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Dissertation on the topic:

Development of Camping Furniture with emphasis on functionality, portability and sustainability issues

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Abstract

This study developed and tested the idea of alternative furniture to be used at campsites. It is motivated by the fact that alternative tourism, as outdoor lodging, has remarkably increased in the last five years. The main purpose of this change is the financial crisis that started in 2008 for some European countries and spread to Greece during 2009.

With this in mind, an extensive research has been conducted about people's needs around that type of vacations. At first, a focus group was conducted to acquire feedback regarding the campers' wishes and then a questionnaire was distributed in order to collect quantifiable data. The results revealed that the primary needs are inexpensive products and easily transported with low environmental impact. More specifically, they showed that useful equipment such as furniture is traded off because of heavy load and high prices.

After this stage, a market research have been performed and variant concept designs have been developed through sketches and 3D modeling using the software SolidWorks, until the optimal concept to be determined. At the same time, with the setting of several constraints, the possible materials were researched through the databases of CES EduPack.

The following step was the estimation of sustainability of the developed concept and the durability of it by stress analysis. Finally, a cost analysis was executed to verify if the final products correspond to the preference of low price.

After testing three eco-friendly materials, cardboard, bamboo and pine wood, it became obvious that the best possible choice is cardboard furniture that can effectively last for the camping days and can totally be recycled after its use and of course without spending a large amount of money to obtain.

Keywords: camping furniture; cardboard; functionality; sustainability;

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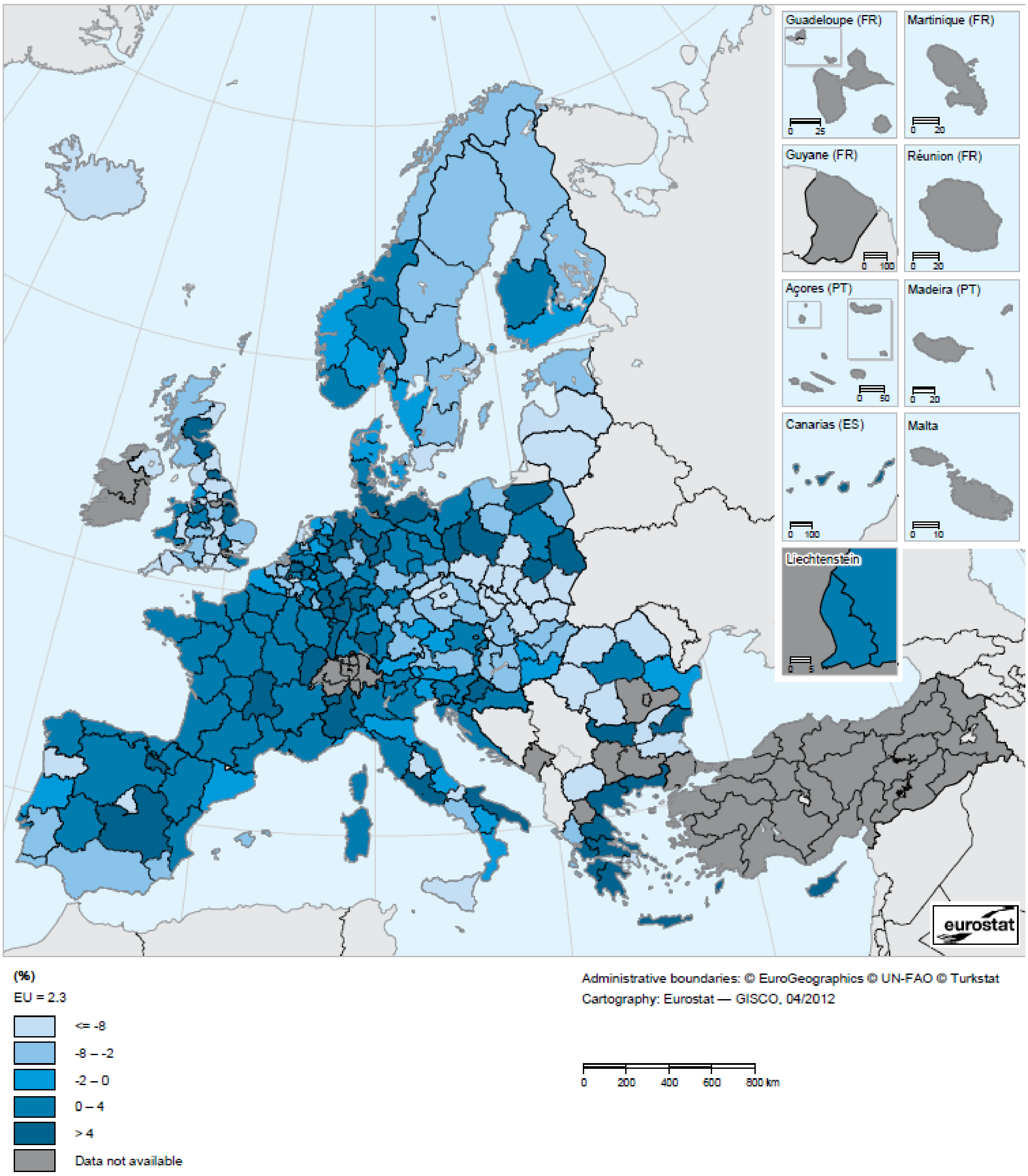
CHAPTER 1 INTRODUCTION

1.1 Introduction

As a result of economic crisis in Greece, a significant percentage of population avoids holidays in hotels and turns to alternative tourism and mainly to camping. This becomes obvious by the detailed statistics of Eurostat, the statistical office of the European Union, in the "Eurostat regional yearbook 2012" that measured the annual average rate of change in the number of nights spent in hotels and on campsites during the period 2007‑10, when the crisis arose. The results made evident that an average decrease of 2.2 % per year for hotels and a rise of 2.3 % per year for campsites occurred, due to financial matters. Specifically, campsites have been chosen with the aim of lower the cost of a holiday.

As it was originated from the research, there were simultaneously reductions and increases of the number of nights spent on campsites in different regions. For instance, although, there was observed a very large decline in 17 European regions, at the same time 47 regions witnessed an annual average increase of about 4%, among which 20 regions succeeded growth averaging more than 10% per annum. In particular, the following map evinces that Greece is one of these regions, along with Cyprus, Spain, Italy and others.



(¹) EU (excluding Ireland and Malta), Nord-Est (ITD), Centro (ITE) and Hungary, provisional; Severozapaden (BG31) and Luxembourg, 2007–09; Freiburg (DE13), Tübingen (DE14), Düsseldorf (DEA1), Münster (DEA3), Sud-Vest Oltenia (RO41), West Yorkshire (UKE4) and the former Yugoslav Republic of Macedonia, 2008–10; London (UKI), by NUTS 1 region.
Source: Eurostat (online data code: tour_occ_nin2)

Figure 1 - Nights spent in campsites, by NUTS 2 regions, average annual change, 2007–10

Another reason for that kind of tourism being selected is to eliminate stress, which have been boosted to many people because of financial problems due to aforementioned crisis. As pointed out by Ruth C. Engs (1987), stress is a crucial generator of many physical and mental health problems, but when someone deals with an activity, experience a special feeling the “flow state”, during which the person unifies with the environment, escapes from daily life and has a general feeling of well-being. An activity that contributes to the development of this feeling is camping that offers tension reduction, self renewal, self awareness and a "natural high."

Nevertheless, by choosing this type of vacations tourists confront practical problems, like less comfort, small space and large weight to transport. Therefore, the aim of this dissertation is to develop concepts of lightweight, comfortable and foldable camping gear and specifically, camping furniture. Such equipment is useful and necessary, but the extensive research has shown that most campers do not carry it due to heavy load and high bulk. For this reason, a design research has been conducted in order innovative and alternative products to be created.

1.2 Scope and constraints

The scope of this product development is to create compact, foldable, transportable and eco-friendly furniture that can be used at Greek coastal areas where the climate is more humid during summer season and where average temperature is approximately 35^{o}C during the day, and lower during night due to cool sea breeze and to north winds.

This kind of equipment is mainly used during vacations, while users have more pleasant and relaxed mood during outdoor camping, which is a nature-based kind of tourism, where people can feel the sea, the sun, the wind, the sand and generally the nature and users can be socialized. In other words, the equipment should fit to the environment, regarding the color, the shape and the material.

On the other hand, the constraints that must be taken into consideration are size issues as they should be easily transported and financial issues. Another issue that should be thought over, is the material selection, as this type of furniture should be as strong and stiff as possible, but also eco-friendly, considering the environmental protection.

1.3 Presentation of the subject

The problems that campers usually confront have to do with weather, safety and noise issues, but also with transportation and storage matters. At this point it should be mentioned that most of people count out appropriate equipment that should take with them to camping, due to the large weight they have to carry and the undersized space they have in cars or even more on motorbikes.

Consequently, the camping products should be lighter and with smaller dimensions for easier storage. Moreover, they usually do not intend to spend lots of money for this purpose. For this reason the concept designs of camping furniture that are developed satisfy the requirements of users for camping furniture through the selection of appropriate materials, which are eco-friendly, recyclable, biodegradable and/or recycled. Moreover, ergonomic issues have been considered, that pertain to user's comfort, and in the end financial issues, that relate to production costs and sales prices.

At the first phase of the study, there will be represented a benchmarking research conducted with reference to the existing camping products and then a Focus Group discussion organized of minimum 8 members, in order to collect qualitative data about the users' needs. Hereupon, in order to quantify the results of the discussion a Questionnaire follows, distributed to at least 150 people. Thereafter is the material is the Designing phase, where the software SolidWorks is used for the representation of the concept ideas and the assessment of the sustainability estimation and the stress analysis. Simultaneously, the material selection is done through CES EduPack, the results of which are applied in SolidWorks. Finally, after the appropriate Refinement, the Final design concept is determined, followed by the financial analysis for cost matters that aims to low products' cost.

The outcome of this research is the development of innovative furniture, such as chairs and tables that contribute to the facilitation of campers during leisure, to the motivation for selecting camping as first choice for vacations – in order to get in touch with the natural world – and indirectly to the protection of the environment.

CHAPTER 2 USER CONTEXT

2.1 Description of Target Group

The following pages document and discuss the research that has been performed as it pertains to the camping needs. As pointed out by the results that are presented in the Appendix C: Statistics, from the questionnaire which is presented in Appendix B, the research's target group includes both male and female gender and has a range of ages between 18 and 35 years old. The data indicate that the group prefers an alternative way of living, travelling and having vacations, away from urban life, hotels and apartments; this kind of people have the need to be close to nature and not to be limited to a room.

Additionally, they are highly educated people as 81% of them have studied at a university, from which most of them are working either independently as free lancers (35%) or as employees at public (10%) and at private (33%) sector. Here it should be mentioned that they have a low to middle monthly income, which means 450.00 to 1,500.00 euro. The 90% of the responders use to go camping during summer in groups of four (4) people or over for about a week per year and they prefer organized camping, because they need to have conveniences and supplies such as drinking water, food etc. The motives for choosing that kind of tourism are the feeling of freedom, the interaction with nature and at a second level the saving of money.

Their main activities that they deal with during camping are cooking, eating food and drinking coffee and beverages, while they also play board games and card games, music instruments or they read books. As for the criteria they evaluate to choose products are utility, practicality and size over frequency of use, sustainability, price and durability and they intend to spend 5.00 to 20.00 euro for each product. The products they take with them are divided into:

(a) Camping gear, such as tent, mattress, pillows, sheets and blankets, flashlight, chairs and tables,

(b) Kitchen gear, that includes refrigerator, utensils and gas stove,

(c) Food,

(d) Clothing and personal care,

(e) First aid kit and

(f) Miscellaneous items, as umbrella for the sun and pocketknife.

As for the use of camping furniture, apart from their use at campsites, they store them, due to the fact that this type of furniture is usually small and foldable and can't be used indoors. Nonetheless, they would use products for temporary use escaping from the need to carry them back to their homes.

The Campers of the target group travel mainly by car, but they tend to carry the necessary equipment, which is not bulky. Alternatively, they use public means of transport that compels them to take as less things as possible.

The choice of the location they go for camping depends on the company, the disposition, if someone else has been there before, if it is clean, what kind of group of people reside there (families, students, children etc) and if there are markets around that place. The objective of the last criterion is to be able to be supplied with relief items such as food, water, or even the use of a bathroom.

In the following moodboard is illustrated visually the direction of target group's style in order to communicate the whole sense that the products should correspond to.

Figure 2 - Moodboard

2.2 Specification of User Requirements

A large comprehensive market research has been executed which makes obvious that camping furniture is categorized in various types, as it can be easily understood in Figure 3. At first, camping chairs are divided in three types: 1. Minimal, which is foldable or inflatable, 2. Regular, which has aluminum legs, arm rests and seat backs and 3. Luxurious, that provides maximum stability and support, and also has extra features such as leg rests, reclining capability and more.

However, all three types have common features and constraints. The most camping chairs have legs made of aluminum for its strength to weight ratio, coated rip-stop nylon fabric for the seating material because of its durability, water resistant and comfort and closed cell foam padding that not absorb water. Furthermore, they usually weight about 1.00 to 5.00 kilograms.

Figure 3 – Camping Chairs

Moreover, the camping tables are also divided in three types: 1. Folding tables, 2. Roll- up tables, which are carried in their bags, and 3. Camping bench, which is also used for seating for more than one people. The common materials that tables are constructed by are aluminum, plastic, steel, wood, bamboo and laminate for the frame, and nylon, polyester, synthetic fibre and textiline for the cover. The usual weight of these products ranges between 1.50 to 7.50 kilograms.

Figure 4 – Camping Tables

By relating the target group's needs and the existing equipment, the products that are to be developed should be small, eco-friendly, light-weighted and should have a low production cost and therefore a low price.

Subsequently of the research, through the interpretation of the raw data from the focus group discussion, the topics of which are in Appendix A, emerged the following assumptions and guidelines.

2.3 Assignation of Product's Guidelines

As continuity to the prior work the following product guidelines are encountered which should be satisfied by the developed concepts.

1. **Functional:** the furnishing must have the appropriate size to be able to be carried to inaccessible places. Also it should be stable and stiff to sustain body weight.

2. **Compact:** according to the research results, campers need small equipment to fit easily in their transport means. Flat pack furniture type is compact, which can be collapsible, assembled, or modular.

3. **Eco – friendly:** the use of lower environmental impact materials, such as non-toxic, biodegradable, or recycled materials, which are preferably local and not imported, sustainably managed renewable sources can obtain to an eco-friendly design. In addition, energy efficient manufacturing processes and reusable and/or recyclable products that can be easily disassembled can lead on to environmentally friendly products.

4. **Comfortable:** the furniture should have the proper height and be made by soft material that is flexible.

5. **Lightweight equipment:** another demand of people using public transport means is to have lighter equipment for easier transfer. The weight of the equipment can be decreased by constructing it by low density material and have few parts.

6. **Ergonomically designed:** ergonomic design reduces user's fatigue and discomfort. For this reason, the camping chair must have the proper seat height and backrest height, the proper width, proper seat depth and proper angles, in order to be cozy.

7. **Low price:** the responses to the research questionnaire revealed that most users wouldn't spend much money for camping furniture, due to their rare usage. As a result, they must be made from inexpensive material. It is preferable to be locally produced and to have simple packaging.

8. **Durability:** durable equipment means capable of withstanding wear and tear, stable and ability to be utilitarian over a long period. In case of camping, the equipment should last at least for the days of stay.

9. **Safety:** in order to be safe, furnishing must be stable and uphold average human weight and not have sharp edges.

10. **Transportability:** Transportability is the capability of a product to be moved by any means such as towing, self-propulsion, or carriage

CHAPTER 3 | DESIGN CONCEPTS

3.1 Product brief

In accordance with the product guidelines that were determined in Chapter 2, the camping furniture should be functional and have small size in order to be easily fitted in the boot of a vehicle and lightweight in case of camping premises is at an inaccessible place. Equally important is to be comfortable and ergonomically designed, given that during vacation campers should feel at ease and relaxed and additionally not wear down their body.

Furthermore, it must be remembered that questionnaire's results shown that most participants (33%) have a middle income, so they would prefer the final product to be available at a low price 5.00 to 20.00 euro. Assuming that it would not be expensive, it could be used for once, endure for the days of holidays and then be disposed, and this means that it should be made of eco – friendly materials. Last but not least, the products should be safe and withstand human's weight.

3.2 Ergonomics deliberation and Design Concepts

3.2.1 Ergonomics deliberation

According to International Ergonomics Association (IEA), ergonomics (or human factors) is the scientific discipline concerned with the understanding of interactions among humans and other elements of a system, and the profession that applies theory, principles, data, and methods to design in order to optimize human well-being and overall system performance and to make systems compatible with the needs, abilities, and limitations of people.

Additionally, anthropometry is the scientific measurement and collection of data about human physical characteristics and the application (engineering anthropometry) of these data in the design and evaluation of systems, equipment, manufactured products, human-made environments, and facilities.

These two complementary sciences are essential for furniture design, as furniture should be comfortable and practical for a wide range of people. Especially, for chair design, specific measurements should be chosen from those that are demonstrated in the next figure.

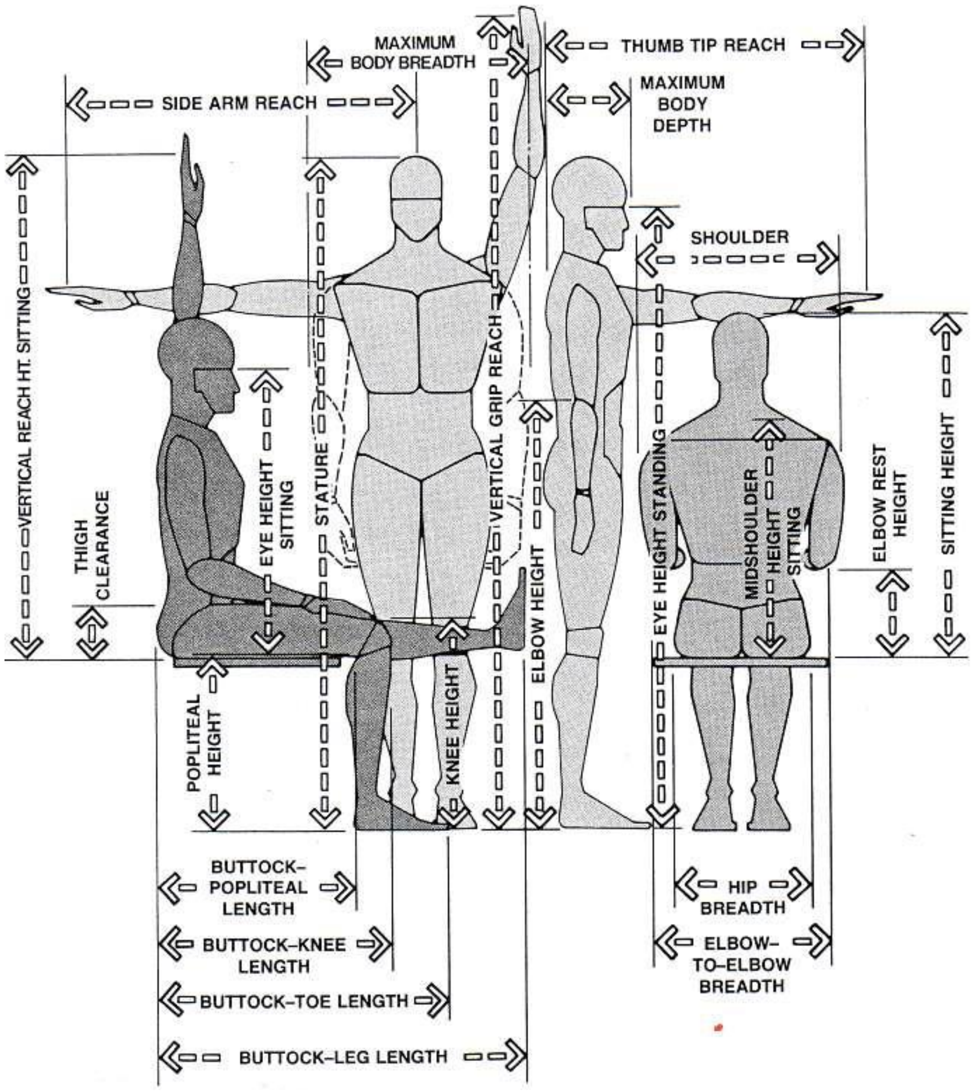


Figure 5 - Anthropometric Dimensions

Namely, the required dimensions for a chair that should accommodate a body or parts of it and that may be based from the 5th percentile of female data that is correlated to the smallest dimension to the 95th percentile of the male that corresponds to the largest one have been calculated with the use of ANSUR database and are represented in the following Table 1.

		MALE			FEMALE		
A/A	**DIMENSION**	**5%**	**50%**	**95%**	**5%**	**50%**	**95%**
1	Buttock popliteal length	45,8	50	54,6	**44**	48,1	52,8
2	Hip breadth	31	34,1	37,6	30,8	34,2	**38,2**
3	Popliteal height	39,5	43,3	**47,6**	**35,2**	38,9	42,9
4	Shoulder height sitting	54,9	59,8	**64,6**	51	55,5	60,4

***Source:** Open Design Lab, “Design Tools: ANSUR Database Calculator”

Table 1 – Calculated Anthropometric Data

As shown above in Table 1, for each dimension has been chosen the lowest or the highest percentile for the development of the concept designs, with attention to the fact that the products are going to be used by both sexes and various body types.

The aforementioned measurements and the product guidelines were considered for the development of the following design concepts.

3.2.2 Design Concepts

All things well thought-out, the next concept designs were developed. Primarily, the ideas were proposed through sketches and secondly by using 3D designing software.

The first concept was thought to be adjustable in three different heights to accommodate wider range of body types and to be made by wood and aluminum. Although, this concept would fulfill important guidelines, such as functionality and comfort, it was rejected because it would be very bulky, heavy and expensive. Moreover, it would have high environmental impact, since it would be produced by a complicated process that would need heavy machinery and molds.

Figure 6 – First Concept

The second concept that was built up was considered to be assembled with joints and it would be made by wood and fabric. Likewise with the first one, this alternative concept would satisfy the same guidelines and would also have a complex production and assemble process, and in this case it wouldn't be stable enough. In the first place, as it was a foldable chair, it had the advantage of gaining space during travelling due to flat packaging, but on the other hand it wouldn't be stable and safe on the rough ground of coastal areas.

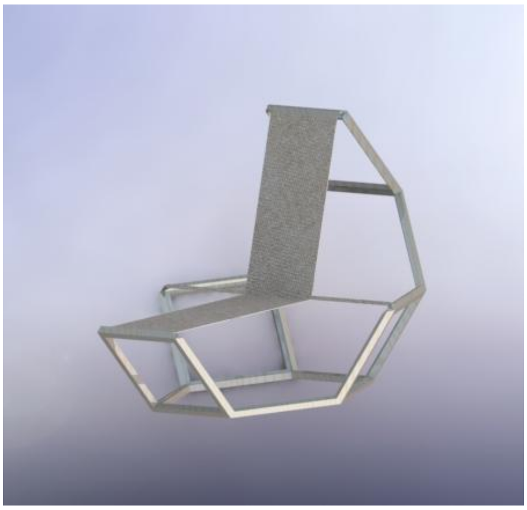


Figure 7 - Second Concept

The third concept which was determined to be developed is shown in the following figures 11, which is thought to be constructed by cardboard. On the contrary to the aforesaid concepts, it is assumed to be lighter and more eco-friendly. Its production process is thought to be very simple, with the only need of large cutting boards and saws. Further to the guidelines, the four boards under the seat, as well as the two protuberances on the seat backrest and the three that is against the ground, gives stability. It should be also declared that it will be flat packed and will be easily carried from the cuttings at the back which are used as handles. Similarly, the concept table (Figure 12) is designed, keeping the same lines, in order the set to be aesthetically nice.

At this point, the first draft sketches are shown below. The differences with the final design are the seat backrest, which in the end is wider for more comfort and the angle under the seat is increased for bigger support.

Figure 8 – Side View

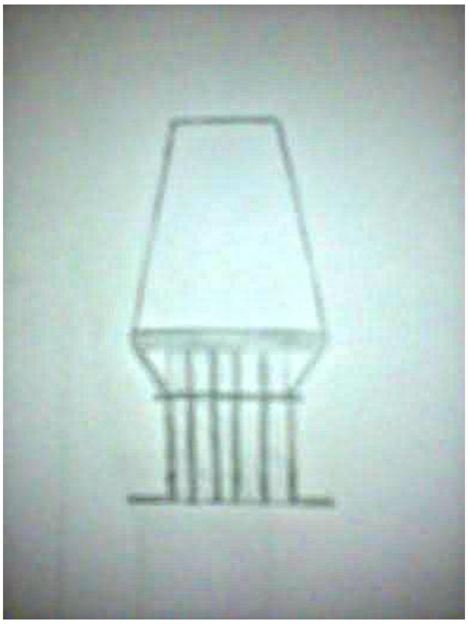


Figure 9 – Front View

Figure 10 – Trimetric View

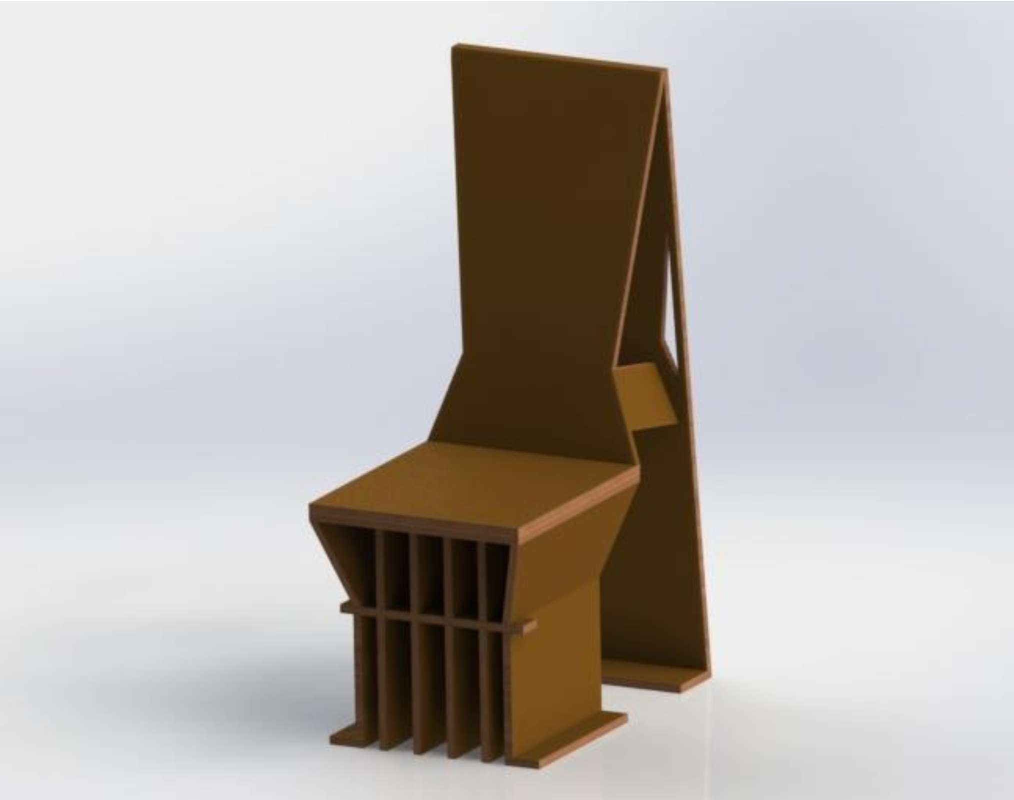


Figure 11 - Final Concept "Chair"

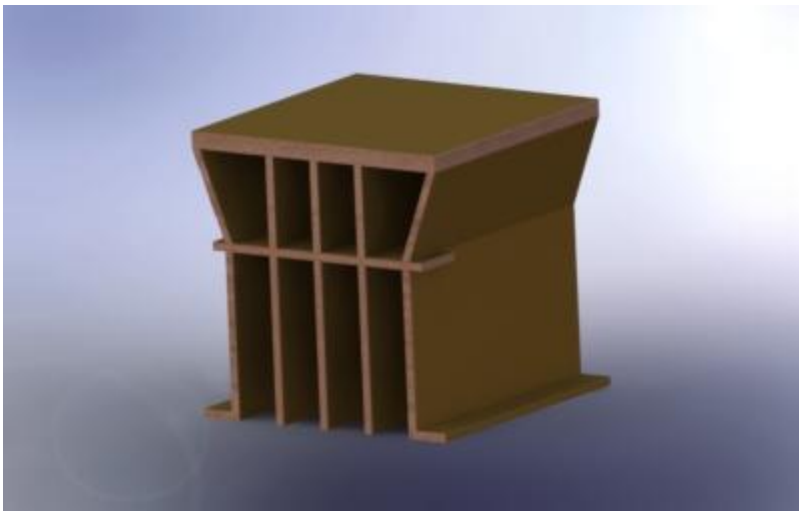


Figure 12 - Final Concept "Table"

CHAPTER 4

DEVELOPMENT & EVALUATION OF FINAL CONCEPTS

4.1 Materials Selection and Production processes

According to the authors, Mike Ashby and Kara Johnson (2010), design problems can have a variety of solutions, as far as they are studied comprehensively through different aspects. In addition, there are two standard prerequisites to this scope:

- An information structure, that allows indexing
- Selection methods that can combine design rules with other features such as technical, aesthetic and perceived dimensions.

Based on the above they presented four complementary methods for material selection which are described below:

- **Selection by analysis** (deductive reasoning), which means the use of particular inputs and entrenched design methods of modern engineering, exploiting databases of materials and their attributes.
- **Selection by synthesis** (inductive reasoning), is the match between the desired features, intentions, perception or aesthetics and those of documented design solutions, stored in a database of product "cases".
- **Selection by similarity**, seeking materials with selected attributes that match those of an existing material,
- **Selection by inspiration**, looking for ideas by randomly viewing Figures of products or materials, until one or more are found that suggest solutions to the present challenge.

By keeping in mind the word "complementary", there was applied a mixture of these methods for the determination of which material should be used for the camping furniture.

As it is presented in Chapter 2, there is camping furnishing made from a wide range of materials and each category satisfy distinctive needs. As a consequence, all these products are not manufactured for the same use. They might be used on mountains during winter or at coastal areas during summer while the climate is more humid and the temperature is higher. The constraints and objectives that define how the furniture should react under diverse circumstances during usage cannot be the same for all materials, which means that the optimal material can vary.

The criteria for the material's selection that have been examined closely were determined in such way to fulfill the products' guidelines. In specific, the objective was to minimize mass, so as to be lightweight for easier transportation. In contrast, the constraints are not to fail under body's weight, be eco-friendly in order to have low environmental impact and have low retail price for the reason that these products will be disposed for recycling after use.

4.2 Determination of Material Index/ices

With the acceptance that products should perform their function effectively and safely, they should be constructed by materials that have physical, chemical, mechanical, thermal and electrical properties that meet the products' requirements.

With this intention, the furniture and especially the chair should bear the forces that are applied by the human body's weight on the seat and on the seat backrest. The seat experience constant compression forces from the users weight as well reactions from the ground pushing back up towards the person. Moreover, the seat backrest also experiences constant compression, but on a much smaller scale. This implies that products are vital to be stiff and strong. Therefore, combinations of properties are important in evaluating usefulness of materials. In this case, the combinations that should be considered are the young's modulus versus density and yield strength versus density.

Here it should be noted that compression and bending are the forces acting on the furniture and hence, the material indices that are going to be calculated are:

- M1 = ρ / (E^1/3), for compression and bending properties, for stiffness
- M2 = ρ / (σ_y^1/2) , for compression and bending strength, for strength

4.2.1 Material Selection

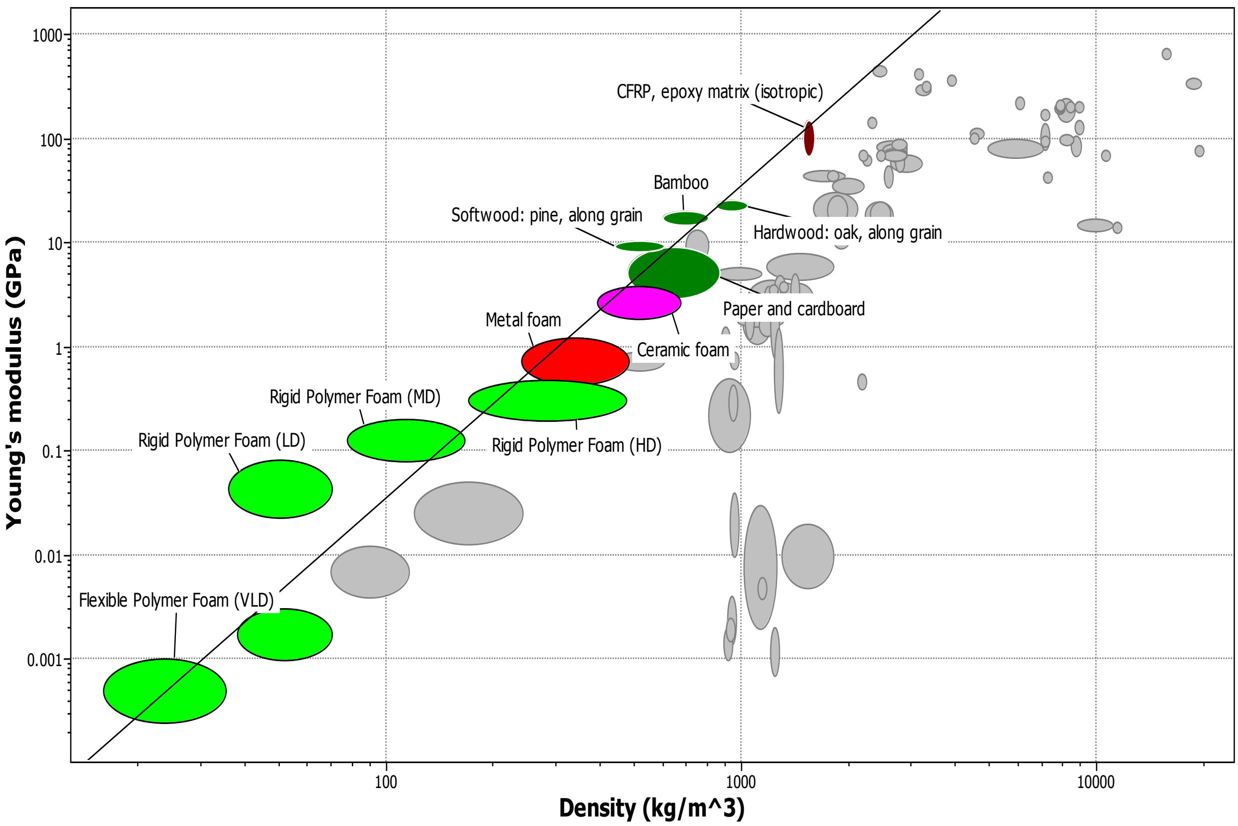
Material selection is a complex procedure and for this reason software has been developed to facilitate it. In this study CES EduPack has been used, which is an application that helps designers to make the right choice of the appropriate materials during early-stage of product development. The results from the relevant evaluation are represented below.

Initially, some constraints have been assigned for several categories of the materials properties. In detail, as for the recycling properties it was chosen to be biodegradable and / or recyclable and / or reusable and non-toxic due to the fact that the products are predestined not to last for long, so their disposal should have been considered. Moreover, a general property that was limited was the price that was set between 0,10 to 5,00 euro per kilogram, with the intention of succeeding an inexpensive final product.

After the setting of the appropriate restrains and of the proper Material Index, a number of materials that satisfy the requirements have been distinguished which are presented in Table 2. Also, they are shown in Graph 1 where the Young's modulus (GPa) vs. Density (kg/m^3) relation that examines the stiffness of the materials is illustrated.

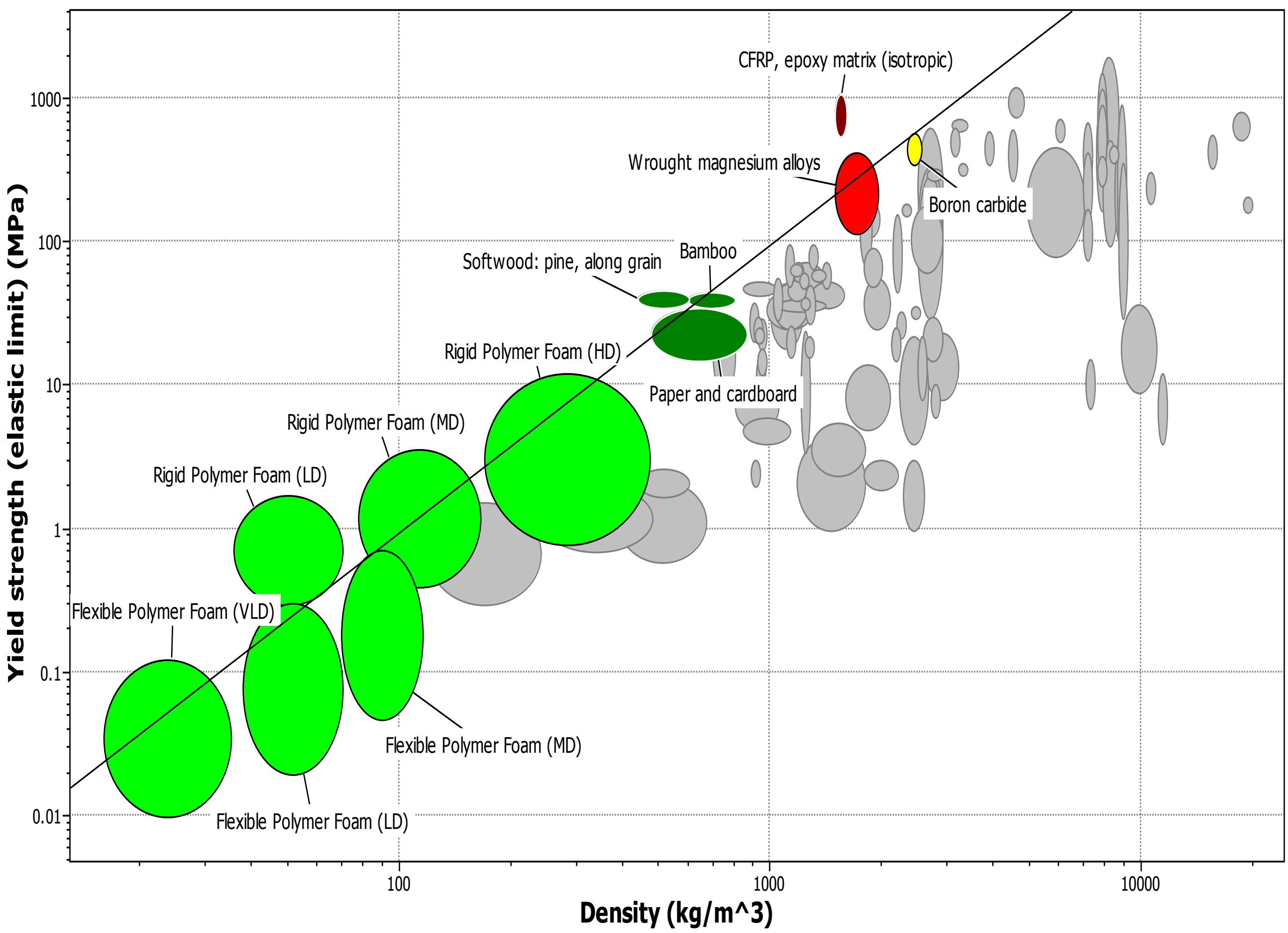
Name	Density	Young's Modulus	Stage 1: Index
Bamboo	600 - 800	15 – 20	0.00373
Ceramic foam	392 - 670	1.9 - 3.8	0.00271
CFRP, epoxy matrix (isotropic)	1.5e3 - 1.6e3	69 – 150	0.00301
Flexible Polymer Foam (VLD)	16 - 35	2.5e-4 - 0.001	0.00335
Metal foam	240 - 480	0.45 - 1.2	0.00266
Paper and cardboard	156 - 860	3 - 8.9	0.00269
Rigid Polymer Foam (HD)	170 - 470	0.2 - 0.48	0.00239
Rigid Polymer Foam (LD)	36 - 70	0.023 - 0.08	0.00697
Rigid Polymer Foam (MD)	78 - 165	0.08 - 0.2	0.00442
Softwood: pine, along grain	440 - 600	8.4 - 10.3	0.00409

Table 2 - Materials that pass Stage 1



Graph 1 – Stage 1: Young's modulus (GPa) vs. Density (kg/m^3)

Thereafter, another relation that was calculated was the Yield strength (elastic limit) (MPa) vs. Density (kg/m^3) presented in Graph 2, that checks the material strength. Following, in Table 3 are represented the part of the materials that fulfilled the requisites.



Graph 2 – Stage 2: Yield strength (elastic limit) (MPa) vs. Density (kg/m^3)

Name	Density	Yield Strength	Stage 2: Index
Bamboo	600 - 800	35 - 44	0.00904
Boron carbide	2.35e3 - 2.55e3	350 - 560	0.0086
CFRP, epoxy matrix (isotropic)	1.5e3 - 1.6e3	550 - 1.05e3	0.0178
Flexible Polymer Foam (LD)	38 - 70	0.02 - 0.3	0.0054
Flexible Polymer Foam (MD)	70 - 115	0.048 - 0.7	0.00477
Flexible Polymer Foam (VLD)	16 - 35	0.01 - 0.12	0.00787
Paper and cardboard	156 - 860	15 - 34	0.0074
Rigid Polymer Foam (HD)	170 - 470	0.8 - 12	0.00623
Rigid Polymer Foam (LD)	36 - 70	0.3 - 1.7	0.0168
Rigid Polymer Foam (MD)	78 - 165	0.4 - 3.5	0.00959
Softwood: pine, along grain	440 - 600	35 - 45	0.0123
Wrought magnesium alloys	1.5e3 - 1.95e3	115 - 410	0.00862

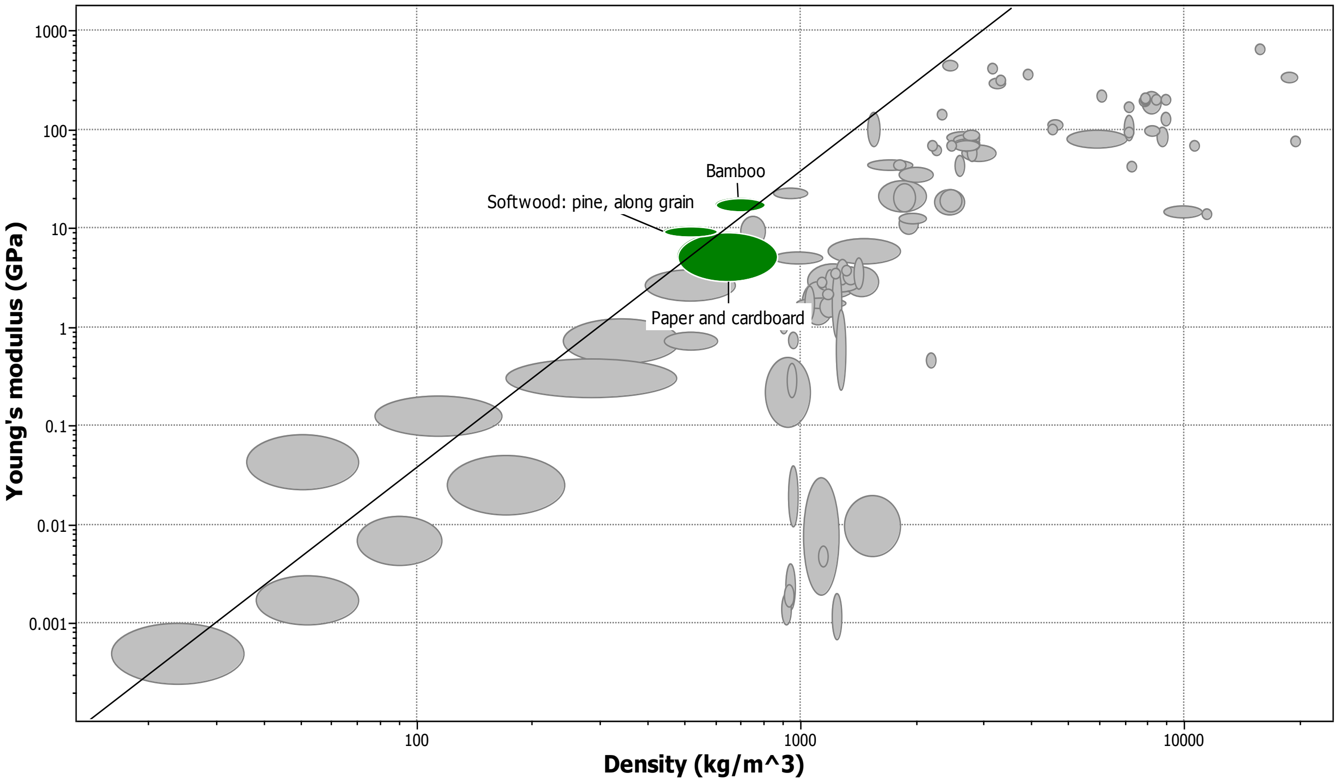
Table 3 - Materials that pass Stage 2

Before the determination of the materials it was also checked which were the materials that fulfilled the general and the recycling properties.

Name	Price (EUR/kg)	Renewable Resource	Non-Toxic
Bamboo	0.996 - 1.49	True	**Non – Toxic**
Cork	1.99 - 9.96	True	**Non – Toxic**
Hardwood: oak, across grain	0.494 - 0.553	True	**Non – Toxic**
Hardwood: oak, along grain	0.494 - 0.553	True	**Non – Toxic**
Paper and cardboard	0.64 – 0.8	True	**Non – Toxic**
Plywood	0.24 - 0.734	True	**Non – Toxic**
Softwood: pine, across grain	0.498 - 0.996	True	**Non – Toxic**
Softwood: pine, along grain	0.498 - 0.996	True	**Non – Toxic**

Table 4- Materials that pass Stage : Price, Toxicity rating, A renewable resource

By comparing the results in the three tables, it becomes obvious that there are some common outcomes that pass all stages. For this reason, it was imposed to make out the next Graph 3 that depicts the result intersection. Complementary in Table 5 are included the final three materials that pass all stages.



Graph 3 – Result Intersection

Name	Stage 1: Index	Stage 2: Index	Yield strength (elastic limit) (MPa)	Young's modulus (GPa)	Price (EUR/kg)
Paper and cardboard	0.00269	0.0074	15 - 34	3 - 8.9	0.64 - 0.8
Bamboo	0.00373	0.00904	35 - 44	15 - 20	0.996 - 1.49
Softwood: pine, along grain	0.00409	0.0123	35 - 45	8.4 - 10.3	0.498 - 0.996

Table 5 - Materials that pass all stages

The results that come from the intersection of the charts show that the most suitable materials for the camping furniture are those mentioned in Table 5 and 6.

Name	Price (EUR/kg)	Uses - Properties
Paper and cardboard	0.64 - 0.8	It is made from pulped cellulose fibers derived from wood, cotton or flax. There are many different types of paper and paper board: tissue paper – newspring, kraft paper for packaging, office paper, fine glazed writing paper, cardboard and a correspondingly wide range of properties.
Bamboo	0.996 - 1.49	It is a grass and it is a hollow tube, exceptionally strong and light, growing so fast that it can be harvested after a year, reaching a diameter of 0.3 meters and a height of 15 meters. Its hard surface and ease of working makes it the most versatile of materials. It is used for building and scaffolding, for roofs and flooring, for pipes, buckets, baskets, walking sticks, fishing poles, window blinds, mats, arrows and furniture. Its natural tubular structure gives it excellent bending stiffness and strength at low weight.
Softwood: pine, along grain	0.498 - 0.996	Softwoods come from coniferous, mostly evergreen trees such as spruce, pine, fir and redwood. It is light, and parallel to the grain, it is stiff, strong and tough, per unit weight. It is cheap, it is renewable and it is easily machined. It is a renewable resource absorbing CO2 as it grows. Woods' typical uses are flooring, furniture, containers, boxes, building construction, particleboard etc.

Table 6 - Materials' Properties

In the preceding Table 6 are described some characteristics of them such as uses, properties and prices.

The materials must be as stiff as possible in order to prevent plastic deformation, but not that much, so to be comfortable. Moreover, it is desirable, the material to be of low cost and to be recyclable, reusable, or biodegradable. Thus, another criterion that was examined for the selection of the materials was their sustainability.

That is the reason that (1) Paper and cardboard, (2) Bamboo and (3) Softwood: Pine, along grain were selected to be tested through SolidWorks.

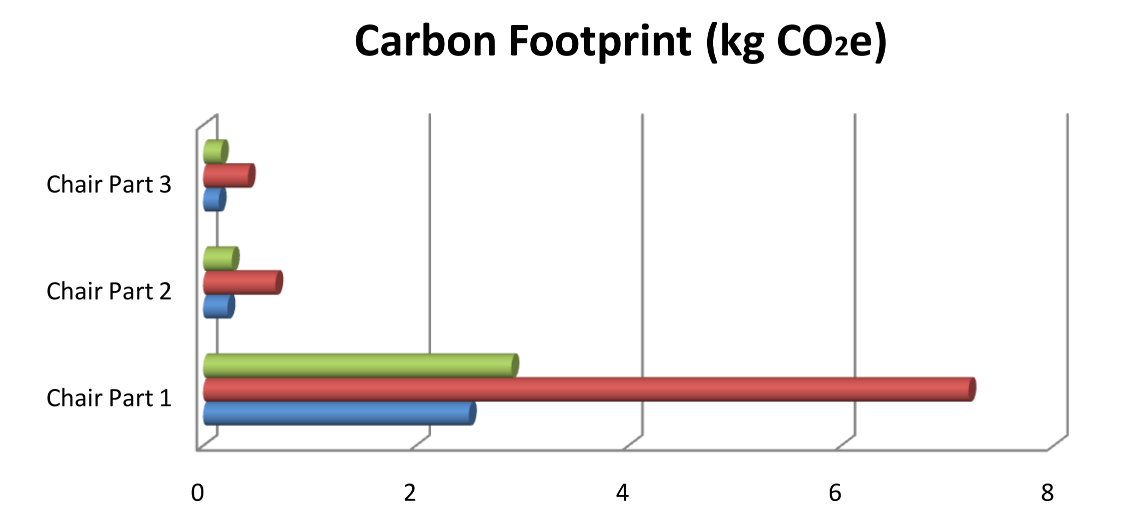
4.3 Sustainability estimation

According to the authors G. Rebitzera,*, T. Ekvallb, R. Frischknechtc, D. Hunkelerd, G. Norrise, T. Rydbergf, W.-P. Schmidtg, S. Suhh, B.P. Weidemai, D.W. Pennington (2003), the human's consumption of products has tremendous environmental impacts which lead to climate change, eutrophication, acidification, the depletion of resources and many others. This environmental degradation comes along all stages of product's life from the resources' extraction and the products' manufacturing until the disposal of them. As a consequence, the necessity for the impacts reduction motivated scientists to formulate Life Cycle Assessment (LCA) that is a tool to calculate indicators of the potential environmental impacts that are linked to products.

Particularly in this research the impacts that have been measured through LCA using SolidWorks Sustainability are (1) the Carbon Footprint, (2) the Water Eutrophication, (3) Air Acidification and (4) the Total Energy Consumed. Moreover, one of the parameters that were set for these calculations was related to the material, from the phase of mining to the manufacturing of it.

Some other parameters that were estimated were the final product's use and the final product's transportation that was defined to be 1.000 kilometers, which corresponds approximately to the total distance between the northern and southernmost Greece. Another parameter was the End-of-Life of the product which refers to the disposal, the reuse or the recycling of it. The last parameter that could be worked out was the product's manufacturing process which fortunately wasn't necessary to be calculated due to the fact that it is based on the labor force and not on heavy machinery and by extension with low energy consumption.

Thomas Wiedmann and Jan Minx (2007) reported that the carbon footprint stands for a certain amount of gaseous emissions that are relevant to climate change and associated with human production or consumption activities, with the term 'footprint' to describe the measurement in area-based units.



	Chair Part 1	Chair Part 2	Chair Part 3
Pine	2,9	0,27	0,167
Bamboo	7,2	0,68	0,421
Cardboard	2,5	0,229	0,146

Chart 1 – Carbon Footprint per part (kg CO_2e)

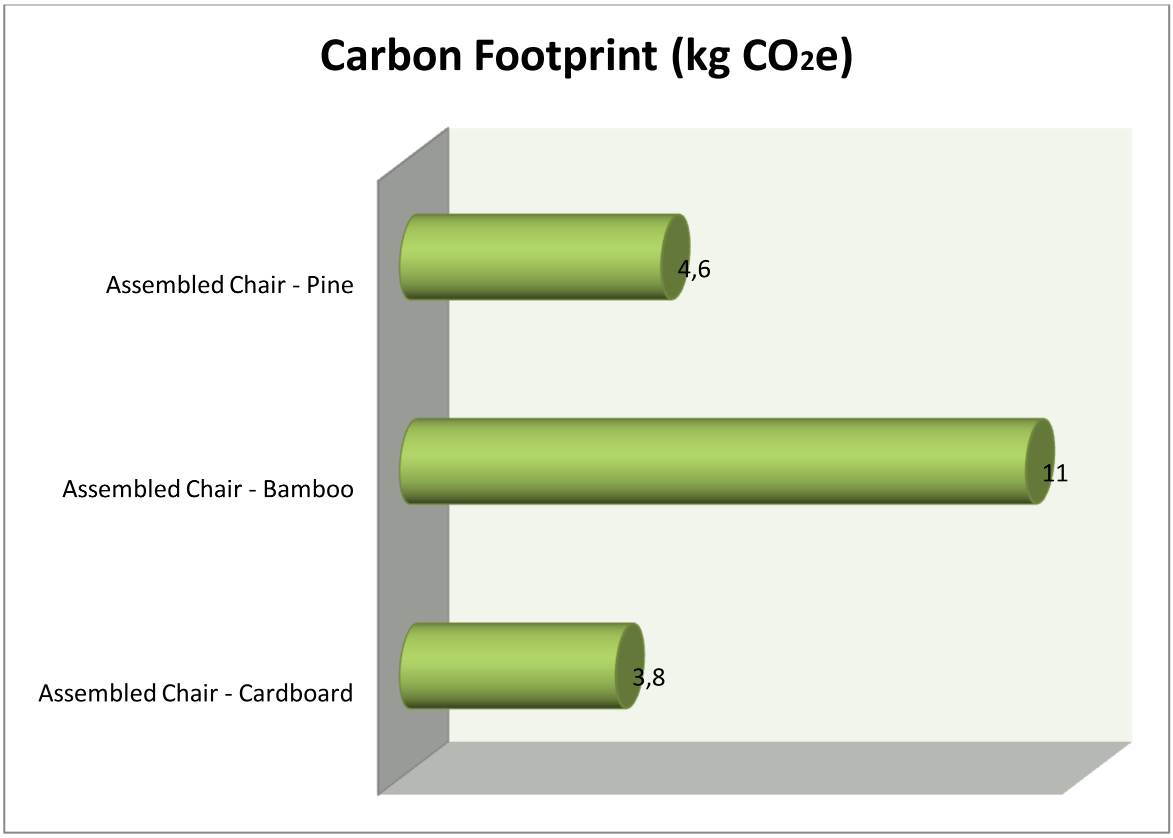
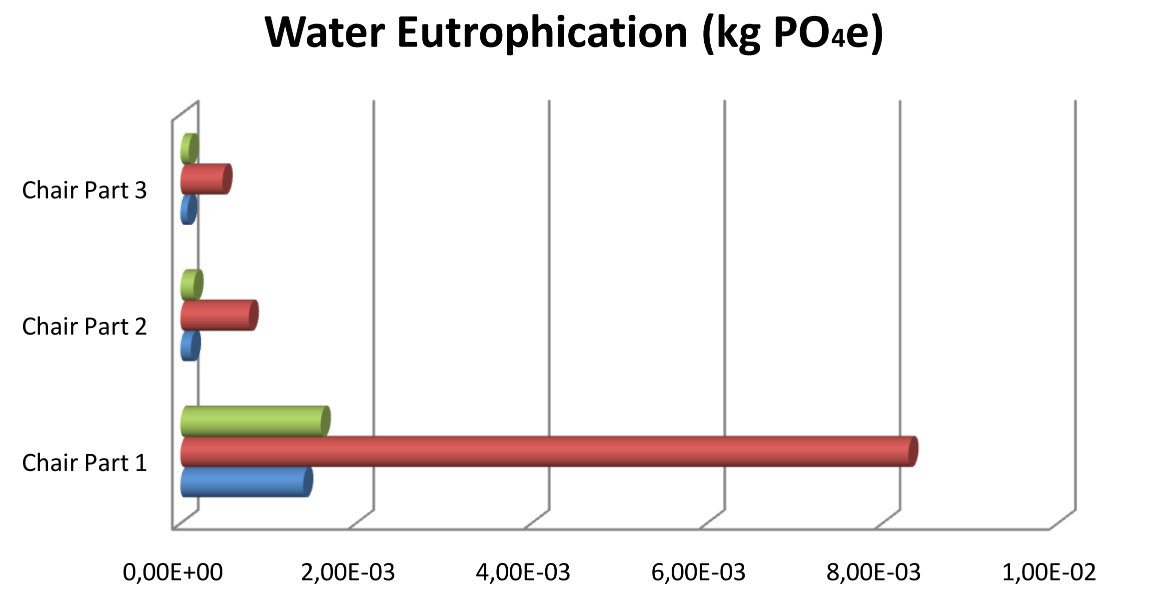


Chart 2 - Carbon Footprint of the assembled chair (kg CO_2e)

By observing Charts 1 and 2, it is abundantly clear that bamboo chair has a significantly high carbon footprint of 11 kg CO_2e in contrast with the low value of the softwood pine chair which has 4.6 kg CO_2e and the lower of the cardboard assembled chair which has 3.8 kg CO_2e.

Secondly, Water Eutrophication is examined which is caused by Phosphates (PO_4, salts of phosphoric acid), nitrates (NO_3, salts of nitric acid), nitric oxides (NOx), ammoniac (NH_3), nitrogen oxide (N_2O), and gaseous nitrogen (N_2) can result in a growth of nutrients in soil and water. The factors that enhance this impact are the nutrient enrichment, hydrodynamics, environmental factors such as temperature, salinity, carbon dioxide, etc.



	Chair Part 1	Chair Part 2	Chair Part 3
Pine	1,60E-03	1,50E-04	9,50E-05
Bamboo	8,30E-03	7,80E-04	4,80E-04
Cardboard	1,40E-03	1,20E-04	7,90E-05

Chart 3 – Water Eutrophication per part (kg PO_4e)

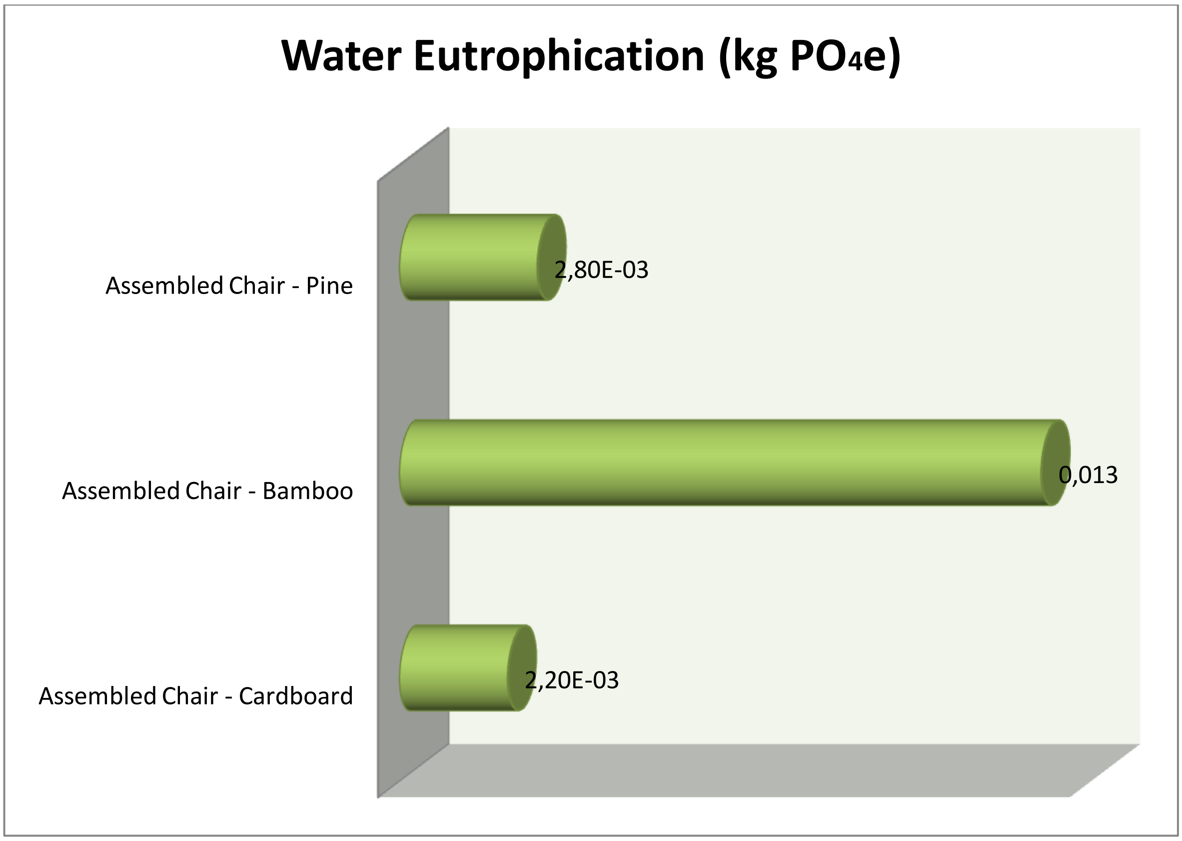
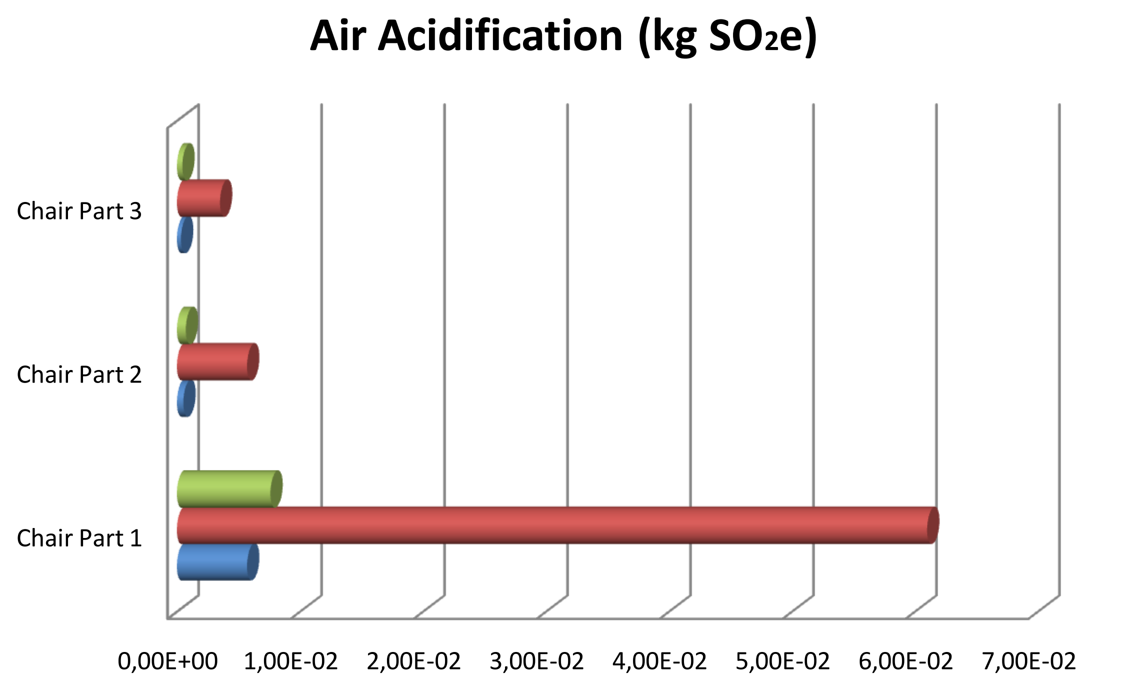


Chart 4 - Water Eutrophication for the assembled chair (kg PO_4e)

Likewise carbon footprint, the impact of water eutrophication is much higher from the chair which is constructed by bamboo. In particular, it is almost five to six times higher than the two other materials, as it is 0.013 kg PO_4e for bamboo, 2.80E-03 kg PO_4e for pine wood and with a slight difference for the cardboard 2.20 kg PO_4e.

The third impact that was measured is Air Acidification which is caused by Nitric oxides (NO_2, NOx) that transform into nitric acid (HNO_3) and sulphur oxides (SO_2, SOx) that transform into sulphuric acid (H_2SO_4) and other substances. These oxide emissions are due to gases emitted by cars, activities of industries, electricity and fossil fuels.



	Chair Part 1	Chair Part 2	Chair Part 3
Pine	7,60E-03	7,20E-04	4,40E-04
Bamboo	0,061	5,70E-03	3,50E-03
Cardboard	5,70E-03	5,20E-04	3,30E-04

Chart 5 – Air Acidification per part (kg SO_2e)

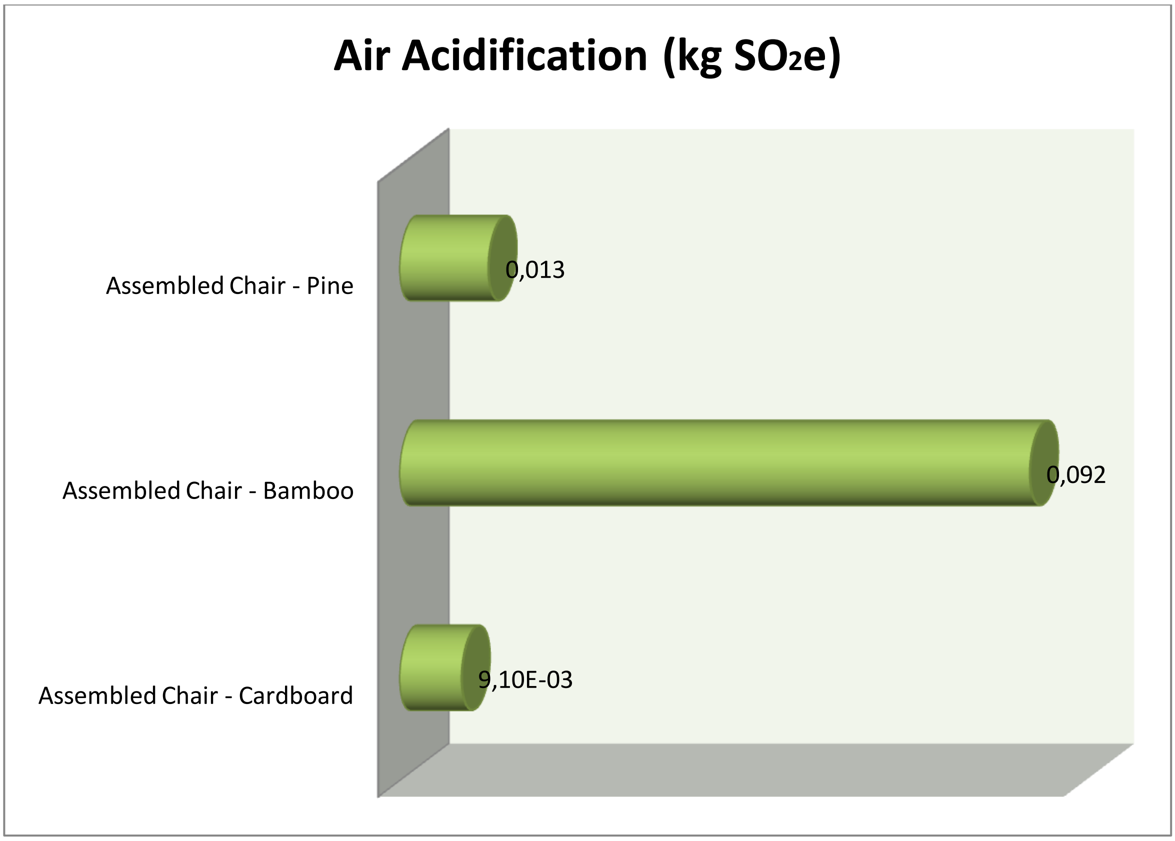
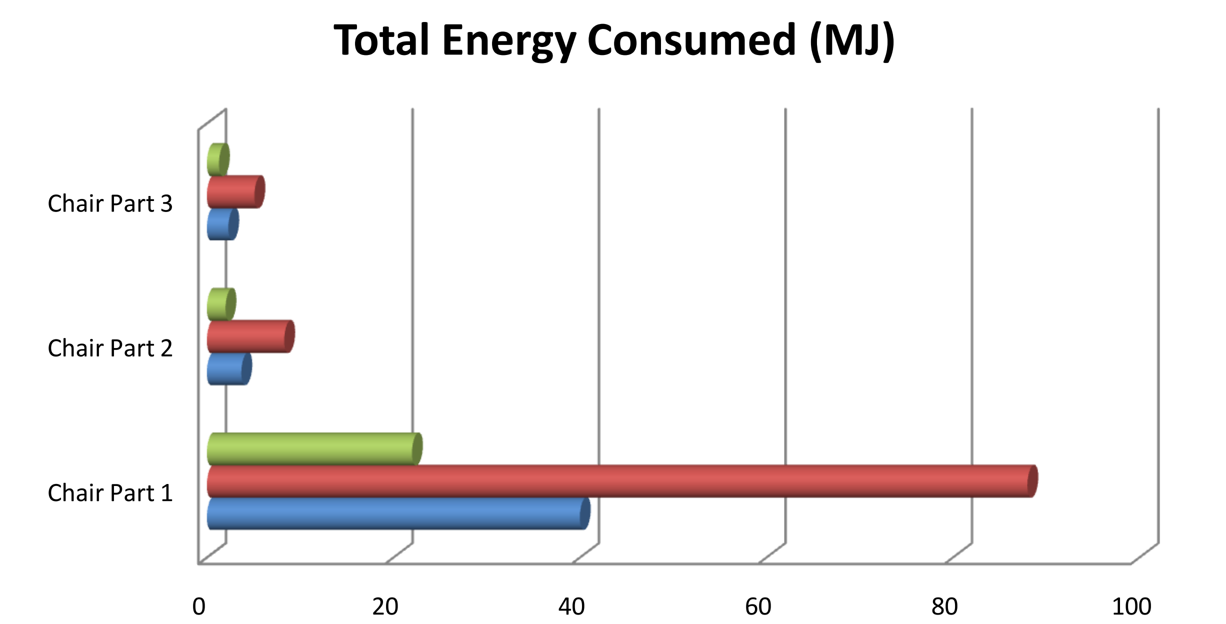


Chart 6 - Air Acidification for the assembled chair (kg SO_2e)

In like manner, the product that is made by bamboo burdens the atmosphere more than the other two concept products. Namely the lowest value 9.10E-03 kg SO_2e is for the product constructed by cardboard, the middle 0.013 kg SO_2e is for the chair made of pine wood and the highest value 0.092 kg SO_2e is for the bamboo chair.

The energy consumption, as it is mentioned in the “Environmental improvement through product development - a guide” includes energy sources and energy aspects in the whole life cycle of the product. More particularly it refers to energy consumption for material processing, depending on the fact if the raw materials are new or recycled raw materials. In addition, it must also be thought if these materials are local or imported, due to the transport and use-related energy consumption.



	Chair Part 1	Chair Part 2	Chair Part 3
Pine	22	2	1,3
Bamboo	88	8,3	5,1
Cardboard	40	3,7	2,3

Chart 7 – Total Energy Consumed per part (MJ)

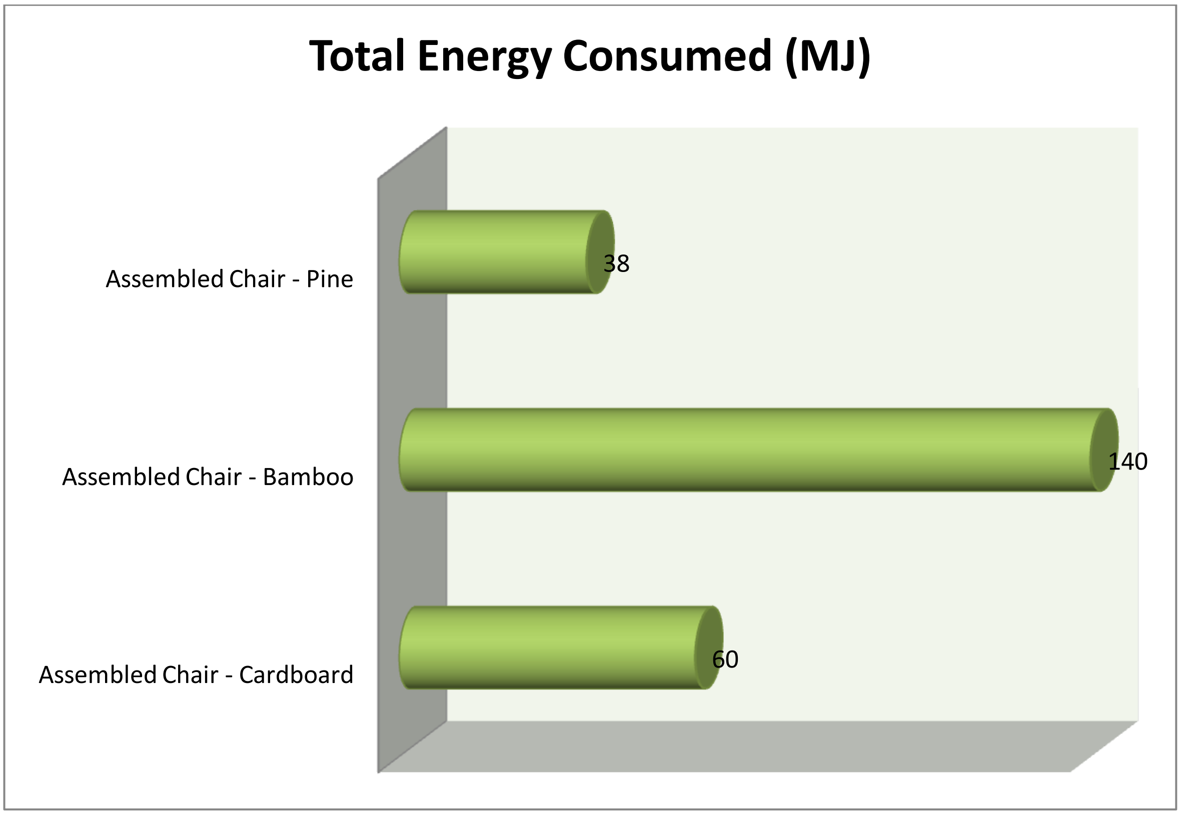


Chart 8 - Total Energy Consumed for the assembled chair (MJ)

At this point it is noticeable that although the bamboo chair still has the higher environmental impact, as it is consumed 140 MJ through its life cycle, the results overturn for cardboard and the wooden chair. Specifically, for the life cycle of the cardboard product are consumed 60 MJ, whereas 38 MJ are consumed for the chair made by pine wood.

After analyzing the data that came out of the sustainability estimation it comes out that the optimal material which has the lowest values for the three out of four impacts is the cardboard. Consequently, the stress analysis through SolidWorks and cost analysis are done for the cardboard for both chair and table.

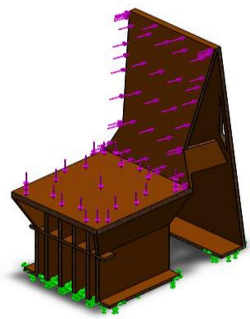
4.4 Stress Analysis

Stress analysis is used to examine the durability of structures and to explore the causes of possible structural failures. This chapter discusses geometry generation that is used for finite element analysis, which describes the accuracy of the model and explains the simplifications that were made to obtain an efficient FE model and about the mesh generation. Moreover, boundary conditions and type of loading were used which affect the results of the finite element analysis.

The finite element modeling consists of geometry generation, application of the material properties, meshing the assembly, description of the boundary constraints, and application of the proper load type. In this study, this analysis was executed for the chair and the table. Thereupon the data that emerge are a quantitative description of the stress over the structure and the deformation that might be caused by those stresses.

Additionally, the implementation of the stress analysis for the camping furniture is executed through SolidWorks Simulation which is a tool that helps to decisions about the improvement of concept products' quality. Furthermore, the chair and the table are examined for strength and safety.

Afterwards, the results of the analysis are presented in the next tables that are giving information about the Model, regarding its properties, the units and the material properties, about the loads and fixtures, the mesh, the resultant forces and the final results. These outcomes are concerning the stress which is the force per unit area, the strain which corresponds to the change in a dimensional quantity and the displacement.



Model name: Assembled chair
Current Configuration: Default

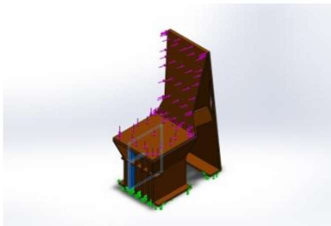
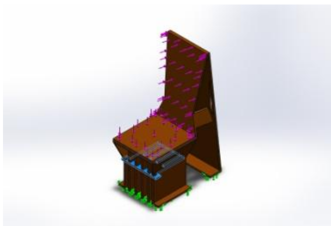
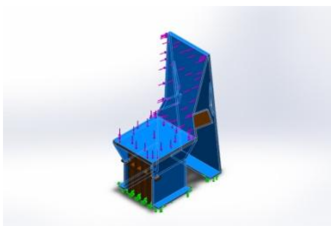
Solid Bodies		
Document Name and Reference	Treated As	Volumetric Properties
Cut-Extrude1 	Solid Body x 4	Mass:0.311337 kg Volume:0.00199575 m^3 Density:156 kg/m^3 Weight:3.0511 N
Boss-Extrude1 	Solid Body	Mass:0.192582 kg Volume:0.0012345 m^3 Density:156 kg/m^3 Weight:1.8873 N
Boss-Extrude6 	Solid Body	Mass:3.31186 kg Volume:0.0212299 m^3 Density:156 kg/m^3 Weight:32.4562 N

Table 7 – Chair Model Information

Study name	Study 2
Analysis type	Static
Mesh type	Solid Mesh
Thermal Effect:	On
Thermal option	Include temperature loads
Zero strain temperature	298 Kelvin
Include fluid pressure effects from SolidWorks Flow Simulation	Off
Solver type	FFEPlus
Inplane Effect:	Off
Soft Spring:	Off
Inertial Relief:	Off
Incompatible bonding options	Automatic
Large displacement	Off
Compute free body forces	On
Friction	Off
Use Adaptive Method:	Off

Table 8 – Study Properties for chair model

Unit system:	SI (MKS)
Length/Displacement	mm
Temperature	Kelvin
Angular velocity	Rad/sec
Pressure/Stress	N/m^2

Table 9 – Units for chair model

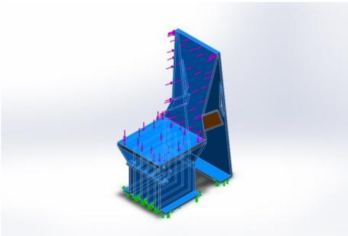
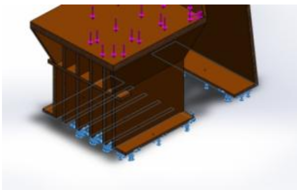
Model Reference	Properties	
	Name:	**Cardboard**
	Model type:	**Linear Elastic Isotropic**
	Default failure criterion:	**Unknown**
	Yield strength:	**2.45e+007 N/m^2**
	Tensile strength:	**3.7e+007 N/m^2**
	Compressive strength:	**4.8e+007 N/m^2**
	Elastic modulus:	**5.95e+009 N/m^2**
	Poisson's ratio:	**0.395**
	Mass density:	**156 kg/m^3**
	Shear modulus:	**1.5e+009 N/m^2**

Table 10 – Material Properties for chair model

Fixture name	Fixture Image	Fixture Details
Fixed-1		**Entities:** **7 face(s)** **Type:** **Fixed Geometry**

Resultant Forces

Components	X	Y	Z	Resultant
Reaction force(N)	**-0.00809014**	**934.739**	**196.976**	**955.268**
Reaction Moment(N·m)	**0**	**0**	**0**	**0**

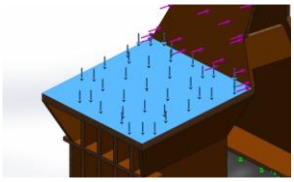
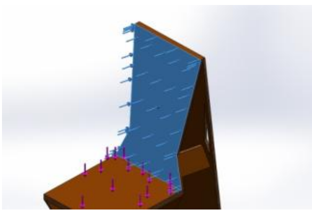
Load name	Load Image	Load Details
Force-1		**Entities:** **1 face(s)** **Type:** **Apply normal force** **Value:** **900 N**
Force-2		**Entities:** **1 face(s)** **Type:** **Apply normal force** **Value:** **200 N**

Table 11 – Chair Load and Fixtures

Mesh type	Solid Mesh
Mesher Used:	Standard mesh
Automatic Transition:	Off
Include Mesh Auto Loops:	Off
Jacobian points	4 Points
Element Size	40.1669 mm
Tolerance	2.00834 mm
Mesh Quality	High
Remesh failed parts with incompatible mesh	Off

Table 12 – Mesh Information for chair model

Total Nodes	16573
Total Elements	8137
Maximum Aspect Ratio	15.976
% of elements with Aspect Ratio < 3	56.9
% of elements with Aspect Ratio > 10	0.0614
% of distorted elements(Jacobian)	0
Time to complete mesh(hh;mm;ss):	00:00:03

Table 13 - Mesh Information for chair model

Reaction Forces

Selection set	Units	Sum X	Sum Y	Sum Z	Resultant
Entire Model	N	-0.00809014	934.739	196.976	955.268

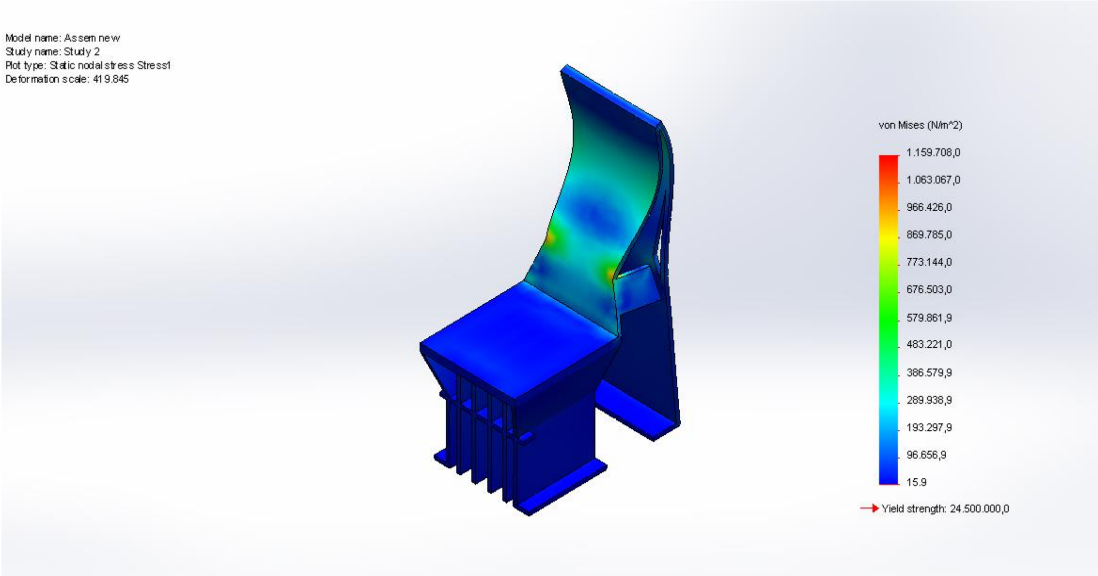
Reaction Moments

Selection set	Units	Sum X	Sum Y	Sum Z	Resultant
Entire Model	N·m	0	0	0	0

Table 14 – Resultant forces for chair model

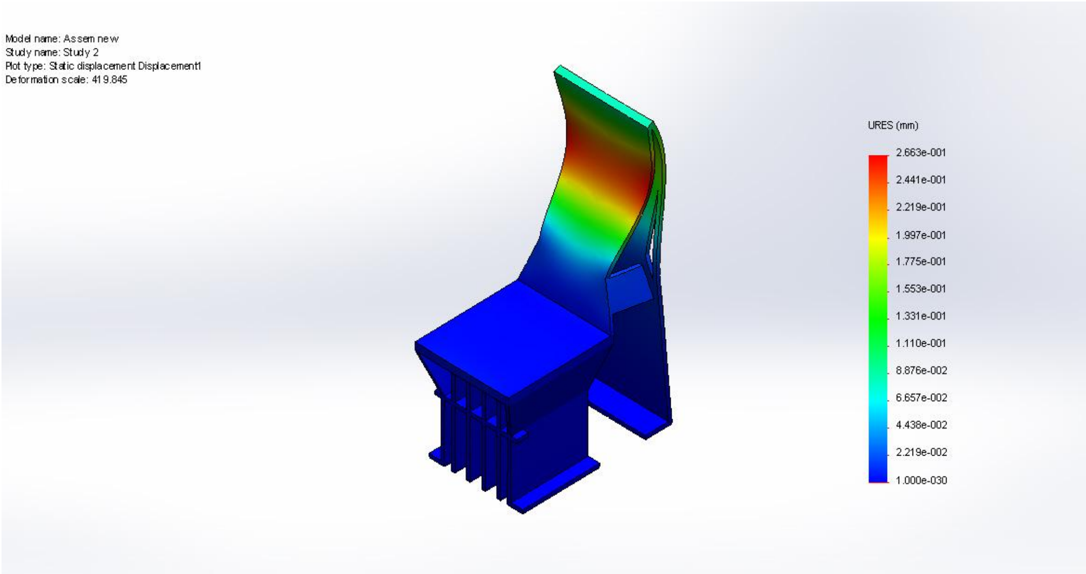
Study Results

Name	Type	Min	Max
Stress1	VON: von Mises Stress	15.9253 N/m^2 Node: 10014	1.15971e+006 N/m^2 Node: 15138



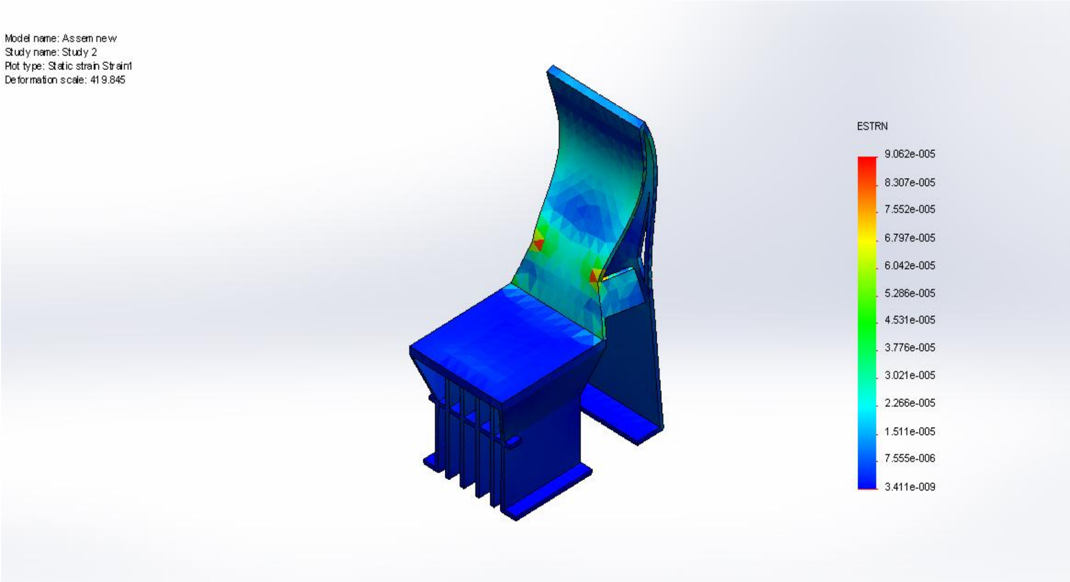
Assemled chair study – Stress - Stress1

Name	Type	Min	Max
Displacement1	URES: Resultant Displacement	0 mm Node: 18	0.266288 mm Node: 15092



Assemled chair study – Displacement - Displacement1

Name	Type	Min	Max
Strain1	ESTRN: Equivalent Strain	3.41123e-009 Element: 7421	9.06222e-005 Element: 5018



Assemled chair study – Strain - Strain1

As it is shown in the tables the cardboard chair has in total a weight of 4.7 kilograms which means that it is lightweight and it is among the existing chairs' weight that was found during the market research and as a result it is easily transported.

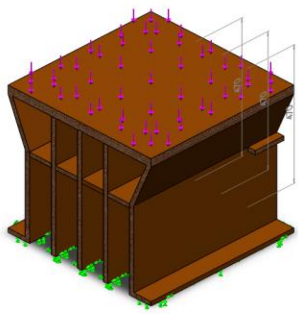
Equally important is for both the chair and the table to be stiff and strong, in order to be functional, durable and safe according to the design guidelines. For this reason, the test run was implemented for a force of 900 N applied on the seat and a force of 200 N on the seat backrest. The force that was concerned accounts for a human of 90 kilos, who is over the average human weight of people among 18 to 35 years old in Greece.

	Min Values	Max Values
Stress	15.9253 N/m^2	1.15971e+006
Strain	3.41123e-009	9.06222e-005
Displacement	0 mm	0.266288 mm

The distribution of Von Mises Stress has the lowest value 15.9253 N/m^2 and the highest which is 1.15971e+006. As it can be seen in the image above that obtained by the analysis in the Stress Study results, the Von Mises stress is maximum at the protuberances, and the value is 1.16e+006 N/m^2. This is less than yield point value of cardboard which has 2.45e+007 N/m^2. As a consequence the design is safe and the product can withstand these forces.

Only a little displacement is noticed on the seat backrest, which does not affect the safety and the stability of the chair.

The same procedure has been performed for the table.



Model name: Assemled table
Current Configuration: Default

Solid Bodies

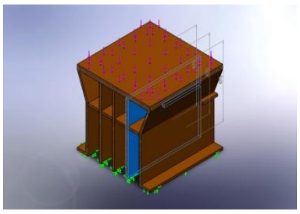
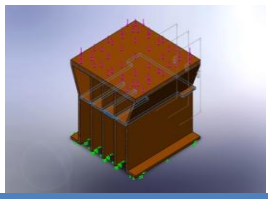
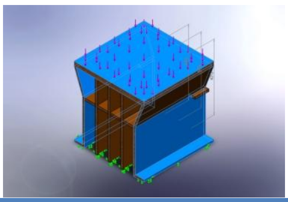
Document Name and Reference	Treated As	Volumetric Properties
Cut-Extrude1 	Solid Body x 3	Mass:0.541125 kg Volume:0.00346875 m^3 Density:156 kg/m^3 Weight:5.30302 N
Boss-Extrude2 	Solid Body	Mass:0.401895 kg Volume:0.00257625 m^3 Density:156 kg/m^3 Weight:3.93857 N
Cut-Extrude10 	Solid Body	Mass:2.40318 kg Volume:0.015405 m^3 Density:156 kg/m^3 Weight:23.5512 N

Table 15 - Table Model Information

Analysis type	Static
Mesh type	Solid Mesh
Thermal Effect:	On
Thermal option	Include temperature loads
Zero strain temperature	298 Kelvin
Include fluid pressure effects from SolidWorks Flow Simulation	Off
Solver type	FFEPlus
Inplane Effect:	Off
Soft Spring:	Off
Inertial Relief:	Off
Incompatible bonding options	Automatic
Large displacement	Off
Compute free body forces	On
Friction	Off
Use Adaptive Method:	Off

Table 16 – Study properties for table model

Unit system:	SI (MKS)
Length/Displacement	mm
Temperature	Kelvin
Angular velocity	Rad/sec
Pressure/Stress	N/m^2

Table 17 – Units for table model

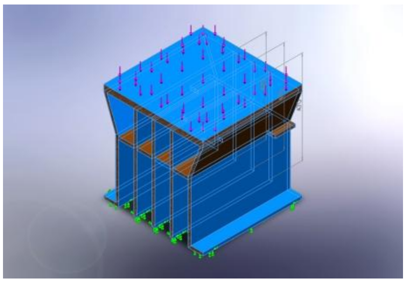
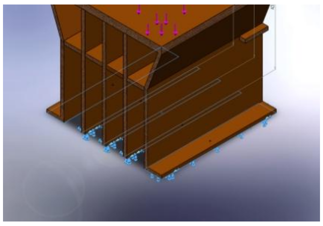
Model Reference	Properties	
	Name:	**Cardboard**
	Model type:	**Linear Elastic Isotropic**
	Default failure criterion:	**Unknown**
	Yield strength:	**2.45e+007 N/m^2**
	Tensile strength:	**3.7e+007 N/m^2**
	Compressive strength:	**4.8e+007 N/m^2**
	Elastic modulus:	**5.95e+009 N/m^2**
	Poisson's ratio:	**0.395**
	Mass density:	**156 kg/m^3**
	Shear modulus:	**1.5e+009 N/m^2**

Table 18 – Material Properties for table model

Fixture name	Fixture Image	Fixture Details
Fixed-1		**Entities:** **5 face(s)** **Type:** **Fixed Geometry**

Resultant Forces

Components	X	Y	Z	Resultant
Reaction force(N)	**-1.8429e-005**	**20**	**-3.48352e-005**	**20**
Reaction Moment(N·m)	**0**	**0**	**0**	**0**

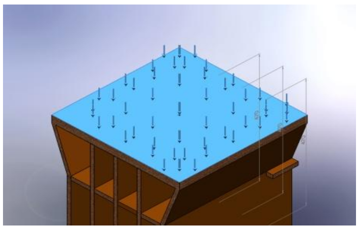
Load name	Load Image	Load Details
Force-1		**Entities:** **1 face(s)** **Type:** **Apply normal force** **Value:** **20 N**

Table 19 – Loads and Fixtures for table model

Mesh type	Solid Mesh
Mesher Used:	Standard mesh
Automatic Transition:	Off
Include Mesh Auto Loops:	Off
Jacobian points	4 Points
Element Size	37.7611 mm
Tolerance	1.88806 mm
Mesh Quality	High
Remesh failed parts with incompatible mesh	Off

Table 20 – Mesh Information

Total Nodes	16965
Total Elements	8532
Maximum Aspect Ratio	7.7548
% of elements with Aspect Ratio < 3	49
% of elements with Aspect Ratio > 10	0
% of distorted elements(Jacobian)	0
Time to complete mesh(hh;mm;ss):	00:00:04

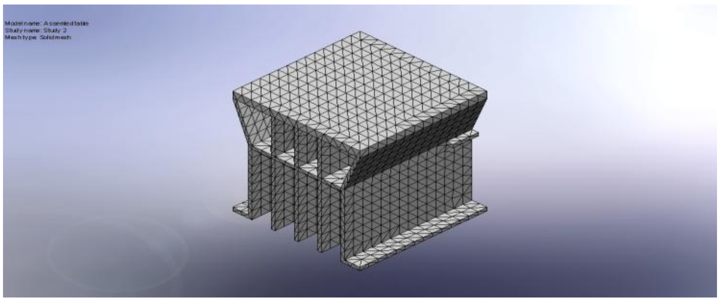


Table 21 – Mesh Information and Details for table model

Reaction Forces

Selection set	Units	Sum X	Sum Y	Sum Z	Resultant
Entire Model	N	-1.8429e-005	20	-3.48352e-005	20

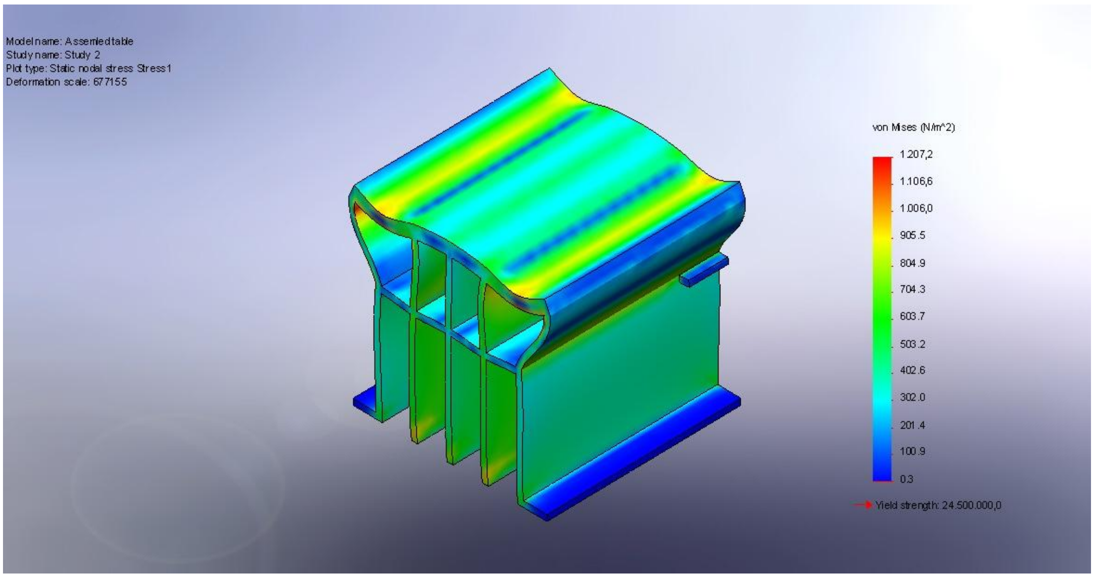
Reaction Moments

Selection set	Units	Sum X	Sum Y	Sum Z	Resultant
Entire Model	N·m	0	0	0	0

Table 22 – Resultant Forces for table model

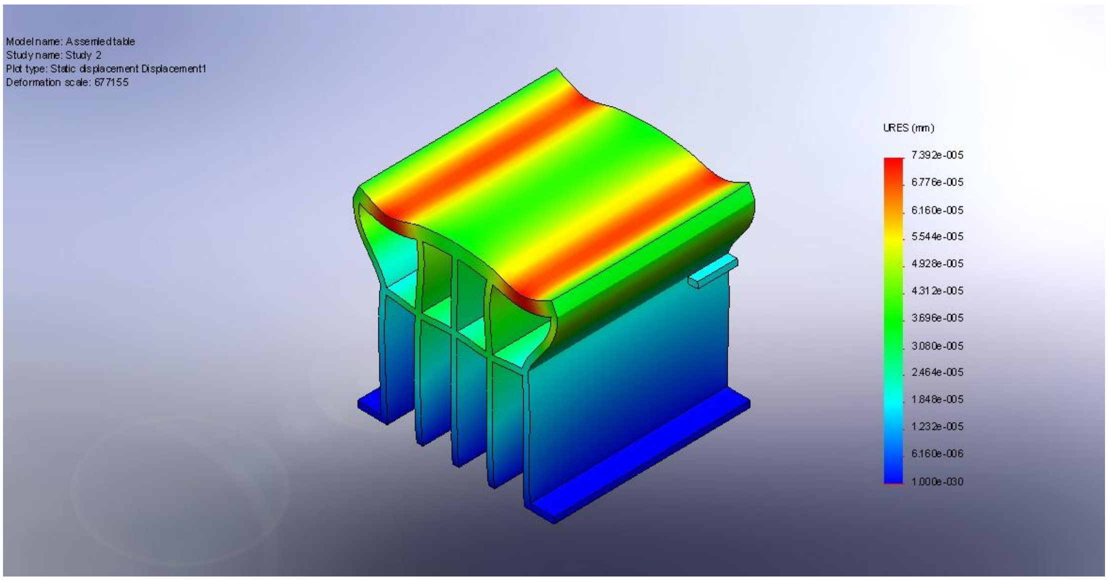
Study Results

Name	Type	Min	Max
Stress1	VON: von Mises Stress	0.28062 N/m^2 Node: 10223	1207.19 N/m^2 Node: 14998



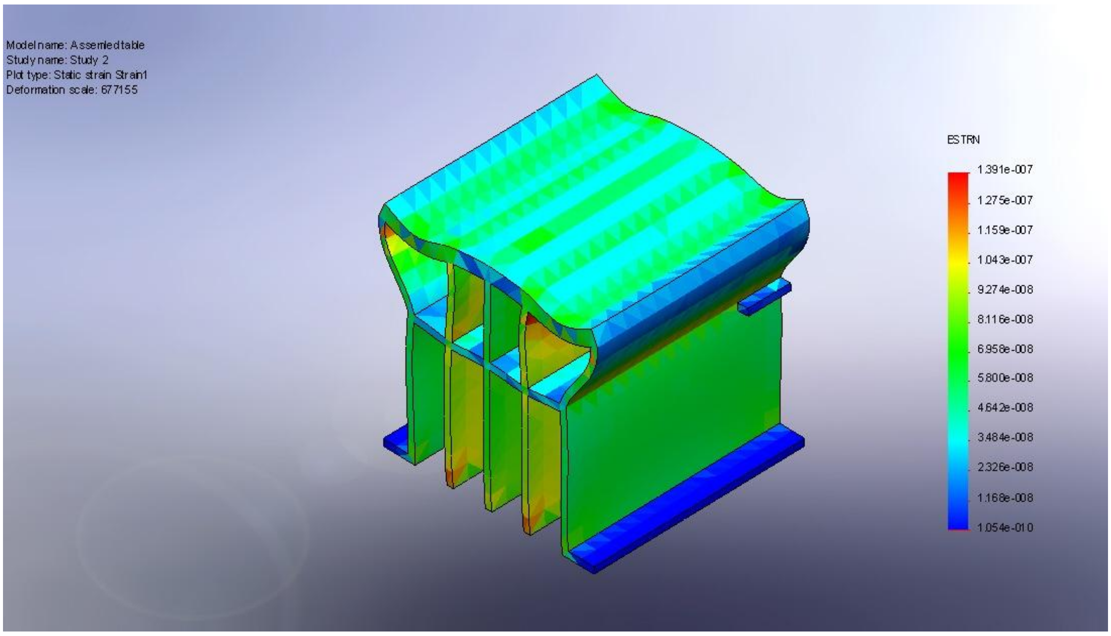
Assemled table stydy -Stress-Stress1

Name	Type	Min	Max
Displacement1	URES: Resultant Displacement	0 mm Node: 16	7.39234e-005 mm Node: 15944



Assemled table study -Displacement-Displacement1

Name	Type	Min	Max
Strain1	ESTRN: Equivalent Strain	1.05406e-010 Element: 7866	1.3906e-007 Element: 2110



Assemled table study-Strain-Strain1

The table should also be stiff and strong, although it is of less importance as it doesn't have to do with humans' safety. The test run was implemented for a force of 200 N applied on the top surface of the table as it will be used for activities such as board games, card games and for placing light stuff on it, like plates, glasses and so forth.

	Min Values	Max Values
Stress	0.28062 N/m^2	1207.19 N/m^2
Strain	1.05406e-010	1.3906e-007
Displacement	0 mm	0.739234e-005 mm

In the same way with the chair, the distribution of Von Mises Stress for the table has the lowest value 0.28062 N/m^2 and the highest which is 1207.19. Likewise, the outcomes of the Stress analysis Study results illustrate that the Von Mises stress is maximum at few points on the top, and the value is 1207.19 N/m^2, which is negligible compared to the yield point value of cardboard which is 2.45e+007 N/m^2. So, the table can also As a consequence the design is safe and the product can endure these forces.

Thus, the optimal material for the furniture that was chosen achieves the goal of low density that provides enough stiffness and safety.

4.5 Cost analysis

The cost analysis is useful for the prediction of the potential risks and profits at the early stage of the product development. The cost categories that are taken into consideration are about the raw materials, the manufacturing process and / or the labor cost, the packaging and the transportation. This kind of analysis is extremely helpful for the phase before proceeding to the production.

In this case, the cost refers to the raw materials, which are the cardboard per kilogram and the paper band which will be printed with information about the product and will be tied around the flat packed furniture. As for the manufacturing process, there is no need for special equipment and heavy machinery and as a consequence, there is no need of molds. Moreover, there will be no special packaging, except for a paper band that will tie the flat packed products, which will be printed with the products' information.

Products	Mass per unit	Weight
Chair	30,447.36 cm^3	4,713.99 g
Table	32,137.50 cm^3	4,428.45 g
TOTAL	62,584.86 cm^3	9,727.44 g

Table 23 – Mass and weight per unit

Even though the cost of cardboard in CES database is estimated to be 64 cents, in Greek market is about 45 cents per kilogram. In accordance, since the chair's weight is 4.714 kilograms, the raw material will cost 2.12 euro and the table weights 4.428, so it will cost 1.99 euro. The craftsman's work is about 0.40 euro per unit and the cost for the paper band is about 20 cents each.

Additionally, it should be mentioned that there is no transportation cost for the materials given that the supplies will be bought from the local region. The total cost is generated after the calculation of the taxes. In table 24, total cost for each piece is presented.

Cost Category	Chair cost	Table cost
Raw materials		
Cardboard	0.45 €/kg x 4.714 = 2.12 €	0.45 €/kg x 4.428 = 1.99 €
Paper Band	0.20 €	0.20 €
Transportation	0 € (due to local materials)	0 € (due to local materials)
Labor cost	0.40 € per unit	0.40 € per unit
Wholesale	2.72 €	2.59 €
Retail	2 x 2.72 = 5.44 €	2 x 2.59 = 5.18
Taxes	23%	23%
TOTAL	6.70 €	6.37 €

Table 24 – Total Cost per unit

The final price of the chair will be 6.70 euro and the table 6.37 euro, which are prices that correspond to research’s results that have given a range of desirable price from 5.00 to 20.00 euro.

CHAPTER 5 CONCLUSIONS

5.1 Conclusions

This project was undertaken to design Camping Furniture and specifically chair and tables and evaluate them with respect to their functionality, portability and sustainability. The reason of the elaboration of this study was the turn of Greek people to alternative tourism at campsites due to economic crisis and hence financial problems. Under those circumstances the necessity for inexpensive, practical and transportable products with low environmental impact came up.

In the first place, there was conducted a focus group interview and a distribution of a questionnaire to campers to discover the problems they face and their demands and secondly, a market research to find out the existing products and observe the human needs that they satisfy.

Additionally, after the determination of the target group and their requirements, the design guidelines have emerged. A few concept designs have been developed, through which the more suitable has been chosen to be tested in terms of sustainability, practicality and stability.

At first, the optimal material should have been selected through the databases of CES EduPack software to be applied to the products and examine firstly their environmental impact and then their stability. The sustainability study has occurred only for the chair, which is the biggest part and covers the need for the table test. This study has shown that the cardboard has the lesser impact compared to the bamboo and the softwood pine and therefore has applied to the products to run a stress analysis with the SolidWorks Simulation.

The evidence from this examination proves that the developed designs meet the users' requirements. Thereupon, the last but most important constraint has been estimate, which was the final price.

The findings of the cost analysis revealed that the final products would have affordable prices, as they came out to be close to the lowest desirable price that was declared during the research.

Taken together, these results suggest that cardboard furniture are strong enough inexpensive and eco-friendly that can be used for camping and can be easily disposed for recycling after use, without obligating the users to carry them back.

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APPENDIXES

APPENDIX A – CONTEXT OF DISCUSSION OF FOCUS GROUP

CONTEXT OF DISCUSSION OF FOCUS GROUP

GENERAL INFORMATION (ABOUT CAMPING)

1. Reasons why someone goes camping
2. Motives that spur people to that kind of tourism
3. Activities that campers do

CAMPING EQUIPMENT

4. Products that campers use
5. Problems that campers confront
6. Time period and duration that the equipment is used
7. Criteria for choosing the location for camping
8. Mode of transport of equipment (car, motorbike, means of transport)
9. Criteria for choosing camping equipment
10. To what extent equipment prices are taken into account
11. What happens to equipment after use

GREEN BEHAVIOR

12. Is there “green” daily routine?

- Saving of energy / water,
- recycling,
- alternative forms of energy

13. Is there “green” purchase behavior?
14. Is there information about sustainable products?

APPENDIX B – QUESTIONNAIRE

ΕΡΕΥΝΑ ΚΟΙΝΗΣ ΓΝΩΜΗΣ

ΕΡΕΥΝΑ No:		**Α/Α ΕΡΩΤΗΜΑΤΟΛΟΓΙΟΥ**	
ΗΜΕΡΟΜΗΝΙΑ			

Καλημέρα σας / Καλησπέρα σας. Αυτές τις μέρες πραγματοποιούμε μία έρευνα κοινής γνώμης και θα θέλαμε και τη δική σας άποψη. Η έρευνα είναι ανώνυμη και οι απαντήσεις θα παραμείνουν απολύτως εμπιστευτικές. Θα μπορούσατε να μας διαθέσετε λίγο από το χρόνο σας;

ΕΡ.1	Εσείς κάνετε κάμπινγκ;	
1	ΝΑΙ	
2	ΟΧΙ	
99	ΔΓ/ΔΑ	

ΕΑΝ ΑΠΑΝΤΗΣΕΙ 2 ή 99 ΚΛΕΙΣΕ ΤΗ ΣΥΝΕΝΤΕΥΞΗ

ΕΡ.2	Και πότε κάνετε κάμπινγκ;	
1	ΚΑΛΟΚΑΙΡΙ	
2	ΧΕΙΜΩΝΑΣ	
3	ΚΑΙ ΣΤΑ ΔΥΟ	
99	ΔΓ/ΔΑ	

ΕΡ.3	Και τι είδους κάμπινγκ κάνετε;	
1	ΕΛΕΥΘΕΡΟ	
2	ΟΡΓΑΝΩΜΕΝΟ	
3	ΚΑΙ ΤΑ ΔΥΟ	
99	ΔΓ/ΔΑ	

ΕΡ.4	Πόσο συχνά κάνετε κάμπινγκ;	
1	1-3 μέρες το χρόνο	
2	4-7 μέρες	
3	8-10 μέρες	
4	11-15 μέρες	
5	Πάνω από 15 μέρες	
6	Τυχαία (αυθόρμητα)	
99	ΔΓ/ΔΑ	

ΕΡ.5	Πόσα άτομα παρέα πηγαίνετε κάμπινγκ;	
1	2 άτομα	
2	3 άτομα	
3	4 άτομα	
4	5 άτομα	
5	Πάνω από 5 άτομα	
99	ΔΓ/ΔΑ	

EP.6	Ποιες από τις παρακάτω προτάσεις ταιριάζουν στο κάμπινγκ για σας;	
1	Είναι φθηνό	
2	Είναι κοντά στη φύση	
3	Νιώθεις ελευθερία	
4	Δεν υπάρχει οργάνωση	
5	Δεν υπάρχει ασφάλεια	
6	Έχει πολλή φασαρία	
7	Άλλο (τι;)	
99	ΔΓ/ΔΑ	

EP.7	Ποια από τα παρακάτω προϊόντα παίρνετε μαζί σας κάθε φορά που κάνετε κάμπινγκ;	
1	Σκηνή	
2	Τραπέζι	
3	Καρέκλες	
4	Είδη για τη θάλασσα (πετσέτες, αντιηλιακό κλπ)	
5	Είδη μαγειρέματος και για ψήσιμο	
6	Όργανα μουσικής	
7	Επιτραπέζια παιχνίδια	
8	Υπνόσακος	
9	Στρώμα	
10	Τρόμπα	
11	Φακό/Φανάρια	
12	Είδη προσωπικής υγιεινής	
13	Είδη καθαριότητας	
14	Ψυγείο	
15	Τρόφιμα και αναψυκτικά	
	Άλλο (τι;)	
99	ΔΑ	

ΕΡ.8	Και ποια είναι τα βασικά κριτήρια για την επιλογή των παραπάνω προϊόντων; (ΜΟΝΟ 3 ΑΠΑΝΤΗΣΕΙΣ)	
1	Τιμή	
2	Πρακτικότητα	
3	Χρησιμότητα	
4	Όγκος / Μέγεθος	
5	Ανθεκτικότητα	
6	Συχνότητα Χρήσης	
7	Άμεσα Ανακυκλώσιμο	
	Άλλο (τι;)	
99	ΔΑ	

ΕΡ.9 Παρακάτω αναφέρονται κάποια προϊόντα και κάποιες τιμές, θα ήθελα να μου πείτε ποια τιμή σας φαίνεται πιο ταιριαστή για κάθε προϊόν:	**ΤΙΜΗ 1**	**ΤΙΜΗ 2**	**ΤΙΜΗ 3**	**ΤΙΜΗ 4**
1. Σκηνή	**5 – 20 €**	**21 – 60 €**	**60 € + Άνω**	**99**
2.Καρέκλα	**5 – 20 €**	**21 – 60 €**	**60 € + Άνω**	**99**
3. Τραπέζι	**5 – 20 €**	**21 – 60 €**	**60 € + Άνω**	**99**
4. Κρεβάτι κάμπινγκ	**5 – 20 €**	**21 – 60 €**	**60 € + Άνω**	**99**
5. Υπνόσακος	**5 – 20 €**	**21 – 60 €**	**60 € + Άνω**	**99**
6. Ψυγείο	**5 – 20 €**	**21 – 60 €**	**60 € + Άνω**	**99**

ΕΡ.10	Και τέλος αν μπορούσατε να βάλετε μια μόνο λέξη για το κάμπινγκ, ποια θα ήταν αυτή;	
1		
99	ΔΓ/ΔΑ	

ΔΗΜΟΓΡΑΦΙΚΑ ΣΤΟΙΧΕΙΑ ΕΡΩΤΩΜΕΝΟΥ

Για καθαρά στατιστικούς λόγους θα ήθελα να μου πείτε:

Δ.1	Σε ποια από τις παρακάτω ηλικιακές ομάδες ανήκετε;		
1	18-24	45-54	**4**
2	25-34	55-64	**5**
3	35-44	>65	**6**
99	ΔΓ/ΔΑ		

Δ.2	Φύλο:	Άνδρας	**1**
		Γυναίκα	**2**

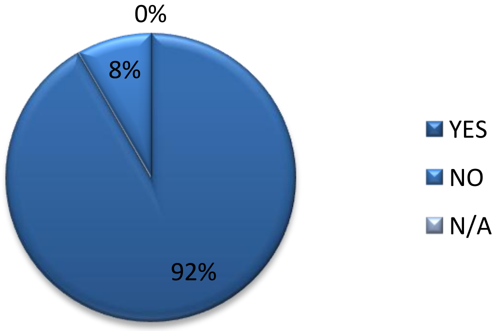
Δ.3	Είσαστε απόφοιτος/η:	
1	Δημοτικού	
2	Γυμνασίου-Λυκείου	
3	ΑΕΙ-ΤΕΙ	
99	ΔΓ/ΔΑ	

Δ.4	Θέση στην απασχόληση:	
1	Εργοδότης/Αυτοαπασχολούμενος	
2	Μισθωτός δημόσιου τομέα	
3	Μισθωτός ιδιωτικού τομέα	
4	Άνεργος	
5	Σπουδαστής/Φοιτητής	
6	Συνταξιούχος	
7	Νοικοκυρά	
	Άλλο	
99	ΔΓ/ΔΑ	

Δ.5	Σε ποια θέση της κλίμακας βρίσκεται το συνολικό μηνιαίο οικογενειακό εισόδημα του νοικοκυριού σας;	
1	Καθόλου εισοδήματα	
2	Λιγότερο από 450 ευρώ	
3	451-1.000 ευρώ	
4	1.001-1.500 ευρώ	
5	1.501-2.000 ευρώ	
6	Πάνω από 2.000 ευρώ	
99	ΔΓ/ΔΑ	

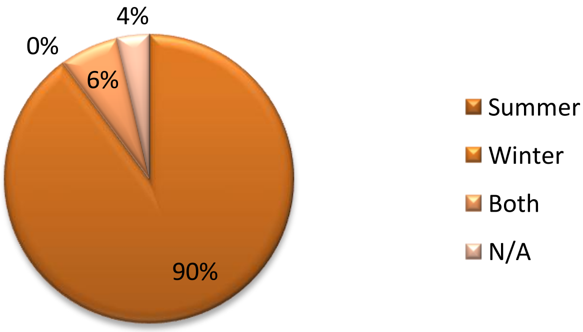
APPENDIX C - STATISTICS

Do you go camping?



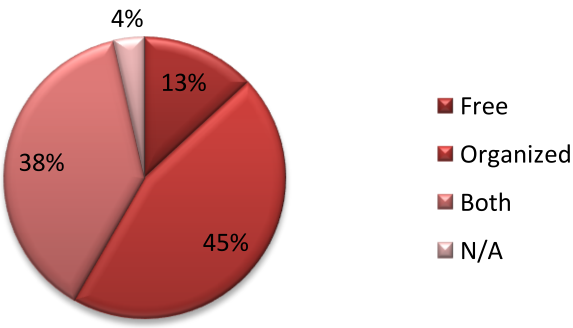
YES	154	92%
NO	14	8%
N/A	0	0%

When do you go camping?



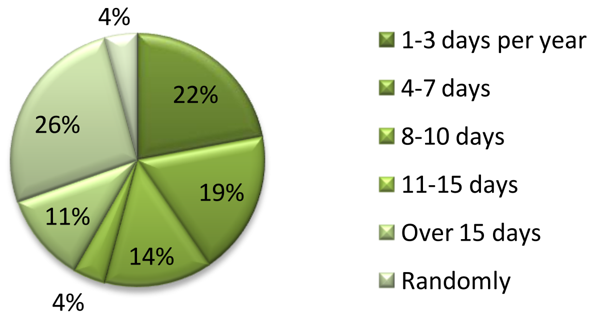
Summer	151	90%
Winter	0	0%
Both	11	7%
N/A	6	4%

What kind of camping do you prefer?



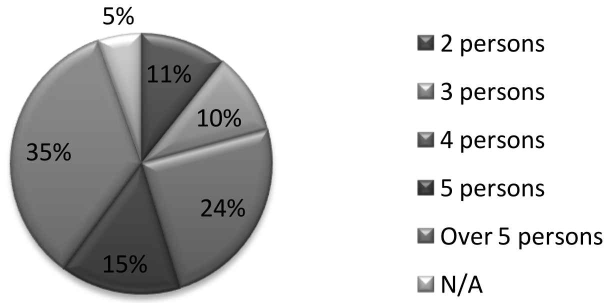
Free	22	13%
Organized	76	45%
Both	64	38%
N/A	6	4%

How often do you go camping?



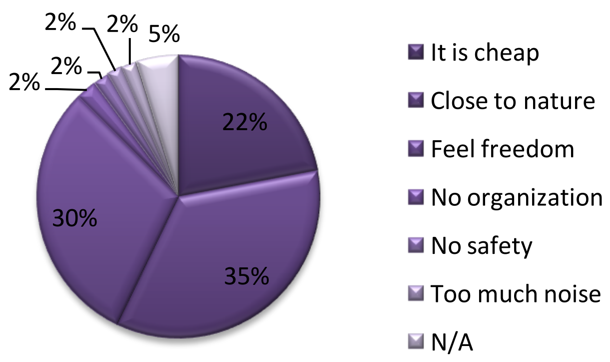
1-3 days per year	37	22%
4-7 days	31	18%
8-10 days	23	14%
11-15 days	7	4%
Over 15 days	19	11%
Randomly	44	26%
N/A Other	7	4%

How many people do you go camping?



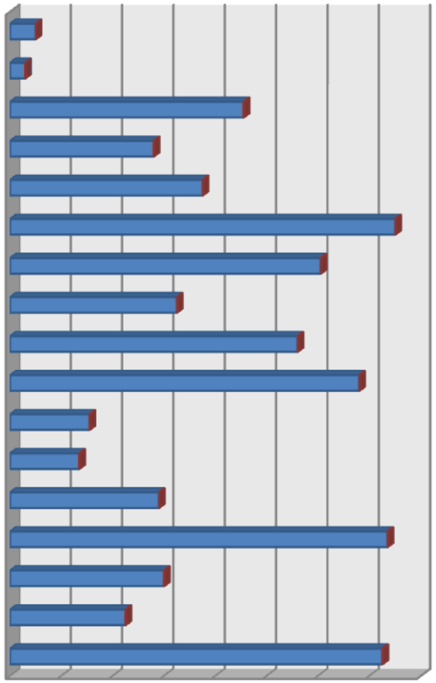
2 persons	18	11%
3 persons	17	10%
4 persons	41	24%
5 persons	25	15%
Over 5 persons	58	35%
N/A	9	5%

Which of the following sentences describe "camping" for you?

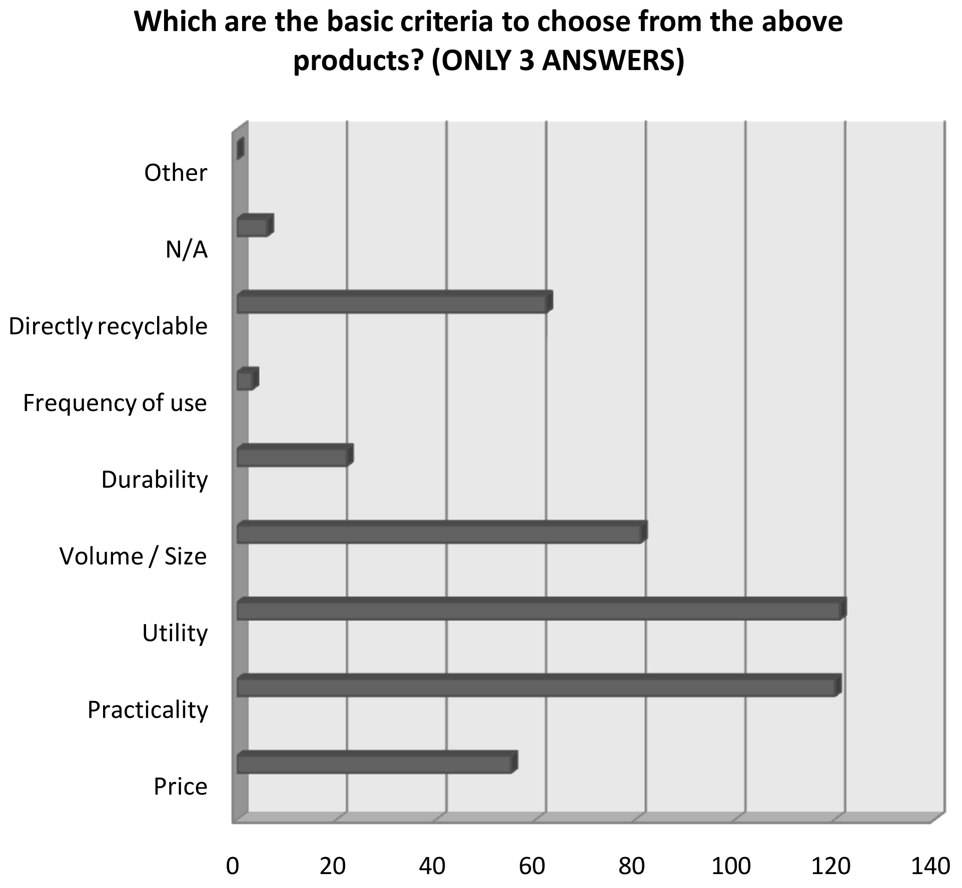


It is cheap	37	22%
Close to nature	59	35%
Feel freedom	51	30%
No organization	4	2%
No safety	3	2%
Too much noise	3	2%
N/A	3	2%
Other	8	5%

Which of the following products do you take with you every time you go camping?

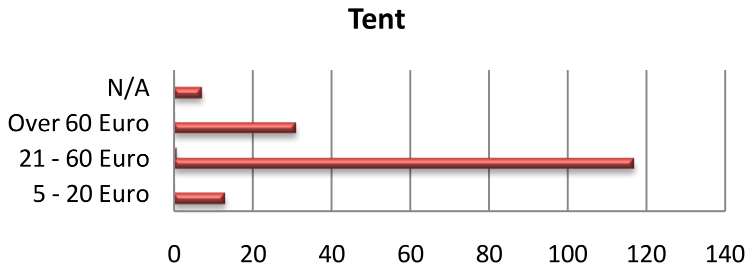


Tent	145	11%
Table	45	3%
Chairs	60	4%
Products for the beach (towels, sun	147	11%
Products for cooking and barbeque	58	4%
Musical Instruments	27	2%
Board games	31	2%
Sleeping Bag	136	10%
Mattress	112	8%
Pump	65	5%
Flashlight	121	9%
Personal hygiene items	150	11%
Cleaning products	75	6%
Refrigerator	56	4%
Food and Beverages	91	7%
N/A	6	0%
Other	10	1%

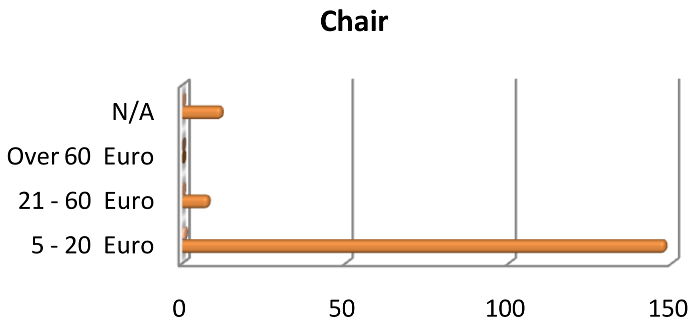


Price	55	12%
Practicality	120	26%
Utility	121	26%
Volume / Size	81	17%
Durability	22	5%
Frequency of use	3	1%
Directly recyclable	62	13%
N/A	6	1%
Other	0	0%

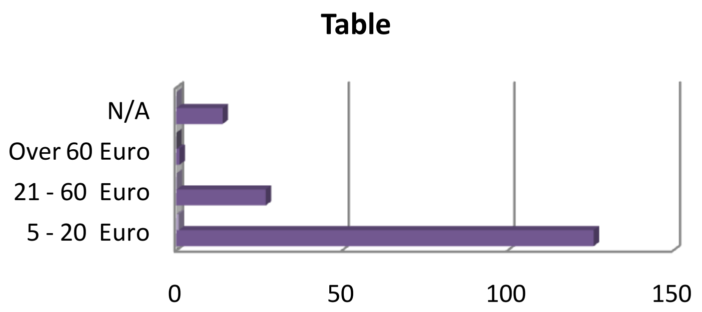
(Below are listed some products and some prices, I would like you to tell me which is the best price for each product)



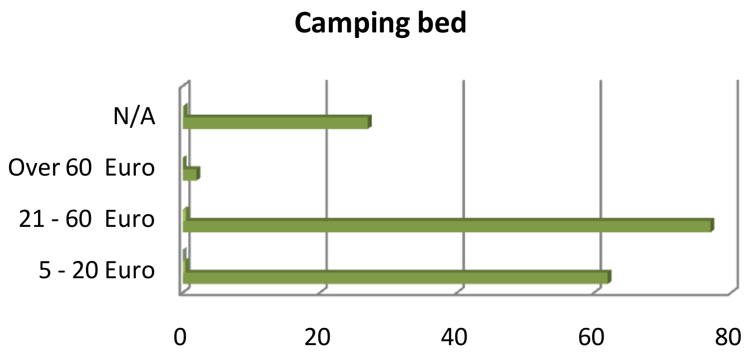
5 - 20 Euro	13	8%
21 - 60 Euro	117	70%
Over 60 Euro	31	18%
N/A	7	4%



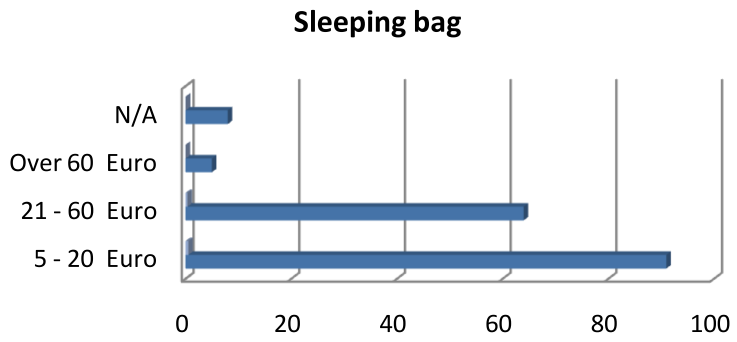
5 - 20 Euro	148	88%
21 - 60 Euro	8	5%
Over 60 Euro	0	0%
N/A	12	7%



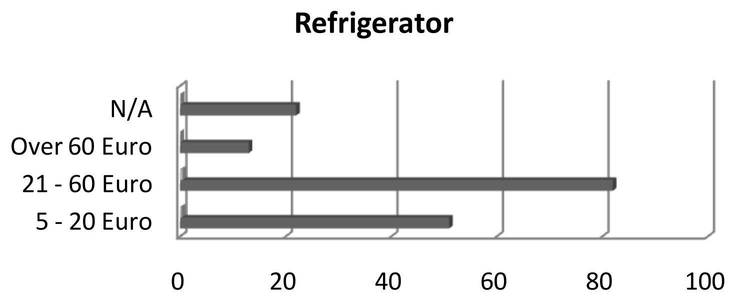
5 - 20 Euro	126	75%
21 - 60 Euro	27	16%
Over 60 Euro	1	1%
N/A	14	8%



5 - 20 Euro	62	37%
21 - 60 Euro	77	46%
Over 60 Euro	2	1%
N/A	27	16%



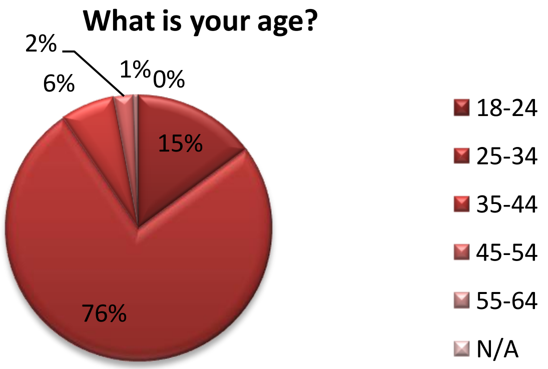
5 - 20 Euro	91	54%
21 - 60 Euro	64	38%
Over 60 Euro	5	3%
N/A	8	5%



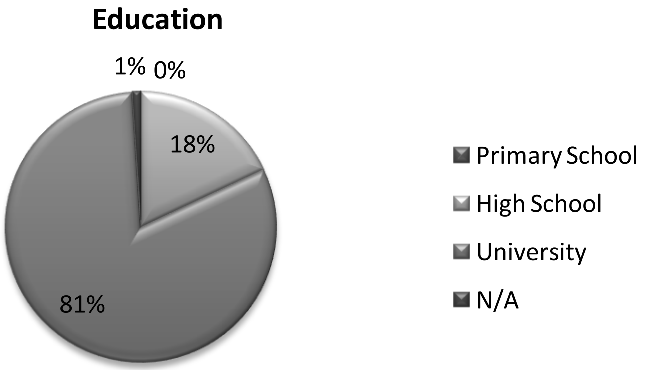
5 - 20 Euro	51	30%
21 - 60 Euro	82	49%
Over 60 Euro	13	8%
N/A	22	13%

If you could use only one word for camping, which would that be?

Freedom	13	Heaven	1	Exhausting	1	Free journey with ourselves	1
Nature	7	Eventually	1	Vitality	1	Very nice	1
Vacations	7	Summer	1	Armenistis	1	Perfect	1
Relaxation	6	Camping is simple	1	Escape	1	Mattress	1
Carelessness	6	Convenience	1	Oxygen	1	Bugs	1
Peace	3	Hippy	1	Fun	1	Microbes	1
Cool	4	Liberation	1	Uncomfortable	1	The best	1
Companionship	6	Snakes	1	Beach	1	Escape	1
Great life	3	Socialization	1	Refreshment	1	Kalamitsi!	1
Hardship	1	Life	1	Slicker	1	Laugh	1
Way of life	1	It has fun	1	Very beautiful!	1	Libertad	1
Idea	1	Beauty	1	Sleep on the ground	1	Beer	1

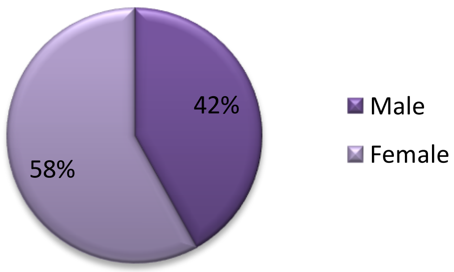


18-24	25	15%
25-34	127	76%
35-44	11	7%
45-54	4	2%
55-64	1	1%
N/A	0	0%



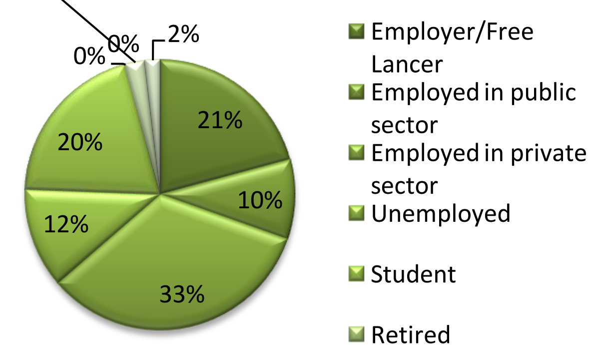
Primary School	0	0%
High School	30	18%
University	136	81%
N/A	2	1%

Gender



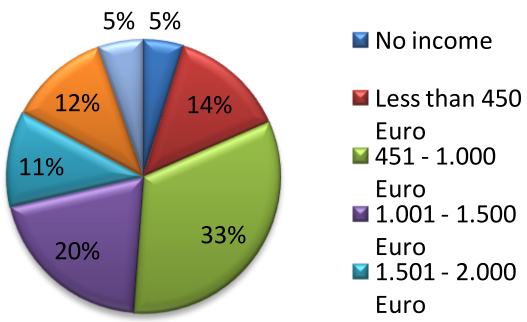
Male	70	42%
Female	98	58%

Kind of employment



Employer/Free Lancer	35	21%
Employed in public sector	16	10%
Employed in private sector	56	33%
Unemployed	20	12%
Student	34	20%
Retired	0	0%
Housekeeper	0	0%
N/A	4	2%
Other	3	2%

Which is your total monthly family income of your home?



No income	8	5%
Less than 450 Euro	23	14%
451 - 1.000 Euro	55	33%
1.001 - 1.500 Euro	34	20%
1.501 - 2.000 Euro	19	11%
Over 2.000 Euro	20	12%
N/A	9	5%

APPENDIX D – SUSTAINABILITY REPORT

Model Name:	Assembled Chair Cardboard	Weight:	4713.99 g
		Built to last:	0.083 year
		Duration of use:	0.083 year

Assembly Process

Region:	Europe
Energy type:	None
Energy amount:	0.00 kWh
Built to last:	0.083 year

Use

Region:	Europe
Energy type:	None
Energy amount:	0.00 kWh
Duration of use:	0.083 year

Transportation

Truck distance:	1000 km
Train distance:	0.00 km
Ship distance:	0.00 km
Airplane Distance:	0.00 km

End of Life

Recycled:	100 %
Incinerated:	0.00 %
Landfill:	0.00 %

Model Name:	Assembled Chair Cardboard	Weight:	4713.99 g
		Built to last:	0.083 year
		Duration of use:	0.083 year

Environmental Impact (calculated using CML impact assessment methodology)

Carbon Footprint

Material:	3.1 kg CO_2e
Manufacturing:	0.00 kg CO_2e
Use:	0.00 kg CO_2e
Transportation:	0.653 kg CO_2e
End of Life:	0.00 kg CO_2e

3.8 kg CO_2e

Total Energy Consumed

Material:	51 MJ
Manufacturing:	0.00 MJ
Use:	0.00 MJ
Transportation:	9.7 MJ
End of Life:	0.00 MJ

60 MJ

Air Acidification

Material:	6.1E-3 kg SO_2e
Manufacturing:	0.00 kg SO_2e
Use:	0.00 kg SO_2e
Transportation:	3.0E-3 kg SO_2e
End of Life:	0.00 kg SO_2e

9.1E-3 kg SO_2e

Water Eutrophication

Material:	1.5E-3 kg PO_4e
Manufacturing:	0.00 kg PO_4e
Use:	0.00 kg PO_4e
Transportation:	6.9E-4 kg PO_4e
End of Life:	0.00 kg PO_4e

2.2E-3 kg PO_4e

Model Name:	Assembled Chair Cardboard	Weight:	4713.99 g
		Built to last:	0.083 year
		Duration of use:	0.083 year

Component Environmental Impact

Top Ten Components Contributing Most to the Four Areas of Environmental Impact

Component	Carbon	Water	Air	Energy
Part1	2.5	1.4E-3	5.7E-3	40
Part2	0.229	1.2E-4	5.2E-4	3.7
Part3	0.146	7.9E-5	3.3E-4	2.3

Model Name:	Assembled Chair Bamboo	Weight:	21313.15 g
		Built to last:	0.083 year
		Duration of use:	0.083 year

Assembly Process

Region:	Europe
Energy type:	None
Energy amount:	0.00 kWh
Built to last:	0.083 year

Use

Region:	Europe
Energy type:	None
Energy amount:	0.00 kWh
Duration of use:	0.083 year

Transportation

Truck distance:	1000 km
Train distance:	0.00 km
Ship distance:	0.00 km
Airplane Distance:	0.00 km

End of Life

Recycled:	100 %
Incinerated:	0.00 %
Landfill:	0.00 %

Model Name:	Assembled Chair Bamboo	Weight:	21313.15 g
		Built to last:	0.083 year
		Duration of use:	0.083 year

Environmental Impact (calculated using CML impact assessment methodology)

Carbon Footprint

Material:	8.4 kg CO_2e
Manufacturing:	0.00 kg CO_2e
Use:	0.00 kg CO_2e
Transportation:	3.0 kg CO_2e
End of Life:	0.00 kg CO_2e

11 kg CO_2e

Total Energy Consumed

Material:	97 MJ
Manufacturing:	0.00 MJ
Use:	0.00 MJ
Transportation:	44 MJ
End of Life:	0.00 MJ

140 MJ

Air Acidification

Material:	0.078 kg SO_2e
Manufacturing:	0.00 kg SO_2e
Use:	0.00 kg SO_2e
Transportation:	0.014 kg SO_2e
End of Life:	0.00 kg SO_2e

0.092 kg SO_2e

Water Eutrophication

Material:	9.8E-3 kg PO_4e
Manufacturing:	0.00 kg PO_4e
Use:	0.00 kg PO_4e
Transportation:	3.1E-3 kg PO_4e
End of Life:	0.00 kg PO_4e

0.013 kg PO_4e

Model Name:	Assembled Chair Bamboo	Weight:	21313.15 g
		Built to last:	0.083 year
		Duration of use:	0.083 year

Component Environmental Impact

Top Ten Components Contributing Most to the Four Areas of Environmental Impact

Component	Carbon	Water	Air	Energy
Part1	7.2	8.3E-3	0.061	88
Part2	0.680	7.8E-4	5.7E-3	8.3
Part3	0.421	4.8E-4	3.5E-3	5.1

Model Name:	Assembled Chair Pine	Weight:	10352.10 g
		Built to last:	0.083 year
		Duration of use:	0.083 year

Assembly Process

Region:	Europe
Energy type:	None
Energy amount:	0.00 kWh
Built to last:	0.083 year

Use

Region:	Europe
Energy type:	None
Energy amount:	0.00 kWh
Duration of use:	0.083 year

Transportation

Truck distance:	1000 km
Train distance:	0.00 km
Ship distance:	0.00 km
Airplane Distance:	0.00 km

End of Life

Recycled:	100 %
Incinerated:	0.00 %
Landfill:	0.00 %

Model Name:	Assembled Chair Pine	Weight:	10352.10 g
		Built to last:	0.083 year
		Duration of use:	0.083 year

Environmental Impact (calculated using CML impact assessment methodology)

Carbon Footprint

Material:	3.2 kg CO_2e
Manufacturing:	0.00 kg CO_2e
Use:	0.00 kg CO_2e
Transportation:	1.4 kg CO_2e
End of Life:	0.00 kg CO_2e

4.6 kg CO_2e

Total Energy Consumed

Material:	17 MJ
Manufacturing:	0.00 MJ
Use:	0.00 MJ
Transportation:	21 MJ
End of Life:	0.00 MJ

38 MJ

Air Acidification

Material:	6.6E-3 kg SO_2e
Manufacturing:	0.00 kg SO_2e
Use:	0.00 kg SO_2e
Transportation:	6.7E-3 kg SO_2e
End of Life:	0.00 kg SO_2e

0.013 kg SO_2e

Water Eutrophication

Material:	1.3E-3 kg PO_4e
Manufacturing:	0.00 kg PO_4e
Use:	0.00 kg PO_4e
Transportation:	1.5E-3 kg PO_4e
End of Life:	0.00 kg PO_4e

2.8E-3 kg PO_4e

Model Name:	Assembled Chair Pine	Weight:	10352.10 g
		Built to last:	0.083 year
		Duration of use:	0.083 year

Component Environmental Impact

Top Ten Components Contributing Most to the Four Areas of Environmental Impact

Component	Carbon	Water	Air	Energy
Part1	2.9	1.6E-3	7.6E-3	22
Part2	0.270	1.5E-4	7.2E-4	2.0
Part3	0.167	9.5E-5	4.4E-4	1.3