and rate them: Who are the potential beneficiaries? Who can be affected poorly? Have vulnerable groups been identified? Do gender-based differences exist inside or between the groups? Have supporters and opponents been identified? What is the relationship between different stakeholders?
- Organize it following 3 levels of involvement:
  1. Direct: affected directly, including the principal beneficiaries
  2. Secondary: affected but not directly
  3. Key: actively involved in the decisions and project management

#### 2. Value the interest of stakeholders and the potential impact on the project

**3. Value of the influence and importance of the stakeholders** Rate the following points for each stakeholder:

- Power and status (political, social, economic)
- Level of organization
- Control over strategic resources
- Relationship of power with the other stakeholders
- Importance in the project success

#### 4. Draft of the strategy of participation of stakeholders

- **Strong interest** stakeholders and a **powerful role** could be associated all project long in order to ensure their support
- **Strong interest** stakeholders, but with a **weak role** are not who/what we aim, although they can be opposition, thus, we must keep them informed and acknowledge their viewpoints to avoid disagreement or conflicts
- **Weak interest** stakeholders, but with a **powerful role** need special efforts to ensure that their expectations are considered and their participation is constructive

- **Weak interest** and **weak role** stakeholders will most likely not very involved in the project and they do not require a particular strategy

The comparison of the impact of stakeholders on the shelters is shown in Table 19.

Table 19: Comparison table of the impact of stakeholders on the shelters

| Stakeholder Impact  | Strong Influence                             | Weak Influence                    |
|---------------------|----------------------------------------------|-----------------------------------|
| <b>Strong Power</b> | Team members<br>EPS Coaches                  | World governments                 |
| <b>Weak Power</b>   | Shelter users<br>NGOs customers<br>Suppliers | Mass customer<br>Other EPS groups |

### 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 management. Table 20 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 subtracted 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 formula shows how to obtain the weekly work efficiency:

$$\text{Efficiency} = 100 * \frac{\text{Velocity}}{\text{Capacity}_{\text{available}}} \equiv 100 * \frac{\text{Hours}_{\text{CompletedTasks}}}{(\text{Amount}_{\text{Days}} * \text{Hours}_{\text{Working}} * \text{Amount}_{\text{Team members}}) - \text{Hours}_{\text{Classes}}}$$

Table 20: Sprint Capacities & Velocities

| Sprint | Work Capacity | hours of school | Available Capacity | Sprint Velocity | Efficiency |
|--------|---------------|-----------------|--------------------|-----------------|------------|
| 1      | 240 h         | 2h x 6          | 228 h              | 50 h            | 21.9 %     |
| 2      | 240 h         | 31h x 6         | 54 h               | 37 h            | 68.5 %     |
| 3      | 240 h         | 19h x 6         | 112 h              | 38 h            | 33.9 %     |
| 4      | 240 h         | 6h x 6          | 204 h              | 16 h            | 7.8 %      |
| 5      | 240 h         | 11h x 6         | 174 h              | 48 h            | 27.6 %     |
| 6      | 240 h         | 16h x 6         | 144 h              | 40 h            | 27.7 %     |
| 7      | 240 h         | 11h x 6         | 174 h              | 81 h            | 46.5 %     |
| 8      | 240 h         | 13h x 6         | 162 h              | 49 h            | 30.2%      |
| 9      | 240 h         | 13h x 6         | 162 h              | 86 h            | 53.1%      |
| 10     | 240 h         | 5h x 6          | 210 h              | 67 h            | 31.9%      |
| 11     | 240 h         | 10h x 6         | 180 h              | 64 h            | 35.6%      |
| 12     | 240 h         | 8h x 6          | 192 h              | 48 h            | 25.0%      |



| Sprint | Work Capacity | hours of school | Available Capacity | Sprint Velocity | Efficiency |
|--------|---------------|-----------------|--------------------|-----------------|------------|
| 13     | 240 h         | 14h x 6         | 156 h              | 90.5h           | 58.0%      |
| 14     | 240 h         | 11h x 6         | 174 h              | 116.5h          | 70.0%      |
| 15     | 240 h         | 10h x 6         | 180 h              | 208.5h          | 115.8%     |

Table 20 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 gets 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. The three last sprints have a high efficiency, this can be explained as a lot of tasks were finished during these last weeks, there were also spent a lot of hours on doing the simulations which was very time-consuming.

Beginning from table 21 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 21: 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 principal research                | Jelte, Gabriel |             |           | x             | this task will take time until the 3th sprint  |
| principal research week1               | Jelte, Gabriel | 15h         | x         |               | all members do research about a specific field |
| ID02 teambuilding resport (individual) | whole group    | 12h (2h x6) | x         |               |                                                |
| ID01 weekly report                     | Eduardo        | 1h          | x         |               |                                                |
| ID03 classes                           | whole group    | 2h p.p.     | x         |               | the classes are not included in the velocity   |
| Sprint Velocity                        |                | 50h         |           |               |                                                |

### 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 22: Sprint 2 Review

| <b>Sprint 2 27/02 - 4/03</b>                  |                |                 |           |               |                                                            |
|-----------------------------------------------|----------------|-----------------|-----------|---------------|------------------------------------------------------------|
| 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  | 8h              | x         |               |                                                            |
| ID06 principle research                       | Jelte, Gabriel |                 |           | x             | this task will take time until the 3th sprint              |
| principal research week2                      | Jelte, Gabriel | 20h             | x         |               | all members do research about a specific field             |
| 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) p.p. | x         |               | 3 of the 4 DT courses were given during this sprint period |
| ID09 classes                                  | whole group    | 19h p.p.        | x         |               | the classes are not included in the velocity               |
| <b>Sprint Velocity</b>                        |                | <b>37h</b>      |           |               |                                                            |

**Stop doing:**

- Vladimir: not coming to the classes
- Be too 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 23: Sprint 3 Review

| <b>Sprint 3 5/03 - 11/03</b>                  |                        |                |           |               |                                               |
|-----------------------------------------------|------------------------|----------------|-----------|---------------|-----------------------------------------------|
| 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 week 3                      | Andreea, Lore          | 8h             | x         |               |                                               |
| ID06 principle research                       | Jelte, Gabriel         | 15h            | x         |               | finish of principle research                  |
| ID10 design thinking (classes)                | whole group            | 4h (1x4h) p.p. | x         |               | the classes are not included in the velocity  |
| ID17 classes                                  | whole group            | 15h p.p.       | x         |               | the classes are not included in the velocity  |
| 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         |               |                                               |
| <b>Sprint Velocity</b>                        |                        | <b>38h</b>     |           |               |                                               |

**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 24: Sprint 4 Review

| Sprint 4 12/03 - 18/03        |               |          |           |               |                                                                                             |
|-------------------------------|---------------|----------|-----------|---------------|---------------------------------------------------------------------------------------------|
| Task name                     | Responsible   | Duration | Completed | Not completed | Notes                                                                                       |
| ID26 leaflet & flyer          | Andreea       | 10h      | x         |               |                                                                                             |
| ID25 design logo & brand name | Andreea       | 5h       | 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 week 4      | Andreea, Lore | 8h       |           | x             |                                                                                             |
| ID23 weekly sprint plan       | Lore          | 2h       |           | x             |                                                                                             |
| ID24 classes                  | whole group   | 6h p.p.  | x         |               | This was the first week we had to stay home because of COVID-19, some courses got cancelled |
| ID22 weekly agenda & minute   | Andreea       | 30'      | x         |               |                                                                                             |
| ID21 weekly report            | Andreea       | 30'      | x         |               |                                                                                             |
| Sprint Velocity               |               | 16h      |           |               |                                                                                             |

**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 Thursday

**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 25: 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             | some parts are still not defined, more time for this research is needed |
| features research week 4              | 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      | 10h      |           | x             |                                                                         |
| ID37 ethics                           | Andreea, Lore | 6h       | x         |               |                                                                         |
| ID35 SWOT analysis                    | Gabriel       | 2h       |           | x             |                                                                         |
| ID31 classes                          | whole group   | 11h p.p. | x         |               | the classes are not included in the velocity                            |
| 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                       |               | 48h      |           |               |                                                                         |

**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 26: Sprint 6 Review

| Sprint 6 26/03 - 01/04            |                        |          |           |               |                                              |
|-----------------------------------|------------------------|----------|-----------|---------------|----------------------------------------------|
| Task name                         | Responsible            | Duration | Completed | Not completed | Notes                                        |
| ID43 List of Materials            | Whole team             | 5h       |           | x             |                                              |
| ID44 material research            | Andreea, Lore, Gabriel | 15h      | x         |               |                                              |
| ID05 features research            | Andreea, Lore          | 8h       | x         |               | finish of features research                  |
| 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               | 10h      |           | x             |                                              |
| ID46 project management (3.1-3.6) | Andreea                | 8h       | x         |               |                                              |
| ID41 classes                      | whole group            | 16h p.p. | x         |               | the classes are not included in the velocity |
| ID40 weekly sprint plan           | Lore                   | 2h       | x         |               |                                              |
| ID39 weekly agenda & minute       | Lore                   | 30'      | x         |               |                                              |
| ID38 weekly report                | Andreea                | 30'      | x         |               |                                              |
| Sprint Velocity                   |                        | 40h      |           |               |                                              |

### 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 27: Sprint 7 Review



| <b>Sprint 7 02/04 - 08/04</b>      |                   |            |           |               |                                               |
|------------------------------------|-------------------|------------|-----------|---------------|-----------------------------------------------|
| Task name                          | Responsible       | Duration   | Completed | Not completed | Notes                                         |
| ID54 Strength of Shelter           | whole team        | 4h         |           | x             |                                               |
| ID59 Improve leaflet & flyer       | Lore              | 8h         | x         |               |                                               |
| ID43 List of Materials             | Andreea           | 6h         | x         |               |                                               |
| ID45 CAD model                     | Eduardo           | 10h        | x         |               |                                               |
| ID48 ventilation system            | whole team        | 2h         |           | x             |                                               |
| ID57 research paintable cotton     | Jelte             | 4h         |           | x             |                                               |
| ID55 add mechanisms (chapter 7)    | Lore, Andreea     | 8h         |           | x             |                                               |
| ID60 material research (chapter 7) | Lore, Andreea     | 8h         | x         |               |                                               |
| ID47 update sustainability         | Jelte             | 3h         | x         |               |                                               |
| ID56 materials (chapter 5)         | Gabriel           | 1h         | x         |               |                                               |
| ID34 marketing (until 4.5)         | Vladimir, Andreea | 20h        | x         |               |                                               |
| ID35 SWOT analysis                 | Gabriel           | 2h         | x         |               |                                               |
| ID58 project management            | Andreea, Lore     |            |           | x             | this task will take time until the 9th sprint |
| project management 3.3-3.6, 3.10   | Andreea, Lore     | 12h        | x         |               |                                               |
| ID51 weekly sprint plan            | Lore              | 2h         | x         |               |                                               |
| ID52 classes                       | whole team        | 11h p.p.   | x         |               | the classes are not included in the velocity  |
| ID50 weekly agenda & minute        | Lore              | 30'        | x         |               |                                               |
| ID53 update gantt chart            | Lore              | 2h         | x         |               |                                               |
| ID49 weekly report                 | Andreea           | 30'        | x         |               |                                               |
| ID61 layout report                 | Andreea           | 6h         | x         |               |                                               |
| <b>Sprint Velocity</b>             |                   | <b>81h</b> |           |               |                                               |

**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

Table 28: Sprint extra Review

| <b>Sprint extra (Easter break) 09/04 - 16/04</b> |                        |            |           |               |       |
|--------------------------------------------------|------------------------|------------|-----------|---------------|-------|
| Task name                                        | Responsible            | Duration   | Completed | Not completed | Notes |
| ID54 Strength of Shelter                         | Lore, Andreea          | 6h         |           | x             |       |
| ID48 ventilation system                          | Vladimir, Eduardo      | 5h         |           | x             |       |
| ID63 door system                                 | Jelte, Gabriel         | 4h         |           | x             |       |
| ID64 connection between shelters                 | Jelte, Gabriel         | 3h         | x         |               |       |
| ID65 measurements whole shelter                  | Andreea, Eduardo, Lore | 3h         |           | x             |       |
| ID66 individual preparation Interim              | whole team             | 6h         | x         |               |       |
| ID67 preparation meeting Interim presentation    | whole team             | 3h         | x         |               |       |
| ID62 weekly sprint plan                          | Lore                   | 1h         | x         |               |       |
| ID68 update project management (3.10)            | Lore                   | 1h         | x         |               |       |
| <b>Sprint Velocity</b>                           |                        | <b>14h</b> |           |               |       |

**Stop doing: -****Start doing:**

- Ask team members for help in the Whatsapp group when you are struggling with something

**Keep doing:**

- Use the Microsoft planner and One Note
- 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
- Being prepared well for the interim presentation

**Comment:** During sprint 7 the team worked hard to catch the deadline of uploading the interim report. The week after, no sprint was initially planned because of the Easter break, but as there were still undefined parts of the shelter, the team decided to plan an extra sprint. During the extra sprint, more research was done so Team BIS would be prepared better for the interim presentation on the 16th of April.

Table 29: Sprint 8 Review

| Sprint 8 16/04 - 22/04                       |                               |          |           |               |                                               |
|----------------------------------------------|-------------------------------|----------|-----------|---------------|-----------------------------------------------|
| Task name                                    | Responsible                   | Duration | Completed | Not completed | Notes                                         |
| ID74 update List of Materials                | Andreea                       | 10h      |           | x             |                                               |
| ID79 sustainability presentation             | Lore, Jelte, Gabriel, Andreea | 7h       | x         |               |                                               |
| ID77 ethics presentation                     | Lore, Jelte, Gabriel, Andreea | 7h       | x         |               |                                               |
| ID78 scenario video                          | Gabriel                       | 6h       | x         |               |                                               |
| ID75 update CAD model                        | Eduardo                       | 20h      |           | x             |                                               |
| ID63 door system                             | Jelte, Gabriel                | 4h       | x         |               |                                               |
| ID48 ventilation system                      | Vladimir, Jelte               | 5h       | x         |               |                                               |
| ID54 Strength of Shelter                     | Lore, Andreea                 | 3h       | x         |               |                                               |
| ID65 measurements whole shelter              | Andreea, Eduardo, Lore        | 3h       | x         |               |                                               |
| ID73 project management (correcting sprints) | Lore                          | 3h       | x         |               |                                               |
| ID57 research paintable cotton               | Jelte                         | 4h       |           | x             |                                               |
| ID58 project management                      | Andreea, Lore                 |          |           |               | this task will take time until the 9th sprint |
| project management 3.7                       | Andreea, Lore                 | 5h       |           | x             |                                               |
| ID76 marketing 4.6                           | Vladimir (Andreea)            | 7h       | x         |               |                                               |
| ID71 weekly sprint plan                      | Lore                          | 3h       | x         |               |                                               |
| ID72 classes                                 | whole team                    | 13h p.p. | x         |               | the classes are not included in the velocity  |
| ID70 weekly agenda & minute                  | Lore                          | 30'      | x         |               |                                               |
| ID69 weekly report                           | Lore                          | 30'      | x         |               |                                               |
| Sprint Velocity                              |                               | 49h      |           |               |                                               |

**Stop doing:**

- Not being able to present your slides during the interim presentation because you fall asleep (Vladimir)

**Start doing:**

- All the members use the Microsoft planner

**Keep doing:**

- Use the Microsoft planner and One Note
- 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
- Being prepared well for the presentations (sustainability & ethical scandal)

Table 30: Sprint 9 Review

| Sprint 9 23/04 - 29/04                   |                        |               |           |               |                                                        |
|------------------------------------------|------------------------|---------------|-----------|---------------|--------------------------------------------------------|
| Task name                                | Responsible            | Duration      | Completed | Not completed | Notes                                                  |
| ID74 update List of Materials            | Andreea                | 10h           | x         |               | Deadline is 23/04 23:59h                               |
| ID75 update CAD model                    | Eduardo                | 34h           | x         |               |                                                        |
| ID78 video                               | Jelte                  | 8h            |           | x             | Deadline is 30/04 23:59h                               |
| ID80 rain resistant legs                 | Lore, Andreea          | 4h            | x         |               |                                                        |
| ID85 drawings of all the mechanisms      | Lore                   | 10h           | x         |               |                                                        |
| ID86 update sustainability               | Jelte                  | 2h            | x         |               |                                                        |
| ID87 marketing 4.7, 4.8                  | Vladimir               | 8h            | x         |               |                                                        |
| ID89 poster design                       | Gabriel                | 16h           |           | x             | search for the ideal text to add + the design          |
| ID58 project management                  | Andreea, Lore, Gabriel |               |           |               | this task will take time until the 9th sprint          |
| project management 3.4                   | Andreea                | 5h            |           | x             |                                                        |
| project management 3.7                   | Andreea                | 5h            | x         |               |                                                        |
| project management 3.11                  | Lore                   | 2h            | x         |               | this task will take time until the 9th sprint          |
| project management 3.9                   | Gabriel                | 7h            |           | x             |                                                        |
| ID88 door and modular connection to wiki | Jelte                  | 1h            | x         |               | add your info to the wiki, also the beautiful drawings |
| ID57 research paintable cotton           | Jelte, Gabriel         | 4h            |           | x             | if there is time                                       |
| ID83 weekly sprint plan                  | Lore                   | 3h            | x         |               |                                                        |
| ID84 classes                             | whole team             | 13h p.p.      | x         |               |                                                        |
| ID81 weekly agenda & minute              | Lore                   | 30'           | x         |               |                                                        |
| ID82 weekly report                       | Lore                   | 30'           | x         |               |                                                        |
| ID90 weekly internal meeting             | whole team             | 3h (30' p.p.) | x         |               |                                                        |
| ID91 additional 'team spirit' meeting    | whole team             | 3h (30' p.p.) | x         |               |                                                        |
| Sprint Velocity                          |                        | 85h           |           |               |                                                        |

**Stop doing:**

- Working with Microsoft Planner (because it's not working for our team)

**Start doing:**

- More internal checks to hear how far everybody got with their tasks

**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
- Being prepared well for the supervisors' meeting
- Having a good communication
- All members show up during team meetings

Table 31: Sprint 10 Review

| Sprint 10 30/04 - 6/05                        |                        |                   |           |               |                                                                                              |
|-----------------------------------------------|------------------------|-------------------|-----------|---------------|----------------------------------------------------------------------------------------------|
| Task name                                     | Responsible            | Duration          | Completed | Not completed | Notes                                                                                        |
| ID78 video                                    | Jelte                  | 8h                | x         |               | Deadline is 30/04 23:59h                                                                     |
| ID100 abstract & introduction paper           | Andreea                | 6h                | x         |               | Mail to Ana Barata on 6/05                                                                   |
| ID98 refining report                          | whole team             | 8h                | x         |               | Deadline is 6/05                                                                             |
| ID97 full check report (add missing parts)    | Lore                   | 4h                | x         |               |                                                                                              |
| ID57 research paintable cotton                | Jelte                  | 4h                |           | x             |                                                                                              |
| ID89 begin poster design                      | Gabriel                | 12h               | x         |               | by Tuesday, give us a first version! check ppt Eduardo sendd (Jelte + Lore can help in need) |
| ID99 strenght simulations (CAD model)         | Eduardo                | 10h               |           | x             |                                                                                              |
| ID104 combination foldable roof and ventilati | Eduardo                | 3h                | x         |               | !!!!!!!                                                                                      |
| ID88 door and modular connection to wiki      | Jelte                  | 1h                |           | x             | add your info to the wiki, also the beautiful drawings                                       |
| ID96 update content flyer                     | Lore                   | 3h                |           | x             |                                                                                              |
| ID102 packaging                               | Jelte                  | 4h                |           | x             | rethink the floor as a box + think about how to keep all the little elements inside the box  |
| ID58 project management                       | Andreea, Lore, Gabriel |                   |           |               | this task will take time until the 9th sprint                                                |
| project management 3.4                        | Andreea                | 5h                |           | x             |                                                                                              |
| project management 3.9                        | Gabriel                | 6h                | x         |               |                                                                                              |
| project management 3.8                        | Lore                   | 2h                | x         |               |                                                                                              |
| ID87 marketing 4.9                            | Vladimir               | 3h                | x         |               |                                                                                              |
| ID101 project development 7.1 + general       | Lore                   | 2h                | x         |               |                                                                                              |
| ID103 summary marketing (for paper)           | Vladimir               | 7h                |           | x             | make a one page summary of the marketing chapter to put in the paper                         |
| ID92 weekly sprint plan                       | Lore                   | 3h                | x         |               |                                                                                              |
| ID96 classes                                  | whole team             | 5h p.p.           | x         |               |                                                                                              |
| ID93 weekly agenda & minute                   | Lore                   | 30'               | x         |               |                                                                                              |
| ID94 weekly report                            | Lore                   | 30'               | x         |               |                                                                                              |
| ID105 weekly task devision meeting            | whole team             | 4h 30' (45' p.p.) | x         |               |                                                                                              |
| ID95 weekly internal meeting                  | whole team             | 4h 30' (45' p.p.) | x         |               |                                                                                              |
| Sprint Velocity                               |                        | 67h               |           |               |                                                                                              |

**Stop doing:**

- Postponing the research of paintable cotton

**Start doing: /**

**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
- Being prepared well for the supervisors' meeting
- Having a good communication
- All members show up during team meetings

Table 32: Sprint 11 Review

| Sprint 11 7/05 - 13/05                          |             |                   |           |               |                                                                                                 |
|-------------------------------------------------|-------------|-------------------|-----------|---------------|-------------------------------------------------------------------------------------------------|
| Task name                                       | Responsible | Duration          | Completed | Not completed | Notes                                                                                           |
| ID106 refine CAD model                          | Eduardo     | 6h                |           | x             |                                                                                                 |
| ID99 strenght simulations (CAD model)           | Eduardo     | 10h               |           | x             |                                                                                                 |
| ID102 packaging                                 | Jelte       | 5h                | x         |               | deadline by 13/05                                                                               |
| ID116 way to fix the fabric to the skeleton     | Gabriel     | 5h                | x         |               | Its important to find a way to fix the fabric easily to the skeleton while building the shelter |
| ID89 poster design                              | Gabriel     | 6h                |           | x             |                                                                                                 |
| ID107 ventilation x roof to wiki                | Eduardo     | 3h                |           | x             |                                                                                                 |
| ID119 redesign bottom part shelter              | Andreea     | 4h                | x         |               |                                                                                                 |
| ID57 research paintable cotton                  | Jelte       | 2h                | x         |               |                                                                                                 |
| ID88 door and modular connection to wiki        | Jelte       | 1h                | x         |               | add your info to the wiki, also the beautiful drawings                                          |
| ID108 state of art & project development paper  | Lore        | 7h                | x         |               | mail to Ana Barata on 9/05                                                                      |
| ID96 update content flyer                       | Lore        | 3h                |           | x             |                                                                                                 |
| ID58 project management                         | Andreea     |                   |           |               | this task will take time until the 9th sprint                                                   |
| project management 3.4                          | Andreea     | 4h                | x         |               |                                                                                                 |
| project management 3.12                         | Andreea     | 30'               | x         |               |                                                                                                 |
| ID109 update marketing chapter                  | Vladimir    | 6h                |           | x             | change according to Luis Lopes' comments                                                        |
| ID110 update ethical chapter                    | Lore        | 3h                | x         |               | change according to Luis Lopes' comments                                                        |
| ID111 update sustainability chapter             | Jelte       | 2h                |           | x             | change according to Luis Castanheiras comments                                                  |
| ID120 website                                   | Vladimir    | 25h               | x         |               |                                                                                                 |
| ID103 summary marketing (for paper)             | Vladimir    | 7h                |           |               | make a one page summary of the marketing chapter to put in the paper                            |
| ID117 summary ethics and deontology (for paper) | Andreea     | 2h                |           |               |                                                                                                 |
| ID118 summary sustainability chapter            | Gabriel     | 3h                |           |               |                                                                                                 |
| ID112 weekly sprint plan                        | Lore        | 2h                | x         |               |                                                                                                 |
| ID96 classes                                    | whole team  | 10h p.p.          | x         |               |                                                                                                 |
| ID113 weekly agenda & minute                    | Lore        | 30'               | x         |               |                                                                                                 |
| ID114 weekly report                             | Lore        | 30'               | x         |               |                                                                                                 |
| ID115 weekly internal meeting                   | whole team  | 4h 30' (45' p.p.) | x         |               |                                                                                                 |
| Sprint Velocity                                 |             | 64h               |           |               |                                                                                                 |

**Stop doing:**

- Postponing the simulations in solidworks because the model has to be changed all the time
- Changing elements of the shelter

**Start doing:**

- Defining the final product

**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
- Being prepared well for the supervisors' meeting
- Having a good communication
- All members show up during team meetings

Table 33: Sprint 12 Review



| Sprint 12 14/05 - 20/05                          |                   |                   |           |               |                                                                      |
|--------------------------------------------------|-------------------|-------------------|-----------|---------------|----------------------------------------------------------------------|
| Task name                                        | Responsible       | Duration          | Completed | Not completed | Notes                                                                |
| ID106 refine CAD model                           | Eduardo           | 6h                | x         |               | add fabric, maybe one window?                                        |
| ID99 strenght simulations (CAD model)            | Eduardo           | 20h               |           | x             | 10 hours were worked on it already                                   |
| ID89 poster design                               | Gabriel           | 12h               |           | x             | 4 hours were worked on the 'EPS' poster                              |
| ID126 research database website                  | Jelte             | 9h                | x         |               | one more hour needed                                                 |
| ID130 consideration beams (Alu)                  | Lore              | 5h                | x         |               |                                                                      |
| ID132 fabric description to wiki                 | Lore              | 3h                |           | x             |                                                                      |
| ID96 update content flyer                        | Lore              | 4h                | x         |               |                                                                      |
| ID128 new chapter to wiki: website               | Lore              | 4h                | x         |               |                                                                      |
| ID109 update marketing chapter                   | Vladimir, Andreea | 10h               |           | x             | change according to Luis Lopes' comments                             |
| ID111 update sustainability chapter              | Jelte             | 2h                |           | x             | change according to Luis Castanheiras comments                       |
| ID103 summary marketing (for paper)              | Vladimir          | 2h                |           | x             | make a one page summary of the marketing chapter to put in the paper |
| ID117 summary ethics and deontology (for paper)  | Andreea           | 2h                |           | x             |                                                                      |
| ID118 summary sustainability chapter (for paper) | Gabriel           | 2h30'             | x         |               |                                                                      |
| ID129 research maquette/maquette paper           | Andreea           | 1h                | x         |               | try to find the desired material (maquette paper) + experiment       |
| ID133 packaging update                           | Andreea           | 6h                | x         |               |                                                                      |
| ID134 rethink dimensions                         | Andreea           | 3h                | x         |               |                                                                      |
| ID131 manual                                     | Andreea, Lore     | 20h               |           | x             |                                                                      |
| ID127 update paper                               | Lore              | 2h                |           | x             |                                                                      |
| ID121 weekly sprint plan                         | Lore              | 2h                | x         |               |                                                                      |
| ID125 classes                                    | whole team        | 8h p.p.           | x         |               |                                                                      |
| ID122 weekly agenda & minute                     | Lore              | 30'               | x         |               |                                                                      |
| ID123 weekly report                              | Lore              | 30'               | x         |               |                                                                      |
| ID124 weekly internal meeting                    | whole team        | 4h 30' (45' p.p.) | x         |               |                                                                      |
| Sprint Velocity                                  |                   | 48h               |           |               |                                                                      |

## Stop doing:

- Not finalizing the requested tasks

## Start doing:

- Asking more frequently how everybody's tasks are going
- Motivate each other more

## 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
- Being prepared well for the supervisors' meeting
- Having a good communication

Table 34: Sprint 13 Review

| Sprint 13 21/05 - 27/05                         |                   |                   |           |               |                                                                                                                 |
|-------------------------------------------------|-------------------|-------------------|-----------|---------------|-----------------------------------------------------------------------------------------------------------------|
| Task name                                       | Responsible       | Duration          | Completed | Not completed | Notes                                                                                                           |
| ID106 refine CAD model                          | Eduardo           | 40h               | x         |               | add fabric, maybe one window?                                                                                   |
| ID99 strenght simulations (CAD model)           | Eduardo           | 14h               |           | x             |                                                                                                                 |
| ID89 poster design EPS                          | Gabriel           | 4h                |           | x             |                                                                                                                 |
| ID143 poster design SOLUTION                    | Gabriel           | 3h                | x         |               |                                                                                                                 |
| ID144 maquette                                  | Andreea           | 20h               |           | x             |                                                                                                                 |
| ID126 research database website (continuation)  | Jelte             | 1h                | x         |               |                                                                                                                 |
| ID147 research forces on the shelter            | Jelte             | 2h                | x         |               | write down the forces under which the shelter is subject                                                        |
| ID148 steel cables                              | Gabriel           | 2h                |           | x             | write a part about the advantages of it + why it's good to use it the shelter, find out the weight and the size |
| ID132 fabric description to wiki                | Lore              | 3h                |           | x             |                                                                                                                 |
| ID149 stability research                        | Jelte             | 2h                | x         |               |                                                                                                                 |
| ID141 ventilation to wiki                       | Lore              | 1h                |           | x             |                                                                                                                 |
| ID142 composite honeycomb panel                 | Lore              | 5h                | x         |               |                                                                                                                 |
| ID96 update content flyer                       | Lore              | 1h                | x         |               |                                                                                                                 |
| ID109 update marketing chapter                  | Vladimir, Andreea | 10h               | x         |               | change according to Luis Lopes' comments                                                                        |
| ID111 update sustainability chapter             | Jelte             | 2h                | x         |               | change according to Luis Castanheiras comments                                                                  |
| ID103 summary marketing (for paper)             | Vladimir          | 2h                |           | x             | make a one page summary of the marketing chapter to put in the paper                                            |
| ID117 summary ethics and deontology (for paper) | Andreea           | 2h                | x         |               |                                                                                                                 |
| ID131 manual                                    | Jelte             | 20h               |           | x             | start writing the manual, how is a normal manual written, what has to be in it?                                 |
| ID127 update paper                              | Lore              | 5h                | x         |               |                                                                                                                 |
| ID146 update project management                 | Lore              | 2h                | x         |               |                                                                                                                 |
| ID145 update gantt chart                        | Lore              | 1h                | x         |               |                                                                                                                 |
| ID135 weekly sprint plan                        | Lore              | 3h                | x         |               |                                                                                                                 |
| ID136 classes                                   | whole team        | 14h p.p.          | x         |               |                                                                                                                 |
| ID137 weekly agenda & minute                    | Lore              | 30'               | x         |               |                                                                                                                 |
| ID138 weekly report                             | Lore              | 30'               | x         |               |                                                                                                                 |
| ID140 additional meeting                        | whole team        | 6h (1h p.p.)      | x         |               |                                                                                                                 |
| ID139 weekly internal meeting                   | whole team        | 4h 30' (45' p.p.) | x         |               |                                                                                                                 |
| Sprint Velocity                                 |                   | 90h30'            |           |               |                                                                                                                 |

## Stop doing:

- Not finalizing the requested tasks
- Postponing tasks

**Start doing:**

- Finishing all little details

**Keep doing:**

- Asking more frequently how everybody's tasks are going
- 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

Table 35: Sprint 14 Review

| Sprint 14 28/05 - 3/06                                     |                |                   |        |         |                                                                               |
|------------------------------------------------------------|----------------|-------------------|--------|---------|-------------------------------------------------------------------------------|
| Task name                                                  | Responsible    | Duration          | Comple | Not com | Notes                                                                         |
| ID99 strenght simulations (CAD model)                      | Eduardo, Lore  | 27h + 10h         | x      |         | try to simplify the model                                                     |
| ID159 strenght simulations (Fusion)                        | Andreea        | 5h                |        | x       | if necessary                                                                  |
| ID106 refine CAD model                                     | Eduardo        | 37h               | x      |         | add fabric                                                                    |
| ID144 maquette                                             | Andreea        | 12h               |        | x       | 3h this week                                                                  |
| ID163 explanation functionality tests                      | Jelte, Eduardo | 4h                | x      |         |                                                                               |
| ID160 update poster design SOLUTION                        | Gabriel        | 4h                | x      |         |                                                                               |
| ID89 poster design EPS                                     | Gabriel        | 4h                |        | x       | dont know if we will finish this                                              |
| ID131 manual                                               | Gabriel        | 20h               |        | x       | 8h already done                                                               |
| ID127 update paper                                         | Lore           | 12h               |        | x       | 6 already done                                                                |
| ID157 update video                                         | Jelte          | 5h                | x      |         | adding renders, adding tekst                                                  |
| ID158 explanation stability (interlock beams)              | Jelte          | 1h                | x      |         | if the force of the wind is to high                                           |
| ID161 define connectors between fabric and construction    | Eduardo        | 1h                |        | x       |                                                                               |
| ID162 searching for solutions after the simulation is done | Vladimir       | 3h                |        | x       |                                                                               |
| ID148 steel cables                                         | Gabriel        | 1h                | x      |         | write a part about the advantages of it + why it's good to use it the shelter |
| ID132 fabric description to wiki (double layer)            | Gabriel        | 3h                |        | x       | 1 hour                                                                        |
| ID141 ventilation to wiki                                  | Lore           | 1h                | x      |         |                                                                               |
| ID170 dimension, volume to wiki                            | Andreea        | 1h                | x      |         |                                                                               |
| ID171 upload all deliverables (check leaflet, flyer...)    | Andreea        |                   | x      |         |                                                                               |
| ID103 summary marketing (for paper)                        | Vladimir       | 2h                | x      |         | make a one page summary of the marketing chapter to put in the paper          |
| ID164 conclusion 8.1 & 8.2                                 | Vladimir       | 4h                | x      |         |                                                                               |
| ID166 update list of materials                             | Andreea        | 4h                |        | x       | Searching for aluminium beams, alu panel... in romania                        |
| ID109 update marketing chapter                             | Andreea        | 3h                |        | x       | 2 more hours                                                                  |
| ID172 update packaging                                     | Lore, Andreea  | 3h                | x      |         |                                                                               |
| ID173 update database website                              | Jelte          | 3h                | x      |         |                                                                               |
| ID167 explanation of database website to wiki              | Jelte          | 1h                |        | x       |                                                                               |
| ID168 update ethical concerns 6.2                          | Andreea        | 1h                | x      |         |                                                                               |
| ID169 paintable cotton to wiki                             | Jelte          | 1h                |        | x       |                                                                               |
| ID156 update project management                            | Lore           | 2h                | x      |         |                                                                               |
| ID150 weekly sprint plan                                   | Lore           | 4h                | x      |         |                                                                               |
| ID155 classes                                              | whole team     | 11h p.p.          | x      |         |                                                                               |
| ID151 weekly agenda & minute                               | Lore           | 15'               | x      |         |                                                                               |
| ID152 weekly report                                        | Lore           | 15'               | x      |         |                                                                               |
| ID153 additional meeting                                   | whole team     | 6h (1h p.p.)      | x      |         |                                                                               |
| ID154 weekly internal meeting                              | whole team     | 4h 30' (45' p.p.) |        | x       |                                                                               |
| Sprint Velocity                                            |                | 116h30'           |        |         |                                                                               |

**Stop doing: /****Start doing:**

- Finishing all little details

**Keep doing:**

- Asking more frequently how everybody's tasks are going
- 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
- Communicating well
- Being well prepared for meetings with the teachers

Table 36: Sprint 15 Review

| Sprint 15 4/06 - 12/06                                  |                   |                   |           |              |                                                                                   |
|---------------------------------------------------------|-------------------|-------------------|-----------|--------------|-----------------------------------------------------------------------------------|
| Task name                                               | Responsible       | Duration          | Completed | Not complete | Notes                                                                             |
| ID99 strenght simulations (CAD model)                   | Eduardo           | 50h               | x         |              | wind sim                                                                          |
| ID144 maquette                                          | Andreea           | 16h               | x         |              |                                                                                   |
| ID182 maquette to wiki                                  | Andreea           | 15'               | x         |              |                                                                                   |
| ID131 manual                                            | Gabriel           | 22h               | x         |              | 8 already done                                                                    |
| ID127 update paper                                      | Lore              | 20h               | x         |              |                                                                                   |
| ID183 refine model (window, hinges)                     | Eduardo           | 50h               | x         |              |                                                                                   |
| ID161 define connectors between fabric and construction | Gabriel           | 1h                | x         |              |                                                                                   |
| ID185 analyzing results simulation + to wiki            | Eduardo           | 5h                | x         |              |                                                                                   |
| ID167 database website + summary                        | Jelte             | 2h                | x         |              |                                                                                   |
| ID187 renders                                           | Andreea           | 1h                | x         |              |                                                                                   |
| ID186 personal outcome of every member                  | whole team        | 3h                | x         |              |                                                                                   |
| ID164 refine conclusion 8.1 & 8.2                       | Lore, Andreea     | 2h                | x         |              |                                                                                   |
| ID188 full check report                                 | Lore, Andreea     | 4h                | x         |              |                                                                                   |
| ID162 conclusion chapter 7                              | Andreea           | 1h                | x         |              |                                                                                   |
| ID157 update video                                      | Jelte             | 6h                | x         |              | adding renders, adding tekst                                                      |
| ID169 paintable cotton to wiki                          | Jelte             | 1h                | x         |              |                                                                                   |
| ID170 dimension, volume to wiki                         | Lore              | 15'               | x         |              |                                                                                   |
| ID109 update marketing chapter                          | Andreea, Vladimir | 5h                | x         |              | 2 more hours needed                                                               |
| ID132 fabric description to wiki (double layer)         | Gabriel           | 1h                | x         |              | 1 hour                                                                            |
| ID171 upload all deliverables (check leaflet, flyer...) | Andreea           | 30'               | x         |              |                                                                                   |
| ID166 update list of materials                          | Andreea           | 4h                | x         |              | Searching for aluminium beams, alu panel... in romania                            |
| ID184 update conclusion fixation connectors             | Lore              | 15'               | x         |              |                                                                                   |
| ID presentation                                         | Jelte             | 2h                | x         |              |                                                                                   |
| ID165 3D model to wiki                                  | Lore              | 30'               | x         |              | add screenshots of the 3D model + in the right order (= how to build the shelter) |
| ID181 update gantt chart                                | Lore              | 15'               | x         |              |                                                                                   |
| ID180 update project management                         | Lore              | 1h                | x         |              |                                                                                   |
| ID174 weekly sprint plan                                | Lore              | 2h                | x         |              |                                                                                   |
| ID179 classes                                           | whole team        | 14h p.p.          | x         |              |                                                                                   |
| ID175 weekly agenda & minute                            | Lore              | 15'               | x         |              |                                                                                   |
| ID176 weekly report                                     | Lore              | 15'               | x         |              |                                                                                   |
| ID177 additional meeting                                | whole team        | 6h (1h p.p.)      | x         |              |                                                                                   |
| ID178 weekly internal meeting                           | whole team        | 4h 30' (45' p.p.) | x         |              |                                                                                   |
| Sprint Velocity                                         |                   | 208h30'           |           |              |                                                                                   |

### 3.11 Sprint Evaluations

In section [3.10 Sprint Outcomes](#) all sprints that were done during the project are shown. The project includes 18 sprints that each had a length of 7 days with 5 workdays. Starting from Thursday and ending on Wednesday the week after, the sprints take off right after the supervisors' meeting that is planned every week.

Every Thursday after the supervisors' meeting, our team plans a team meeting. This meeting is arranged to divide the tasks for the next sprint, to process the criticism of the supervisors, and to discuss the behavior of our team, namely the things the team has to stop doing, start doing, and keep doing. By discussing these last subjects (the outcomes of it are shown in [3.10 Sprint Outcomes](#)), our team strives towards better performance and behavior throughout the group. The team mainly hopes to achieve open communication and a good team spirit by doing this.

A second scrum meeting is organized every Tuesday or Wednesday, as it fits the best for the team members. During this internal meeting, the team can review how tasks are going and check if someone needs help finalizing a certain task. Furthermore, the team is involved in everyone's tasks as the team is daily communicating by Whatsapp. This Whatsapp group helps all members to share the difficulties that we occur and the solutions that are founded.

When focussing on project management, we are reminded of the fact that having fluent communication is extremely important. As all the members are separated from each other because of COVID-19, clear communication is more important than ever before. Having all the member attempting to the two team meetings every week and providing them with the right tasks and feedback, is essential during this project.

### 3.12 Conclusion

A good project manager is a link that holds a project together and ensures quality and objectives are

met on time and on budget.

Project management is more than simply tracking deadlines and setting a budget. A good project manager takes control of a project from beginning to end, ensuring that the initiatives and goals are strategically aligned, the project has stakeholder support, and everyone is on the same page.

In the next chapter, [4. Marketing Plan](#), our team will be introduced in the Marketing term, which is an important strategy to ensure the growth of our business. While our current customers should always be our main priority, marketing efforts can help us expand this base. Little efforts like social media posts and email campaigns can not only engage existing consumers but spread the word to new potential customers. In essence, marketing secures our business's future through new customer engagement.

## 4 Marketing Plan

### 4.1 Introduction

By initially conducting a global analysis, we can better understand the problems and disasters that have occurred around the world at a given time, thus realizing their severity and considering all aspects necessary to ensure health and safety for our users. Marketing aims 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.

Our purpose is to create the ideal product in the event of an imminent disaster so that it will be suitable for the customers, a useful and innovative product so that the created design can be maintained for a long time on the market. In this chapter, they will follow the marketing plan for the designed product, namely SafeBIS, a foldable shelter in case of disasters, and it consists of market analysis, tracking and analysis of strengths and weaknesses, threats, competition and establishing steps to follow for fulfilling the objectives initially set.

The positioning strategy, the establishment of the budget factor, and the control of the strategy to launch the product on the market will be debated.

We will start to develop the market analysis by using Porter's Five Forces. This method of analysis is for a better understanding of the market environment where we are getting in to helps us to make proper decisions. In the following steps, the SWOT analysis is used to understand our position in the market, strengths, weaknesses, opportunities, and threats.

Continuing with the Strategic Objectives, the S.M.A.R.T.E.R method is used to set up proper objectives.

After goal setting, the next important topic consists of establishing an audience and targeting, where we will make an analysis of our audience and better define the age demographics and everything related to our target audience.

The four P's of marketing are the next topic it's a framework that will help in designing the strategies and campaigns for the product. The last two topics are Budget and Strategy Control. In Budget, we discuss the marketing budget, where and how it will be used.

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 satisfy the customers. The balance between demand-pull and technology-push has strongly shifted toward demand-pull in recent years [\[41\]](#). Therefore, the benefit for the customer should always be in the focus during the development process. It is

necessary to know the actual customers, the market, and especially the future customers to adapt the strategy to obtain the desired results.

## 4.2 Market Analysis

### 4.2.1 The global impact of disasters

A disaster is a serious disruption occurring over a short or long period of time that causes widespread human, material, economic or environmental loss which exceeds the ability of the affected community or society to cope using its own resources.

If we look at the average over the past decade, approximately 60.000 people globally died from natural disasters each year. This represents 0.1% of global deaths. What we see is that in many years, the number of deaths can be very low – often less than 10.000, and accounting for as low as 0.01% of total deaths. But we also see the devastating impact of shock events: the 1983-85 famine and drought in Ethiopia; the 2004 Indian Ocean earthquake and tsunami; Cyclone Nargis which struck Myanmar in 2008; and the 2010 Port-au-Prince earthquake in Haiti. All of these events pushed global disasters deaths over 200.000 – more than 0.4% of deaths in these years.

Low-frequency, high-impact events such as earthquakes and tsunamis are not preventable, but such high losses of human life are. We know from historical data that the world has seen a significant reduction in disaster deaths through earlier prediction, more resilient infrastructure, emergency preparedness, and response systems.

In Figure 17 is illustrated the number of deaths from natural disasters.

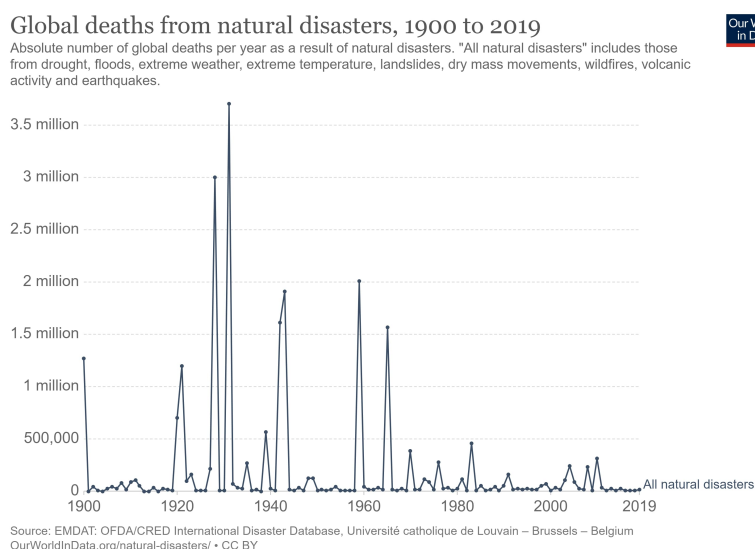


Figure 17: Global deaths from natural disasters

- Annual deaths from natural disasters [42]

In the visualization shown in Figure 18 we see the long-term global trend in natural disaster deaths. This shows the estimated annual number of deaths from disasters from 1900 onwards from the EMDAT International Disaster Database. What we see is that in the early-to-mid 20th century, the annual death toll from disasters was high, often reaching over one million per year. In recent decades we have seen a substantial decline in deaths. In most years fewer than 20.000 dies (and in the most recent decade, this has often been less than 10.000). Even in peak years with high-impact events, the death toll has not exceeded 500.000 since the mid-1960s.



## Number of deaths from natural disasters, 2017

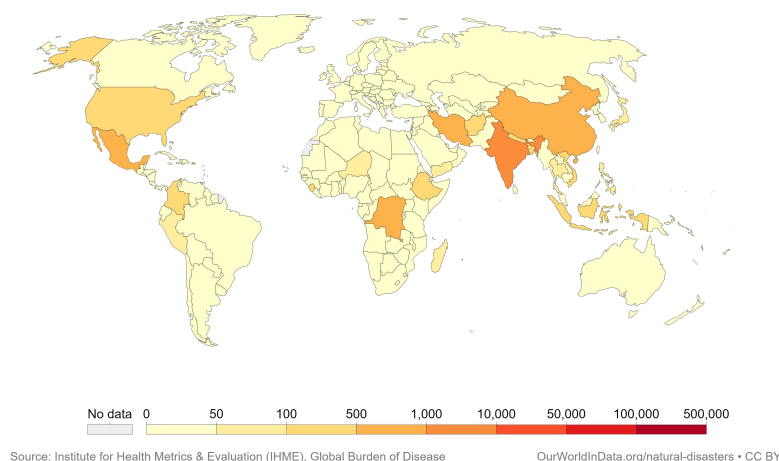


Figure 18: Number of deaths from natural disasters 2017

Human impacts of natural disasters are not fully captured in mortality rates. Injury, homelessness, and displacement can all have a significant impact on populations.

Figure 19 shows the number of people displaced internally from natural disasters. Note that these figures report on the basis of new cases of displaced persons: if someone is forced to flee their home from natural disasters more than once in any given year, they will be recorded only once within these statistics.

## Internally displaced persons from natural disasters, 2017

Internally displaced persons are defined as people or groups of people who have been forced or obliged to flee or to leave their homes or places of habitual residence, as a result of natural or human-made disasters and who have not crossed an international border.

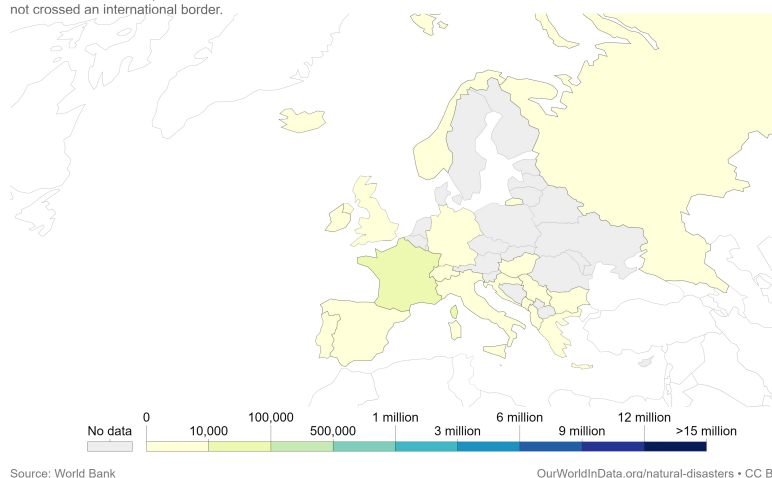
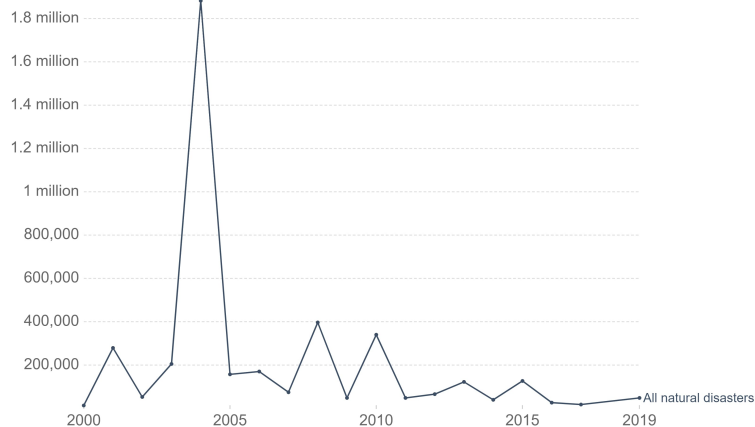


Figure 19: Displaced persons from disasters

- Injuries: the number of people injured is defined as “People suffering from physical injuries, trauma or an illness requiring immediate medical assistance as a direct result of a disaster.”

## Global injuries from natural disasters, All natural disasters, 2000 to 2019

Global number of people injured from natural disaster events. This is defined as "people suffering from physical injuries, trauma or an illness requiring immediate medical assistance as a direct result of a disaster."

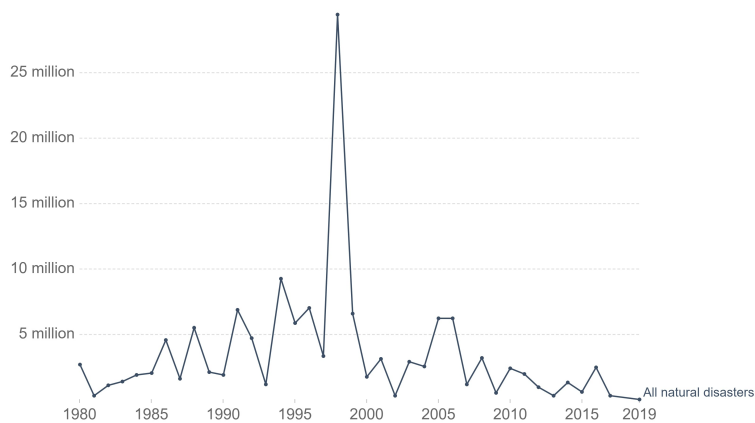


Source: EMDAT (2020): OFDA/CRED International Disaster Database, Université catholique de Louvain – Brussels – Belgium  
OurWorldInData.org/natural-disasters • CC BY

- Homelessness: the number of people homeless is defined as "Number of people whose house is destroyed or heavily damaged and therefore need shelter after an event."

## Number left homeless from natural disasters, All natural disasters, 1980 to 2019

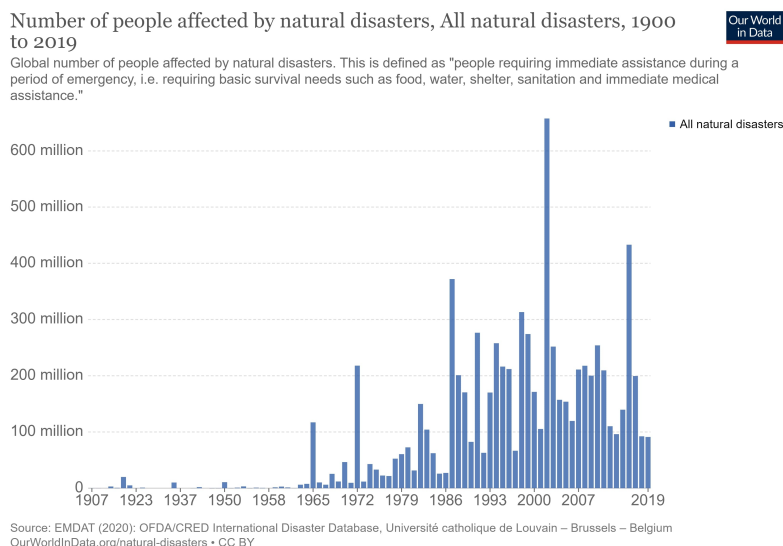
Global number of people left homeless from natural disaster events. This is defined as "number of people whose house is destroyed or heavily damaged and therefore need shelter after an event."



Source: EMDAT (2020): OFDA/CRED International Disaster Database, Université catholique de Louvain – Brussels – Belgium  
OurWorldInData.org/natural-disasters • CC BY

- Affected: the number of people affected is defined as "People requiring immediate assistance during a period of emergency, i.e. requiring basic survival needs such as food, water, shelter, sanitation, and immediate medical assistance."





- Global disaster costs [\[43\]](#)

Natural disasters not only have devastating impacts in terms of the loss of human life but can also cause severe destruction with economic costs.

When we look at global economic costs over time in absolute terms we tend to see rising costs. But, importantly, the world – and most countries – have also gotten richer. Global gross domestic product has increased more than four-fold since 1970. We might, therefore, expect that for any given disaster, the absolute economic costs could be higher than in the past.

A more appropriate metric to compare economic costs over time is to look at them in relation to GDP. This is the indicator adopted by all countries as part of the UN Sustainable Development Goals to monitor progress on resilience to disaster costs.

In Figures [20](#) and [21](#) we see global direct disaster losses given as a share of GDP. There is notable year-to-year variability in costs – ranging from 0.15% to 0.5% of global GDP. In recent decades there has been no clear trending increase in damages when we take account of economic growth over this period.

This is also true when we look at damages specifically for weather-related disasters. This trend in damages relative to global GDP is also shown in the interactive chart.

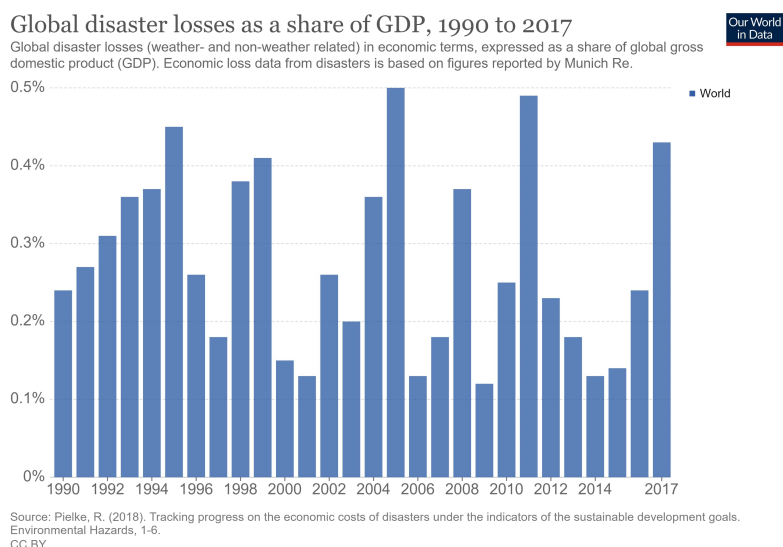


Figure 20: Disaster losses GDP

### Direct disaster economic loss as a share of GDP, 2018

The monetary value of total or partial destruction of physical assets existing in the affected area from natural disasters, as a share of gross domestic product (GDP). Direct economic loss is nearly equivalent to physical damage.

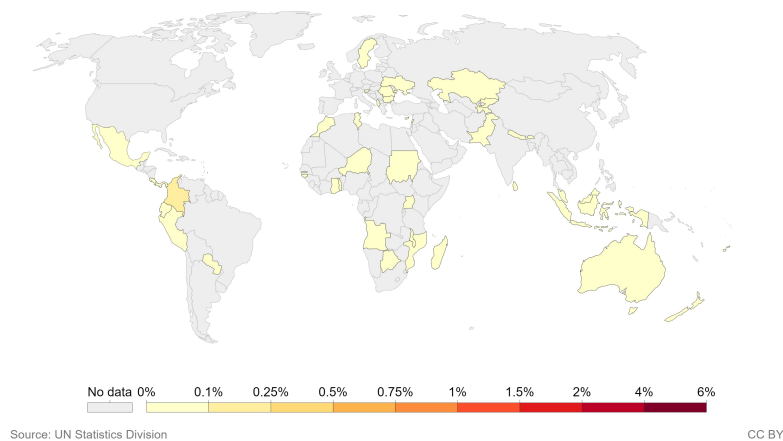


Figure 21: Disaster economic losses GDP 2018

One of the major successes over the past century has been the dramatic decline in global deaths from natural disasters – this is despite the fact that the human population has increased rapidly over this period.

Behind this improvement has been the improvement in living standards, access to and development of resilient infrastructure, and effective response systems. These factors have been driven by an increase in incomes across the world. Overall development, poverty alleviation, and knowledge-sharing of how to increase resilience to natural disasters will, therefore, be key to reducing the toll of disasters in the decades to come.

Considering these natural calamities that have a disastrous impact on people and buildings and the many methods adopted over time, whether temporary or permanent, the method that our company implements is, in terms of construction, a long-term one, being able to accommodate many families by creating modules. This solution follows certain requirements and standards, as previously discussed in other chapters, providing the safety and housing needed for refuge, not being a product made of non-resistant materials, or harmful to the environment, or without exploiting non-renewable resources.

At the same time, considering studies on the number of deaths, economic losses, destruction of buildings and relocations, SafeBIS wants to promote the idea of a new beginning, belonging to a place and the considerable reduction of these percentages illustrated above.

#### 4.2.2 Marketing strategy

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” [44].

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 words, 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 [45].

The threat of new entrants Porter's Five Forces explained is one of the factors to consider when analyzing the structural environment of an industry.

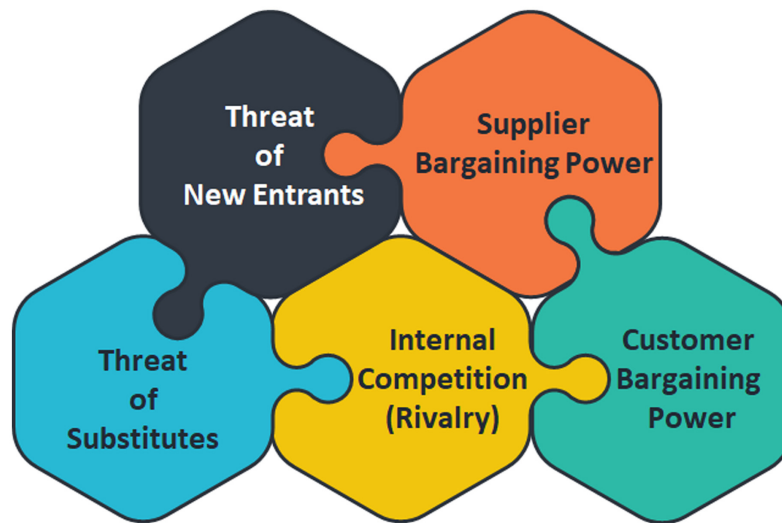


Figure 22: Porter's Five Forces [46]

### 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.

### Suppliers Bargaining Power

The power exerted by suppliers in the form of price, volume limitations, shifting costs to customers [47]. 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 [48].

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 [49]. 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 [50].

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 [51]. 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 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.

## 2. Supplier Bargaining Power

Supplier Power:

- The whole industry relies on few suppliers;
- Increased bargaining power of 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. The threat of Substitutes

The Threat of Substitution:

- Substitute product quality is equal or superior to industry product quality;
- Substitute performance is equal or superior to industry product performance;
- Consumer switching costs are high;
- Substitute product is cheaper than industry product.

### 4.2.3 PESTEL Analysis

Using a PESTEL Analysis we want to identify and analyze the key drivers of change in the external business environment, as we plan to launch a new product into the market. Understanding these environments helps to minimize threats while maximizing opportunities.

These environments include:

- Political (involve governmental influences affecting the economy and how our business can be operated)
- Economic (determine an economy's performance resulting in impacting the organization's operational capabilities as well as their profitability and sustainability)
- Social (consider the beliefs, attitudes, and trends of the population that affect the market and community socially)
- Technological (impact the way organizations market their products)
- Environmental (determined by the surrounding environment)
- Legal (internal and external policies that must be taken into account)

When the factors for each environment are assessed, this information can then be analyzed further using a SWOT Analysis ([4.3 SWOT Analysis](#)) to identify the threats and weaknesses associated with each of the factors.



Figure 23: PESTEL Analysis

### 4.3 SWOT Analysis

The SWOT 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 SWOT for the product, Figure [24](#), and the representative one for the BIS team, Figure [25](#).

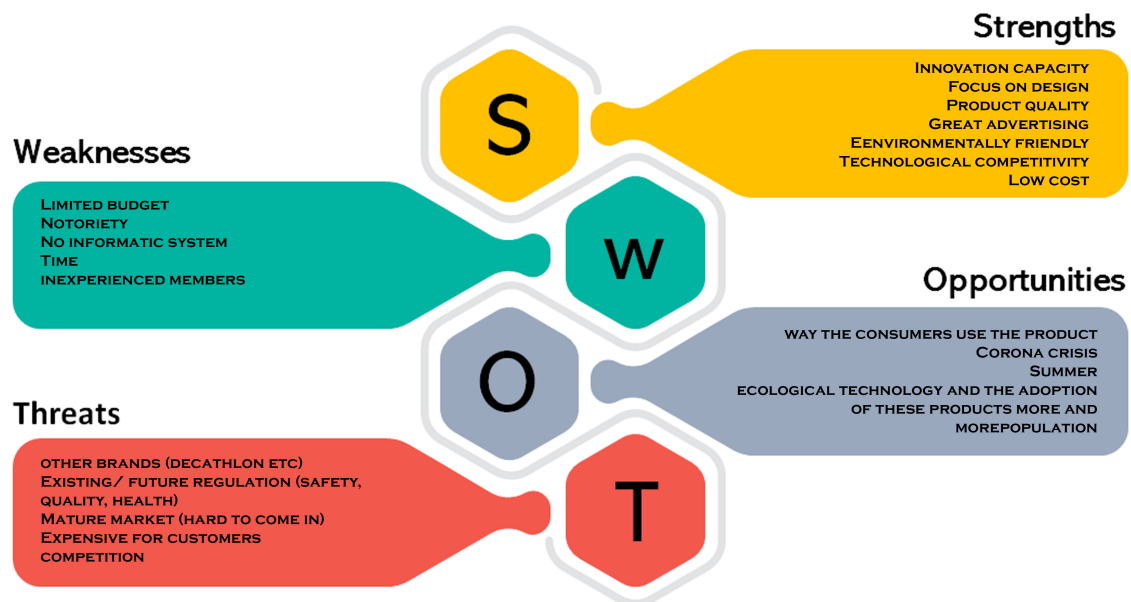


Figure 24: SWOT Analysys

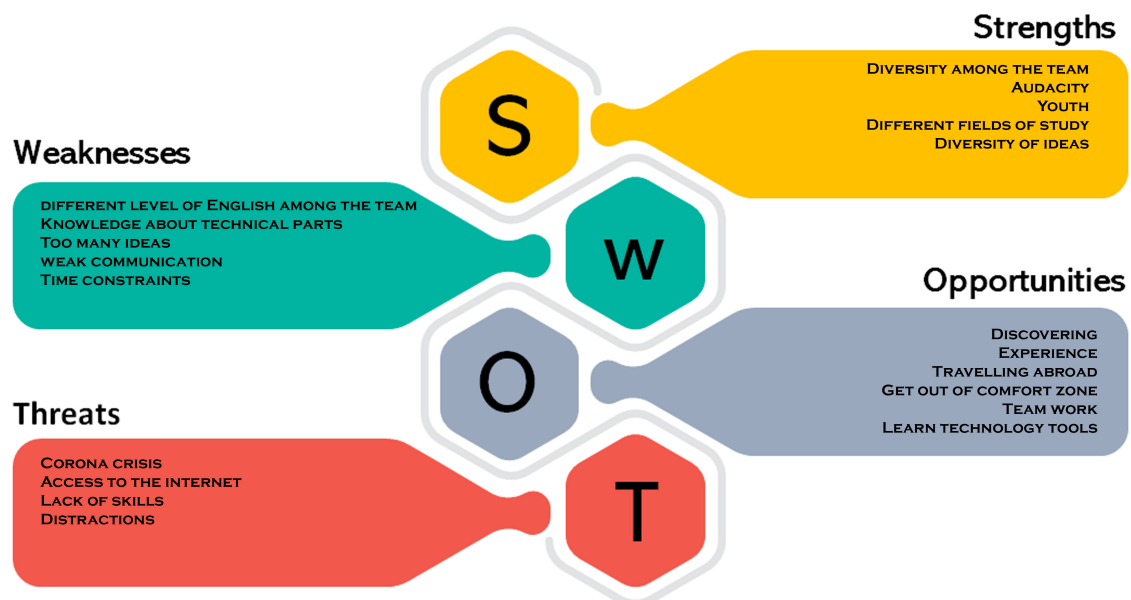


Figure 25: Team SWOT Analysys

## 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 [52]. This method is illustrated in Figure 26.





Figure 26: 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 [53]. 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 [54]. 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 [55].

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 customer 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:

- Marketing research by the end of April 2020
- Marketing/Ethics/Sustainability research by the end of April 2020
- Define the technological model/system by the end of May 2020
- Define the design by the end of May 2020
- Beginning of production by the end of September 2020

### **“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.

Considering the approaches and the evolution with the purpose of creating a foldable shelter product in case of disasters, the aim is to achieve certain events, in the sense of developing, promoting, and conferring all the promised aspects in order to maintain the health and safety of people in need. The Product Roadmap [27](#) will illustrate the events to be accomplished.

# Product Roadmap

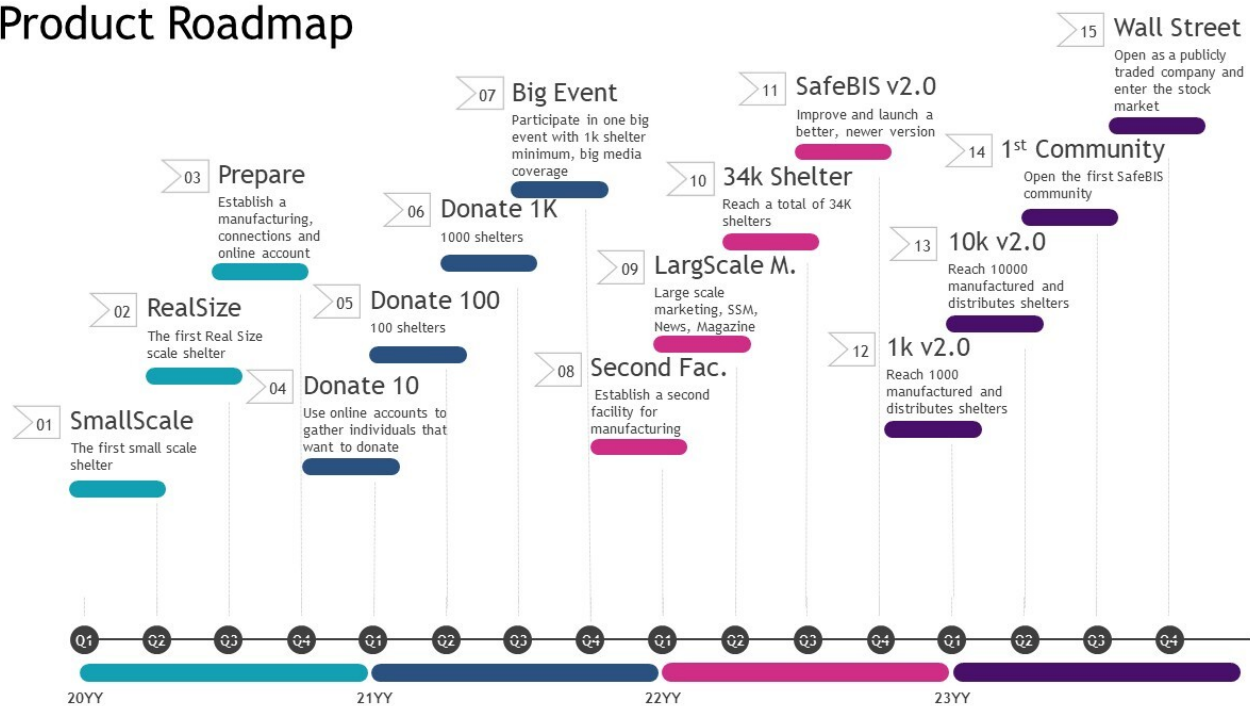


Figure 27: The Product Roadmap

## 4.4.1 Leaflets and flyer objectives

Leaflets and flyers are something that paper-based and has to be delivered in person. A typical example is when you go to a concert and there are some of the sponsors marketing personal giving this to everyone that enters and usually, they end up thrown away without the people paying attention to them. The second example is when you are walking down downtown there might be stands where also the same happens. What can we learn from this?

First of all, we have to give it to the right audience, not just random people walking down the street or at a concert. For this purpose, we have to visit events, gatherings, and conventions where we will give of the flyers and get active in conversation with the people that we give it to. Especially charity events where people gather for the same reason that is crucial to our business.

Using this method of promotion, a better understanding of the occupation that our company has is possible, clarifying, and encouraging the public to realize the real need in case of imminent disasters.

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.

## 4.5 Strategy/Targeting/Positioning/Brand

### 4.5.1 Segmentation

SafeBIS's primary focus will be dealing with businesses, organizations, and governments around the globe, and the 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 only cover a certain area. Looking at the Figure 28 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 manufacturers 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 28: World map of the 50 major loss events 2016 [56]

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 [57] 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 29: Percentage of households giving

As we can see from that Figure 29 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 30:

- 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 themselves 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.

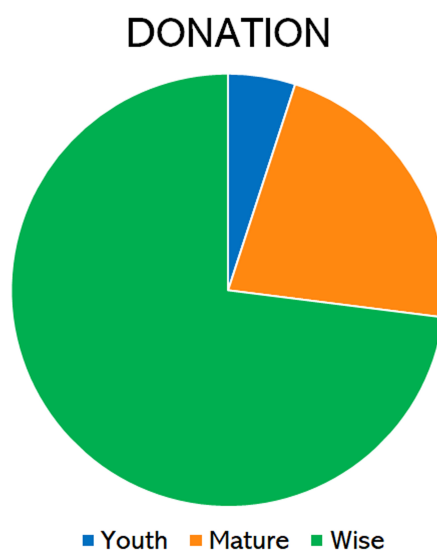


Figure 30: Donation Diagram

## 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.

### 4.5.2 Brand Promotion

The marketing communication strategy is used to inform, persuade, convince, and influence the decision-making process of buyers when they choose a particular brand. It is done to promote brand awareness to create a consumer's interest. So they could make a sale and convert them into loyal customers. The process starts with the idea of the particular, marketing research is done based on the customer's need and marketing demand analysis. Then the marketing of the product starts to promote our particular and unique product.

In the brand promotion, our main focus is on branding and marking the overall image, reputation, and strength of the company.



Given the pursuit of a strategy, the main aspects to be achieved are:

- To establish a positive image and brand equity;
- To increase the product demand;
- To highlight the unique features of the shelter;
- To address on a large scale to raise awareness of the need for shelters in case of disasters;
- To promote a new beginning by quality assurance (to use recyclable materials; the adoption of long-term shelters in order to protect and conserve raw materials and energy used).

Brand promotion techniques include all of those tools which are usually used by the marketers to communicate with their target market and end customers. Those marketing communication tools for brand promotion are as follows [58].

## ADVERTISING

The company's advertising is based on the distribution of flyers and leaflets to target groups, which are of real interest in this field so that the connection between the product and the buyer is ensured. The design chosen for the creation of flyers (Figure 31) and leaflets (Figure 32), offers viewers an anticipated idea about the design of the SafeBIS shelter, capturing the attention through the color composition and the clear and concise text about the attributions that the product has.



Figure 31: SafeBIS Flyer



Figure 32: SafeBIS Leaflet

Our logo gives the image of modules, to symbolize the idea of hexagonal modular shelters, the name

SafeBIS shows the main aspect pursued throughout the design process, namely the respect of safety and health of users, and the motto contributes to the completion of the image of a new beginning, of the chance given for recovery from past disasters. SafeBIS logo is illustrated in Figure 33.



Figure 33: SafeBIS Logo

## ONLINE BRAND PROMOTION

Through the online environment, we want to promote our modular shelters, so that the concept created to be recognized worldwide, being a current and most used method to achieve the propagation of the unique SafeBIS design. There are many advantages to using online promotion:

- There almost no barriers for newcomers, very simple and easy;
- A very big task of brand promotion is performed by few people in very little time at a very reasonable price;
- Online platforms welcome all the new small businesses that can't compete in the market because of their lower marketing and advertising budget;
- Tagging technology has made online promotion much easier and measurable rather than conventional billboards and banners.

Our team resorted to this way of promotion, creating a representative site of our company ([7.6 Website SafeBIS](#)), where certain aspects related to SafeBIS shelters are explained in detail.

## 4.6 Adapted Marketing-Mix

The 4Ps were created by marketing professor E. Jerome McCarthy in 1960, seven years after Borden's speech. They are a framework that marketers and businesses can use when designing strategies and campaigns to promote their products and services.

In general terms, the marketing mix is a variety of different factors that can influence a consumer's decision to purchase a product or use a service. It most commonly refers to the 4Ps of marketing- product, price, promotion, and place.

These four factors can be controlled by a business to a certain extent. When "mixed" or blended strategically, they can produce desired behaviors from your target audiences. It can also help businesses further understand their product and service offerings and the best ways to plan for a successful launch and marketing strategy [\[59\]](#).

In general, if you do not understand which is the target and the strategy that must be followed in detail or at all, then there is a fairly certain chance that you are missing out on the key ingredients that will ensure scalable success from the ground up. On the other hand, you can be sure to attract mountains of profits when you have a deep understanding of these concepts.

Marketing Mix 4P's is illustrated below in Figure 34 and explained in detail in the following steps.

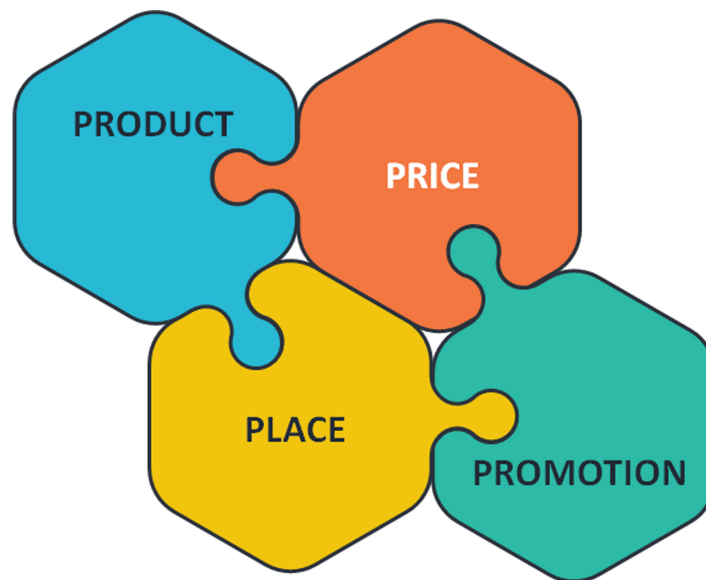


Figure 34: Marketing Mix 4P's

The four P's of marketing are the key factors that are involved in the marketing of a good or service. They are the product, price, place, and promotion. Often referred to as the Marketing Mix, the four P's are constrained by internal and external factors in the overall business environment, and they interact significantly with one another [60].

- **Product**

The product corresponds to goods or services provided to clients by a business. Optimally, a product should satisfy a certain market need or be so convincing that customers believe that they need it. SafeBIS offers a unique shape that is stronger and more durable than regular disaster shelters, it offers space and security. One of the important things in our product is that we have a customizing feature which is the drawable walls. This feature gives the end-user a feeling that he is creating his own shelter and give him the feeling of belonging to a place. And as an extra feature, the production is focused to be as more eco-friendly as possible.

- **Price**

Price is the cost of a product that consumers pay for. Marketers must relate the price to the actual and perceived demand of the product, but they must also consider the cost of production, seasonal discounts, and the prices of the rivals. The standard UNHCR shelters cost 530 €, but some shelters do not provide all the human needs, being insecure shelters composed of materials such as nylon, lower quality, and low entertainment. Really a primitive and simple shelter that people affected in disaster or refugees has to stay in. Our price should be 3x the price of manufacturing if we want to be able to cover all of our costs, marketing and succeed to grow. Based on our estimate, the cost of production is 289 € and the price at which it will be sold is 867 €.

- **Place**

Place specifies where and how the product is distributed to the consumer. Business executives' goal is to get their products before consumers who are most likely to buy them.

As discussed geographic considerations in our previous chapter, [4.5](#)

[Strategy/Targeting/Positioning/Brand](#), the placement must be in a safe place close to the affected areas where manufacturing will be cheap.

## • Promotion

The promotion covers advertising, publicity campaign, and public relations. It fits into the Marketing Mix's other three P's when selling a product tells customers that they like it and should pay a certain amount for it. Additionally, advertisers prefer to bind aspects of marketing and positioning together so they can meet their target audiences.

This part has also been covered in [4.5 Strategy/Targeting/Positioning/Brand](#) sub-chapter about Demography. Our marketing will be focused on business and organization trying to form a direct relation and as for our secondary focus, we will focus on wise people that fall in the age group of 60+ years as well as mature people that are between 30 and 60 years.

The promotion is separated into two groups, in-person and online.

In-person will be with promoters visiting fundraising events and other events of similar nature. The online promotion will consist of four parts. Social media (Youtube, Instagram, and Facebook), the second part is represented by famous magazines, the third part is [gofoundme.com](https://gofoundme.com), and lastly is our own website.

The plan is to post one video per week on Instagram, Facebook, and Youtube that will lead to the [gofoundme.com](https://gofoundme.com) with a split test to our website to see which one will perform better. For this purpose, we will hire a social media manager that will manage the content of the posts and everything social media related, supported by video creator. This will be followed by paid advertising across all of the three social media until we get enough data to compare which social media outperforms the others.

## 4.7 Budget

Without a budget, you may not know how your business is performing. A budget provides an accurate picture of expenditures and revenues and should drive important business decisions such as whether to:

- Increase marketing;
- Cut expenses;
- Hire staff;
- Purchase equipment;
- Improve efficiencies in other ways [\[61\]](#).

It is important to be realistic with the budget projections. Our team must be conservative and overestimate our expenses and underestimate our revenues. It is particularly difficult if someone is starting a new business and have no previous year's budget figures to guide the estimates. In this case, it is typically much easier to estimate expenses than revenues.

It was necessary to count the required amount of money for a successful promotion of the product and the business. The business will make the most effective acquisitions during the first year to ensure that the campaign is large enough to expand its reputation and build a stable base of customers. The organization will have to expend a substantial sum of money from the budget in the first months at the same time is important to expend another substantial amount of money on advertising during the first months, however, advertising must be maintained at all times in order to maintain a good image and to promote the product at all times.

A monthly budget of 2998.00 € was issued for the promotion portion. The marketing is separated into two groups Online and In-person, the list of these costs is shown in Table [37](#).

In-person marketing will be done in such a way that we will have three promoters visit events, found

raising events, and other similar events. There, the promoters will distribute flyers and have small discussions with the people to present clear ideas about our product and about the aspects that our company has in mind to cover people's needs.

Social media may be a perfect partner in the product's networking and marketing systems because these platforms hardly cost money and in a few seconds is ensured a large number of users. The plan is to use three social media including sites like "Gofoundme.com", other targeted social media will be Youtube, Facebook, and Instagram. The plan is to post promotional videos every week.

In view of the company, being able to build accounts in social networks for free, the company will need someone to take care of these sites: the material to bring up, posting news, and answering messages. The organization will pay 300.00 € per month to the group manager responsible for the social networks to ensure that the accounts are kept up-to-date and successful. The video content and editor will be paid 350.00 € per month to provide 4 videos.

A web page has to be created to put all the information about the company and the product, where to find it, how it operates, curiosities, and all sorts of details. It is not a costly task to build a web page but needs upkeep and upgrading much like social networks. This operation must be carried out by a qualified person, who can be part of the business or outside it.

The total expense of building the website is expected to be 500.00 € (42€ per month for the first year) and the annual upkeep is 192.00 € which's equal to 16.00 € per month. Lastly, we will have one famous magazine advertising every month, magazines like Financial Times, Architectural Digest. The fees vary between 500.00 to 20.000 €, but our budget will be 1000 € for start.

Depending on the results of the first three months, we will change our budget and use the advertising that shows more results. Table 37 provides an outline of the projections of our six-month campaign expenditures.

Table 37: Marketing Budget

| Way of promotion         | Price [€]      |
|--------------------------|----------------|
| <b>In-Person</b>         |                |
| Flyers                   | 160.00         |
| Promoters                | 360.00         |
| Events                   | 120.00         |
| <b>Total</b>             | <b>640.00</b>  |
| <b>Online</b>            |                |
| Video creation           | 350.00         |
| Social media advertising | 600.00         |
| Social media manager     | 300.00         |
| Website creation         | 42.00          |
| Website upkeep           | 16.00          |
| Website manager          | 50.00          |
| Online magazines         | 1000.00        |
| <b>Total</b>             | <b>2358.00</b> |
| <b>Total Budget</b>      | <b>2998.00</b> |

## 4.8 Strategy Control

The American statistician and physicist Walter Shewhart is considered the father of PDCA. He was passionate about statistical analysis and quality improvement and he built the foundation of PDCA

recorded in numerous publications.

PDCA cycle is an iterative approach for continually improving products, people, and services. It became an integral part of what is known today as Lean management. The model includes solutions testing, analyzing results, and improving the process.

The PDCA process should be enforced to ensure consistent improvement and prevent recurring mistakes in order to ensure the team and the organization operating at full efficiency. It is an important part of lean production/management that promotes continuous operation and enhancement of quality [62].

The four phases are shown in Figure 35:

- **Plan.** Identify the potential for change and set the goals and processes required to achieve the desired results.
- **Do.** The program is adopted and the proposed solution is preferably first evaluated on a small scale. The effects will be calculated.
- **Check it out.** Test findings and compare effectiveness, and determine whether or not to accept the hypothesis.
- **Act.** If they succeeded in implementing the solution, they would adapt it instead and go through the circuit again.

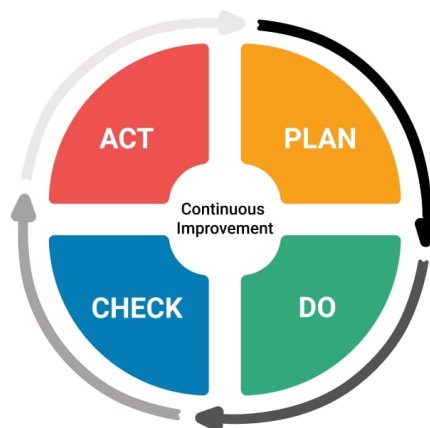


Figure 35: PDCA process

By splitting it into smaller steps, the PDCA system can boost any process or product. It can be effective for the following:

- Helping to enforce Complete Quality Control or Six Sigma programs, and generally helping to develop processes, it is especially successful;
- Exploring and piloting a variety of approaches to issues before choosing one for implementation in a managed manner;
- Avoiding resource wastage by carrying out a large scale, unsuccessful solution.

Including new product development, project and change management, through product lifecycle and supply chain management, this model can be used in all kinds of business environments [63].

### Pros and Cons

This model is an easy but effective way to solve new and recurrent problems in every business, organization, or procedure. The iterative approach allows you and your team to test solutions and analyze outcomes in a cycle of waste reductions.

It instills a dedication, however small, to continuous improvement and can increase performance and productivity in a managed manner, without the possibility of making large-scale changes to the processes untested.

However, it can be much slower to go through the PDCA / PDSA loop than a simple implementation of “gung ho.” So, it may not be the best solution for dealing with an emergency or urgent issue.

It also requires significant “buy-in” from team leaders, which provides fewer incentives for revolutionary creativity if that is what the company needs.

This tool is very important to ensure that the product and service are of high quality. It allows for the adaptation of the process based on customer and market requirements. This also acts as an instrument for testing whether the marketing campaign has not been successful and whether it needs to be re-adjusted to best attract the target audience.

The SafeBIS objectives in terms of the online environment are shown in Figure 36.

## Marketing Milestones



Figure 36: The Milestones Timeline of Business

## 4.9 Conclusion

Based on this market/economic analysis can be concluded that the team puts the primary and secondary focus on marketing. The primary focus will include business and global organization. In order to reach this, team BIS has to attend events and gatherings where the desired contacts (companies and businesses) are present. Being at the same places as these contacts, will give SafeBIS a chance to get in touch with the representatives of the organizations. By sharing flyers and leaflets of our project at these places, SafeBIS hopes to reach the audience and to create brand awareness. Online recognition is something that will be necessary and ongoing. For this the team will use social media and a website. With paid advertisements SafeBIS will target the secondary focus which is individual.

The next step for our company is to voluntarily donate some shelters in affected areas in order to get media coverage for free. This will impact BIS in a major way and create more awareness. More



companies and global organizations will be aware of the shelters and the unique solutions that SafeBIS offers.

The third idea the team wants to cover is using sites like “Gofoundme.com”. These sites will put BIS in front of an audience that wants to donate and with their help, we can produce and ship our shelters to affected areas. By doing these small steps BIS will gradually start to become a recognizable brand.

In chapter 5 an explanation about the sustainability of our project is given.

## 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.

### 5.2 The pillars of sustainability



Figure 37: The three pillars [64]

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. In this chapter, there will be given an overview of each of the three pillars and the implementation of those pillars in the shelter [65].

#### 5.2.1 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, good materials are needed. These materials need to be able to survive harsh weather circumstances while being good for the environment. That's why the materials that are used in the BIS shelter are: Aluminium, cork, and cotton. All these materials are easy to recycle and with the exception of Aluminium, they are biodegradable. Aluminium was chosen because of its low weight and robustness. For the fabric part of the shelter, cotton was used this improved because it has only one disadvantage: absorbing water. This will increase the weight of the shelter and make it hard to transport. Of course, this is easy to solve by drying the fabric.

The location of the shelter is really important as well because there will always be a footprint of society in the area where it's placed. 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 [66]. The SafeBIS team decided to build their warehouse in Romania. This decision was made as Romania offers a lot of high-quality manufacturers, this makes it possible for us to select the most reliable ones and to reduce the transport distance for getting the needed components.

### 5.2.2 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 [67]. 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. This is implemented in the shelter by using a packaging solution that is entirely made of the shelter itself. By implementing the honeycomb design (nature's strongest structural form) the shelter is made robust. Because it is important that the materials can withstand high levels of drought and sun, cotton was chosen as the main material for the shelter.

### 5.2.3 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 at a location that is easy to reach from an urban environment. The shelter is built with a few different components, this makes the shelter more robust and this causes less waste in the environment. Because a big part of the shelter is made from biodegradable material, leaving materials behind in nature is not as bad as leaving non-biodegradable materials in nature. 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. That's why the focus still lies in the comfort and space of the

shelter.

## 5.3 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 38.

- 3: Good health and well being;
- 11: Sustainable cities and communities [68].



Figure 38: Sustainable Development Goals [69]

### 5.3.1 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 [70].

### 5.3.2 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 [71]. One of the design choices that were made to improve mental

health is the option to customize the shelter fabric with eco-friendly paint to give the inhabitants something to call their own.

## 5.4 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 39. All the stages will be observed and explained with the shelter in mind.



Figure 39: Life Cycle Analysis [72]

### 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. Regular shelters are often made from nylon this, however, is not biodegradable and will stay in nature indefinitely.

### Manufacturing, Production

The manufacturing process should be limited to as few components as possible. By using fewer components the stability and robustness of the shelter can degrade depending on the way the materials are used. A common technique in regular tents is to weave the tent poles in each other to create a stable structure that can stand against strong winds. Of course, it is incredibly important to keep the employees safe by implementing good work environments. Another thing that will be done is the education of our employees, so they are qualified and will not spill the materials.

### 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 size, 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. In regular shelters, it is important to strive to get the setup system as easy as possible so that is what we tried to do as well.

### **Retail, Distribution**

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 easy to transport. The plan is to use health organizations like the Red Cross or governments to transport them to the place that needs help the most. The shelter should be able to withstand a lot of impacts, be robust, be repaired easily, and be autonomous (no extra needed). The materials of the shelter should be Nature-based or easy to absorb in nature also as be easily separated from each other.

### **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 the extra waterproof spray to make the shelter waterproof, to limit emission. Currently, shelter camps are not set on privacy at all but it is really important for mental health.

### **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 absorb in nature. In the case that the shelter is damaged beyond repair, the materials should be easy to separate from each other. In some shelters non-nature materials like nylon are used in combination with other non-degradable materials this is really hard to recycle and should not be used in our shelter.

## **5.5 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.

Chapter 6 shows the ethical and deontological concerns that the team took into account while developing the shelters.

## **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 [73].

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 [74].

This chapter will approach different perspectives of ethics. The addressed perspectives are Engineering, Marketing & Sales, Environment and Liability. Each of them will be explained and will be applied on the project.

## 6.2 Engineering Ethics

The study of related questions about moral ideals, character, policies, and relationships of people and organizations involved in technological activity, can be termed as Engineering ethics.

An engineer, as we are and work in a team, not individually, within a company with a common purpose, has to go through some ethical issues, mostly under the conditions such as, the conceptualization of a product, issues arising in design and testing departments, or may be on the issues involving the manufacturing, sales, and services. Questions related to morality also arise during supervision and team works.

The ethical decisions and moral values of an engineer need to be considered because the decisions of an engineer have an impact the products and services - how safe they are to use, the company and its shareholders who believe in the goodwill of the company, the public and the society who trusts the company regarding the benefits of the people, the law which cares about how legislation affects the profession and industry, the job and his moral responsibilities and about how the environment gets affected, etc.

### ENGINEERING ETHICS FOCUSES ON:

1. The study of the moral topics and judgments regarding people and societies belonging to the engineering field [75], [76], [77];
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 [78].

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 [79].

### **THE FUNDAMENTAL PRINCIPLES:**

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

- Using their knowledge and skill for the enhancement of human welfare;
- Being honest and impartial, and serving with fidelity their clients (including their employers) and the public;
- Striving to increase the competence and prestige of the engineering profession [80].

### **FUNDAMENTAL CANONS:**

Engineers, in the fulfillment of their professional duties, shall:

- Hold paramount the safety, health, and welfare of the public;
- Perform services only in areas of their competence;
- Issue public statements only in an objective and truthful manner;
- Act for each employer or client as faithful agents or trustees;
- Avoid deceptive acts;
- Conduct themselves honorably, responsibly, ethically, and lawfully so as to enhance the honor, reputation, and usefulness of the profession.

### **PROFESSIONAL OBLIGATIONS:**

- Engineers shall be guided in all their relations by the highest standards of honesty and integrity.
- Engineers shall at all times strive to serve the public interest.
- Engineers shall avoid all conduct or practice that deceives the public.
- Engineers shall not disclose, without consent, confidential information concerning the business affairs or technical processes of any present or former client or employer, or public body on which they serve.
- Engineers shall not be influenced in their professional duties by conflicting interests.
- Engineers shall not attempt to obtain employment or advancement or professional engagements by untruthfully criticizing other engineers, or by other improper or questionable methods.
- Engineers shall accept personal responsibility for their professional activities, provided, however, that engineers may seek indemnification for services arising out of their practice for other than gross negligence, where the engineer's interests cannot otherwise be protected [81].

Our behavior should include the following:

- Respecting others and ourselves;
- Respecting the rights of others;
- Keeping promises;



- Avoiding unnecessary problems to others;
- Avoiding cheating and dishonesty;
- Showing gratitude towards others and encourage them to work.

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 40.



Figure 40: 10 Principles of Fair Trade [82]

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 41: Environmental Ethics [83]

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 these three 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 [84]. 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 [85].

Despite the fact that no general directives of the European Commission 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) [86].

Another important component, separated from following the directives, is respecting the rights of other brands. Every enterprise can protect their goods or services by making it a trademark. A trademark is an item that defines and identifies a company's brand, such as a logo, brand name, slogan, design, color. While developing our brand it is essential to take the trademarks of other existing brands into account as SafeBIS does not want to infringe the rights of these brands. Trademarks are protected by intellectual property rights, this is why designing a unique logo, name, and slogan for the brand matters is very important [87].

## 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.

This chapter is followed by chapter 7 in what the entire development of the project is explained.

# 7 Project Development

## 7.1 Introduction

In this chapter the development of SafeBIS shelters will be explained. It contains the entire process the team went through, starting with the first rough ideas and ending with a fully defined solution. The chapter is divided into five different sections.

The first section, [Architecture](#), is about the design process. It represents our black box diagram followed by the process the team made to become the final solution. The second section, [Components](#), gives an overview of all the necessary components to develop the SafeBIS Shelters. In this chapter all used materials are showed as well. The third section, [Functionalities](#), explains the main functionalities of SafeBIS. The fourth section, [Tests and Results](#), shows the development of the

tests performed with the prototype. The sixth and last section, [Conclusion](#), is a summary of the main relevant points of the entire shelter development.

## 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 [42](#) 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 aluminium, and cotton canvas, which are environmentally friendly, do not pollute, are fully recyclable, and very resistant. The fabric will be attached by using 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 good insulator, at the same

time, for the floor is used aluminium which can be covered by a layer of cork. The properties of the cork material are incomparably excellent, 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 a cotton canvas that can be painted in different colors and the environment is not affected.

In Figure 42 is illustrated the Black Box Diagram for the project.

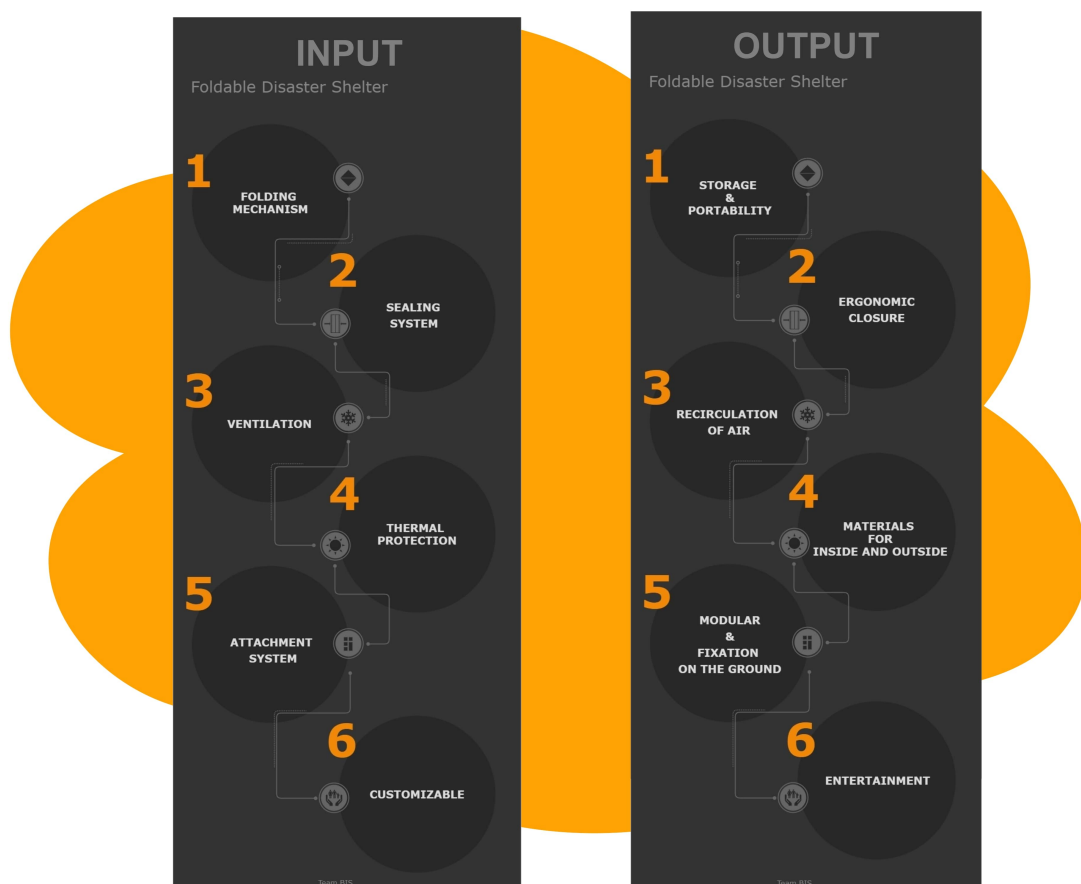


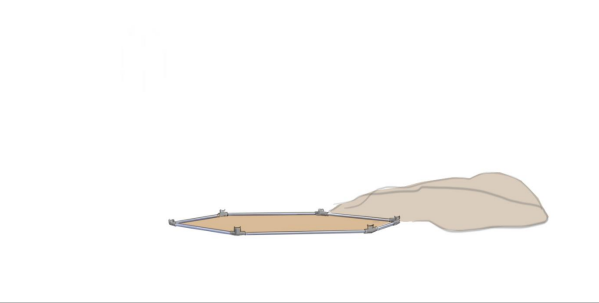
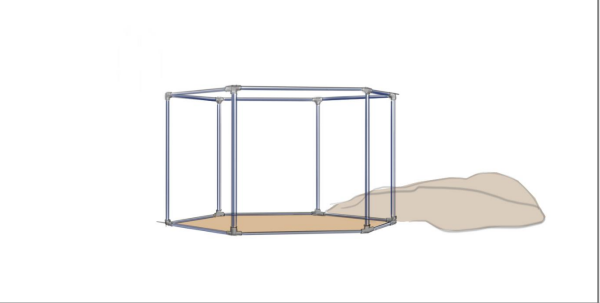
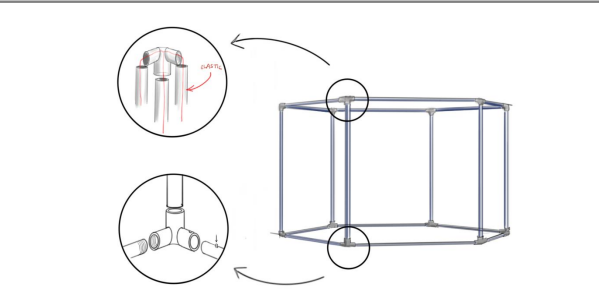
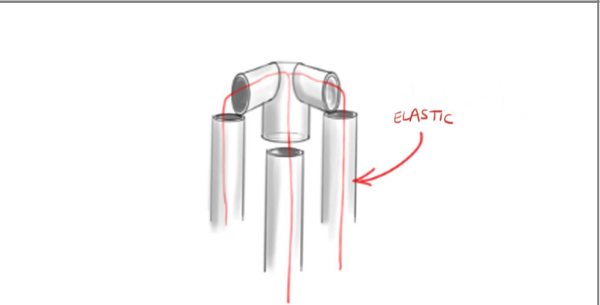
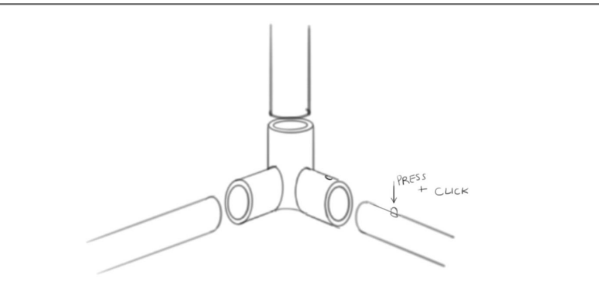
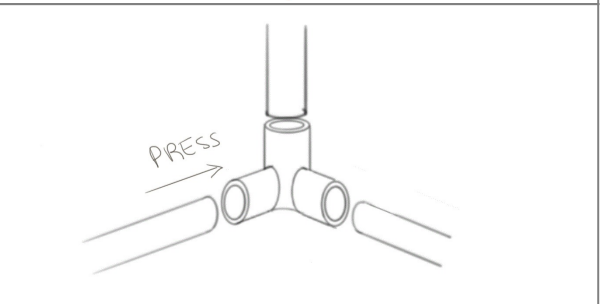
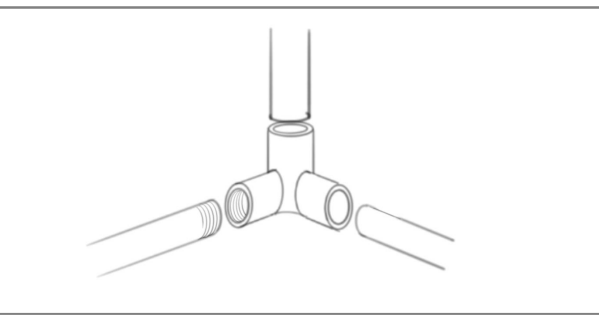
Figure 42: Black Box Diagram

### 7.2.1 Assembly Methods Studied

#### Assembly 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. The folding method 1 is shown in Table 38.

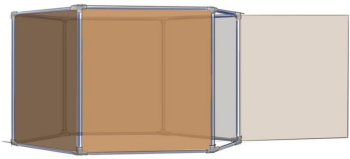
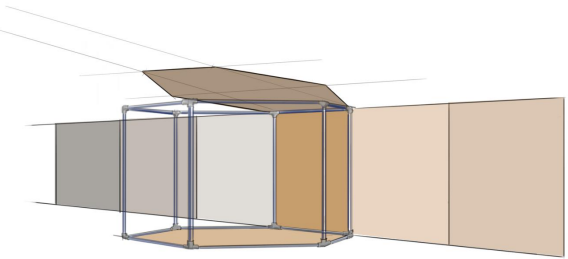
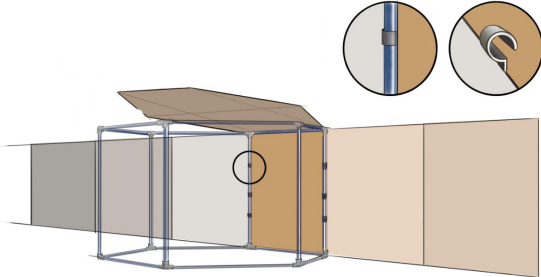
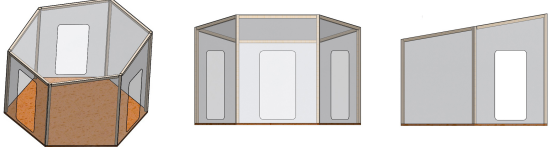
Table 38: Folding Method 1

| Step | Picture                                                                             | Step | Picture                                                                             |
|------|-------------------------------------------------------------------------------------|------|-------------------------------------------------------------------------------------|
| 1    |    | 2    |   |
| 3    |    | 4    |   |
| 5    |   | 6    |  |
| 7    |  |      |                                                                                     |

Assembly 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. The folding method 2 is illustrated in Table 39.

Table 39: Folding Method 2

| Step | Picture                                                                           | Step | Picture                                                                            |
|------|-----------------------------------------------------------------------------------|------|------------------------------------------------------------------------------------|
| 1    |  | 2    |  |
| 3    |  | 4    |  |

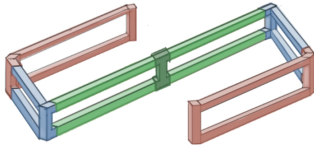
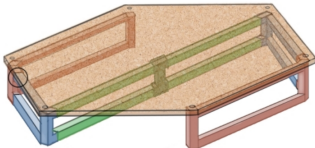
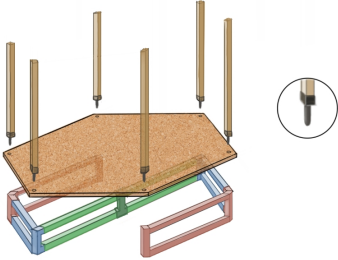
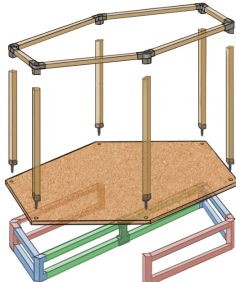
### Assembly Method 3

The foldable disaster shelters must be placed on the flat surface in the specially arranged places, thus, initially, is placed the metal support that will support the entire shelter. This support has an elastic rope inside to facilitate folding and storage, to occupy as little space as possible. Once this support is placed, in step 2, the base of the shelter will be fixed over this support.

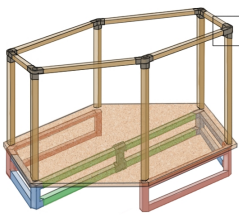
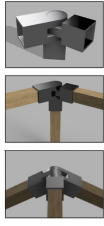
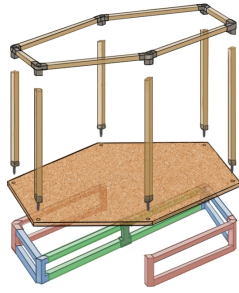
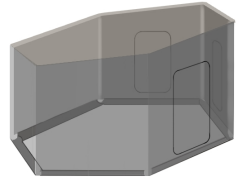
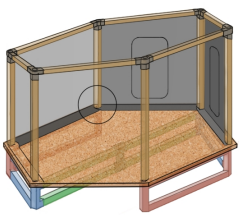
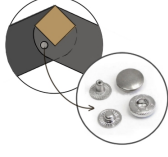
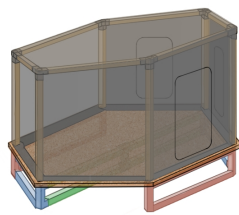
In step 3, the laminated oak wood beams are mounted using pivoting metal supports. For better support and so that the beams do not move, metal pins are inserted from one side to the other. In step 4, the “frame” of the roof is unfolded, is fixed in each corner using spherical joints, and is installed properly on the wall beams. In the last steps, the cotton canvas is attached to the entire surface of the shelter, using clips, both for the roof and for the walls.

In Table 40 are shown all the steps required to install the shelter.

Table 40: Shelter Assembly

| Step | Picture                                                                             | Step | Picture                                                                               |
|------|-------------------------------------------------------------------------------------|------|---------------------------------------------------------------------------------------|
| 1    |  | 2    |   |
| 3    |  | 4    |  |

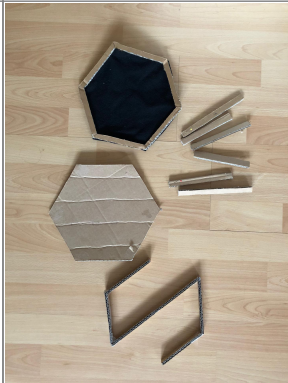
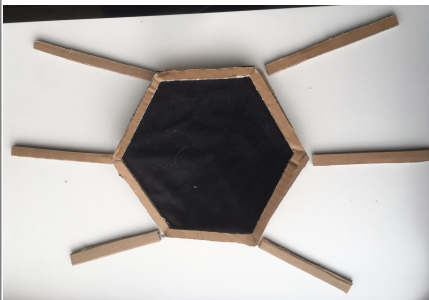


| Step | Picture                                                                                                                                                             | Step | Picture                                                                                                                                                                |
|------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 5    |   | 6    |   |
| 7    |   | 8    |                                                                                      |

7.2.2 Cardboard model

In Table 41, the cardboard model for the shelter is made following some steps:

Table 41: Shelter Cardboard Model

|   |                                                                                     |   |                                                                                      |   |                                                                                       |
|---|-------------------------------------------------------------------------------------|---|--------------------------------------------------------------------------------------|---|---------------------------------------------------------------------------------------|
| 1 |  | 2 |   | 3 |  |
| 4 |  | 5 |   | 6 |  |
| 7 |  | 8 |  | 9 |  |

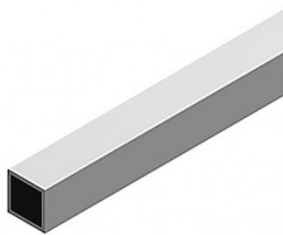


### 7.3 Components

The list of materials for the product SafeBIS is shown in Table 42.

Table 42: List of materials and components for the product

| Nr. | Item                                       | Part of SafeBIS | Provider      | Dimensions            | Picture                                                                               |
|-----|--------------------------------------------|-----------------|---------------|-----------------------|---------------------------------------------------------------------------------------|
| 1   | Cotton Canvas                              | Roof            | fibre2fashion | 13.388 m <sup>2</sup> |   |
| 2   | Cotton Canvas                              | Outer Layer     | fibre2fashion | 35.42 m <sup>2</sup>  |  |
| 3   | Cotton Canvas                              | Inside Tent     | fibre2fashion | 58.78 m <sup>2</sup>  |  |
| 4   | ALU Panel-<br>Aluminium<br>Composite Panel | Floor/Packaging | GEPLAST       | 16.69 (10 mm thick)   |  |

| Nr. | Item                           | Part of SafeBIS | Provider      | Dimensions        | Picture                                                                               |
|-----|--------------------------------|-----------------|---------------|-------------------|---------------------------------------------------------------------------------------|
| 5   | Aluminium Square Profile Beams | Structure       | DEPO          | 0.05×0.05×0.003 m |    |
| 6   | Cork Roll                      | Floor           | Corklink      | 15x1x0.004 m      |   |
| 7   | Steel Plate                    | Legs            | /             | /                 |  |
| 8   | Zipper                         | Doors           | Ebay          | 3 m               |  |
| 9   | Fabric fasteners               | Walls           | Snowl/Alibaba | 18 cm             |  |



| Nr.                           | Item        | Part of SafeBIS | Provider  | Dimensions               | Picture                                                                             |
|-------------------------------|-------------|-----------------|-----------|--------------------------|-------------------------------------------------------------------------------------|
| 10                            | Steel Cable | Roof            | WebsiLor  | 7x7AA04G (4 mm diameter) |  |
| 11                            | Tent Pegs   | To fix the legs | Multivers | 30 cm                    |  |
| <b>Total cost : ~893.39 €</b> |             |                 |           |                          |                                                                                     |

### 7.3.1 Construction materials

#### 7.3.1.1 Materials for beams

First of all the team focused on finding the best type of wood to use as a construction material because creating a shelter with a warm, homey atmosphere was our priority. Trade-offs between different types of wood were done when SafeBIS decided to choose laminated oak wood as the material for the beams. A couple of weeks later when the team defined the fabric of the walls more precisely, changes were made, and rethinking the material of the beams was necessary. As the beams were too heavy and had to be attached to the fabric, the team decided to change the material from laminated oak wood to aluminium. The research that was done about oak wood and aluminium is explained below.

#### • 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 [88].

#### 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 [89].

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 [90]:**

- 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 [91], 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 [92], 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 43.

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 %.

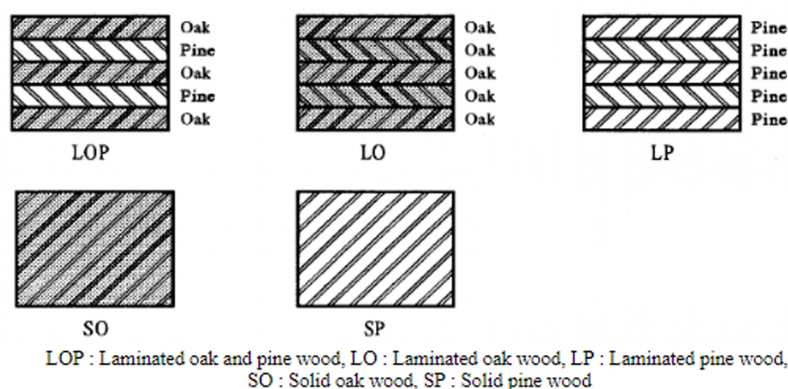


Figure 43: Solid and laminated wood samples [93]

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 44.

| Process                    | Values     | Air-Dry Density<br>$\text{g/cm}^3$ | Bending Strength<br>$(\text{N/mm}^2)$ | Modulus of Elasticity<br>$(\text{N/mm}^2)$ | Compression Strength<br>$(\text{N/mm}^2)$ | Shear Strength<br>$(\text{N/mm}^2)$ |
|----------------------------|------------|------------------------------------|---------------------------------------|--------------------------------------------|-------------------------------------------|-------------------------------------|
| LO<br>(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<br>(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 44: Descriptive statistical values of technological properties [94]

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 ( $\text{g/cm}^3$ ): SO=0.611; LO=0.639;
- Bending Strength ( $\text{N/mm}^2$ ): SO=106.05; LO=109.02;
- Modulus of elasticity in Bending ( $\text{N/mm}^2$ ): SO=10742.727; LO=10985.705;
- Compression Strength ( $\text{N/mm}^2$ ): SO=67.17; LO=70.02;
- Shear Strength ( $\text{N/mm}^2$ ): 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.

## • UNTREATED ALUMINIUM

The advantages of aluminium are well known, aluminium is a silver-white, strong material that is extremely light compared to other metals, but nevertheless not less durable and corrosion-resistant (thanks to a thin oxide skin). In addition, aluminium can be formed fairly easily and it is suitable for both cutting and casting. Aluminium is one of the most recycled materials, it is practically 100% reusable and is not subject to loss of quality (degeneration).

Untreated aluminium can perfectly be used outdoor as it will always form an oxide layer when it comes into contact with oxygen. This oxide layer is completely closed and adheres firmly to the surface of the aluminium profile. The layer protects the aluminium and increases corrosion resistance, it is self-healing in case of scratches, water-resistant and comparable in hardness to glass. This oxide layer also ensures that the surface of an aluminium profile becomes duller [95].

The downside is that there are a number of factors that negatively affect the corrosion resistance of aluminium, such as contact with other metals (copper, lead, iron) especially in combination with high moisture content, inorganic acids, chlorinated solvents, seawater, moist wood, wood impregnated with copper-containing salts and alkaline building materials (such as fresh concrete). It is also the case that contamination can lead to a reduction in the corrosion resistance of aluminium, especially if the dirt is damp. This is why it is recommended to clean the aluminium twice a year (this, of course, depends on the degree of contamination). When developing the SafeBIS shelter it is important to take this downside into account to make sure an oxide layer will be formed and all the positive characteristics can be received [96].

The properties (air-dry density, bending strength, modulus of elasticity in bending, compression strength, shear strength) of aluminium are as follows [97]:

- Air-Dry Density ( $\text{g/cm}^3$ ): 2.70
- Bending Strength ( $\text{N/mm}^2$ ): 310
- Modulus of elasticity in Bending ( $\text{N mm}^{-2}$ ): 68900
- Compression Strength ( $\text{N/mm}^2$ ): 276
- Shear Strength ( $\text{N/mm}^2$ ): 207

## • CONCLUSION

When comparing laminated oak wood with aluminium, it isn't hard to see that aluminium has the best mechanical properties. The bending strength is 3 times bigger, the modulus of elasticity in bending is 6.4 times bigger, the compression strength of oak wood is a fourth of the compression strength of aluminium and the shear strength has a difference of  $196 \text{ N/mm}^2$  as this is  $207 \text{ N/mm}^2$  for aluminium and  $11 \text{ N/mm}^2$  for oak wood. Despite the fact that aluminium has a bigger density, which makes it heavier than oak wood and our main goal of comparing oak wood with aluminium was to find the lightest one, the aluminium beams will be less heavy. This is possible as the better mechanical properties mean that a smaller mass of the material is needed to receive the same strength. Instead of oak wooden beams with an average total mass of  $16000 \text{ cm}^3$  ( $8 \times 8 \times 250 \text{ cm}$ ), the team can use a square tube of aluminium that only has a mass of  $1410 \text{ cm}^3$  ( $5 \times 5 \times 250 \text{ cm} - (5-0.6) \times (5-0.6) \times 250 \text{ cm}$  (0.6 is subtracted because a tube with a thickness of 3 mm is used)). According to this, the weight of a wooden beam is  $10.1 \text{ kg}$  ( $16000 \text{ cm}^3 \times 0.63 \text{ g/cm}^3$ ) and the weight of the aluminium tube is  $3.8 \text{ kg}$  ( $1410 \text{ cm}^3 \times 2.70 \text{ g/cm}^3$ ). This difference in weight made the team decide to use the tubes made of aluminium instead of oak wood. The square tubes of aluminium will be  $5 \times 5 \text{ cm}$ , with a thickness of 3mm. The total weight of all beams together 75 kg.



### 7.3.1.2 Floor materials

#### • CORK & SPRUCE WOOD

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 [98].

- 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/m<sup>3</sup> and a thickness of 10 mm, we have to make it stronger [99]. The bottom plate is essential 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/m<sup>3</sup> [100].

For a surface of 16.3 m<sup>2</sup>, the weight is (16.3 m<sup>2</sup> x 0.03 m x 250 kg/m<sup>3</sup>) 122.3 kg. A disadvantage of this solution is that even with a thickness of 30 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 4.39 m long and has a width of 1.22 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 [101].

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. Multiple species of wood and also aluminium were compared to see which material could serve the best. Aluminium 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  $450\text{ kg/m}^3$  [102], for the floor a plate of 15 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, the team choose for an expanded cork [103]. The expanded cork has the same good properties but is more light because the density is  $180\text{ kg/m}^3$  instead of  $210\text{-}250\text{ kg/m}^3$ . The upper layer will have a thickness of 4 mm. For a surface of  $14.3\text{ m}^2$ , this layer with a thickness of 4 mm, will have a weight of  $(14.3\text{ m}^2 \times 0.004 \times 180 = )\text{ }10.3\text{ kg}$ . Only a surface of  $14.3\text{ m}^2$  instead of  $16.3\text{ m}^2$  is needed as the cork layer indicates the living space and not the entire surface of the shelter.

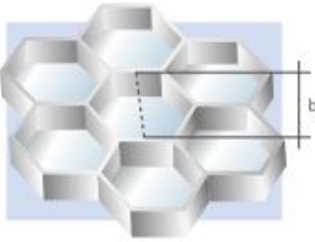
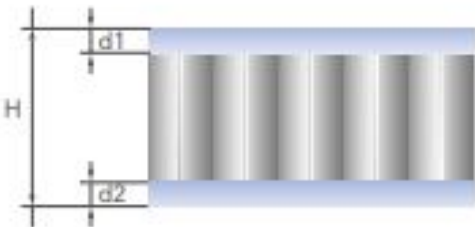
The weight of the bottom layer, namely the spruce wood plate is  $(16.3\text{ m}^2 \times 0.02\text{ m} \times 450 = )\text{ }146.7\text{ kg}$ . This makes a total weight of 157 kg for the floor.

• **CORK & ALUMINIUM COMPOSITE PANEL**

After the team decided to change the oak wooden beams to beams made of aluminium, the floor was also rethought. As the team didn't stick to the wooden beams and chose for lightness instead of a homey atmosphere, research was done to check if the wooden bottom layer of the floor could also be replaced by a layer made of a lighter material. The team bumped into an aluminium composite panel with honeycomb core as it is known to be used as a very light construction material.

The aluminium composite panel is a sandwich panel that is constructed of a honeycomb core and cover sheets. The core consists of aluminium foils made of the allow AlMn (EN AW 3003), the cover sheets consist of corrosion-resistant Peraluman alloys (AlMg). The construction of the aluminium composite panel is illustrated in Table 43 [104].

Table 43: Construction composite panel

| Honeycomb core                                                                      | Structure panel                                                                      | Full sandwich panel                                                                   |
|-------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
|  |  |  |

The sandwich panel offers high rigidity and extremely low weight. Other advantages are the high quality and surface evenness, the material does not become brittle-hard but shows tough and resilient properties and excellent peel strength. As shown in Figure 45 the weight that accompanies an ALUCORE panel with 10 mm thickness, is  $5.0\text{ kg/m}^2$ . When calculating the weight of a composite panel of 15 mm that serves as a surface of  $16.3\text{ m}^2$ , a weight of  $(5.0\text{ kg/m}^2 \times 16.3\text{ m}^2)\text{ }81.5\text{ kg}$  is found. Comparing this weight to the 146.7 kg heavy layer of Spruce wood, a difference of 65.2 kg is noticed. As the team focuses on developing a portable shelter, this difference is essential to take into account while choosing the material of the floor.

## TECHNICAL DATA

|                                                                               |                  |                | ALUCORE® / ALUCORE® A2                                                                            |        |        |                                                 |         |         | ALUCORE® base                             |        |
|-------------------------------------------------------------------------------|------------------|----------------|---------------------------------------------------------------------------------------------------|--------|--------|-------------------------------------------------|---------|---------|-------------------------------------------|--------|
| Standard thickness [mm]                                                       |                  | Unit           | 6                                                                                                 | 10     | 10.5   | 15                                              | 20      | 25      | 9.5                                       | 14     |
| Cover sheet thickness, front side                                             |                  | [mm]           | 1.0                                                                                               |        |        |                                                 |         |         | 0.5                                       |        |
| Cover sheet thickness, rear side                                              |                  | [mm]           | 0.5                                                                                               | 0.5    | 1.0    | 1.0                                             | 1.0     | 1.0     | 0.5                                       |        |
| Weight                                                                        |                  | [kg/m²]        | 4.7                                                                                               | 5.0    | 6.3    | 6.7                                             | 7.0     | 7.3     | 3.5                                       | 3.7    |
| Technical properties                                                          |                  |                |                                                                                                   |        |        |                                                 |         |         |                                           |        |
| Section modulus                                                               | W                | [cm³/m]        | 2.5                                                                                               | 4.5    | 8.63   | 13.1                                            | 18.1    | 23.1    | 4.3                                       | 6.5    |
| Rigidity                                                                      | E-I              | [kNmcm²/m]     | 7100                                                                                              | 21 900 | 34 800 | 75 500                                          | 138 900 | 221 600 | 15 600                                    | 35 000 |
| Alloy of cover sheet<br>(accord. to EN 485-2 / EN 1396:2007)                  |                  |                | EN AW-5005A (AlMg1)<br>H22 / H42                                                                  |        |        | EN AW-5005A (AlMg1)<br>H28 / H48<br>(H22 / H42) |         |         | EN AW 5005A<br>(AlMg1)<br>H22 / H42       |        |
| Modulus of elasticity                                                         | E                | [N/mm²]        | 70 000                                                                                            |        |        |                                                 |         |         | 70 000                                    |        |
| Tensile strength of cover sheets                                              | R <sub>m</sub>   | [N/mm²]        | ≥ 125                                                                                             |        |        | ≥ 185 (125)                                     |         |         | ≥ 125                                     |        |
| 0.2% Proof stress                                                             | R <sub>0.2</sub> | [N/mm²]        | ≥ 80                                                                                              |        |        | ≥ 160 (80)                                      |         |         | ≥ 80                                      |        |
| Elongation                                                                    | A <sub>50</sub>  | [%]            | ≥ 5                                                                                               |        |        | ≥ 2 (5)                                         |         |         | ≥ 5                                       |        |
| Linear thermal expansion                                                      | α                |                | 2.4 mm/m at 100° C temperature difference                                                         |        |        |                                                 |         |         | 2.4 mm/m at 100° C temperature difference |        |
| Core                                                                          |                  |                |                                                                                                   |        |        |                                                 |         |         |                                           |        |
| Bare compressive strength                                                     |                  | [N/mm²]        | approx. 2.5                                                                                       |        |        |                                                 |         |         | approx. 1.5                               |        |
| Cell size                                                                     |                  | [inch]<br>[mm] | 3/8<br>(9.5)                                                                                      |        |        |                                                 |         |         | 1/2<br>(12.7)                             |        |
| Surface                                                                       |                  |                |                                                                                                   |        |        |                                                 |         |         |                                           |        |
| Lacquering                                                                    |                  |                | both sides polyester platinum white<br>or fluoropolymer lacquer (e.g. PVDF),<br>one or both sides |        |        |                                                 |         |         | both sides mill finish                    |        |
| Brilliance (standard)                                                         |                  | [%]            | 25-40                                                                                             |        |        |                                                 |         |         |                                           |        |
| Hardness (pencil hardness)                                                    |                  |                | HB-F                                                                                              |        |        |                                                 |         |         |                                           |        |
| Acoustical properties                                                         |                  |                |                                                                                                   |        |        |                                                 |         |         |                                           |        |
| Sound absorption factor                                                       | α <sub>s</sub>   |                | 0.05                                                                                              |        |        |                                                 |         |         | 0.05                                      |        |
| Air-borne sound insulation index<br>(accord. to ISO 717-1, ISO 140-3)         | R <sub>a</sub>   | [dB]           | 21                                                                                                | 21     | 21     | 22                                              | 23      | 25      | approx. 20                                |        |
| Thermal properties                                                            |                  |                |                                                                                                   |        |        |                                                 |         |         |                                           |        |
| Thermal conductivity (depends on total<br>panel thickness incl. cover sheets) | λ                | [W/mK]         | 0.95                                                                                              | 1.35   | 1.42   | 1.78                                            | 2.25    | 2.70    | 1.01                                      | 1.30   |
| Thermal resistance                                                            | R                | [m²K/W]        | 0.0063                                                                                            | 0.0074 | 0.0074 | 0.0084                                          | 0.0089  | 0.0093  | 0.0094                                    | 0.0107 |
| Heat transition coefficient                                                   | U                | [W/m²K]        | 5.67                                                                                              | 5.64   | 5.64   | 5.61                                            | 5.59    | 5.58    |                                           |        |
| Temperature resistance                                                        |                  | [°C]           | +40 to +80                                                                                        |        |        |                                                 |         |         | +40 to +80                                |        |

Figure 45: Properties of the aluminium composite panel [105]

Also in terms of the environment, the composite panel is a valuable candidate. During the life cycle of aluminium sandwich panels, no substances containing CFC are set free at any time. The panel can be fully recycled, i.e. the panels are fed back into the material cycle and used in the production of new material. The panels that SafeBIS will use are produced at '3A Composites', a company that has an own environmental management system that is regularly audited by independent auditors. It is of utmost importance for them to preserve natural resources in order to ensure a livable tomorrow for future generations. They offer panels that have certification according to EN ISO 14001 [106].

### • CONCLUSION

Regarding the research the team did about the aluminium composite panel and the comparison between this and the spruce wooden layer, the team decided to choose for a floor made of the composite panel. This decision was made because this panel is a typical construction material that will serve perfectly as a floor for the shelter. Just as aluminium beams were chosen instead of oak wooden beams for the material of the beams, the team decided to choose the aluminium sandwich panel instead of the wooden layer. Again preference was given to weight over a homey atmosphere.

As the team still wanted to find a way to make the shelter as homey as possible, the decision was made to keep the cork roll. The cork roll is easy to roll out in the shelter so it can serve as carpet. The weight of the roll is 10.3 kg for covering the living area. Summing up this weight and the weight of the

panel, a total weight of 119.5 kg is found.

### 7.3.1.3 Covering material

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

Table 44: Canvas Comparison

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

- COTTON

For the shelter the walls and roof we are going to use a canvas of fabric. The fabric is going to be made out of cotton, as this material has interesting outdoor performance properties, it's a natural isolant that keep a decent temperature whatever the weather is outside. Moreover, it's perfectly water-resistant and has a long lifetime, with proper maintenance we can expect it to be working well for 15-20 years. It's also UV resistant which in our case is one of the most interesting facts due to the location we want it to be deployed in. Unlike polymer material fabrics the cotton will not be deteriorated under sunlight. When it comes to mechanical properties, the canvas can be resistant enough to the stress it will be under by choosing the right weaving.

To provide both isolation and ventilation a double-layered fabric will be used. This will not only be great for the first two requirements but will help with the assembly as well. As the external layer is the one which will be connected to the exoskeleton whereas the internal one will provide a stretched a sturdy shelter for our users. Cotton is a more expensive material than plastic however it has the properties we look for and the comfort we want to give to our customers make us choose the best possible material. For maintenance, we recommend that the shelters shouldn't fold with the fabric cocoon attached to it, and to ensure that the cocoon is perfectly dry to avoid mold with moisturized areas. We intend to protect our cocoon with a water repellent coating to minimize this issue every 5 years, although this is just protection we want to give, it is not ensuring to avoid any kind of moisturization.

- PAINTABLE COTTON

A shelter is supposed to be a safe environment. Most companies are dealing with this by making the shelter more robust and stable. Of course, this is the case for BIS shelters too. However, BIS Shelters is taking it a step further. Besides physical safety it is really important that the mental safety of our victims is guaranteed. The best way to do this in our opinion is to give the inhabitants of our shelter the option to customize the shelter. By doing this the inhabitant can feel much more at home which as consequence improves the mental health of the inhabitant. There are multiple options to improve the customizability of the shelter. But the easiest way without any big consequences is to paint the

outside of the shelter.

The shelter is in most cases built in equatorial areas so it is important that the paint can withstand high amounts of sun and rain. Besides that, it is important to use a solution that keeps the environment in mind. The shelters are painted on the spot it is important that the paint dries fast. That is why water-based paint is the best option because it dries fast water-based paint has a lot of pro's if compared with oil-based paints. water-based are a lot more environmental pro and they can be used to paint over existing paint something that can't be done with oil-based paint. The main material of the shelter is cotton. One of the biggest complaints is that fabric paint on cotton or other soft fabrics makes the paint stiff, itchy, and crack easily. A solution to this is to use soft paint.

### 7.3.2 Shelter Connection

There are multiple solutions to the problem of connecting multiple shelters. But first, it is important to set some boundaries. An important boundary is to build it so water can't stay on top of it. Another boundary is to be able to close it from either side. And the last boundary is to be enclosed on every side. To attach shelters there are multiple solutions.

- Velcro
- Click buttons
- Zipper

These are some of the best solutions to get 2 shelters together. The most common technique seen in tents on the market is the zipper. It is easy to create, light, able to get used in combination with locks, and easy to use. A big disadvantage of zippers is that they are not easy to repair by most people and you need extra materials if they are broken. This has to be combined with fabric to connect two tents together. Other options like Velcro and buttons are possible as well. The Velcro is extremely sustainable but has a big disadvantage of keeping weeds in the Velcro so, in the long run, it will not work anymore.

Extra materials to hold two shelters means to have an extra extension that you can add to the shelter that holds the poles of shelter 1 and shelter 2 to have a stable connection. This can only be used as an extra because it does not solve all the boundaries.

The use of buttons has its advantages but the biggest disadvantage is that the more stable you want it, the more buttons you need and it will take a longer time to attach all the buttons.

Overall an extendable fabric with a zipper looks like the best option because it is easy to implement and easy to supply. A good combination can be using a metal extension bar for stability and some buttons to keep the zipper in the side of the shelter if it is not in use.

All doors of the shelter will be created with a zipper, so every door can be used for making the connection with an other shelter.

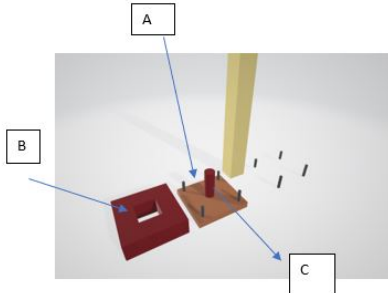
### 7.3.3 Fixation Components

Our shelters will be placed in equatorial regions. As these regions are not known for heavy storms, our team still wants to make sure that the shelter is strong enough to be resistant to wind storms. SafeBIS adheres to this by providing fixations that hold the shelters to the ground. In the following paragraph, 8 possible fixations are compared. The main purpose of the fixations is to connect the wall rods to the ground so the shelter can not move anymore from the spot where it is placed. The fixations have to serve more stability for the entire shelter. Research is done to examine what type of fixation serves as the best.

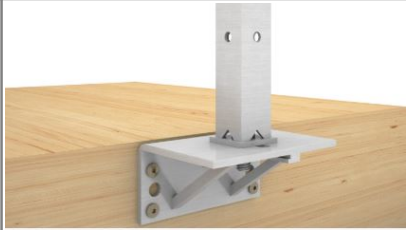


A series of fixing methods is represented in Table 45, specifying for each product certain characteristics.

Table 45: Fixations

| Name                                                  | Specifications                                                                                                                                                                                                                                                                                                  | Picture                                                                               |
|-------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
| Socket base x little pins                             | The element A must be fixed to the floor by fixing it with screws, then, element B is attached to element A with the other 4 screws. The beam has a hole that fits perfectly in the C element (metal cylinder) and then the beam is very well fixed on the ground. It can be easily disassembled when you want. |    |
| Metal Post Skirt x fasteners<br><a href="#">[107]</a> | The Metal Post Skirt covers anchor and fasteners for a completely concealed appearance. Since the post skirt snaps securely together, you can install them before or after construction. These durable metal, hot-dip galvanized and powder coated skirts are made to last for years.                           |    |
| Ground screw<br><a href="#">[108]</a>                 | Ground screws replace and outperform concrete blocks. Considering the environmental cost of concrete, ground screws offer a way forward in these changing times without sacrificing stability, cost, or longevity.                                                                                              |  |
| Post anchor<br><a href="#">[109]</a>                  | This post anchor is provided with a big four-sided pin, which is easy to press into the ground. The post anchors are fast to install and can help prevent your wood post from premature rot that can occur with direct burial in the ground.                                                                    |  |



| Name                                      | Specifications                                                                                                                                                                                                                                                                                                                                 | Picture                                                                               |
|-------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
| Post base cover <a href="#">[110]</a>     | Made from paintable durable Nylon plus Glass-Fiber, no fading, aging, and weakening from sun exposure. Stainless Steel 304 screws are included: 8 short screws (installed horizontally) to post, 12 long screws (vertically) to the deck floor. Ideal for the contractor and home DIY's use of a fence, deck, porch railing, or post mounting. |    |
| Face mount brackets <a href="#">[111]</a> | Face fix only requires five Heco-Topix screws into timber, allows 60 mm of adjustment away from leading-edge for other trades to gain access. The system requires a steel frame post and Rapid Panel for BSEN 13374.2013 class A protection.                                                                                                   |    |
| Timber socket base x Expansion Bolts      | This system is related to the post base cover. The base that will be used is more or less the same but instead, small fasteners, expansion bolts will be used. These bolts provide the shelter with more stability because their diameter is bigger, they are longer and stronger.                                                             |   |
| Tent pegs                                 | These fixations are inspired by recreational tents. To secure the tents and make them fixed to the ground, tent regs are put throughout the foreseen placed of the cover material. This technique is easy to apply for shelters.                                                                                                               |  |

## Conclusion

The shelter is lifted to keep humidity that comes from the ground away from the shelter floor. The vertical beams of the aluminium structure are extended and metal plates are attached to it to create little 'feet'. It is essential to fix the feet to the ground as the UNHCR imposes this as a guideline. This fixation will be done by providing all 7 feet (6 in the corners and 1 in the middle) with a tent peg, such as the last fixation component that is showed in the table. 7 tent pegs will be needed as every feet will be attached to the ground with one peg.

### 7.3.4 Ventilation

Ventilation is one of the most important things in a shelter. To implement ventilation a very important objective to keep is to make an airway where air can get into the shelter and out of the shelter through another point. Just like in most shelters/tents, mesh fabric is used to create possibilities to aerate the area. By using the mesh fabric optimal ventilation is pursued while keeping insects and

dust outside.

As the shelter is provided with a double-layered fabric for the walls and doors, the inner layer of the doors serves as a ventilating area as this is a mesh fabric. All three doors have an inner layer of mesh fabric and an outer layer of strong cotton. The users ventilate their shelter by opening the outer layer and keeping the inner layer closed. Besides the tree doors, a window is provided as there is a possibility that two of the three doors are used for the connection. The team decided to provide a window to make sure optimal airflow is possible through the shelter in any situation.

As the shelters will be placed in equatorial areas that can have extremely high temperatures, it is important that the hot air which flows upwards can leave the shelter. This is possible because the outer layer of the roof is not attached to the walls or inner layer, it is stretched between the beams of the roof. This makes it possible for fresh air to flow easily between the inner and outer layers of the roof. The figure below illustrates the airflow.

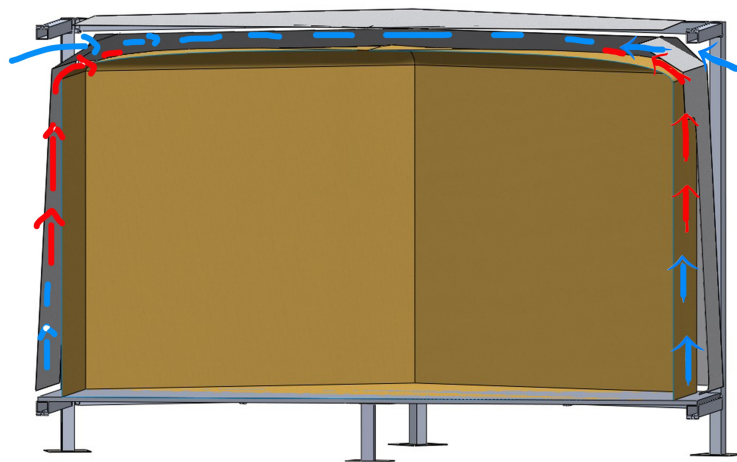


Figure 46: Airflow through the double layers

## 7.4 3D Model

- DIMENSIONS

In order to pursue the requirements of the UNHCR, a living surface of at least 14.0 m<sup>2</sup> had to be achieved to shelter four people as every person requires a minimum space of 3.50 m<sup>2</sup>. According to this, following dimensions were defined. The hexagonal outer structure in what 'the living cocoon' is placed, has a surface of 16.3 m<sup>2</sup>, the sides of the hexagon have a length is 2.56 m, the structure has a maximum width of 5.11 m and a maximum height of 2.85 m including the 0.30 m height legs on which it is placed. The living cocoon has a surface of 14.3 m<sup>2</sup>, hexagonal sides of 2.35 m, a maximum width of 4.70 m and a height of 2.30 m. When the shelter is transformed into the storage container, it has a length of 4.39 m, a width of 1.22 m and a height of 0.73 m.

- MODEL

Table 46: Design full shelter

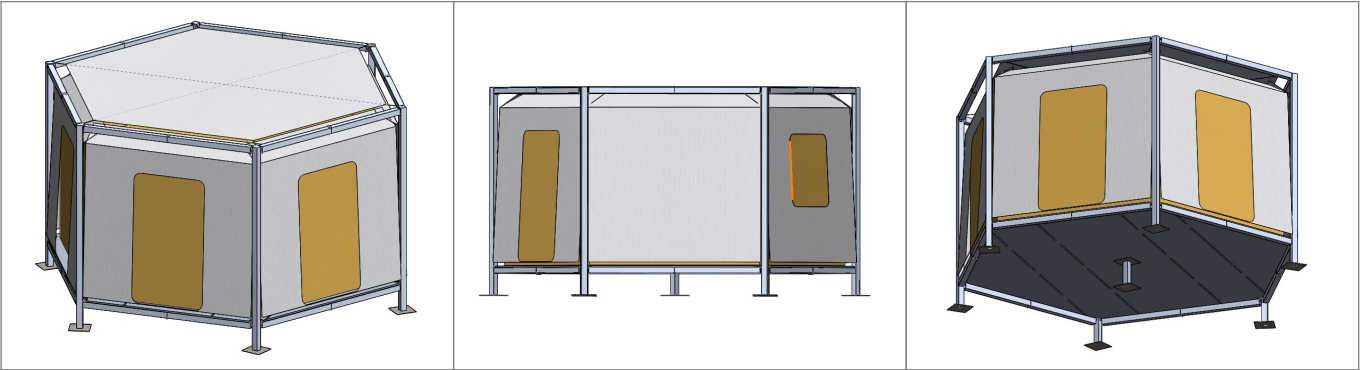


Table 47: Design structure

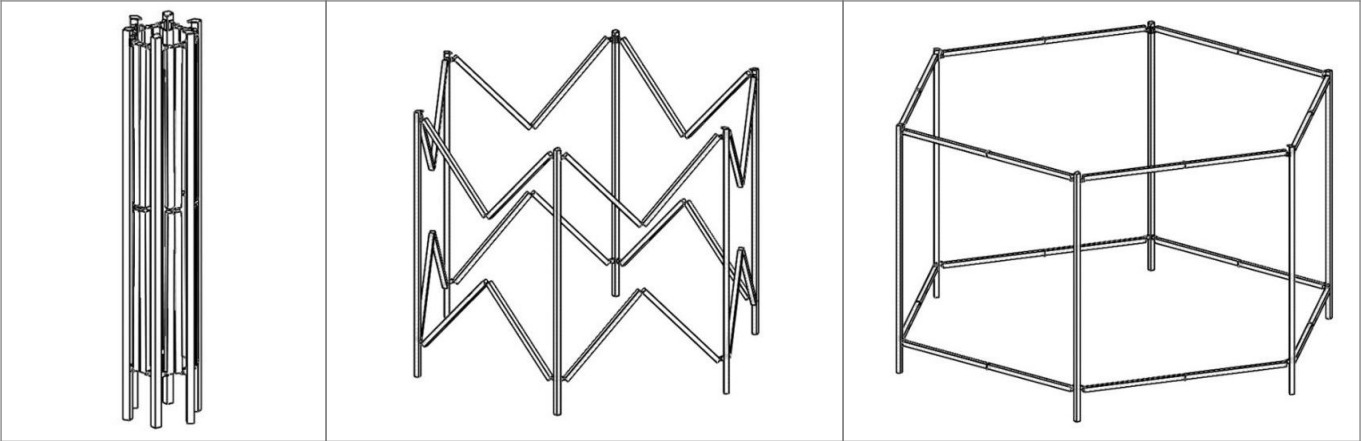


Table 48: Design floor

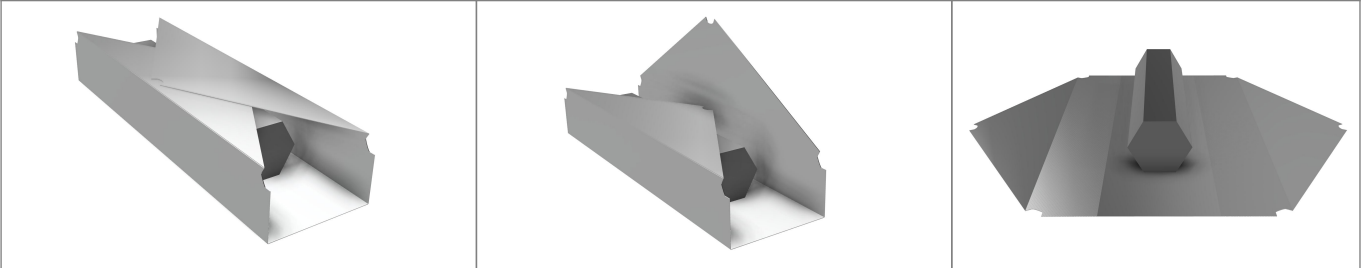


Table 49: Design fabric

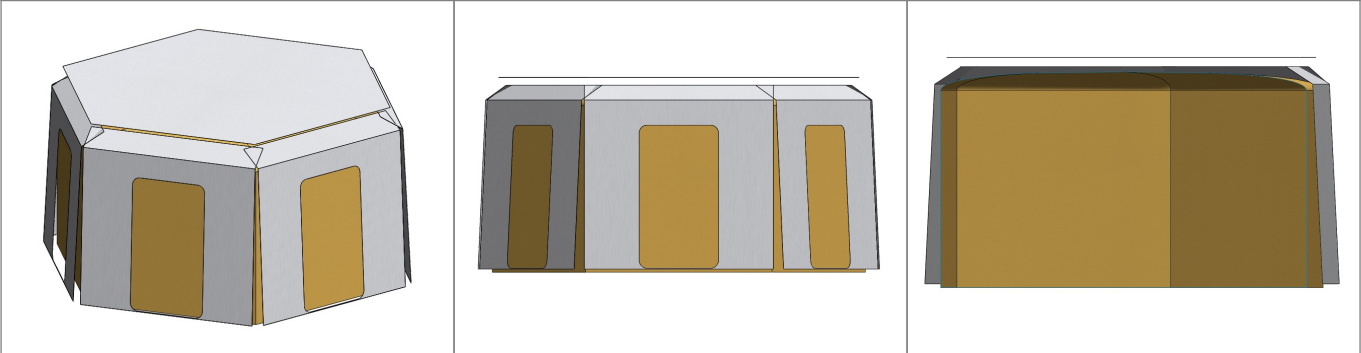
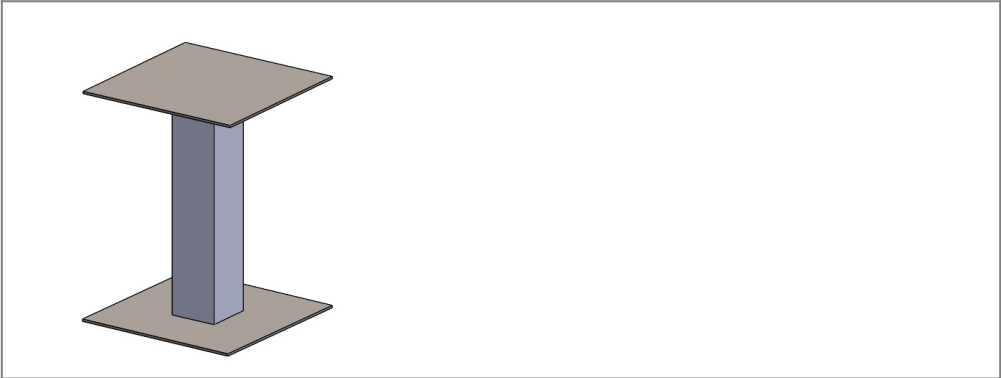


Table 50: Design seperated leg for in the middle



7.5 Packaging Solution

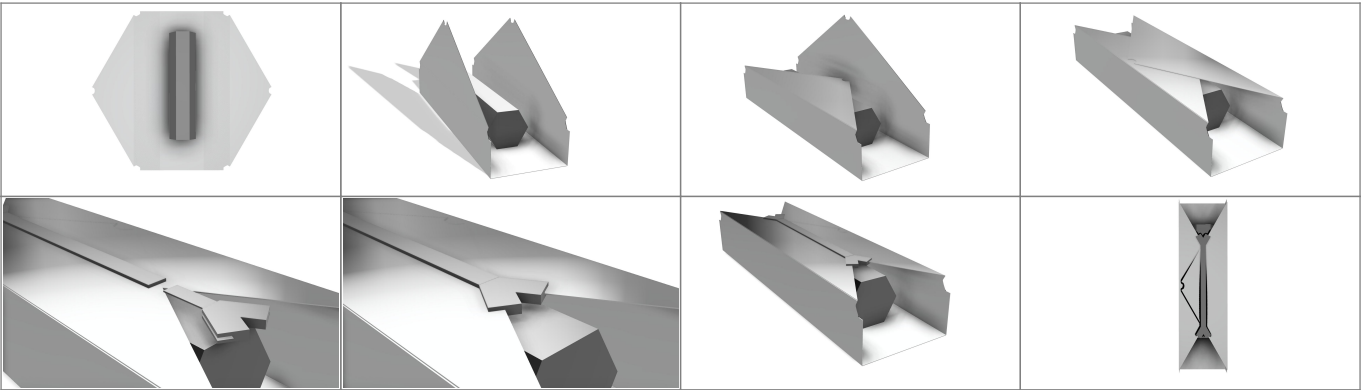
Packaging refers to all those activities related to designing, evaluating, and producing the container for a product. Simply, the box-like container, wherein the product is stored to protect it from any physical damage and at the same time attracting the customer through its appeal is called packaging. The Bis Team set out to design a different, innovative packaging by using a component part of the shelter. Thus, the floor is used to incorporate inside of it all the necessary components for the construction of a shelter. The innovative packaging also helps in bringing huge profits and benefits for the firm. Here, the company gives a unique design to its product package with the intent to grab customer’s attention.

By using as few materials as possible and turning the floor into a storage container, the costs are considerably reduced, but at the same time the impact on the environment, because it is no longer necessary to use extra materials.

The floor, obtained from a material with considerably good characteristics, high strength, aluminium composite panel (see Figure 45), over which a layer of 4 mm of cork is added, is divided into 5 sections that fold through hinges. Clamping these parts and ensuring that all elements are kept intact is achieved by using an extensible steel clamp, which can be adjusted to secure the entire assembly.

The way in which the floor is folded is illustrated in Table 51. The content of this storage box, created from the floor, is made in accordance with the dimensions of an aluminium pipe up to 80×80 mm, so we can conclude that it will fit very well the structure of the shelter, given that the pipes are smaller than those in the figure.

Table 51: Packaging Solution



The dimensions of the storage box are described in Figure 47.

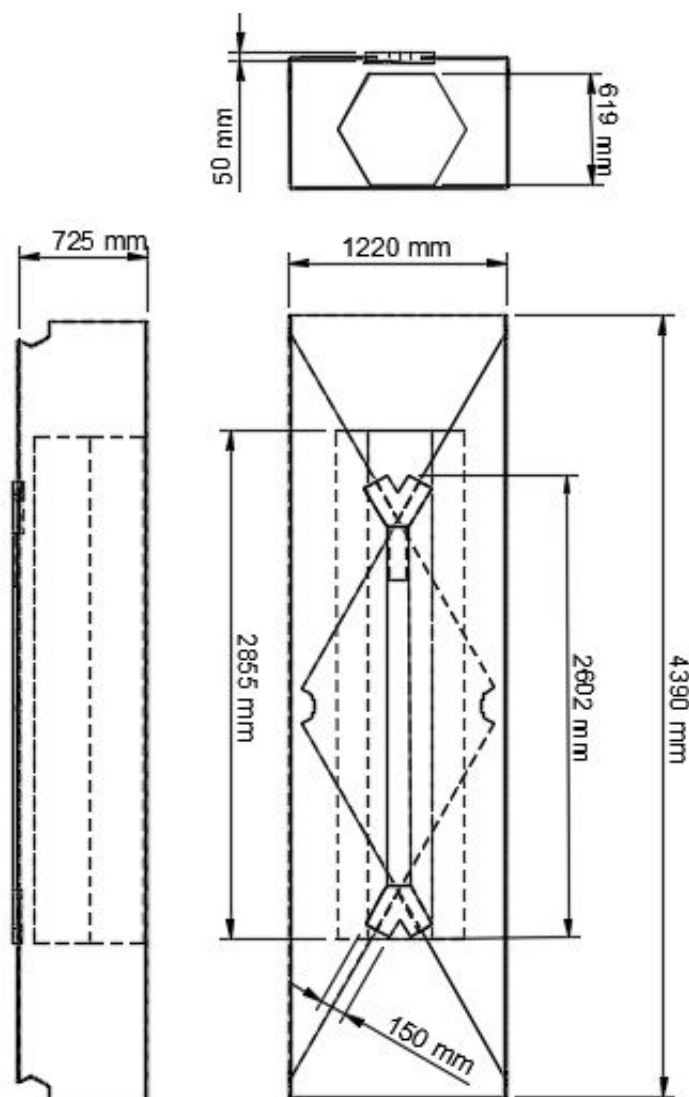


Figure 47: Box Dimensions

### 7.5.1 Transport

Considering that time and budget are some of the most important aspects of this product, the distribution of shelters promptly, given the time required to install them, can lead to saving as many lives as possible.

Thus, using the road transport route, we resorted to the use of a program named “EasyCargo 3D”, through which we can simulate the loads considering the dimensions of the truck and the load capacity supported depending on the truck model used. For a simulation was used a truck (Lamberet SR2 Heavy Duty) with dimensions 1339x246x260 cm with a load capacity of 24000 kg, respectively 85.64 m<sup>3</sup> (Figure 48).

At the same time, considering the current weight of a package of approximately 200 kg with the corresponding dimensions, according to the packaging model 47, the load in this truck will be 18 shelters, load having a total weight of approximately 3600 kg (15%), a total volume of 69.89 m<sup>3</sup> (82%), and with a free space of only 0.22 m.





Figure 48: SafeBIS Road Transport

Using the sea transport route we can use special containers for keeping the products inside intact. Considering at the same time that we are addressing a fairly large area, that of the Equator, the transport of shelters is not always possible by road transport with the use of trucks. For maritime transport, any container can fit, depending on the capacity of the ship, and in a container with dimensions of 1203x235x238 cm, with a maximum loading weight of 26480 kg and a volume of 67.28 m<sup>3</sup>, can be placed a number of only 8 packages with shelters, leaving a free space of 3.25 m (Figure 49). The weight loaded in the container is 1600 kg (7%), with a total volume of 31.06 m<sup>3</sup> (47%).



Figure 49: SafeBIS Sea Transport

7.6 Functionalities

7.6.1 Maquette

The model was made on a scale of 1:5 compared to the actual dimensions of the 3D model, considering the possible minor errors that occurred during the manufacture of materials and assembly of components.

To make the model were used wooden beams that were painted to illustrate the aluminium beams (an easier method to process the materials and to avoid some mistakes, and at the same time cheaper). At the same time, we used 6 trapezoidal beams in the corners of the hexagon, to form the hexagon and completely close the structure, as ordinary hinges would not have done this in combination with simple square beams. Thus, by using the trapezoidal shape, the angle of inclination of the hinges projected in the 3D model was compensated.

The floor also respects the structure, becoming the packaging solution for the entire ensemble. Finally, inside the skeleton was integrated the fabric that folds inside, at the same time with the movement of the skeleton. This whole body, together with its elements, is placed in the box and stored very easily.

Table 52: Maquette SafeBIS





## 7.7 Functional Testing

### Space Requirements by the UNHCR

By the mandated requirements set by the UNHCR for the covered living space of the shelter to have, for hot climates, that every person of interest should have 3.5 m<sup>2</sup> to live in. So, to accommodate 4 people inside it needs to have:

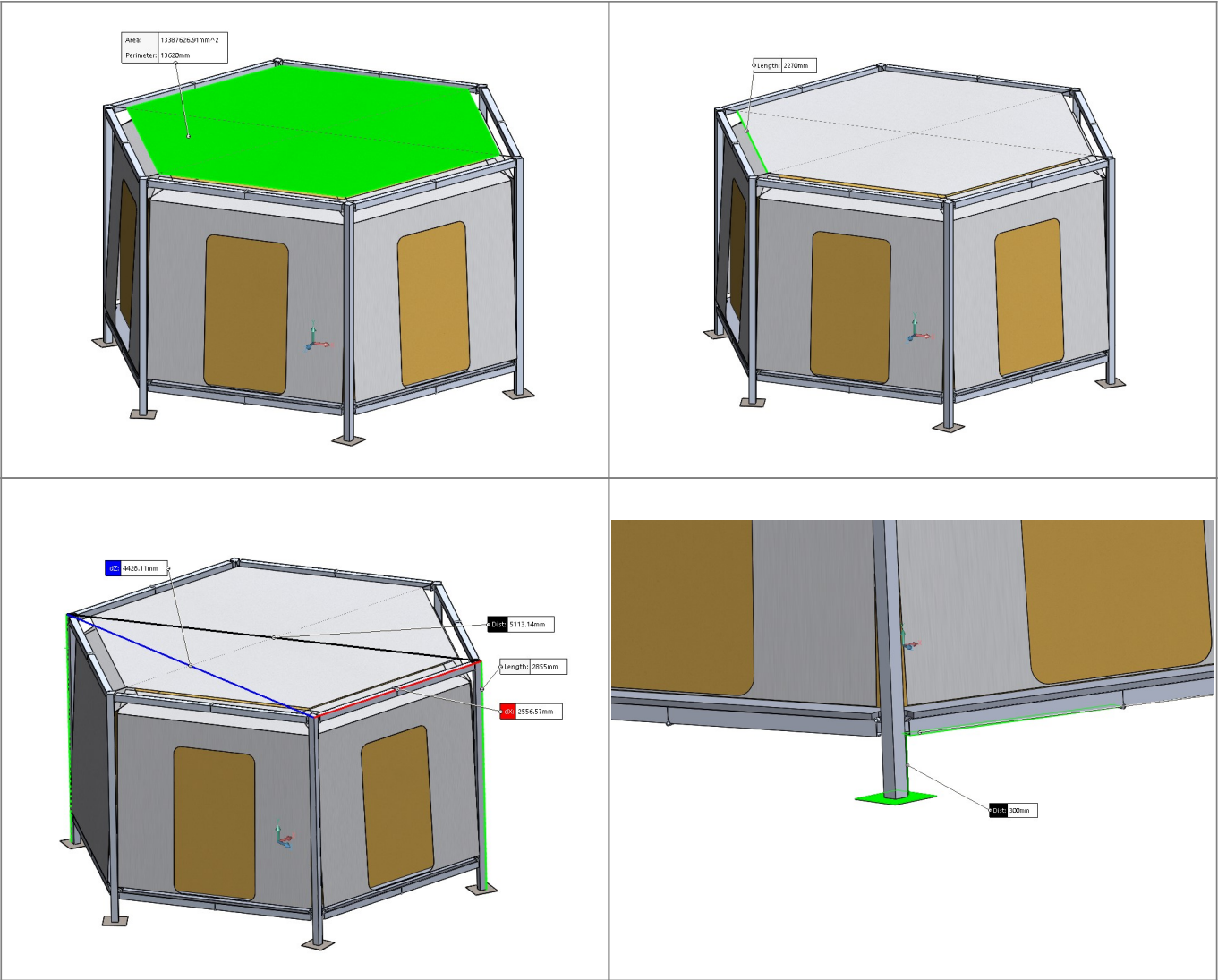
- $3.5 \times 4 = 14 \text{ m}^2$

### Dimensions of the SafeBIS Shelter

The fourth and last version of the SafeBIS Shelter has the following dimensions:

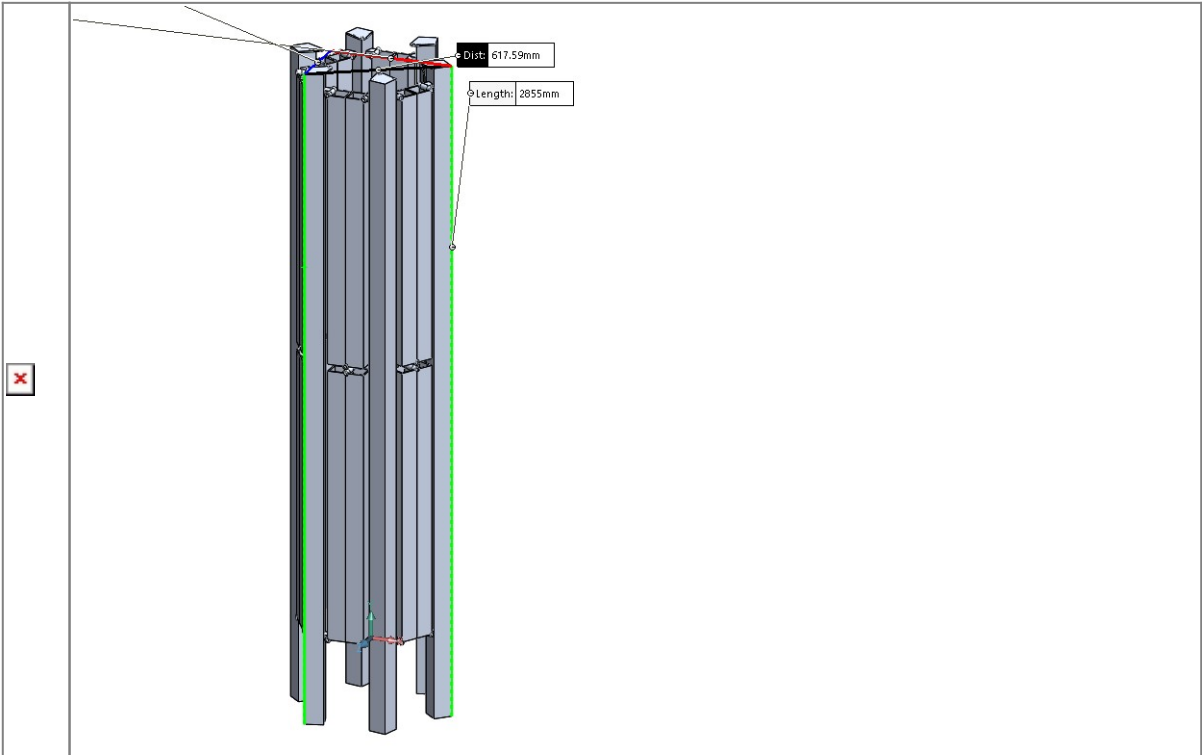
### DEPLOYED STRUCTURE

Table 53: Deployed Structure



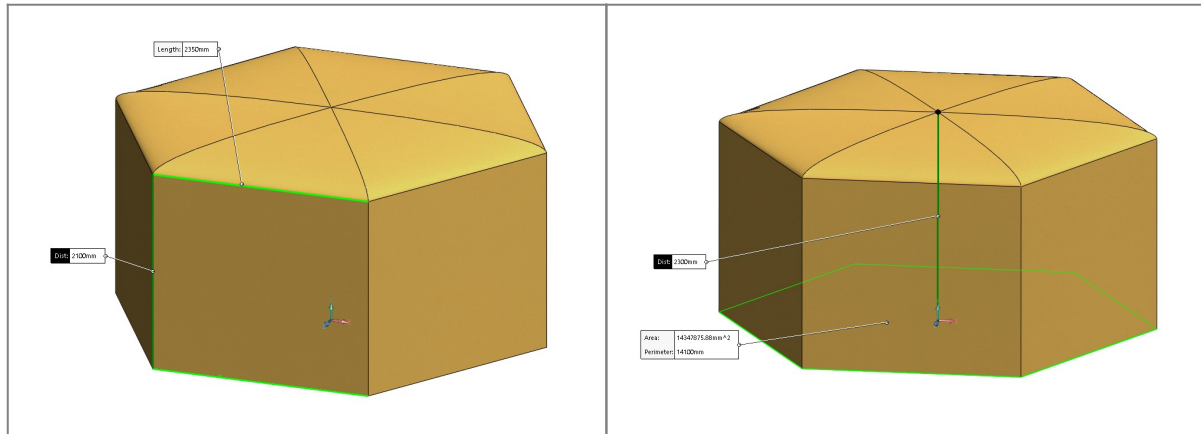
CLOSED STRUCTURE

Table 54: Closed Structure



## FABRIC TENT

Table 55: The Fabric Tent



To comply with the requirement for the minimum covered living area for four people the final dimension of the tent has an area of approximately 14.4 m<sup>2</sup> with a hexagonal polygon-shaped tent with a side of 2.35 m.

The shelter has a 2.1 m height at the outer edge and 2.3 m at its center.

All these dimensions combine to give the shelter an internal volume of 32.15 m<sup>3</sup> (Figure 50).

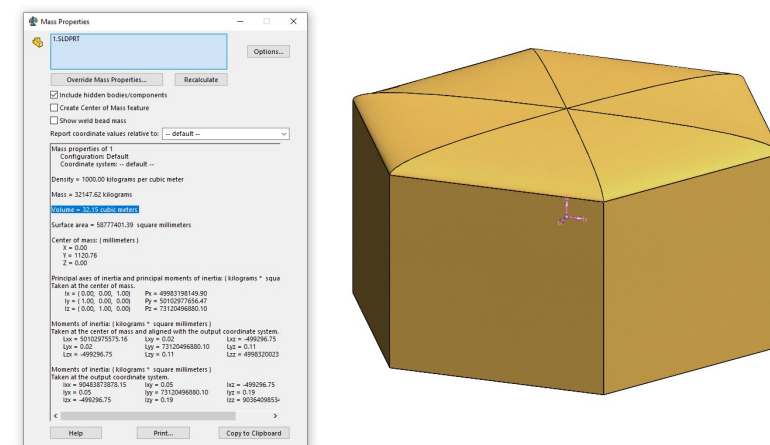


Figure 50: Volume of the tent

### 7.7.1 SIMULATION

In order to ensure that the final design is strong enough and will not break, simulation tests had to be performed in Solidworks. The simulation is done with load requirements that the SafeBIS team set up.

#### Load Requirements by the UNHCR

From the UNHCR Family Tent for Hot Climate Datasheet we have from the:

- General Points for the Finished Product:
- Performances:

The final product must be able to withstand 75 km/h wind, to be strongly attached to the ground and tensioned without any damages.

When closed, the tent must give good protection against dust, wind, rain, snow, insects, and small crawling fauna.



Minimum roof load to be 300 N/m<sup>2</sup> under ISO8937 (snow load for camping tent). To evaluate if the design the team came up with can withstand wind speeds of up to 75 km/h the shelter needs to be subjected to a CFD simulation. Also, it is required that the shelter needs to be strongly secured to the. It is also required that the roof needs to be able to withstand a load of 300 N/m<sup>2</sup> and with an area of approximately 13.38 m<sup>2</sup>, it is required that the roof can handle a load of  $13.38 \times 300 = 4014$  N. To this load of 4014 N will be needed to add the weight of the tent and its outer layer as it will partially hang off the cables that run through the top of the shelter structure. As a first iteration of the load being applied to the roof, it will be arbitrated that the tent fabric will weigh 50 kg or 491 N. The total weigh then being  $4014 + 491 = 4505$  N.

This was an important test to do but the team didn't succeed to do this simulation as it is very complicated to simulate wind in Solidworks. Also the fact that the program isn't ideal to create fabric contributes to not succeeding to simulate this. In the near future it is very important to ensure the wind simulation can be done by using an other program or the prototype. This test is essential as the team wants to develop a completely safe shelter.

### Our Load Requirements

Our shelter will house 4 persons of interest and their belongings. Regarding to the anthropometric measurements among Asian coun-tries, the team calculated with a body mass of 81 kg per person as this is 95 % of the male population has weight below this. An extra weight of 50 kg is added for the belongings and furniture. This makes a total load of 293 kg. Two simulations were done concerning this load. The first one was to simulate this weight on the floor, the second one to simulate the weight on the structure. To calculate this second one, also the weight of the floor had to be added. A total load of 480 kg was founded. After doing the first runs of the simulation could be concluded that the model was too strong as it had a very high factor of safety. Regarding to this, the thickness of the floor was reduced from 20 mm to 10 mm and the dimensions of the aluminium beams from 60×60mm to 50×50mm. By reducing both materials, a lighter shelter was created. The shelter was still strong enough to carry the weight. Figure 51 shows the simulation of the structure. The blue colour indicates that the structure is strong in this case.

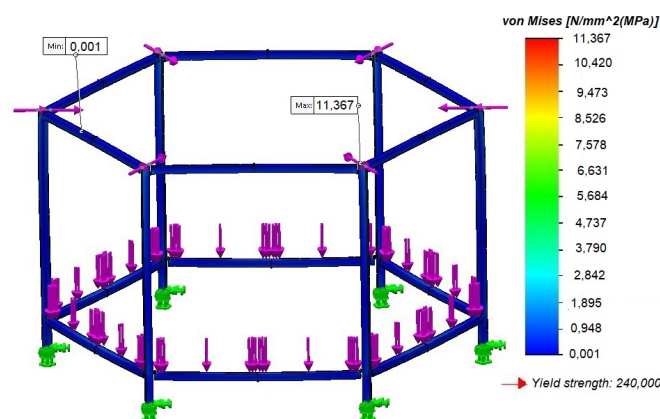


Figure 51: Simulation results

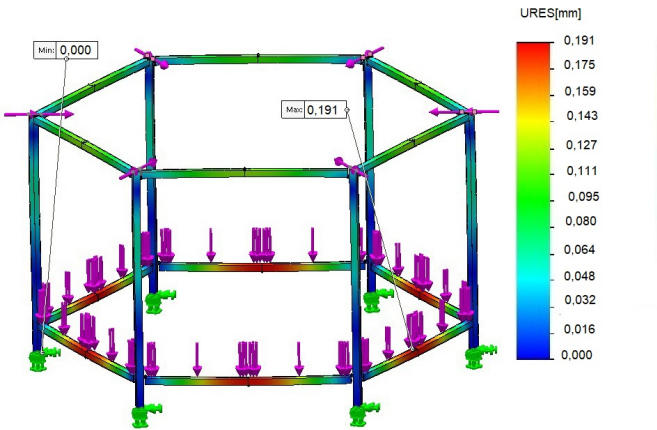


Figure 52: Simulation results

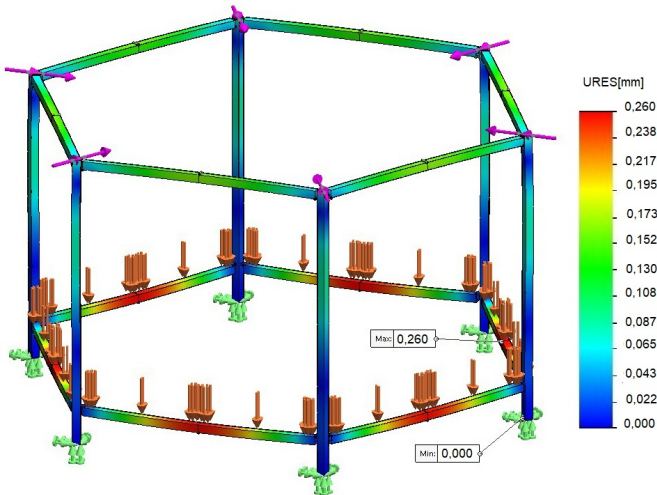


Figure 53: Simulation results

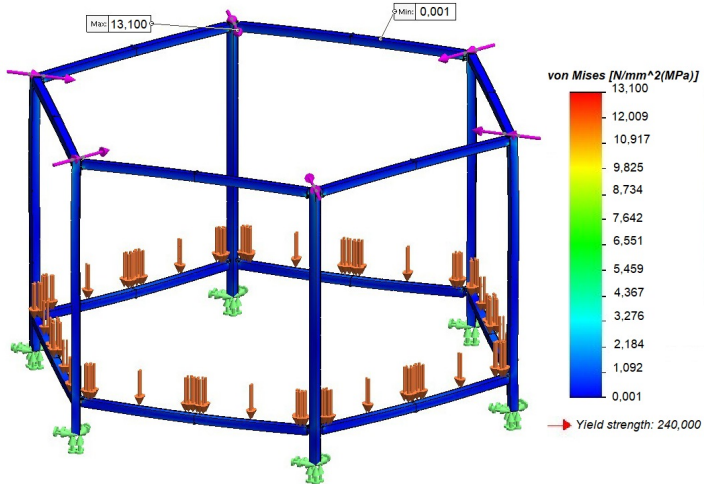


Figure 54: Simulation results

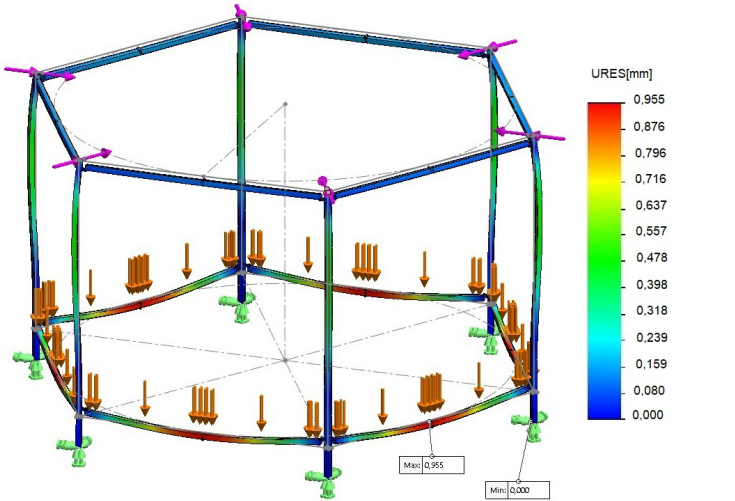


Figure 55: Simulation results

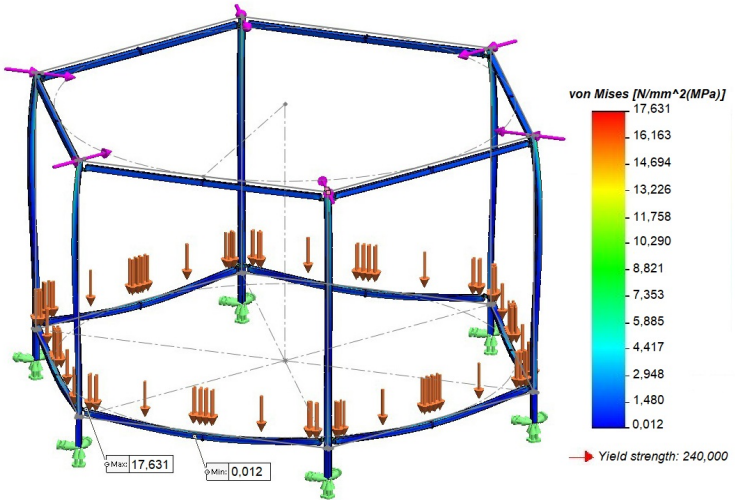


Figure 56: Simulation results

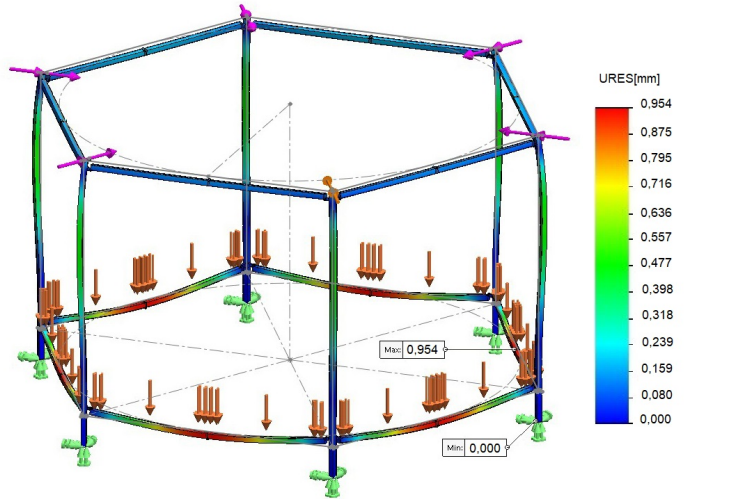


Figure 57: Simulation results



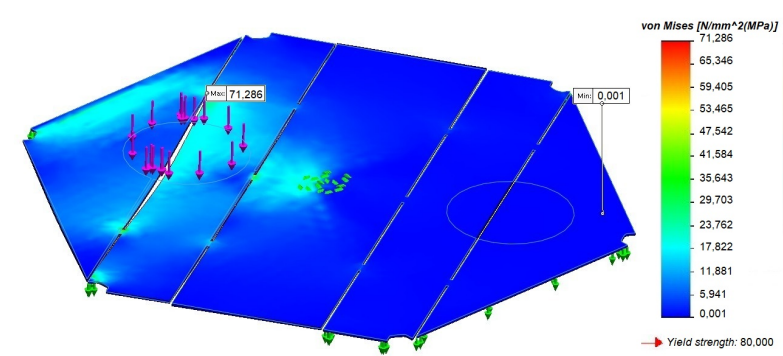


Figure 58: Simulation results

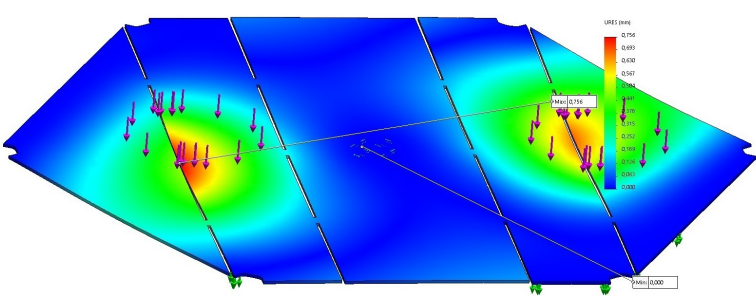


Figure 59: Simulation results

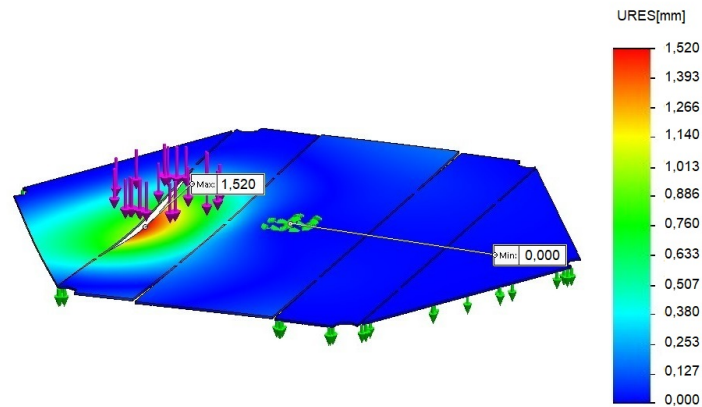


Figure 60: Simulation results

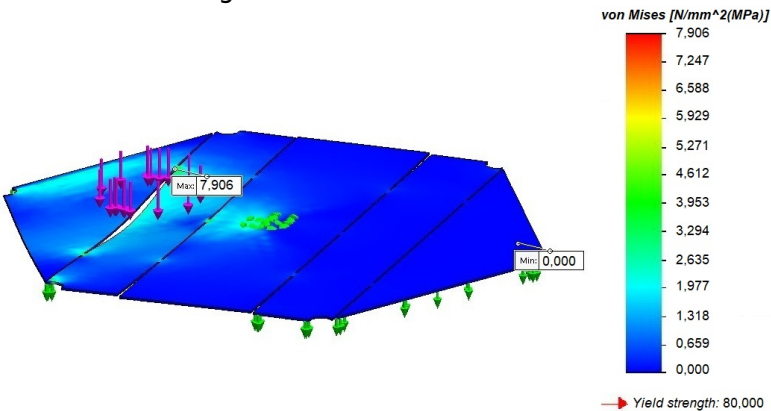


Figure 61: Simulation results

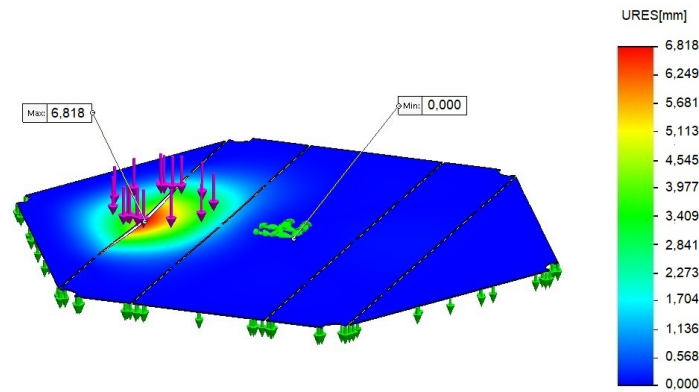


Figure 62: Simulation results

During the simulation the weakest points were identified as well. These points were at the hinges that connect all beams together and create the structure. This is logical as these are the smallest parts of the shelter and a lot of loads will be attended on it. The weakest point is illustrated in Figure 63. Regarding to these results, the team designed hinges which would fit perfectly and which are stronger than the first ones. The hinges that were created have to be manufactured, the team will focus on this in the future. In figure 64 the ideal hinge that connect all beams in the structure is showed.

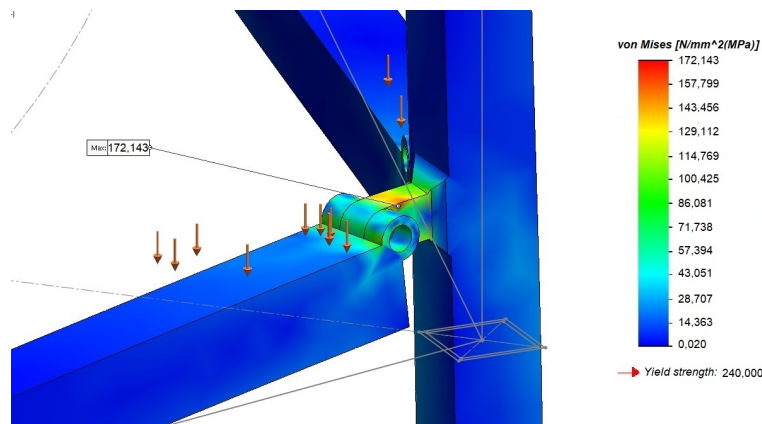


Figure 63: Simulation results

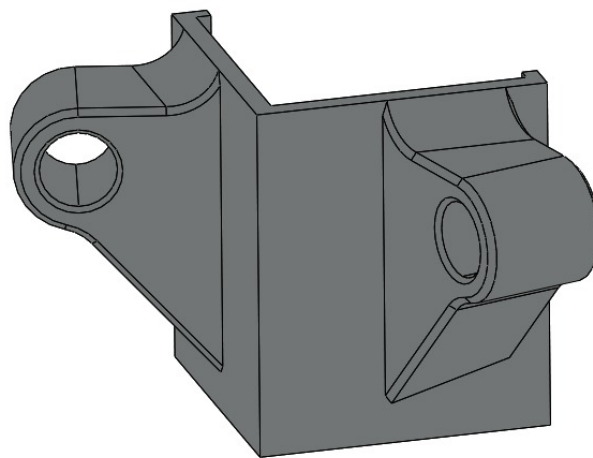


Figure 64: Ideal hinge

We can conclude that the hinges of the floor are strong enough, no changes are needed as the floor will serve perfectly. Also the aluminium structure can be relied when the hinges will be replaced by

the hinges that we created.

At the deliverables a document called '*SafeBIS Shelter - Components and Functionality, Testing and Future Development*' will explain more clear the steps which were taken to simulate the tests of the team.

## 7.8 Website SafeBIS

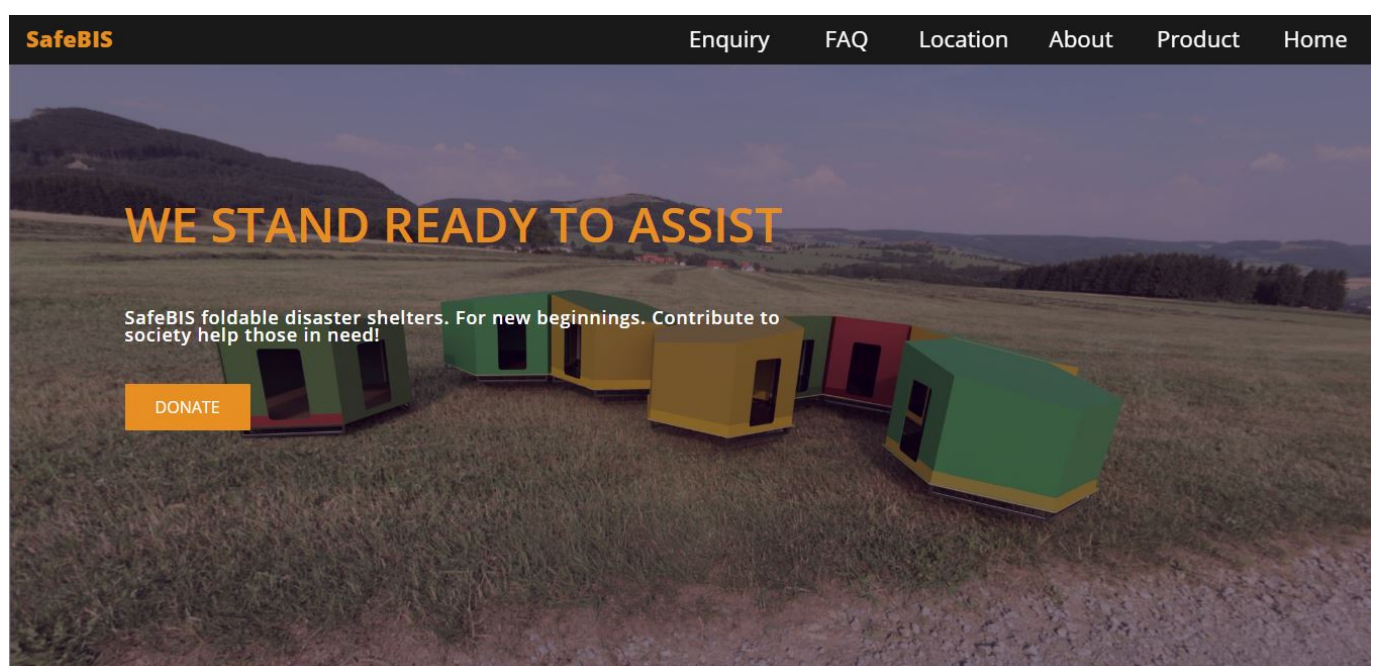
As the digital world is significant in most people's daily life, the SafeBIS team decided to invest in creating a website for the shelters. A website is an ideal way to reach customers and donors/sponsors for the project. Developing a website gave the team the opportunity to create brand awareness worldwide, to make the shelters better accessible, and to share information about the project. Due to the site, people stay informed about SafeBIS and are able to contact the team in case they have questions.

The website is accessible by going to following link: <https://www.risendev.com/elementor-514/#>

The website includes a home page, a description of the product, an “About Us” section, the location, a list of frequently asked questions, an enquiry form, and data to contact us. The top right corner of the website shows all containing sections, by clicking on one of them the user will arrive at the information of that section.

### Home Page

When going to the website, this page will pop up as the first image. The home page shows a render of the SafeBIS shelters, this render gives the people who visit the site a good view of how the shelters will look and how they will create a temporary community for the affected people. As the marketing strategy of SafeBIS includes reaching people who want to donate a charity gift to our project, a “DONATE” button is provided on the home page. By clicking on this button, a new window will show up.



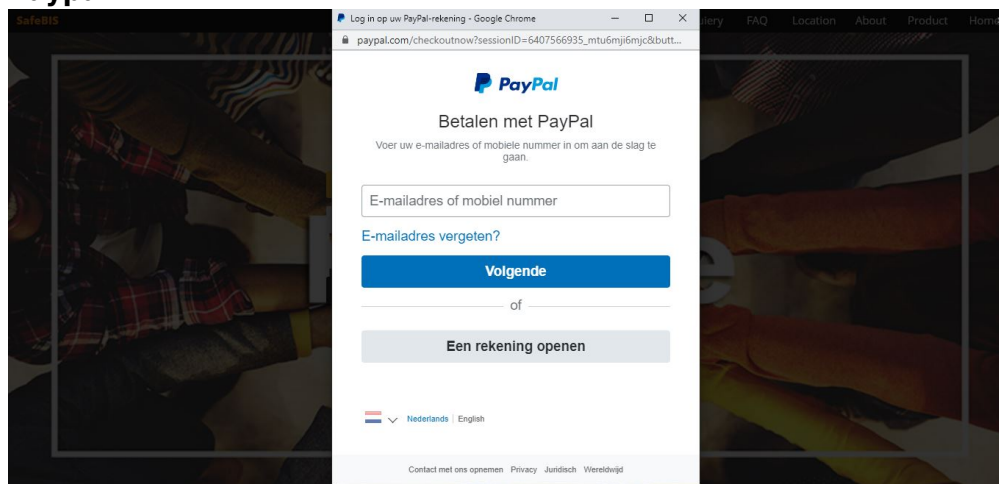
## Donate

This page pops up when people click on the “DONATE” button, through this way, a charity gift can be given. The payment can be made by choosing one of the four payment options. When clicking on one, the sponsor is assisted in his own language to make the gift. The provided payment options are Paypal, Bancontact, Sofort, and Creditcard.



## Four Payment Options

### 1. Paypal



### 2. Bancontact



SafeBIS

PayPal-betalprocedure - Adres wijzigen - Google Chrome

paypal.com/latinumcheckout/change-address?sessionId=6407566935...

PayPal Bancontact 100,00 USD

Bevestig de verzendgegevens

Land/regio  
België

Voornaam Achternaam

Type telefoon  
Mobiel Telefoonnummer  
+32

Adresregel 1

Adresregel 2

Postcode

### 3. Sofort

SafeBIS

PayPal-betalprocedure - Adres wijzigen - Google Chrome

paypal.com/latinumcheckout/change-address?sessionId=6407566935...

PayPal Sofort 100,00 USD

Bevestig de verzendgegevens

Land/regio  
België

Voornaam Achternaam

Type telefoon  
Mobiel Telefoonnummer  
+32

Adresregel 1

Adresregel 2

Postcode

### 4. Creditcard

SafeBIS

Enquiry FAQ Location About Product Home

Creditcard

Creditcardnummer

Vervaldatum CVC code

Voornaam Achternaam

Adresregel 1

Adresregel 2

Postcode

Plaats

Telefoonnummer  
+31

Email

☒ Verzenden naar factuuradres

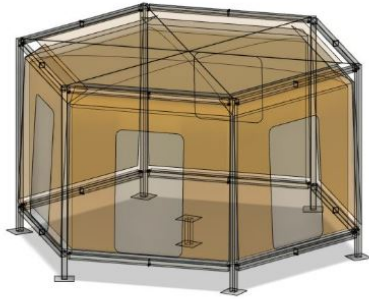
U stemt in met de [voorwaarden](#) van de service die u nu gebruikt en aan uw account met de [PayPal-omgeving](#) verbonden.

Nu betalen

## Product

This section shows the full look of shelter and gives a short explanation of the 4 most important characteristics of the design. A full look is included as SafeBIS wants to be transparent with the donors and other visitors. By showing the entire design we hope to convince people about the reliability of our brand and to gain their confidence. The four characteristics on the left are included to summarize the shelter shortly and to inform the visitors easily about the project.

## SafeBIS Shelter



### HONEYCOMB STRUCTURE

The unique shape allows the SafeBIS Shelter to be more resistant and its a naturally strong structure.



### MODULAR

The structure allows the SafeBIS Shelter to connected with other units.



### HARD FLOOR SURFACE

The floor is made out of aluminium composite panel, this provides good isolation from the ground of where its placed and a stable, flat, surface to walk on.



### SUSTAINABLE AND RE-USABLE DESIGN

The design is made from natural and decomposable materials, also one can easily replace parts of the shelter in the event of any damage.

## About Us

It is important for the team that our stakeholders and sponsors/donors get a good image of us as they will sponsor or work together with us. On the basis of pictures of all members and a description of the team, this section helps to introduce our team.

## Our creative team





FOR NEW BEGINNINGS

## About US

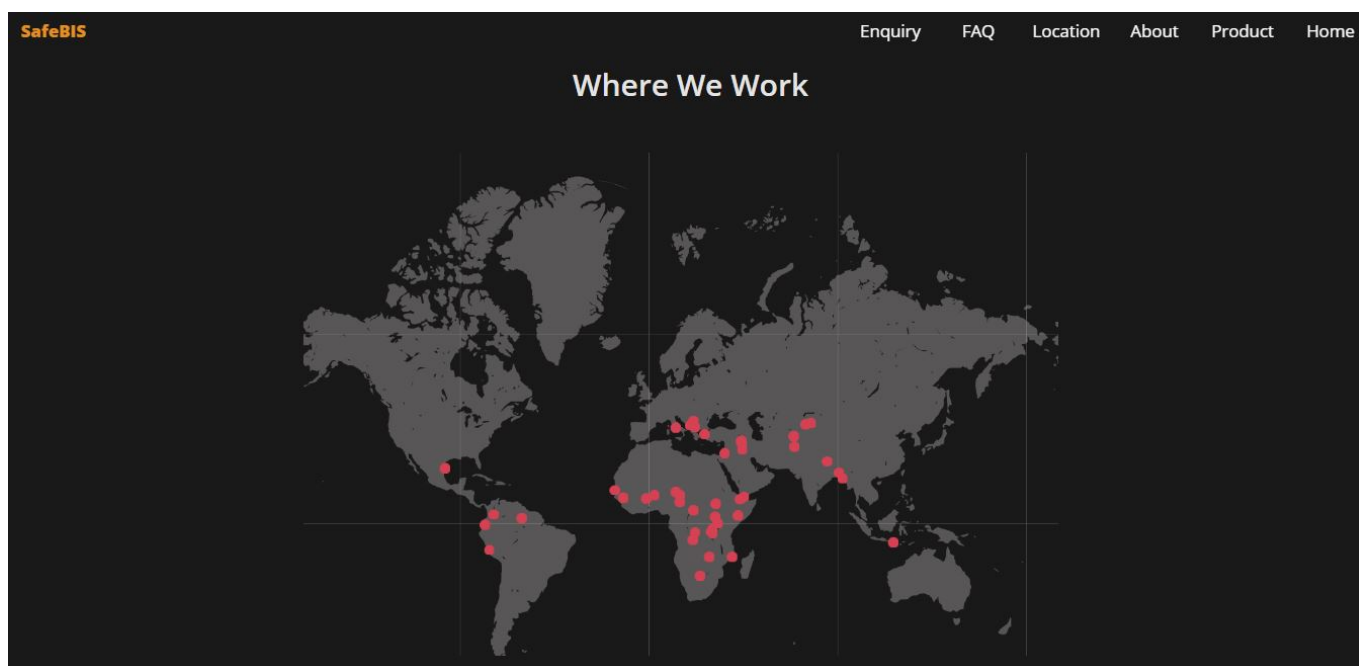
A home away from home. We are a team with a mission to improve the lives of people affected by disasters, by providing affordable temporary shelter and a dignified, safer life away from home.

We are a team of 6 people dedicated to change the lives of those who have been forced to flee, by providing a safer and more dignified home away from home.

The project, Initiated In February 2020 In **partnership between SafeBIS, and European Project Semester at ISEP.**

## Location

The map shows all places where SafeBIS shelters work. The team focuses on regions with an equatorial climate as this area is the most affected by natural disasters. The shelters are designed to be placed in sunny areas that are accompanied with a lot of rainfall.



## Frequently Asked Questions

This section shows the six most frequently asked questions according to the project. All six questions are followed by an answer to the team. In case someone has a question that is not answered in the FAQ, they can scroll more down to arrive at the section with the enquiry form.

**SafeBIS**

EnquiryFAQLocationAboutProductHome

## FAQ

Most frequent questions and answers

**WHAT IS THE SIZE OF A SAFE BIS SHELTER?**

**HOW IS THE SAFE BIS SHELTER PACKAGED?**

**CAN THE SAFE BIS SHELTER BE DISASSEMBLED AND RE-PACKED?**

**WHAT IS THE SAFE BIS SHELTER MADE OF?**

**IS THE SAFE BIS SHELTER WATERPROOF?**

**WHAT DOES A BETTER SHELTER COST?**

**SafeBIS**

EnquiryFAQLocationAboutProductHome

## FAQ

Most frequent questions and answers

**WHAT IS THE SIZE OF A SAFE BIS SHELTER?**

The shelter is 17.5 m<sup>2</sup> and designed to host 5 persons with 3.5 m<sup>2</sup> covered living space per person, in line with the Sphere minimum standards. Shelter dimensions are (L) 5.68 m x (W) 3.32 m x (H) 2.83 m.

**HOW IS THE SAFE BIS SHELTER PACKAGED?**

**CAN THE SAFE BIS SHELTER BE DISASSEMBLED AND RE-PACKED?**

Yes. The shelter can be disassembled, re-packed, moved and re-assembled. Disassembly takes about 1 hours and requires a team of minimum two people.

**WHAT IS THE SAFE BIS SHELTER MADE OF?**

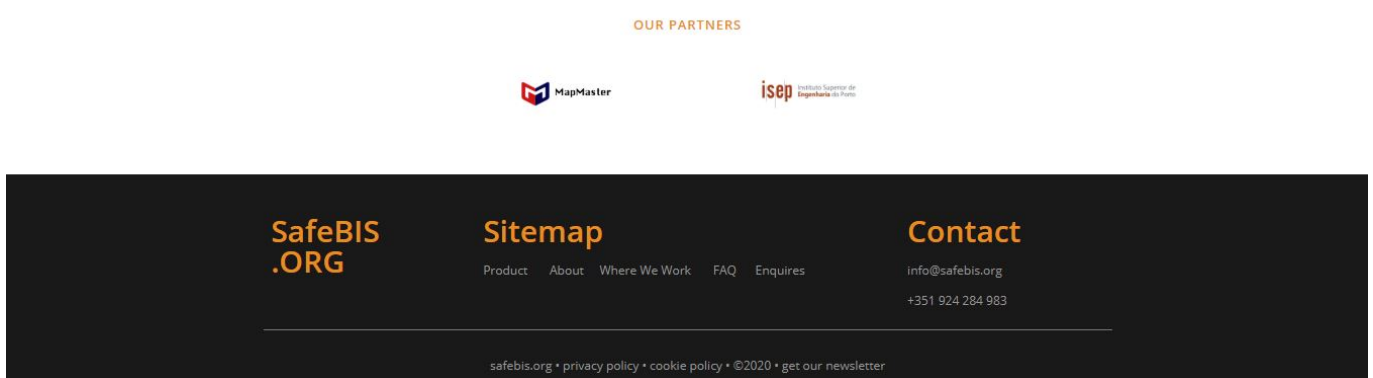
**IS THE SAFE BIS SHELTER WATERPROOF?**

## Questions/Enquiry

An enquiry form is included on the website to make sure all questions of the visitors can be answered and to ensure that uncertainties are cleared. By filling in the form a question can be mailed to our team. One of our specialists will try to answer the question as well and as fast as possible.

## Partners & Contact

On the bottom of the website, the sponsors of SafeBIS are shown, there is also a little section provided with additional information about SafeBIS, such as our phone number.



## 7.9 Tracking Website

It is necessary to create a database to help shelter owners and the BIS shelter company to see what information is available on the shelter. It will help to have a platform that can store all this information in one place. That's why the best option is a website that can let people add information to their own shelter. This information is only available to the writer and the admins of the site. In this case, the admins are people from the BIS company. The entire site is comprised of four pages. An introduction page, an insert shelter page, an index page where all the shelters can be found, and a page that displays the shelter information (this is only available for the shelter owner and BIS Shelters). Below this text, a small explanation will be shown for every page.

### • INTRODUCTION PAGE

In this page, a quick introduction is written with an explanation of all the information that is necessary to move around the site it will display our newest shelter with a button that connects to the index page where all shelters are shown.

## • INSERT SHELTER PAGE

This page is created to give the shelter owners a chance to add their shelter to the database in a user-friendly way. The design of the page is pretty simple and will only allow people with the right email address on the page.

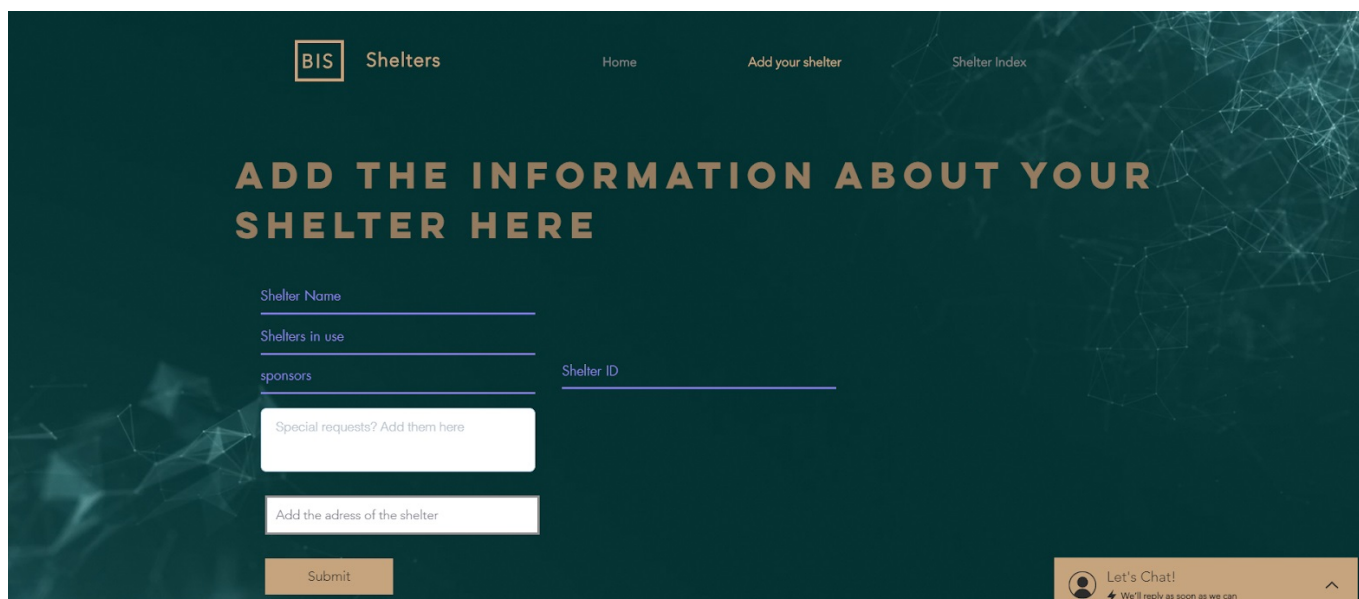
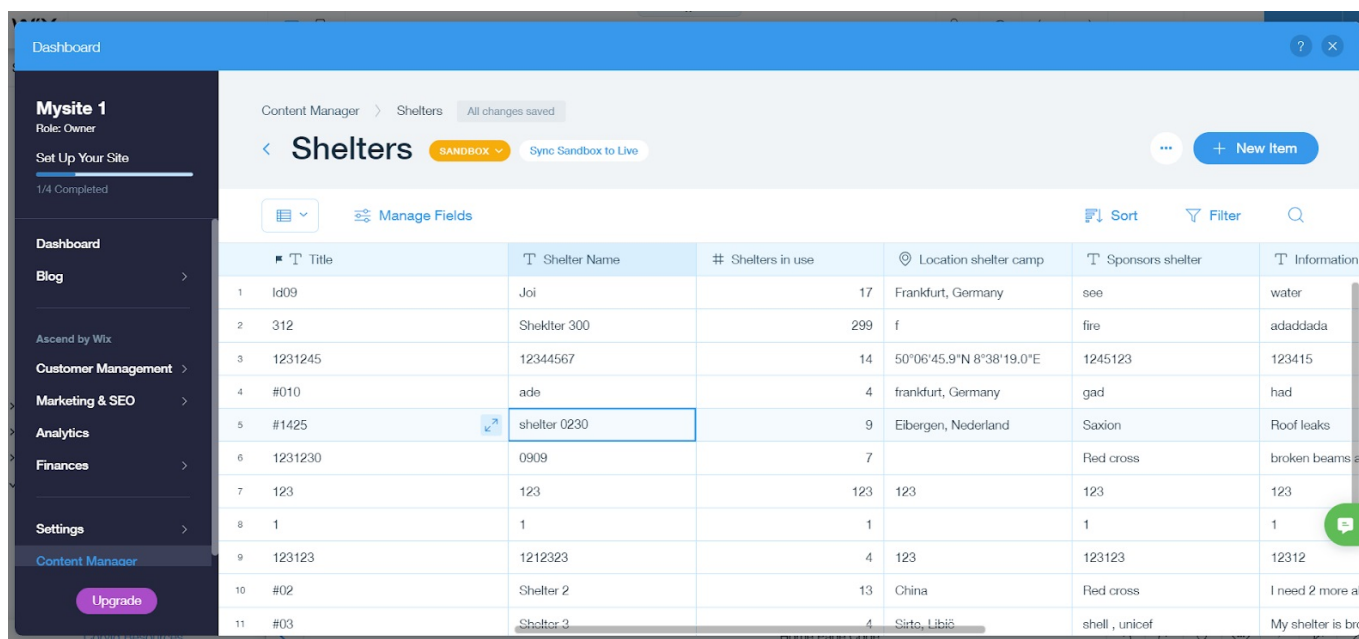


Figure 65: Insert page

As seen in Figure 65 it is possible to fill in some information on the shelter when everything is filled in and the submit button is pressed the information is stored in a database as shown in Figure 66.



| T Title   | T Shelter Name | # Shelters in use | Location shelter camp    | T Sponsors shelter | T Information     |
|-----------|----------------|-------------------|--------------------------|--------------------|-------------------|
| 1 Id09    | Joi            | 17                | Frankfurt, Germany       | see                | water             |
| 2 312     | Sheldter 300   | 299               | f                        | fire               | adaddada          |
| 3 1231245 | 12344567       | 14                | 50°06'45.9"N 8°38'19.0"E | 1245123            | 123415            |
| 4 #010    | ade            | 4                 | frankfurt, Germany       | gad                | had               |
| 5 #1425   | shelter 0230   | 9                 | Eibergen, Nederland      | Saxion             | Roof leaks        |
| 6 1231230 | 0909           | 7                 |                          | Red cross          | broken beams      |
| 7 123     | 123            | 123               | 123                      | 123                | 123               |
| 8 1       | 1              | 1                 |                          | 1                  | 1                 |
| 9 123123  | 1212323        | 4                 | 123                      | 123123             | 12312             |
| 10 #02    | Shelter 2      | 13                | China                    | Red cross          | I need 2 more al  |
| 11 #03    | Shelter 3      | 4                 | Sirto, Libia             | shell, unicef      | My shelter is bro |

Figure 66: Database

## • INDEX PAGE

The index page is the place where all the shelters are shown. In the insert shelter page, the ID of the shelter is filled in and this will be used to store the shelter in the index. All the shelters will be put in a scroll down table that shows all the indexes with the name of the shelters right after it so it can be found really easy. An example is shown in Figure 67.

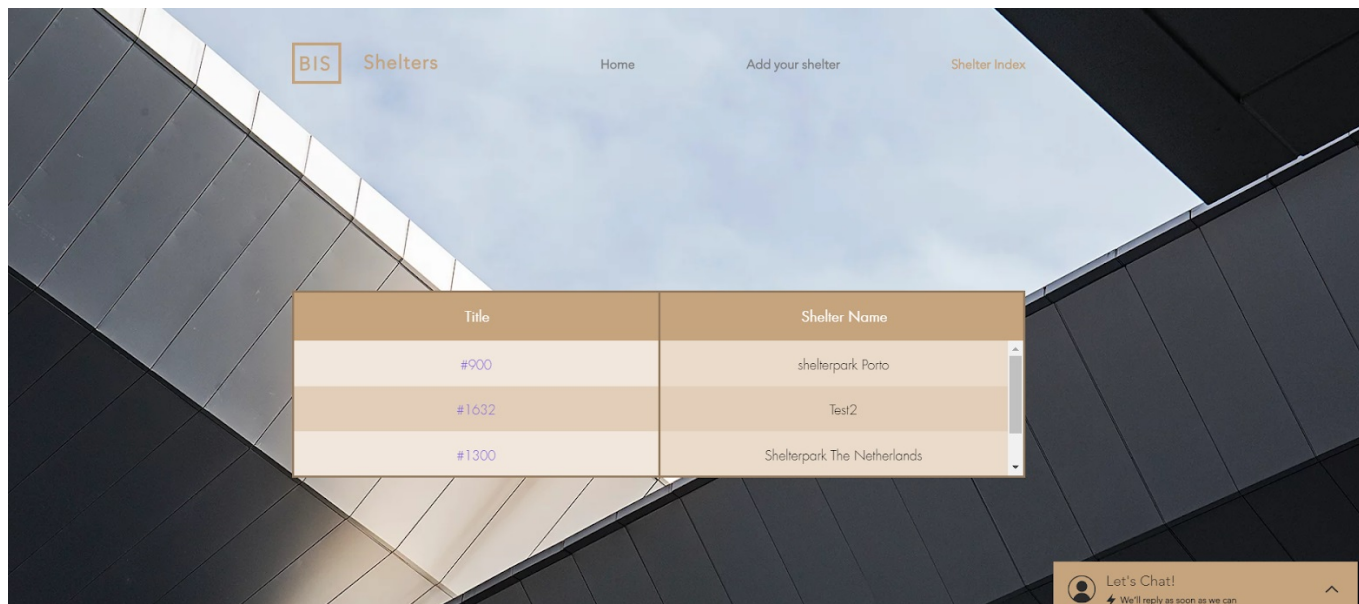


Figure 67: Index page

After the ID of the right shelter is clicked the user will be reconnected to the page of that particular shelter this page will have all the information that the shelter owner filled in for his own shelter.

### • YOUR OWN SHELTER PAGE

After the right shelter is clicked the user will have to connect with his email to confirm that the information is not shown to random users. This page will contain all the relevant information of the shelter which contains the location, name, etc. The page is shown in Figure 68.

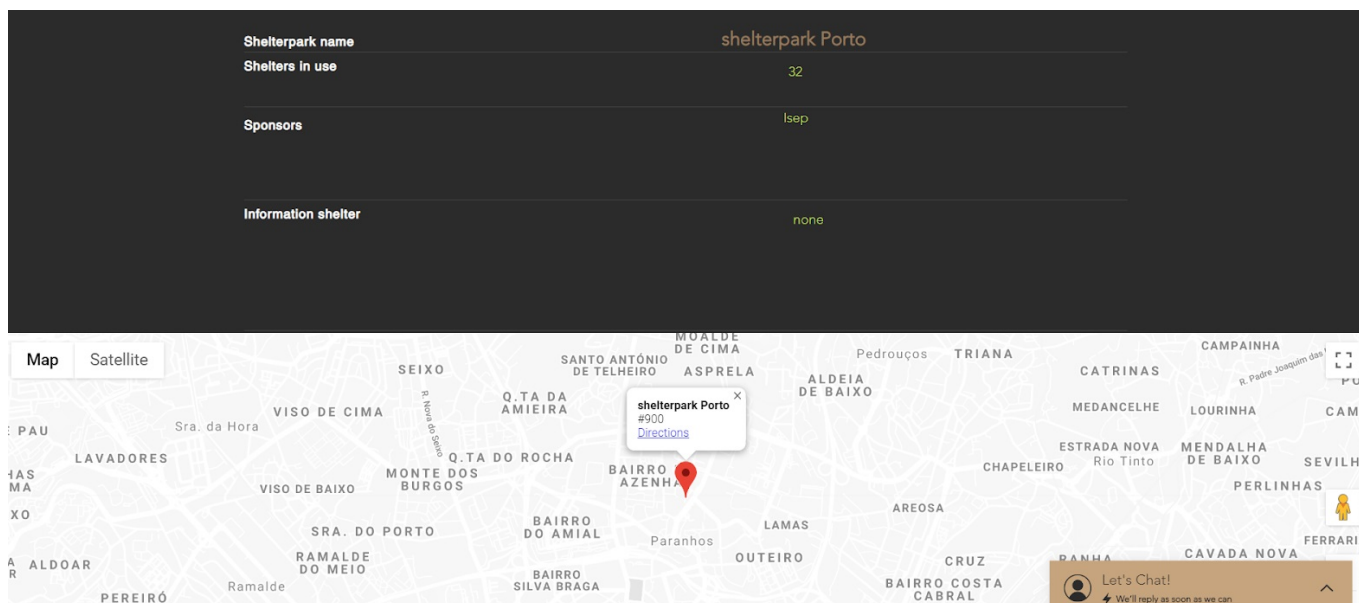


Figure 68: Your own shelter page

All the information on the shelter site can be found on this website:

<https://bisshelters.wixsite.com/bisshelters>

The website itself will be connected to the main site that is on the website:

<https://www.risendevlop.com/elementor-514/#>

## 7.10 Conclusion

The project had its beginning with the first searches to discover the market, to find out the special requirements and needs for each user.

Starting from the natural disasters that happen all over the world, from the number of deaths, the destruction of buildings, the displacement of people, and the considerable economic declines, our team decided to create a sustainable solution for long-term use due to materials used and foldable construction. Thus, the first steps were taken in the development of this product by exploiting as many ideas as possible.

Here was the starting point for product development, where we analyzed the different possibilities of folding, assembly, analyzing these aspects to streamline the handling of shelters once they are distributed for use.

In this part of the project, a diagram was developed in which certain necessary requirements were assigned and the result we obtain for maximum performance. The analysis of the necessary materials was done very carefully, researching information about the properties of each material to select the best option, thus sustainable and recyclable materials were chosen, mostly dominating aluminium, which is a lightweight material and cotton, which is the specific element of this shelter.

All the materials used to build the SafeBIS shelter ensure safety, well-being, and the possibility of coexistence of a lot of people by creating modules.

The requirements to be observed were analyzed, then the dimensions, capacity, and requirements to which the shelter is subjected were calculated in order to determine its resistance in case the maximum number of people recommended to live inside is exceeded. At the same time, these tests simulated the external forces in case of unfavorable weather conditions. The tests confirmed that the SafeBIS materials and structure contributed to obtaining very good results, being resistant to very high loads, and being a suitable product for the Equatorial area to which it is addressed. Due to the inevitable situation of COVID-19 and certain limitations, the work was a bit difficult and the prototype could not be made, but to compensate for this, a model was made to illustrate the folding and the image of the whole of this product. Although this was no longer possible, a list of materials for assembling the real product was made, as well as a possible prototype.

The team encountered difficulties during the project, but the dedication of each member and the cooperation led to the realization of a feasible, sustainable product that provides safety to the user and is in accordance with current rules and legislation, respecting the laws of ethics and human rights.

In the next chapter, is described the future development and a discussion that will present the conclusions and prospective the team drew during this project, so the team will discuss aspects related to the product, limitations, requirements, and results obtained.

## 8 Conclusions

### 8.1 Discussion

The team set out to test the feasibility of creating a successful business surrounded the idea of providing safe unique temporary shelters, for people in areas affected by natural disasters. The team created a marketing plan to promote the foldable disaster shelter to target people and organizations.



A detailed business plan was created to specify logistics, costs and funding, supplies, and target consumers. This allowed the team to fully specify the ins and out of the business to potential sponsors for future funding. In addition to the marketing plan, there were also goals of sustainability and ethical concerns pursued.

According to the ideas the team started with at the beginning, the result is quite different. Starting with the design, the folding system and the materials used, they were optimized as much as possible, so that from the wood used for the whole structure of the shelter, the team agreed, following some tests, that aluminium is a very resistant material and with a much lower weight, thus streamlining the assembly of the shelter and its timely use.

The folding system is more efficient and fast, avoiding the use of additional bonding materials and the use of too many materials.

In terms of creating the shelter, the team has made a good start in refining the process and testing the concept. The entire shelter was developed and prototyped virtually, the functionality was tested using simulations however the team was not able to create a physical prototype of the shelter due to restrictions and time lags. Despite this, the team is striving toward a successful functional shelter.

Concerning the virtual model, strength simulations were done and the results obtained led the team to modify certain parts of the shelter, so that, as mentioned above, due to the values obtained from the tests, the weight of the shelter was reduced, but the resistance remained very high. The weak points highlighted by the simulation were concentrated in the hinge area, but this was changed in the end, being made a better design of them.

The team created a scale model to get a better vision of how the shelter would look and work but as we could not use the real materials, no tests were able to simulate with the model. This limited us to check the functionality of the shelter. Not knowing if the cocoon of cotton can stay inside to the structure while folding it to its compact version, is the first limitation. The team predicts that this will be possible but can not ensure it without testing. Being able to keep the cocoon connected to the structure while folding it would be an advantage as this facilitates the set-up. In case this would not be possible, the team has to provide the shelter with new attachment points so the cocoon can be detached/attached easily when breaking down/setting up the shelter. More time will be needed to do this. Not been able to test if the compact version of the structure and cocoon fits perfectly in the storage box is a second limitation. So far the dimensions of the box were calculated using the dimensions of the folded structure with the addition of extra space for the fabric (cocoon). Only by making a prototype with the right materials, we can find out whether everything fits perfectly in the box or whether adjustments of the dimensions are needed. The team focused on the implementation of ventilation in the shelter to pursue a pleasant temperature inside. Also, in this case, a prototype is needed to test the temperatures inside and to decide if additional ventilation is necessary. In the near future, a prototype has to be made to check all the above limitations.

In general, the team will continue developing the shelter while striving for optimal safety. The team would like to investigate potential problems in order to prevent risks in the future and develop countermeasures for prevention.

- TEAM OUTCOME

The team worked with each member's strengths which consolidated their own knowledge in the field while also developing many other skills in subjects such as marketing and sustainability. Soft skills such as organization and communication were also practiced and developed. All the team members can agree that the EPS@ISEP was a very useful experience in not just personal development but also preparing them for future employment. Not to mention the whole experience allowed the members to

explore Portugal and indulge in its rich culture.

At the beginning of this semester, we faced the problem of building a solid team between different cultural people from different countries and most important with different levels of English as a method of communication. Collaborative work can be difficult, especially in a multi-cultural and multi-disciplinary context. One of the biggest challenges the team faced was time management while organizing logistics and distributing tasks amongst the team members. There were a lot of ups and downs during our time working together but we decided to see this experience as a lesson. In our future as strong individuals we will be faced with similar situations and the solution the team has found to work through it, to be solid and to support each other in our weaknesses, will become a useful skill. We divided each task depending on our knowledge and our strengths. During the project, we had to trust our teammates and help each other when it was needed. The positive thing about this experience is that we learned a lot about each member's fields, about how to work with strangers and most importantly about ourselves.

## 8.2 Future Development

Throughout the project, our team had the chance to apply their knowledge and skills to achieve a common result, thus overcoming certain barriers of differences between us and could make a feasible product to be offered for testing, and then distributed in areas with high needs.

Due to time, budget restrictions, and sometimes a lack of experience, the team was not able to develop its product to its full potential and encountered certain problems; the impossibility of making a prototype to be able to observe more closely the possible problems or improvements that may occur, but a model was made to observe the general idea of the shelter.

The development of this product can be extended in the longer term, and improvements and more efficient solutions can be made to optimize the SafeBIS product, so for a vision of the future, the team has established some aspects.

Certain aspects are related to the functioning of the team, so to be much more efficient, the team members must manage their time very well and be very well informed and fully devoted.

In order for the project to be fully functional, the team would like to focus on several aspects in the future:

- perform several tests to ensure the health and safety of the user;
- to optimize the use of materials, so that there is no high consumption of materials;
- to reduce the weight of the shelter as much as possible for better manoeuvrability and to facilitate transportation;
- there is a possible extension of the living space so that we can also design the inside space, developing pieces of furniture to work together with the foldable shelter;
- to make partnerships with as many volunteer associations as possible to save as many people affected by disasters as possible;
- to make the shelter as customizable as possible for a high degree of entertainment;
- to extend the area of applicability, not only in the Equator area but everywhere in the world where necessary;
- to develop as much as possible the online environment to implement people's idea of disaster anticipation and prevention measures, so that they can purchase their shelter before something terrible happened.
- improve the design of the shelter (after doing the simulations the team made up a document to explain which adjustments can be made in the future to improve the shelter, the document can be found at the deliverables, it is called '*SafeBIS Shelter V4.2 - The (New) Components and*

### Functionality, Testing and Future Development'

In the future, a prototype will be created with the right materials. This prototype will allow the team to do proper functional tests, to limit mistakes, and to optimize the shelter. Concerning the prototype, the team will go to many manufacturers to compare all the needed materials. By comparing different manufacturers, high quality and reliability will be pursued. Regarding the cotton, it is essential to test and feel various kinds of cotton. By doing this we will get informed better and will be able to select the best isolation. In the near future, the team would like to develop an effective partnership with all selected manufacturers.

After creating the prototype and optimizing the shelter, the team will have its final model.

Prospectively, to guarantee success the team would invite an expert to share some knowledge into the manufacturing process while lowering production costs. Another option would be to outsource the manufacturing process. Once the manufacturing has been established the team would start to distribute the shelters to areas in need.

## 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

- 
- [1] Paul DE TROCH. *Internal Market, Industry, Entrepreneurship and SMEs, Machinery*. European Commission [Accessed in March 2020].
  - [2] European Commission. *Electromagnetic Compatibility (EMC) Directive*. European Commission [Accessed in March 2020].
  - [3] European Commission. *The Low Voltage Directive (LVD)*. European Commission [Accessed in March 2020].
  - [4] European Commission. *Radio Equipment Directive (RED)*. European Commission [Accessed in March 2020].
  - [5] European Commission. *Restriction of Hazardous Substances in Electrical and Electronic Equipment*. European Commission [Accessed 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 [Accessed in March 2020].
  - [7] Ken Schwaber. *Agile project management with scrum*. Microsoft [Accessed in Febr 2020].
  - [8] Ken Schwaber. *SCRUM Development Process*. Business Object Design and Implementation [Accessed in Febr 2020].
  - [9] SlideModel. *3D Animated Scrum Process PowerPoint Template*. SlideModel [Accessed in March 2020].
  - [10] United Nations High Commissioner for Refugees. *Emergency shelter standard*. EMERGENCY HANDBOOK [Accessed in March 2020].
  - [11], [13], [15] United Nations High Commissioner for Refugees. *Shelter Solutions*. EMERGENCY HANDBOOK [Accessed in March 2020].
  - [12] United Nations High Commissioner for Refugees. *SHELTER DESIGN CATALOGUE*. UNHCR Shelter and Settlement Section [Accessed in March 2020].
  - [14] United Nations High Commissioner for Refugees. *Emergency Handbook*. Older persons [Accessed in March 2020].
  - [16] Runner Front. *Roof Top Tent - by Front Runner*. Front Runner [Accessed in Febr 2020].
  - [17] Attwoolls Outdoors. *Vango Capri 500XL Airbeam Tent 2019*. Attwoolls Outdoors [Accessed in

Febr 2020].

[18], [19] Amazon. [ZOMAKE Automatic Camping tent 2 3 Person - 4 Season Backpacking Tent Portable Dome Quick Up Tent](#). Amazon [Accessed in Febr 2020].

[20] TINA HOVSEPIAN. [SHELTERS](#). Upswell [Accessed in Febr 2020].

[21] UPSWELL. [Cardborigami: A pop-up solution to reshaping the LA homelessness crisis](#). Upswell [Accessed in Febr 2020].

[22] 2020 The Animal Club January 9. [Rescue sets up makeshift koala shelter in school gym after Australian bushfires](#). Johan Rikner [Accessed in Febr 2020].

[23] HangZhou TianYuan. [Speedypet High Quality Wholesale Custom Cheap Pet House Foldable Dog Bed](#). Alibaba [Accessed in Febr 2020].

[24] Escambia County Florida. [Animal Services](#). My Escambia [Accessed 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 [Accessed in Febr 2020].

[28] Amazon. [Wooden Pet House](#). Amazon [Accessed in Febr 2020].

[29] Amazon. [PUPPY KITTY Cat House Insulated Foldable Pet House](#). Amazon [Accessed in Febr 2020].

[30] Shopee. [Cage for dogs Collapsible-Pet Crate Brand](#). Shopee [Accessed in Febr 2020].

[31] Work Breakdown Structure. [Work Breakdown Structure \(WBS\)](#). Work Breakdown Structure.com [Accessed in March 2020].

[32] Glassdoor. [Salary: Engineer in Porto](#). Glassdoor [Accessed in April 2020].

[33] Larry Smith. [Shift-Left Testing](#). Dr. Dobb's [Accessed in May 2020].

[34] Unice.fr. [Achieving Quality Through Teamwork](#). Unice.fr [Accessed in May 2020].

[35] Your Article Library. [Product Quality: Definition, Characteristics and Importance](#). Your Article Library [Accessed in May 2020].

[36] Jose Maria Delos Santos. [Understanding Responsibility Assignment Matrix \(RACI Matrix\)](#). PM [Accessed in March 2020].

[37] wikipedia. [Responsibility assignment matrix](#). Wikimedia Foundation [Accessed in March 2020].

[38] Your Article Library. [Communication: Meaning, Purpose, Importance and Principles](#). Your Article Library [Accessed in April 2020].

[39] Project Management Institute Annual Seminars & Symposium. [Effective Strategies For Exploiting Opportunities](#). Project Management Institute [Accessed in April 2020].

[40] Andrew Blackman, Andrew Blackman, Andrew BlackmanFreelance, Blackman, Andrew BlackmanFreelance, Andrew Blackman, Wall Street Journal, Wall Street Journal. [Effective Risk Management Strategies](#). Envato Tuts+ [Accessed in April 2020].

[41] Ann Handley. [How to Repel the Wrong Customers -- and Attract the Right Ones](#). Entrepreneur [Accessed in Febr 2020].

[42], [43] Hannah Ritchie, Max Roser. [Natural Disasters](#). Our World in Data [Accessed in June 2020].

[44] Startup Guide IONOS. [Market analysis: definition](#). Startup Guide IONOS [Accessed in 2020].

[45], [46], [47], [49], [50], [51] Disruptiv Nation. [Drive Business Strategy & Competitiveness with Porter's Five Forces " Disruptiv Nation](#). DRIVE BUSINESS STRATEGY & COMPETITIVENESS WITH PORTER'S FIVE FORCES [Accessed in March 2020].

[48] Corporate Finance Institute. [Bargaining Power of Suppliers - Factors that Give Suppliers Power](#). Corporate Finance Institute [Accessed in March 2020].

[52] Wanderlust Worker. [Setting S.M.A.R.T.E.R. Goals: 7 Steps to Achieving Any Goal](#). Wanderlust Worker [Accessed in April 2020].

[53] Randy Olson, Liang Sen, Daniel Leal-Olivas. [How People Make Only a Jar of Trash a Year](#). National Geographic Society [Accessed in April 2020].

[54] Julie Beck. [The Psychology of Home: Why Where You Live Means So Much](#). Atlantic Media Company [Accessed in April 2020].

[55] Michelle Douglass. [Earth - Nine incredible buildings inspired by nature](#). BBC [Accessed in April

2020].

[56] MUNICH RE. *World map of the 50 major loss events 2016: Munich Re*. MUNICH RE [Accessed in April 2020].

[57] Guardian News, Media. *Charitable giving - how does it differ by age?*. Guardian News and Media [Accessed in April 2020].

[58] Ahsan Ali, Shaw. *Brand Promotion – Importance, Techniques & Examples*. Marketing Tutor [Accessed in June 2020].

[59] Toggl. *Marketing Mix: The 4Ps Of Marketing For Businesses*. Toggl [Accessed in April 2020].

[60] A Twin. *The 4 Ps of Marketing: Know What They Are*. Investopedia [Accessed in April 2020].

[61] Susan, Ward

[62] Kanbanize. *What is Plan-Do-Check-Act Cycle?*. Kanbanize [Accessed in April 2020].

[63] BillIT, Mind Tools Content Team, Mind Tools Content Team, Mind Tools Content Team. *Plan-Do-Check-Act (PDCA): Continually Improving, in a Methodical Way*. MindTools [Accessed in April 2020].

[64] FutureLearn. *The three pillars of sustainability*. FutureLearn [Accessed in May 2020].

[65] FutureLearn. *The four pillars of sustainability*. Futurelearn [Accessed in April 2020].

[66], [67], [70], [71] Sophia Apel. *THE ROLE OF SUSTAINABLE DESIGN IN THE CURRENT REFUGEE CRISIS*. Greenofficevu [Accessed in April 2020].

[68] Division for Sustainable Development Goals-United Nations. *Transforming our world: the 2030 Agenda for Sustainable Development*. United Nations [Accessed in April 2020].

[69] Unilever Nederland. *UN Sustainable Development Goals*. Unilever Nederland [Accessed in April 2020].

[72] Vietnambiz. *Phân tích vòng đời sản phẩm (Life Cycle Analysis – LCA) là gì? Lợi ích*. vietnambiz.vn [Accessed in April 2020].

[73] Larry Alexander, Michael Moore. *Deontological Ethics*. Stanford University [Accessed in March 2020].

[74] David B. Resnik. *What is Ethics in Research & Why is it Important?*. National Institute of Environmental Health Sciences [Accessed in March 2020].

[75] Gail D. Baura. *Engineering ethics: an industrial perspective*. Academic Press [Accessed in March 2020].

[77] Charles B. Fleddermann. *Engineering ethics*. Prentice Hall [Accessed in March 2020].

[78] W. RICHARD. BOWEN. *ENGINEERING ETHICS: challenges and opportunities*. SPRINGER [Accessed in March 2020].

[79] Jay D. Humphrey, Jeffrey W. Holmes. *Style and ethics of communication in science and engineering*. Morgan & Claypool [Accessed in March 2020].

[80] ASME. *ASME Code of Ethics*. MAFIADOC.COM [Accessed in March 2020].

[81] National Society of Professional Engineers. *Code of Ethics*. National Society of Professional Engineers [Accessed in May 2020].

[82] World Fair Trade Organization. *10 PRINCIPLES OF FAIR TRADE*. World Fair Trade Organization [Accessed in March 2020].

[83] Civildaily. *The Ethics of Environment is Environmental Ethics*. Civildaily [Accessed in April 2020].

[84] Rinkesh Kukreja. *What are Environmental Ethics?*. Conserve Energy Future [Accessed in March 2020].

[85] European Commision. *Internal Market, Industry, Entrepreneurship and SMEs*. European Commision [Accessed in March 2020].

[86] European Commission. *Humanitarian Shelter and Settlements Guidelines*. European Commission [Accessed in April 2020].

[87] USPTO Office of Public Affairs. *United States Patent and Trademark Office*. United States Patent and Trademark Office - An Agency of the Department of Commerce [Accessed in May 2020].

[88] URBANARA. *Oak Wood*. URBANARA [Accessed in April 2020].

[89] Kavisha Desai. *Complete Guide on Oak Wood: Strong and Durable Hardwood!*. GharPedia

[Accessed in April 2020].

[90] Valger Lemn. *Lemn Stratificat - Grinzi Lemn Stratificat*. Valger Lemn [Accessed in April 2020].

[91], [92], [93], [94] 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 [Accessed in April 2020].

[95] ALUMINIUMvakman. *Aluminium koker vierkant 60x60x3 mm brut ALU - 10 tot 600 cm op maat!*. ALUMINIUMvakman [Accessed in May 2020].

[96] Alumeco. *Buitengebruik van onbehandeld aluminium*. Aluminium oplossingen [Accessed in May 2020].

[97] Aerospace Specification Metals. *ASM material data sheet*. ASM Material Data Sheet [Accessed in May 2020].

[99], [100] kurk. *Ondervloeren in Kurk en Rubberkurk*. kurk [Accessed in April 2020].

[101] 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 [Accessed in April 2020].

[102] Cedarstripkayak. *Wood Density Chart*. Cedarstripkayak [Accessed in April 2020].

[103] CorkLink. *Cork rolls for underlay / insulation - CorkLink - cork products direct from Portugal*. CorkLink [Accessed in April 2020].

[104], [105], [106] 3A Composites GmbH. *Plastics and Composites*. 3A Composites GmbH [Accessed in May 2020].

[107] DIY Home Center. *Titan Metal Post Skirt - Black*. DiyHomeCenter [Accessed in April 2020].

[108] Stop Digging UK. *Ground screw for solid foundations - Stop Digging*. Stop Digging UK [Accessed in April 2020].

[109] Menards. *Post Anchor*. Menards [Accessed in April 2020].

[110] The Home Depot. *Myard 4 in. x 4 in. Black Post Base Cover Skirt Flange and Screws for Deck Porch Handrail Railing Support Trim Anchor (2-Pack)-PNP114040 2pk*. The Home Depot [Accessed in April 2020].

[111] RAPID EPS UK. *Universal face mount brackets*. RAPID-EPS [Accessed in April 2020].

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