Using discarded surgical face masks in producing individual portable sleeping tent for Barcelona disfavored individuals

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Given the emergence of the coronavirus pandemic and the ensuing obligatory usage of face masks, the number of used face masks being dumped in the environment, landfills and incineration sites has become a significant issue. In this project, a service-product has been proposed to enable efficient handling of used face masks with respect to the environment but also in such a way that benefits disfavored people. Therefore, the two primary objectives of this project are the reduction of environmental pollution and improvement of the living conditions of underprivileged individuals who have no place to stay. The methodology proposed to achieve these objectives consists of three main stages; the first step is mask collection, followed by recycling the masks and finally the reproduction of new product from the recycled raw materials. In the first stage, used face masks are gathered from by pharmacies through providing citizens with financial incentives. Consequently, the collected face masks are sent to recycling centers to first apply disinfection method and second extract the raw materials i.e. polypropylene, and afterwards these raw materials are sent to production centers for the production phases of proposed design. Finally, after achieving the objectives of this project, BioBuild tent has been designed and will be distributed through the use of intermediaries such as NGOs, charities and volunteers to disfavored individuals in Barcelona.

**Keywords:** Surgical face mask, sustainability, revision, non-woven fabric, recycle, discarded face masks, disfavored individuals, rough sleepers, portable tent, sleeping tent, temporary shelter.
Chapter 1
Introduction:

“The number of face masks have been exceeded of the number of jellyfishes on the ocean” BBC news stated this terrifying report on 8th of July 2020 [1]. The concept of face masks usage literally is referred to couple of reasons which are human protection against infectious diseases, in some points it is conventionally utilizing in hospitals for both staffs and patients and also it has been using in air polluted countries which has caused by fossil fuels like China, India and Russia. Although there is a wide range of face mask that has been developing since it has invented, still some defects about them are not neglectable which those are generally related to its shape, material and also manufacturing process. In terms of material, additionally, it seems that responsible groups of masks production in most countries need to revise the manufacturing process specifically on its materiality and end of life.

Since the early 2020 once the Covid-19 has begun with a few cases that has recorded at the moment and also a few months later it has announced as a pandemic by World Health Organization (WHO) the situation was changing gradually in such a way that some rules and regulations has established but using face masks for most of social groups in the societies (there is a clear instruction about masks usage for each group of people with their specific characteristics, situations, profiles and also their activity types in the society) and it became a mandatory principle in many countries like: most of European and some Asian countries (Spain, Italy, France, Germany, China, Japan, Turkey and etc.) as such regarding to this fact the face mask usage has sharply increased in the world and this has been leading to a vital challenge as the most of face masks could be used only for once and after usage it should be discarded ;as a consequence, the waste which is caused by them is rising quickly and the demands of waste management in this specific product is highly considerable.

Alternatively, as it is examined by responsible organizations this huge amount of discarded face masks couldn’t be organized properly as long as the capacity of waste management sites are almost limited and it is hard to keep this balance between face mask production and its waste which is generated by masks.

Therefore, it could be more beneficial to manage this kind of waste by taking advantage of them in order to producing something useful due to resolving another social capital problem that could be referred mainly to a group of disfavored individuals on the street.
1-1) Objectives:

1-1-1) Environmental Pollution reduction:
By dividing face mask usage into two main phases which are 1) Before Covid-19 and 2) After Covid-19 it is obvious that the pollution caused by this kind of masks has been referring mostly to second phase. After coronavirus pandemic announcement the usage of surgical face masks has been increased due to WHO instructions [2], simultaneously, such as other products in the global market by increasing their demand and without thinking about their end of lives the unavoidable environmental pollution has been caused and in the case of single-use face masks this problem also has been caused since its demands has risen up, as a matter of fact, coronavirus waste has become a new form of pollution as single-use personal protective equipment (PPE) has been abandoned more than normal situation in the environment. The main goal of this project, therefore, is recycling and reusing this kind of waste in terms of reducing its harmful impacts on the nature.

![Fig1: Millions of masks are being thrown away every day; REUTERS/Eduardo Munoz](image)

1-1-2) Improving disfavored individuals living situation in Barcelona:
Considering the wide range of disfavored people in the society it requires to be more defined in this project to approach them consciously. Disfavored people are those people in the society who has rejected as a result of being different from other members of a group or society [3] or in other words those who has been ignored by other people in the society because of some reasons such as race, social class, language and etc. the main focus of this project is those
disregarded people on the street (public spaces) with least living condition that normally are passing their lives without shelter or any other proper living place. Regarding to the last counts of this rough sleepers in May 2020 during emergency condition because of Covid-19 the number of these people in Barcelona was about 1,239 [4] which is vital importance. The secondary proposed aim for this project could be toward overcoming this rough sleeper problem which is mainly - after food and clothes - a safe, secure and convenient place for sleeping with taking advantage of those used face masks since their demand of safe and secure sleeping place has been stood out specifically after March 2020 lock down announcement in order to street emptiness as such there was no activity in the city since everything was closed. The truth is these disfavored people could resist a bit better on the street if there would be normal life situation because at least if they will be lucky, they could find their basic living stuffs such as cardboards, discarded mattresses or blankets and also other basic disposed things that could help them for building their temporary sleeping place and they could not find those stuffs at that intolerable period at all.

Fig2: Taken by Emilio Morenatti; Barcelona homeless in the time of corona; 25.03.2020
“It is as if there has been a nuclear explosion and (people) are all sheltering in the bunker. Only us, the homeless, are left outside,” says 36-year-old Gana, who has lived on the street for more than eight years and uses only one name [5]

![Image](image.jpg)

Fig3: Taken by Emilio Morenatti; Gana Gutierrez sits in an empty street; Barcelona Covid lockdown period; 25.03.2020

1-2) **Hypothesis:**

Taking advantage of discarded single-use surgical (medical) face masks that are most popular in terms of usage in the society due to its cost instead of its using duration which is almost eight hours [6] – those are still in users’ hands for its usage period – by designing an efficient collecting service in order to use in individual portable sleeping tent production after applying disinfection methods for Barcelona underprivileged people who are spending their lives mostly on the street.
Chapter 2
Context

2-1) History of face masks:

1800-1900

The introduction of mouth and nose coverage (mouth protection, face veils, face masks, mouth bandages) can be followed back to the turn-of-the-20th-century.

In 1897, the hygienist Carl Friedrich Flügge (1847–1923) working in Breslau at this time published his works on the development of droplet infections as part of his research on the genesis of tuberculosis. At that time, the respiratory system as a transmitter of germs came into focus of research and already mandated instructions to keep distance. In the same year, 1897, a cooperation work between Flügge and Theodor Billroth’s (1829–1894) disciple Johannes von Mikulicz (1850–1905), who also worked in Breslau since 1890, was published. Their publication dealt with performing operations wearing a ‘mouth bandage’. In here, Mikulicz described a one-layered mask made of gauze. Mikulicz, who had already been responsible for the introduction of sterile gloves made from cloth, noted concerning the applicability of surgical masks: “...we breathed through it as easily as a lady wearing a veil in the streets…” Mikulicz’ assistant Hübner resumed the topic and described a two-layered mouth protection made of gauze that should prevent driblet spread. More studies regarding the germ content in the operating room air followed. Until 1910, the application of face covers was not common in surgery and the general hospitals. Nevertheless, an earlier illustration of a multilayer face mask made of gauze can be found in the surgical operating teachings of the British surgeon B.G.A. Moynihan (1865–1936).

Fig4: Face mask following Berkeley George Andrew Moynihan (1865-1936) Abdominal Operations 1906 Saunders, Philadelphia Vol I S 24, Repro Moll-Keyn
2-2) Modern Area:

Fritz König (1866–1952) a surgeon has noted in a handbook for general surgery practitioners in 1914: “according to many years experience we consider that mouth masks are a bit frustrating and its usage is in some times unnecessary. Only those cases with sore throat and infectious diseases should wear mouth mask (mouth bondage) for any kind of medical operations and it needs to be sterilized in steam and also speaking should be in limited format”. The first time that surgical face mask has used in one operating room was on 1920s in Germany and USA. Specifically in endoscopic procedures or small surgery. Later on in next edition of the book which called ‘assistance for operating staff” and published in 1935, it is mentioned that the germs reduction were related to use of face masks and also during first world war in United States several research addressed face masks with varying thickness but still masks were generally refused as can be seen in (Fig4) and also it is shown while nurses and other operation staffs were already wearing face masks which has been made of cloth or gauze, but mostly the generation of physicians has rejected those face masks since those masks were considered really irritating for them.

Fig5: Hermman Otto Hoyer (1894-1968) 1992 Sauerbruch in a thoracotomy, Museum of Medical History at the Charité, art collection Charité, picture Bruns Inv.-Nr. 123330 Repro Moll-Keyn
In the 1940s, washable and sterilized face masks obtained advocates in many parts of the world such as Germany. In the early 1960s, the problem of disposal items made of paper and fleece was introduced in the most parts of the world after it was started in the United States. After that, in 1990s, however, there were only uncertain data available, but an unresolved debate was present between surgery and hospital hygiene which was about wound infections that could have decrement by mouth and nose protection and following recommendations of RKI (German Robert Koch-Institute for hygiene), the available data and information show that medical face mask could reduce the indoor contamination [7].

In the late 2019, after emerging Covid-19 pandemic which is caused by the SARS-CoV-2 virus the best nonpharmaceutical interventions against disease spread via the respiratory route are broadly termed social or safe distancing measures such as reducing close contact between individuals. Where safe distancing was not possible, Personal Protective Equipment (PPE) has been the most accepted term for self-protection. Face masks and respiratory equipment again has been more appearing based on competent specialists’ statements and it has been getting over and over conventional since it leads to couple of developments for this kind of PPE which are mainly face masks and gloves so far. Additionally, the idea of disposable face masks usages has been rising since its cost in the first approach is much cheaper than other kinds of face masks in the real world. Evolution of single-use face masks has been exponential since its first days back in ancient era but it is still saving the basic shape in terms of its usability and only the materials, colors and manufacturing process might have been change recently [8].
2-3) General:

- 2-3-1) Technical specifications and standard requirements for medical face masks

Common testing standards for masks are as follows (China):

- **EN 149** “Respiratory protective devices – filtering half masks to protect against particles – requirements testing marking”
- **ASTM F2100** “Standard specification for performance of materials used in medical face masks”
- **CFR 42 Part 84** “NIOSH guide to the selection and use of particulate respirators”
- **EN 14168** “Medical face masks, requirements and test methods”
- **GB 2626** “Respiratory protective equipment. Non-powered air-purifying particle respirator [9].

- Surgical face masks ongoing material:
The material most commonly used to make the surgical face mask is polypropylene, either 20 or 25 grams per square meter (gsm) in density [10].

![Fig7: Disposable 3ply surgical/medical face masks material; EN14683, NOISH STANDARD](image)
2-4) Disfavored individuals

2-4-1) Definition:

Generally speaking, there is no specific data and information about the amount of these kind of people on the street around the world and the reasons for this are widely different regarding to different territories involved.

The most important thing in this issue is categorizing these people in order to approach their problem more clear and help them to overcome it in an easier and faster way. In spite of lack of information about the amount of them there is a firm categorizing method particularly in Europe which is called European Typology of Homelessness and Housing Exclusion (ETHOS) that in this case could cast some light on this issue on the European countries which Barcelona in Spain is one of them and they are following this classification.

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<th>Operational category</th>
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<td>Roofless</td>
<td>1 People living rough</td>
<td>1.1 Public space or external space</td>
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<td></td>
<td>2 People staying in a night shelter</td>
<td>2.1 Night shelter</td>
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<tr>
<td>Houseless</td>
<td>3 People in accommodation for the homeless</td>
<td>3.1 Homeless hostel</td>
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<td></td>
<td>4 People in a women’s shelter</td>
<td>4.1 Women's shelter accommodation</td>
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<tr>
<td></td>
<td>5 People in accommodation for immigrants</td>
<td>5.1 Temporary accommodation, reception centres</td>
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<tr>
<td></td>
<td>6 People due to be released from institutions</td>
<td>5.2 Migrant workers' accommodation</td>
</tr>
<tr>
<td></td>
<td>7 People receiving longer-term support (due to homelessness)</td>
<td>6.1 Penal institutions</td>
</tr>
<tr>
<td></td>
<td>8 People living in insecure accommodation</td>
<td>6.2 Medical institutions</td>
</tr>
<tr>
<td></td>
<td>9 People living under threat of eviction</td>
<td>6.3 Children's institutions/homes</td>
</tr>
<tr>
<td></td>
<td>10 People living under threat of violence</td>
<td>7.1 Residential care for older homeless people</td>
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<tr>
<td></td>
<td>11 People living in temporary/ non-conventional structures</td>
<td>7.2 Supported accommodation for formerly homeless persons</td>
</tr>
<tr>
<td></td>
<td>12 People living in unfit housing</td>
<td>8.1 Temporarily with family/friends</td>
</tr>
<tr>
<td></td>
<td>13 People living in extreme overcrowding</td>
<td>8.2 No legal (sub) tenancy</td>
</tr>
<tr>
<td></td>
<td>14 People living in extreme overcrowding</td>
<td>8.3 Illegal occupation of land</td>
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<td></td>
<td>15 People living in extreme overcrowding</td>
<td>9.1 Legal orders enforced (rented)</td>
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<td></td>
<td>16 People living in extreme overcrowding</td>
<td>9.2 Repossession orders (owned)</td>
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<td></td>
<td>17 People living in extreme overcrowding</td>
<td>10.1 Police recorded incidents</td>
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Source: adapted from FEANTSA, 2007

Fig8: ETHOS – European Typology of Homelessness and Housing Exclusion
The term ‘literally homeless’ is often used to denote the people staying in shelters for the homeless, on the streets, or in other similar settings (e.g., in abandoned buildings, in make-shift structures, in parks). And within the group of people experiencing ‘literal homelessness’, it is common to distinguish between the ‘unsheltered homeless’ and the ‘sheltered homeless’. Unsheltered homelessness is also sometimes referred to as ‘rough sleeping’ or ‘rooflessness’. Aside from the ‘literally homeless’, there are many other persons who are often classified as ‘precariously housed’. This term is often used to denote people living with a family member or friend for lack of alternatives and unfortunately for the purpose of measurement, estimates are not available across all these groups. In many countries it is common to report together the ‘literal homeless’ with the ‘precariously housed’ [11].

2-4-2) Spain - Barcelona:

National systems for data collection on homelessness are in place in Spain but there are some significant gaps. The estimated homeless population according to NGO service providers is between 23,000 and 30,000/35,000 people. However, in Spain it is impossible to determine the extent of residential exclusion. Although there has not been existing clear estimation about homelessness in Spain, it is clear that they are rising mainly because of socio-economic situation which has been held during last 5 years (specifically coronavirus). According to Spanish National Statistics Institute (INE) 2016 data, the daily average of people who stayed in homelessness services increased by 20.5% in 2016 compared to 2014. Homeless shelters in Spain received an average of 16,437 people daily during the year 2016. This figure is 20.5% higher than the registered in the previous homelessness services survey carried out in 2014. The average occupancy reached 85.9%, a figure higher than that observed in 2014, which was 81.8% [12].

Fig9: Evolution of the capacity and occupancy of the accommodation network
In Barcelona there are some foundations and institutions who are tackling with this uncomfortable situation in a large scale and the most famous one of them is Arrels Fundació. They have started since 1997 and they are the most active charity that are dealing with this homelessness topic in most of the aspects in Barcelona and Spain. Based on their inquiries which has held in May 2020 during the emergency state they counted around 1,239 rough sleepers on the street in Barcelona [13].

2-5) Shelter/tent (sleeping tent):
Convenient shelter of canvas, skins, felt, matting, or other material generally upheld by posts and utilized mainly by trackers, nomads and campers. Tents have been utilized by peaceful people groups since old occasions and are referenced in the Old Testament and in Homer. Persian tents, typically roundabout, were early noted for rich hangings and rugs coverings. Armed force tents created by old people groups incorporate the little, skin-shrouded tents of the Greeks and the Roman tents of material upheld by two upstanding shafts and a ridgepole. Middle age military tents were round or oval and were regularly extravagantly hung with silks or hides. Armed force tents were broadly utilized in Europe in the 17th and 18th century. however, are currently utilized mostly for preparing purposes. Current sorts incorporate chime tents with a focal shaft; the A tents with sides inclining from a ridgepole; and the marquee, an enormous field tent, utilized for wreck or clinic covers. More modest tents for sporting setting up camp and exploring incorporate vault, "spotlight," and different plans that ordinarily use shock-corded aluminum or fiberglass shafts and lightweight textures. The yurt, a round, felt-shrouded construction of meshwork overcomes by bended posts fitted at the top into a ring framing a smoke opening, has for some time been utilized by travelers of the Asian steppes. Desert tribespeople of W Asia and North Africa for the most part utilize a ridgepole tent. One of the most straightforward tent structures is the windbreak, which was predominantly utilized in Patagonia. Extraordinary tent plans incorporate mountain tents, which are planned minimally for use in states of outrageous cold and hefty snow, and exploring tents, which utilize very lightweight engineered textures and lightweight metal shafts. "Pop" tents are planned with
spring-stacked edges that erect the tent consequently when delivered; these are normally hemispheric fit [14].
Chapter 3
3-1) Recycling masks

3-1-1) PLAXTIL: One of the firsts circular mask recycling solutions, Launched by industrialists from Châtellerault, France, PLAXTIL is the fruit of a research project that started in 2017. In partnership with the New Aquitaine Region, the Grand Châtellerault, Eco-Tlc and Adème, PLAXTIL was officially launched at the plastics industry show K2019 in Düsseldorf, Germany. The circular operation for the recycling of protective masks was launched in June 2020 in the agglomeration of Grand Châtellerault. About fifty collection points were distributed throughout the city with merchants and voluntary SMEs. Collection is ensured by AUDACIE, which quarantines the masks 4 days before they are integrated into the PLAXTIL manufacturing process. In addition to this, at the end of August 2020, more than 70,000 masks had already been recycled.

3-1-2) Decontamination process
The decontamination of the masks was a prerequisite for the launch of the operation. After consultation with the regional health agency in France, the decontamination process follows two specific steps:

- A minimum quarantine of 4 days after collection,
- A systematic passage of the crushed masks in a very powerful ultraviolet tunnel which removes any virus or any germ in less than 5 seconds. The mask compound remains for almost 30 seconds in the UV tunnel.

To design this innovative decontamination tool, PLAXTIL joined forces with the French start-up UVMOBI (UVmobi is inventing innovative solutions for disinfection by germicidal ultraviolet rays), a specialist in the decontamination of shared transport. Therefore, their solution is a kind of ecological plastics because it enhances all-comer textiles that no longer
end up in landfill or burnt. It is infinitely recyclable and can replace 100% petroleum plastic materials. It is a credible alternative for the industry in general and for the fashion industry in particular [15]

Fig14: PLAXTIL boxes for collecting discarded face masks

3-2) WASAMASK: Recycling the face masks to protect the environment,

ITAINNOVA is the Technological Institute of Aragon, a Technological Center with its own legal personality, non-profit making and whose purposes are of general interest, legally constituted at the initiative of the Government of Aragon in 1984 and chaired by the Department of Science, University and Society of the Knowledge of the Government of Aragon that also has the recognition of the Ministry of Science. At ITAINNOVA, they wanted to study the option of obtaining a mixture of recycled materials, obtained from masks. The masks used by the workers have been used, they have been disinfected by spraying with alcohol and with heat. Subsequently, and after the elimination of the rubbers and the adjusting metal, the whole grinding has been carried out without separating any of the different types of plastic. Once they have the material in flake type format, it has been processed in the same way as other plastics are processed, by extrusion and subsequent injection into a mold. The end result has been pieces with defined geometry. The material obtained has been characterized to know the properties of the mixture and it has been seen that they are comparable to those that can be obtained with other polypropylene and polyethylene plastics. What they want to achieve with this study is a first step, to try to reduce the contamination that masks are generating in these times of
pandemic. In such a way that, from this current staple product, others can be produced such as "ear protectors" for use or others for daily use such as toys, flowerpots and etc. [16].

3-3) Products, produced by fabric and textile

3-3-1) Studio Samira boon: designs productive workspaces with 3D textile acoustic elements,

“The era of the open office plans presents new spatial needs and challenges”. Acoustic properties have to be combined with the ability to accommodate flexible, collaborative working habits. as the tips and examples above show, this required a flexible and creative approach to the interior design of offices. 3D textiles are an example of a sound absorbing materials that can be designed and engineered to suit the specific needs, while their tactility influences the way experience spaces. experimenting with new materials and structures generates unexpected solutions [17].
3-4) **Woven Spaces: Porcelain Textiles,**

This project has been received the 1\textsuperscript{st} prize in the 15\textsuperscript{th} student competition ‘textile structures for new building 2019’ in the field of material innovations category. This contribution by Magdalena Wierzbicka documents an empirical research process, which harks back technically to the Thuring- ian tradition of porcelain lace from the late nineteenth century and transforms it into a modern formal language. The process represents an inversion of the casting process usual for porcelain, whereby the textile weave becomes the substrate as a “positive form” and, in firing, finally evaporates as a “lost casing.” Through the use of course, partially damaged or heavily corrugated fabrics the results look like the “styles” of a movement. The contradiction between seemingly accidental snapshot and a fragile image frozen in eternity has a high aesthetic quality. The next stage in the concept, of making from the individual parts a more complex textile structure again, is seen by the jury as just one of the many interesting possibilities of this inspiring process. Many further exciting structural concepts are yet conceivable [18].
3-5) Shelter/tent

3-5-1) Cardboard tents: Origami style tent for homeless in Brussels,

With material tents taboo in the city of Brussels, disfavored individuals in the Belgian capital are regularly left without a protected spot to rest. However, one business person appears to have discovered a way around the standard: origami-style cardboard tents. The tents can be collapsed and carried on somebody's back, and are adequately large to house two individuals. The expectation is that they can keep going two or three weeks prior to waiting be substituted, said Xavier Van sanctum Stappen, the business person behind the ORIG-AMI project.

Cardboards are light, they keep the heat, and if they do not get wet, they are pretty resistant. The Brussels region had in excess of 2,600 homeless in early 2017, as per La Strada, which screens vagrancy in city. Yet, a large portion of the safe houses there are stuffed by wintertime, said Olivier Vanden Avont, the leader of L'Appel du Coeur, the group that helped distribute the tents, just as everyday fundamentals: a blanket, underwear, a T-shirt and a toilet kit. On the off chance that the cardboard tents can keep going for a month, this will be a success as of now," Mr. Vanden Avont said, adding that homeless feared the cold weather more than whatever else. Temperatures in Brussels have gone from 30 degrees to 50 degrees Fahrenheit (less 1 to 10 Celsius) in December. Mr. Van den Stappen said he first thought about the cardboard tents in early 2017, when he was discussing the dangers of the cold with a homeless man who was using cardboard in the streets of Brussels. The general concept of origami style tent was about using least materials in terms of its cost and also the most durable and lightweight one for supporting the idea of portability since the target users need to carry their temporary shelter from one place to another one. It is, therefore, designed by folding cardboards vertically in an equal networks and general shape of triangle [19].

Fig18: One of the cardboard tents, known as the ORIG-AMI project; outside the Brussel metro station; Agency France-presse; Getty Images; 2017
3-6) Beluga tent from Qaou:

Setting up camp is about area and climate, and those two variables can vigorously impact how you camp. Sometimes it’s sunny out, sometimes it suddenly begins pouring. Your campsite could be grassy, muddy, gravel-filled, or even have a rivulet or stream flowing underneath. What is more, it just bodes well that your setting up camp gear/cover changes itself dependent on those elements. Beluga it is a new product which is designed in Qaou (France) to be portable, adjustable, and modular too, it easily transforms based on users’ needs. The tent comes with an inner enclosure, held in place using aluminum rods, and covered with an outer cover that helps properly shield you from elements like the rain or even the sun. Beluga tent wears its white color as a badge of honor because it made entirely from recycled plastic water bottle and to prevent the use of environment-harming chemical dyes, the tent just opts to stay white instead. Each Beluga tent is made using an average of 125 plastic bottles, helping cut environmental waste [20].

Fig19: Eco friendly Beluga tent from Qaou company; fabric production process outline; 2020
Chapter 4
Methodology

Based on investigation referred to users’ demands and the general context of the proposal so far, due to overcome disfavored people needs this project will be consisted of 3 main steps: 1) Identify and explore 2) Discover, frame and emphasize 3) Ideation, design and development. The goal of each phase is developing the idea by taking advantage of other steps while those are not linear since each phase is independent and at the same time related to others. The purpose of the first stage (identify and explore) is to explore more the topic of sustainable design in relation with portable sleeping tent by surgical face masks material that could help rough sleepers and also reducing environmental pollution to identify potential opportunities to refer it for next steps as a firm backbone. In step two, moreover, it is aimed to dive deeply into the problem(s) which has been trying to solve by becoming immersed in the lives of the people involved directly with identifying and framing needs, gaps and opportunities, besides, finding all related stakeholders both direct and indirect who play role(s) in this project in order to assess and analyze all the information for design and development phase. Finally in step 3 as it is obvious everything should be gathered together since the problem is clear and after framing it, it is just needed to think of solution and the possibility of achieving it. The main process in the last stage would be ideation as much as possible based on all the information and data which has been achieved in a convergence way and after checking and evaluation, applying divergence method and going narrow down about those ideas that would be selected in order to achieve the final design.
4-1) Identify and explore

• 4-1-1) Surgical face masks secondary advanced research:

4-1-1-1) What happens to the face masks after throwing them away:

Normally disposable face masks are becoming the main part of our livings and it is a little dangerous since they are mostly made of polypropylene and polyethylene which have several harmful impacts on environment. The main concern about them is referring to its caused waste and in many countries with advanced waste management system there is a lot of problem to deal with it. In some countries it is decided to end them up in the landfill sites and in another countries, they choose incineration methods. Both landfill and incineration are ongoing way of tackling with this problem in the world so far and still developing countries are trying to find a most proper way in order to resolve the problem which has been caused by face mask wastes since it is a trendy topic these days.

In India, The GMC (Indian waste collector) Commissioner has appealed through SC (Sikkim Chronicle - reliable digital news platform) to the general public to segregate the masks beforehand so that it’s not mixed with the other waste. This little act could save cleaners the health risk and pains of having to segregate everything themselves, the same could be applied to sanitary napkins, anything with body fluids, during the pandemic and during normal times as well. Pritam Pany (CEO and founder of Vouyage; private social Indian enterprise working in the space of zero waste and sustainability) We must understand this face mask goes somewhere; it doesn’t just disappear. If the general public’s face mask waste was also incinerated it would be well and good, but the face mask disposed of by the public is taken to Martam’s or 32 Mile’s landfills where they are buried [21].

Likewise, in the case of England, used (and potentially contaminated) face masks are considered medical waste and typically directed to incineration when they arise from a clinical setting. However, there is currently no specific waste stream for these products if used by the general public. Conventionally, waste PPE is placed in mixed general waste at a household level, which may put waste collectors at risk of contracting infections. The Association of Cities and Regions for Sustainable Resource Management has advised keeping contaminated waste in a double bag for 72 hours before disposing into general waste. Considering that the half-life of the virus is 5.6 hours, this seems reasonable [22].

Moreover, in Barcelona according to Catalunya waste agency, ministry of health, ministry of labor and social economy and also government of Spain there is some rules and regulations in
order to discard the masks by citizens and also about the following procedure that competent authorities need to apply on them.

4-1-1-2) What is the medical/surgical face masks waste process in Barcelona:

1) **Usage:** After using face masks, once the user wants to discard it, it is suggested by ministry of health to take them off without touching outer surface and washing hands with water and soap after throwing them out ideally between 40-60 seconds after discarding.

2) **Discarding:** Obviously, mainly there are two kinds of face mask users that could categorize them in 1) Hospital: The hospital masks are in high risk groups, those are sanitary waste which are considered as infectious wastes (they will be collecting in a separated way by separated municipality trucks from hospitals, laboratories and other health centers) and also This was the normal way before COVID-19, these masks considered as sanitary waste and the final destination for them was elimination and no recycling program has been seen on new rules after coronavirus.

<table>
<thead>
<tr>
<th>Type</th>
<th>Transport</th>
<th>Treatment</th>
<th>Disposal</th>
</tr>
</thead>
<tbody>
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<td>Groups I &amp; II</td>
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<tr>
<td>Group III</td>
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<tr>
<td>Group IV</td>
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<td>ENRESA</td>
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<tr>
<td>Cytotoxic</td>
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<td></td>
</tr>
<tr>
<td>Chemically contaminants</td>
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Fig20: Waste agency of Catalonia – management diagram

2) **Household (non-hospital):** in the case of non-hospital users it is mentioned that they should be divided in two main situations: 1) Covid positive: All the generated masks in this category should be discarded after put in 3 layers plastic trash bag (each should be closed properly by insulating tape) and ideally store 72 hours before discarding (it is cited in some references but in Barcelona it depends on competent authorities) 2) Covid negative: The separation of the waste will be carried out as usual (based on order SND/271/2020, of
March 19, which establishes instructions on waste management in the health crisis caused by COVID-19), but according to Barcelona waste agency they will be disposing in gray trash bins after putting them inside 2 layers plastic bag (each should be closed properly by insulating tape) - The final end up will be like hospital masks [23].

3) **Collection:** This step is carrying on by municipality trucks from gray trash bins in Barcelona with three main instructions: 1) Under no circumstances will the remaining fraction bags be manually opened in collection or treatment (for Waste Recovery Plant (PIVR) that includes two facilities with different, but complementary, treatment processes. One is mechanical and refers to the biological treatment that separates recoverable materials from organic matter for the production of biogas. The other process corresponds to energy recovery, where non-recyclable waste is incinerated to generate electricity and heat) facilities 2) Masks will be using for incineration, preferably, or for landfill 3) In case of applying treatments, it will be carried out automatically prior to their incineration or landfill, admitting manual selection only for the separation of bulky, metallic or other waste that does not go in bags and it is essential to separate, provided that all necessary security measures are taken [23].

4) **Transferring:** This step accomplishment is by municipality truck like household waste to eco-parks or warehouses for storage (based on local government orders) and all the process is automated and it is running by maximum safety (using masks, gloves and other related protective rules for operators) and like previous steps there are some instructions which include 1) Under no circumstances will the bags be manually opened at collection facilities 2) The competent authorities of the Autonomous Communities may decide to allocate it to incineration, preferably, or to landfill without prior treatment, but not beyond the date on which the entire territorial unit served by the facility exceeds phase 3 of the Plan for the transition to a new normal 3) When appropriate, the treatments prior to incineration or landfill disposal may be carried out automatically or manually, provided that all the necessary security measures are adopted 4) The competent authorities may agree that the recovered materials are stored for at least 72 hours [24].

5) **Storage:** As it is mentioned in the last stages masks during COVID-19 will be stored for 72 hours in some countries like Spain (in Spain, government are trying to motivate people to store their masks for 72 hours before discarding by advertising, but they are storing in warehouses in some points according competent authorities) [23].
6) **Elimination**: After all steps finally surgical face masks will end up mainly by eco-parks in two ways of landfill or incineration in terms of generating energy such as electricity for different aspects [24].

• **4-2) Principles of sustainable design:**

Supportable plan goes about as a way of thinking that is applied by various organizations, administrative elements, and non-legislative associations to accomplish a superior future for humanity through the insightful and low-volume utilization of Earth's assets. Organizations and governments that have progressed plan procedures can possibly apply supportable plan than others. Companies like IKEA, for instance, are moving toward building manageable items. Also, numerous legislatures that carry out public plan arrangements have given positive steps toward applying sustainability. Although there are lots of sustainable instructions, following explained topics are mentioning some of them which are more important items.

**4-2-1) Form:**

The form represents the visual shape of the product and is usually perceived to be the main element of the design. The form of physical product could affect on cost of production, packaging, transportation cost and many more.

**4-2-2) Function and usability:**

The product function and usability play an indirect role in product sustainability as it helps consumers use the product more easily in less time and with less energy consumption, so usable products can ensure less waste and throwaways.

**4-2-3) Energy:**

It is worth to stop using carbon energy (fossil fuels) in both sides of production phase and using steps, and rely more on renewable energies such as solar, wind and etc.
4-2-4) **Materials and recycling:**

Same as energy, materials have an important role in sustainability, as such every designer should search for materials that can be easily recycled or for which the planet can recreate in a short amount of time. For instance, IKEA relies on blended woods and creative materials to substitute traditional groups of wood that can consume a long time of the day to fill in woodlands. The blended and reused materials can likewise assist with decreasing item cost [25].

• **4-3) Surgical face masks disposal estimation in Spain:**

As things stand, over the next few months everybody will have to use masks daily. This new situation has all kinds of impacts: difficulties in supply, which have been resolved to a certain extent, the extra cost in families’ budgets (the Organization of Consumers and Users [OCU] calculated at least 70 euros a month for a family of four) and the environmental impact of the waste that is generated. If 47 million Spaniards consumed two surgical masks a week, this would lead to 220 tons of waste per week. This calculation is really an underestimate, as the life of disposable masks is around four hours, in principle and one estimation shows that more than half of this wastes will end up in the Mediterranean Sea [26].

Saliu et al. (2021), Sullivan et al. (2021), and Wang et al. (2021) provided the first evidence on microfibers and micro and nano plastics released from disposable face masks. Saliu et al. (2021) estimated the release of microfibers from surgical face masks into the marine environment, under the effect of UV light. Results indicated that one tested mask submitted to 180 h UV-light irradiation and vigorous stirring in artificial seawater could release up to 173,000 fibers/day.

Fig 21: Potential effects of disposable face masks on aquatic and terrestrial organisms
Authors also observed similar morphological and chemical degradation signature in surgical masks collected on Italian beaches (via SEM and micro-FTIR analysis), highlighting that similar processes could be happening in the natural marine environment (Saliu et al., 2021). Wang et al. (2021) estimated the release of microfibers from surgical masks also into the marine environment, now in the presence of UV light and sediments. According to the authors, higher mask-layers fragmentation into microplastics was observed in the longest UV light exposure (5-fold; up to 5 μg/L) and in the presence of sand (2 to 10-fold, depending on the mask-layer; up to 18 μg/L) [27].

• 4-4) Disfavored individuals’ situation in Barcelona:
The average amount of time spent on the street rose to 3 years and 9 months among people interviewed during the census (2019) five months more than the average in 2018, 59.4% had spent a year or more sleeping in the street (2019). Totally in Barcelona there are more than 4700 disfavored people and more than 1230 of them sleeping roughly on the street (2020) as such between 100 and 125 of them are sleeping at ATMs, under archways, or in squats or abandoned warehouses. Around 49% of them are between 25-49 years old and mainly they are man. In Barcelona there is a guide provided by Arrel foundation that compiles more than 70 resources that disfavored people can access directly, however, most of them have their own rules and limitations in term of the service they provide, for instance, there are 3 main kitchens in Barcelona that prepare foods in certain times of a day for this people, but there is a limitation in terms of their capacity in relation with both service they provide and also the place they have [28].

• 4-5) Barcelona temporary sleeping shelter for disfavored people:
In Barcelona there are 3 hostels – Centro Residencial de Primera Acogida Sant Gervasi, Centro Residencial de Primera Acogida Zona Franca and Equipamiento Integral Nou Barris - that people can go directly and they are temporary. Most have shared room with low privacy and there are separate rooms for women. Besides, there is one short stay center which is called winter hostels (Centro de Estancias Breves) and normally it is open from December to March also it opens when the temperature drops below 5 degrees centigrade. Based on research and interviews with people who has used these temporary shelters they mentioned some common
issues about them, 1) it is not easy access to one shelter, sometimes you have to wait in a long
queue and finally you should leave it because the capacity is full, 2) Once you get in to one
center you have time to stay only between one week to 10 days since there are other people
who need it, 3) Lack of privacy is mentioned many times by users who have attended at least
to one temporary shelter, 4) There is a waiting list for each center when the users reach them
and could not go inside because of lack of capacity they could put their names and a phone
numbers on this waiting list and the center will contact them once they have free space for them
(after checking out someone) [28].

Fig22: Nou Barris Residential located on Marie curie street; Google maps
Chapter 5
Discover, frame and emphasize

- 5-1) Stakeholders:

Fig23: Stakeholders definition
In this chapter as it is mentioned earlier, the main goal is to immerse deeply into the problem(s) which has been aimed to be solved. The main point of this step is figuring out all the involved people, organizations, companies and generally all of those who will have the impact on the final solution. There would be, besides, all the stakeholders who might be touched by the probable final solution. Better understanding of their behavior and their motivations and also how these might be influenced by environment, social, economic and organizational and regulatory factors in order to figure out final touchpoints needs, values and challenges to propose the best possible solution at the end.

5-1-1) Pharmacy:
Pharmacies are those main stakeholders in the cycle of supply chain as they are normally involved in the process of face mask distribution to society in the most countries around the world – Barcelona is not an exception in this case - hence, the main idea about pharmacies during Covid-19 in Barcelona was helping inhabitants to give them Personal Protection Equipment (PPE) and still they are one of the main sources of these equipment in the city. Moreover, one of the main proposed objectives was directly related to reducing the pollution caused by PPE (surgical face masks), and it is worth to make pharmacies more involved in the cycle of reverse logistic deliveries since they could contribute in supply chain of final solution product which will be made of those discarded masks (face masks waste). They will have the high influence and the same time they have to be keep informed in relation with other stakeholders as they would be the main link between supply chain and production sites.

5-1-2) Citizen:
The most valuable key players in this chain with high influence and interest is citizens. Their role in collecting used face masks – can cause the environmental pollution if abandoned in the nature carelessly - and return them again to production cycle in order to produce another product with a concentrated service designed is not neglectable. However, their role in face masks collection phase that could help underprivilege group of society would be the focal point which could motivate them to participate as well as their empathy would be involved in the process.
5-1-3) Disfavored individuals (rough sleepers/homeless):
Although there are several kinds of disfavored individuals in Barcelona but the targeted users in this project are those people who are sleeping roughly on the street in both day and night. They will have high interest and also they should be the most satisfied group in this service.

5-1-4) Municipality:
The one and the only governmental sector involved in the project would be the Barcelona municipalities which will have high influence and almost mid interest in the project as the policy maker, coordinator, tutor and supervisor with an important key player role in both sides of reducing environmental pollution caused by surgical face masks and improving rough sleepers’ situation in the city.

5-1-5) Charities (NGOs):
Non-Governmental Organizations (NGOs) which in this case are environmentalists and mainly charities that are working on underprivileged people and disfavored individuals topic. They are the key players who will have both high interest and influence in this service same as Barcelona citizens.

5-1-6) Recycling factories:
Based on secondary advanced research in previous chapter and also two case studies about recycling face masks in Spain (Plaxtil, Wasamask) it has shown that there are a few scientific methods for face masks disinfection and also it is easier to start it from household users since they are the source of this discardness chain also the 72 hours mask storage in a sealed pack is one of the simplest way in order to reach 90% disinfection before throwing them out (mentioned by Barcelona waste agency). Therefore, the recycling factories have same level of interest and influence which are more than mid-level and their role is also as important as key players in relation to others and the main reason is they will prepare (disinfecting masks, turn them back to yarn and textile for tent production) materials after collection phase for the production step.
5-1-7) Logistic teams:
Obviously, all the mentioned process in each phase and step needs to be carry by one integrated logistic team. From collection to recycling, recycling to production and production to distribution there is a high demand of transferring channel. They should be keep informed about all the procedure since they are the main link between each player. Their high influence is worth to mention as well.

• 5-2) Scope:

A) Frame the project:
It is a dual-purpose project for disfavored individual (homeless people) between 25-49 years old mainly focused on male since they are the 49% of this community in empty warehouses yard and empty construction sites which are currently occupied mostly by underprivileged individuals in Barcelona [28], and also for all the Barcelona habitants since the side effects of those abandoned face masks can impress their lives in a very hazardous way.

B) Contextual stakeholder people research:
This part has been accomplished to assess the current situation of the first problem referred to face masks pollution in the nature that has a possibility to be solved by helping homeless people in the society. It has to be done to figure out in which part there might be some overlaps, possibilities and also opportunities to connect both objectives and resolving them by each other.

C) Map the experience:
The better understanding in this part could happen by mapping the experience and like step B it has to be started by one side (objectives) with more possibilities in order to tackle the problem(s) from one side and creating a general solution at the end for reaching both explained objectives.
• 5-3) Persona:

**PERSONAL DATA**

Julian Sala Ruis

35 years old

Single

He has been living in Poble Sec neighborhood, Barcelona For 3 years and he sleeps roughly on the street in this area during the nights and days as well.

**Concerns:**

1) Food
2) Weather condition (specifically in winter)
3) Pityness
4) Health – He has depression and he is suffering from cognitive impairment
5) To be arrested by police
6) Street fights

**Advantages:**

1) He has access to temporary facilities of municipality and charities once in a while
2) Basic necessary knowledge about daily routines

**Hopes:**

1) Warm home/shelter
2) Not being worried about food
3) Proper clothes
4) Proper social level

**Needs:**

1) Proper accommodation
2) Safety, security and privacy
3) Dignity
4) Healthiness
• 5-4) Ethnography field guide (interview):

There is a proven method of ethnography which has introduced by Institute of Design at Stanford which has to be done for people who are targeted as the final users. The aim is that to hear stories and observe actions that help in order to see people’s behavior, motivations, beliefs, and feelings. By deeply understanding people who are designing for, it could help to be able to design for them a better desirable result [29]. There are three research approaches in this field that are Immerse, Observe and engage and all of them have been evaluated through 5 interviews with rough sleepers age ranged 27-50 with 1-5 years rough sleeping experience on the street.

3 out of 5 interviewed persons were African, one was from Italy and the other one was from France. Their names, pictures and living spots have been changed, deleted and mentioned approximately due to protect their identities and privacies.

1- What is your daily routine?

Older African guy 1: Wake up by passersby noise around 9am (he had been sleeping in a narrow street close to Raval area for 2 weeks – he had been rough sleeper for 4 years), try to find something for eat, panhandling on my sleeping place, pack up my sleeping stuffs (he had some cardboards and one blanket), after packing he’ll be heading to one public toilet nearby, wandering on the street and trying to find food in several places (bakeries, restaurants, bars and etc.), searching in the city trash bins for finding anything that can work (clothes, sleeping stuffs and any useful object), around 4-5 pm going to one park close to sleeping spot and looking for people’s aid (food, money and etc.), again wander the streets for several hours, going back to sleeping spot and prepare sleeping stuffs for sleeping (usually after 12 midnight).

Young African guy 2: normally waking up around 6 am (he had been sleeping on a park bench around 22 district for couple of days – he had been rough sleepers for 1 year – normally he prefer not to sleep on the ground specially in rainy day), pack up and using public toilet in the park, trying to find food, wandering the city to find friend (he has some African friends in the common context) and sometimes using the metro lines, trying to find saleable and usable things all the day and sell them to proper places ((warehouses – he was new to chattaras (illegal trash pickers in Barcelona) business – he had been working in this market for 4 months)) most of the day, heading to buyers place and try to sell the items, receiving less than 13 Euros per day (in the ideal situation – some days there is not salable things on the street or he cannot find),
walking on the street till the late night and try to find food, heading back to his sleeping spot for sleep usually by midnight.

**Youngest African guy 3:** Wake up at 6-7 am, He had been sleeping in one of his friends coach for 3 months (his friends had occupied a big empty construction sites with his other relatives), packing up his belongings which won’t take too long because he did not have too much stuffs, heading to Arrel foundation near to Montjuic area and checkup if there is available place for staying at night or not (he had been waiting in a queue for 5 months), seeking for food, try to reach one of the provided facilities by the governments to take a shower which is so far (normally it needs to walk more than 2 hours from my place I sleep, so, I go once in a week or 10 days), then try to make money (he had some handmade pieces – he sells each of them for less than 1 Euro - he said he has been working near Sagrada Familia for 3 years and after Covid because of tourists reduction he couldn’t gain money like the first year he started), after 10 pm trying to find food in one familiar neighborhood with many bars and restaurants (if he would be lucky he could find food in the bins in front of them or receiving from them directly), heading back to friends place after midnight sleep (he paid 20 Euro for his sleeping place every night).

**French guy:** Wake up at 8am (it was not set up as a plan for his daily routine since he was alcoholic), recently he had been stayed at public shelter for 2 weeks and again back to street and staying at one close street to Placa Catalunya (he has been come out from the public facility/shelter 2 days before interviewed) as a rough sleeper he had a specific spot for sleeping and after he wakes up, he tried to reach Placa Catalunya pound for hand/face washin. Around 10-11am after packing his belongings he approaches to busy bars and restaurants for finding food and specially drink if he cannot find anything he try to search on the bins. By afternoon (after 2-3 pm) after long distance walking, he normally stays at a park to recover his energy and he normally backs to his sleeping area around 9 pm as it is the best time for searching the bins again on that crowded area specifically on that time and if he would be lucky, he finds some alcoholic beverages before sleep. A few months ago, he found a small shelter which has been discarded by citizens and he hid it during the day since he scares of thieves because of the shelter size and his other belongings he could not carry it, thereby, he hid it in greenery space until he come back to it for usage and also he use it in a camouflage way during the night and he hopes to wont be caught by police and/or other aggressive disfavored individuals.

**Italian guy:** His sleeping spot was near to Fira Barcelona and normally he wakes up before 8am. He usually starts his job on his sleeping spot (guitar player). He plays guitar to gain money and to make the ends meet and for the first round he plays till midday (around 12), then he
packs up (he had several stuffs such as his guitar its case, bicycle, backpack, blanket and some other sleeping things) due to move and find some foods (he had money but he tried to save it for his essential needs in daily life). For lunch he knows some Italian restaurant who knows him as well and they had a deal such a way that he plays guitar for their customers freely and can receive money from them. Furthermore, they allow him to search inside the kitchen for left over foods before throwing them out. He plays guitar almost all the day and try to make money from his art (he receives between 20-50 Euros per day depending on the days and locations). Almost half of his money has been dedicated to buy cigarette since he was a heavy smoker (he said he pays 200 Euros monthly for this matter). Usually, his sleeping time was around 2 or 3 am on a certain area close to Barcelona international exhibition.

2- Where do you typically sleep on a given night?

**Older African guy:** On the ground in summer and in winter I try to find upper place like benches.

**Young African guy:** On the benches, inside the ATM corridors.

**Youngest African guy:** If I would be on the street, I prefer to sleep on the ground close to public facilities.

**French guy:** On the park bench, high places in the sidewalks (like bank corridors and some stores).

**Italian guy:** On the ground and in rainy days or during the winter I prefer to stay under the bridges.

3- Have you ever slept outside? What do you use when you sleep outside to protect yourself from the elements (e.g., cold weather, rain, hot weather, etc.)?

**Older African guy:** Yes, I have a small knife.

**Young African guy:** Yes, bare hands.

**Youngest African guy:** Yes, nothing (bare hands).

**French guy:** Yes, I have one multipurpose swiss army knife.

**Italian guy:** Yes, whatever I find on the street like poles and sticks.

4- What problems have you encountered when sleeping outside?

**Older African guy:** Proper sleeping place, illness.
Young African guy: Body pain, musculoskeletal disorders and chronic pain, skin illness.
Youngest African guy: Violence, being bullied by other peers or even in some cases citizen.
French guy: Least sleep quality, illness.
Italian guy: Being exposed to robbery, several illnesses.

5- How often do you sleep outside?

Older African guy: Usually outside sleeper.
Young African guy: Most of the time.
Youngest African guy: Most of the time.
French guy: Since I became rough sleeper, I always sleep outside only sometimes I allowed to use public facilities/shelters.
Italian guy: Always, I like this way of living.

6- During a typical day, do you carry all of your belongings with you? Please explain your answer.

Older African guy: Yes, I only have one blanket which is the most useful thing during winter for me.
Young African guy: Yes, I carry all of my personal belongings unless I find some salable materials from the street waste searching, in this case, sometimes I have to ask my friends to keep them for me.
Youngest African guy: Normally I keep my personal belongings by myself, but I have a small space to keep my additional stuffs in my friends place like a storage.
French guy: Yes, I have to carry all of them or they might be robbed.
Italian guy: Most of the time yes, but sometimes I try to hide them near to my sleeping area.

7- Do you prefer to sleep in a common place with other rough sleepers or sleeping in an individual place?

Older African guy: There is no difference for me.
Young African guy: I prefer individual place.
Youngest African guy: Individual place if I can afford it.
French guy: Individual place.
Italian guy: Individual place.
8- Do you use discarded waste (such as cardboards, plastic covers and etc.) for making individual tents for yourself?

**Older African guy:** Yes, most of the time  
**Young African guy:** Yes, I use them many times  
**Youngest African guy:** Yes, they are all the free things that rough sleepers can use from.  
**French guy:** Yes, always  
**Italian guy:** Yes, always

9- What do you normally use specifically to sleep with (do you use blanket, plastic bags, cardboards, discarded mattress, tarps)?

**Older African guy:** It depends on what I find, but normally I use cardboards and nylon covers.  
**Young African guy:** Nothing special, whatever I find.  
**Youngest African guy:** Pillow and blanket specially for cold weather.  
**French guy:** 2 pillow, blanket, cardboards, hard structural foam (those which are using in packaging industry) for making a foundation on the ground for sleep on top of it, recently I found a traveler tent which I use too.  
**Italian guy:** Cardboards, thin mattress and blanket.

10- How many belongings normally do you have?

**Older African guy:** Only one small bag of my personal stuffs (sleeping stuffs).  
**Young African guy:** A small bag pack.  
**Youngest African guy:** One luggage and 2 small packs (including sleeping stuffs).  
**French guy:** One bag, 2 small plastic bags of personal things and a traveler tent (recently found).  
**Italian guy:** Bicycle, guitar and its case and the sleeping stuffs.

11- To what extend is important for you to be sticked on your belongings when you want sleep?

**Older African guy:** Very much, it is the only things that I have.
**Young African guy:** Very important.

**Youngest African guy:** Very much.

**French guy:** Very important for me.

**Italian guy:** My belongings are like my everything.

12- What do you think about something like sleeping bag with a bigger measure and dimension by portable properties to let you carry it whenever you want? (a sample picture had shown to them)

**Older African guy:** It sounds interesting, but its wight is important because normally we have some belongings to carry.

**Young African guy:** Sometimes could work but sometimes it can waste the times (set up and also collection process).

**Youngest African guy:** It would be a good idea specially in cold weather.

**French guy:** Recently I found one traveler tent but it is a bit big to hide, and maybe something smaller that could be hide properly or even something carriable would be a good idea.

**Italian guy:** Nice! (He didn’t say anything else)
• 5-5) General rules and regulations in Barcelona:

Based on article 58 of ordinance on measures to promote and guarantee coexistence citizen in the public space of Barcelona which has plenary council agreement on 23rd of December 2005 [30] it has mentioned that:

1. It is forbidden to make improper use of public spaces and their elements, in a way that prevents or hinder the use or enjoyment by other users.

2. The following improper uses of public spaces and their elements are not allowed:

   a) Camping on roads and public spaces, an action that includes stable installation in these spaces public or their elements or furniture installed in them, or in tents, vehicles, motorhomes or caravans, except for authorizations for specific places. It is also not allowed to sleep day or night in these spaces. In the case of people in a situation of social exclusion, the provisions of the article 60.2 of this Ordinance.

   b) Use benches and public seats for uses other than those for which they are intended.

   c) Wash or bathe in fountains, ponds or the like.

   d) Wash clothes in fountains, ponds, showers or the like.

With regarding to rules and regulations it will be feasible to use the individual sleeping tents in the proposed places since currently some of the target users of this project are already living in these areas (abandoned construction sites and empty warehouses yard) with some fixed constructions, whilst, the proposed tents will be portable and very efficient in term of space occupation without having bothering effect on other users.

Now we have a better perception of the situation in the real life for both sides of final users and stakeholders. Likewise, it is more feasible to frame and define the situation with all the information which has been gained so far.
FRAME AND DEFINE

Interviews and insights

GOAL

Identify

Gaps

Challenges

Key points

Translate into THEMES

Current situation mapping

Envision and Speculate

Possible and desirable FUTURES

What if?

How might we?

RE-WRITE

More focused

Design Proposal

NEEDS STATEMENT

Challenge

Synthesizing information

Fig25: Frame and define scheme
• 5-6) Frame and define:

- Current situation mapping (challenges – gaps):

5-6-1) Gaps and challenges:
Looking as a system, one service that will give a physical product at the end as an output to the end users and on the other side it will give profit to the society in relation to their environment of living (pollution reduction). There is no enough facility and space in the temporary shelters for targeted users. Besides, there is no enough capacity for discarded surgical face masks landfill and incineration.

5-6-2) Pharmacy:
The very early official face masks distributors who are still the most reliable and involved in this process that people are connected with them mostly when they want to get PPE. This is the good opportunity to use this channel (pharmacies) in order to motivate face mask users to return their used masks to them with setting some promotional rewards (10 used masks = 2 new masks). This can be the first stage of individual portable sleeping tent supply chain.

5-6-3) Citizens:
They are discarding their used face masks in Barcelona as normal as household wastes which has mentioned in Chapter 4. Thus, there is a gap between used face masks and individual portable sleeping tent production phase that is the main backbone of supply chain (returning used masks and receiving promotional offers from pharmacies to them).

5-6-4) Municipality:
Can accelerate the collection process and also helping recycling factories for making tents (funding and organizing the project in both sides of collection and production).

5-6-5) NGO(s):
As it has been mentioning throughout the other chapters the NGO(s) can be the most reliable channels in the aspect of sleeping tent distributing and setting up for rough sleepers. Arrel Foundation is the most popular in Barcelona which already has an application for knowing, organizing and helping disfavored individuals in the city. Therefore, taking advantage of this
active NGO in this field in Barcelona will be the best opportunity to overcome the gap between end users and the product.

- **Key points and themes:**

After 5 interviews and several rough sleepers’ living observations which have led to many inspiring stories it is time to review all of them more and more to have a better perception in the real life in order to find the most patterns emerged such as the most heard complain(s) again and again, the consistent problems mentioned or observed more and more, the surprising point(s) and the most vital significant points that have been standing out throughout the discovery phase. Since this phase is ideation and design, it is needed to sorting all mentioned criteria and their meanings due to continue with a solid theme.

5-6-5) **Mobility:**

It is important but they have other belongings. Some of them have to carry bicycle, instrument(s), sleeping stuffs and etc. and if the tent would be portable it is required to consider their belongings too (using the tent as a real back pack due to put their stuff inside it).

5-6-6) **Dignity:**

Regarding their situation in the society (social level), they constantly mentioned that they don’t want to bold their condition on the street and show other citizens they are rough sleepers, in the contrary, they want to hide it. Therefore, it should be considered to the final design of the tent.

5-6-7) **Size and weight:**

As it has mentioned the tent would be portable in order to facilitate their movement which can lead to theft prevention as well.

5-6-8) **Weather and structure:**

The structure should be as firm as possible and at the same time very light weight to fulfill both consistency and portability. Moreover, the long lasting of the product should be considered as it will be a sustainable shelter and it expects that rough sleepers will use it till it has functionality
for them such as their other belongings (using until it works), hence, it should be durable and resistant against all climate condition in Barcelona.

5-6-9) Theft, security and fear:
The obvious parameter for a sleeping place is security and it has a correlation with privacy in this case. People inside the proposed tents concept should feel safe and secure at least against the animals and passersby. Meaning while, there has been lots of theft cases which has mentioned through interviews by rough sleepers and it is vital significant to consider it for the final design of tent.

- Need/opportunity statement:

With regarding to obtained insights, themes and key points it is time to rephrase the needs and include all the important factors on it.

Our user(s) needs a way to addresses this need so that they benefit in this way.

The Barcelona rough sleepers need a way to be supported by municipality, pharmacies, NGOs and Barcelona habitants surgical single use face masks user who care about their living environment in order to support the system all together and help rough sleepers on the street so they can have a more private, safer, more convenient, warmer in winter/cooler in summer and easier to carry place, simultaneously with their other belongings on the street.
Chapter 6
Ideation, design and development

6-1) Mind map:

The main idea of BioBuild has been made and developed gradually by a basic organized mind map. As can be seen most of the important particles have been mentioned precisely throughout the dissertation and some others have been developed and reached during the development phases.
6-2) Inspirations

Fig27: Inspiration mood board (1)
Fig28: Inspiration mood board (2)
Surgical Face masks for construction
Is there a product / service or idea that inspires some functionality?

**Disruption**
- Using soft material in order to create constructions with enough consistency.
- Using soft material in order to create architectural constructions even for decorative purpose.

**Programming**
- Online pharmacies platform + waste applications.
- Using soft material in order to create constructions with enough consistency.
- AI during manufacturing process in order to classify data and materials for preparing basic materials for constructions (3D printer or compressor machines + AI).

**Generalization**
- Using environmental protector NGOs and environment organizations to invest and help used and discarded mask collections in order to architectural construction production.

**Specialization**
- Production expert, data scientist, material and expert in recycling.

**Complementation**
- Using compressor machines in order to achieve hardness from soft material (surgical masks).
- Waste collection application for collecting disposable surgical masks.

**Group**
- Creating advertising channels in social networks, different platforms and also in mass medias in order to promote mask users to return their used masks to one certain organization.

**Connection**
- Mass medias (tv show advertisement) and social medias (Instagram, Facebook and Linkedin).
- A collaborative platform for internal usage of system.

**Experience**
- Local start up networks Investment Mentorship.
- Easy to collect used and discarded masks.

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Fig29: Cool-hunting technique board
6-3) Sketches & ideations

Using many inspiring ideas, methods and concepts obviously could help a lot to start sketching phase wisely and well oriented; however, the demand of novelty and uniqueness is the important key to develop the main idea according to the objectives and hypothesis of the project.

Fig30: Sketches and ideations
Trying to eliminate the recycling steps in order to cut the cost and also production process at first and then trying to use the most space with a foldable shape.

Inspiring from normal surgical face masks outer shape (from the lateral view) and using the expanding and condensing characteristic as a main function for the whole tent due to facilitate the carrying – attaching to the wall from one side, and roll out/in as a quarter of circle.

Fig31: Sketches and ideations
Applying new recycling procedure on face masks material and reuse its material (only the soft part – Polypropylene) for another purpose with some other structural components such as structural flexible bars, strap and etc.

Recycling and reusing again the soft material of face masks in a non-woven way. Rollable with roll out and roll in ability. Using a tiny cubic box due to put the mainrollable part inside with the magnetic mechanism in order to be attached to the wall. Only a temporary roof.
6-4) Selected idea

Based on pros and cons analysis and the conducted research; therefore, taking advantage of light weight and soft material with couple of structural plastic rods with medium flexibility level in order to reach that desirable curve and a zipper from one side to facilitate going in/out. Besides, three velcro adhesive strips in each connected edges since it is needed to be used after folding as a fixature and stabilizer during carrying process, as such, adjustable straps – ergonomic reason - placement in opposite side of zipper for making easier carrying process as a normal backpack, and lastly, human dimensions which is necessary to be taken into account for the final selected idea.

Fig33: Sketches and ideations
6-5) Idea development

Structured unmounted portable tent

Unmounted, foldable, backpack and soft (face masks material (PP)) individual homeless shelter which also has potential for co-housing purpose.

**Description:** Choosing proper diameter of flexible reinforced plastic rod for applying pop-up mechanism on expanding tent phase. Providing a mattress with proper thickness for avoiding direct connection with the floor and also better sleeping experience.

Fig34: Sketches and ideations
• 6-5) **Final concept:**

After lots of investigation in the field of carrying it is figured out that one diagonal strap could be more efficient and functional in both terms of easy carriage and also using 5 flexible plastic rods for its main structure in order to reach enough consistency.

After polishing the primary idea over and over, it has decided to use zipper for both sides of tent in order to allow users to go in/out from both sides (user conveniency).

Fig35: Final concept schematic
2 soft layers have been made of recycled surgical face masks in terms of hiding flexible plastic rods and also controlling inside temperature specifically during the winter.
• 6-6) Concept analysis:

6-6-1) Material:

**Disinfection:** Those used surgical face masks first need to be quarantine at least for 5 days (based on competent authorities’ statement), then it goes to a systematic passage with a very powerful ultraviolet tunnel which removes any virus or any germ in less than 5 seconds and the masks will be remained around 30 seconds I UV tunnel which is recommended by the solution inventors. It only takes 30 minutes to disinfect around 12 kg of masks, equivalent to about 5,000 masks without no harmful effect for both operators and next users since this process has approved by scientists and specialists. The Ultra Violet intensity would be between 15495 and 2449 uW/cm2 that will lead to destruction of 99.9999% of Sars-CoV-2 in 2 to 9 seconds [31].

![Fig37: UVmobi Ultra Violet tunnel for face masks disinfection](image)

**Recycling process:** After the elimination of the rubbers and the adjusting metal, they will be proceeded to the whole crushing without separating any of the different types of plastic. Once we have the material in flake type format, it has been processed in the same way as other plastics are processed.

There are 2 major processes in terms of reach to the non-woven PP material in order to use tent production: 1) Web formation 2) Web consolidation. The main web formation methods are carding, air laying, wet laying, spun-bonding, melt-blowing and more recently electro-spinning and the main web consolidating methods are needle punching, spun lacing, chemical bonding,
and thermal bonding. Although these two processes are usually sequential, they are sometimes combined into a single step [32]. After reaching again to clean non-woven fabric, the production phase which needs measuring and cutting the fabric in an appropriate defined dimensions will begin, then after cutting, 5 flexible plastic rods will be attached to the fabric that have cut in a tent pattern with 3 main connectors in each vertex and also 3 main fasteners for each and all the structural flexible rods will be covered with another layer of non-woven fabric (structure will be hidden 2 2 layers of fabric). 2 zippers will sew in 2 opposite sides and finally one adjustable backpack strap will sew from one side in a diagonal direction.

Fig38: Schematic overview of dry laid process. Reproduced from Kritzer P and Cook JA (2007)

6-6-2) Color:
According to interviews, observations and investigations have been conducted it realized that because of 2 important variables 1) Rough sleepers’ dignity and 2) Dirtiness there is a high demand of using dark achromatic (neutral) color. With this neutral dark color selection not only we can prevent peoples’ attention to rough sleepers (specifically during tent carrying on their back) but this also will lead to delay for revealing dirtiness on tent.
6-6-3) Measure and dimension:
According to the targeted users in chapter 5 (men 25-49 years old) and international backpack measures and dimensions standard sources there are 3 main important factors which need to be considered A) Back length (from shoulder to hip) B) Chest width and C) hip width which is called torso.

With regarding to ergonomics and anthropometric research it has found out that there is an international standard as a guideline for the users and as BioBuild is a tent with portability option such as backpack characteristics and its shape is not as similar as regular backpacks; thus, after many research in terms of users’ conveniency and also users’ safety throughout carrying phase its measures and dimensions are considered as 80L backpack size.
In the meantime, in sleeping phase another aspect of human dimensions has been considered in order to create a better sleeping experience for the users with at least the minimum standards and qualities [33].

Considered model is a young man with:
- 175cm height
- 40cm shoulder width

Fig41: Technical drawing, measures and dimensions of tent in extended situation (mm)
6-6-4) Carrying process:

1. Fixed with rubber fixture
2. Rotate 45 degree ~ 15cm
6-6-5) Weight:

Calculation of mask usage weight and final weight of the tent (estimation):

All the calculations have been estimated with +- 200 grams tolerance. Moreover, other objects (flexible plastic rods, joints, joints holders, strap and adjusting part, buttons and zippers) have been premised around 4 kilograms, consequently, the final weight of individual portable sleeping tent will be around 6 kilograms.

Fig42: Weight calculations draft

Fig43: Schematic weight equality of face masks and sleeping tent
6-6-6) Exploded view:
- 6-7) 3D model (materials and details):
Rubber button fixature
Elasticity rubber fixture
strap
ISO 22843:2020
Plastic snap button
ISO 13453-3 [35]

Strap and also zipper lines connections to main
tent body are by sewn.

Rubber fixture straps have pressed by press
machine (glue with high temperature)
Flexible fiber reinforced plastic rods with approx. 1mm diameter have been used in sides for tent consistency and also as a helper for applying both expanding and condensing mechanisms.
• 6-8) Environmental render:
Chapter 7
**Design workflow**

**BioBuild**

- **Composed of**
  - Surgical masks
  - Collection service
  - Collecting in hand masks after usage
  - Disinfection
  - Disposal to recycling factories

- **Objectives**
  - Novel portable sleeping shelter
  - Promoting disfavored people living situation
  - Environmental pollution reduction
  - Recycling surgical face masks

- **NGOs, charities, and municipality**

- **Users**
  - Barcelona disfavored people (rough sleepers)

**PRODUCTION PHASE (producing portable individual sleeping tent)**
Conclusion

In this research a multipurpose project has been planning to be implemented for disfavored people in Barcelona who are living roughly on the street and in some articles they called rough sleepers who are more than 1,200 based on 2020 Arrels foundation census report which was also approved by municipality, however, it will have benefit mainly for waste management by reducing environmental pollution which has caused by surgical face masks with a motivational collection service that also will have benefit for citizens by receiving promotional rewards during the process of face masks collection in the case of those used masks which are ready to discard since they would be the crucial part of solution for 2 main social and environmental issues. Therefore, it has a beneficial impact for local governments and municipalities in terms of both pollution reduction caused by masks, and design - produce a safer, cheaper (in comparison with temporary mounted shelters), more secure and also more convenient portable lightweight sleeping tent due to improve disfavored individuals living situation. Moreover, for the future development of the project, It could be used in some unforeseen circumstances like natural disasters upon arrival of emergency shelters, co-housing with specific approaches and also in long festivals and events which will have need for temporary sleeping place.
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