

Kirigami carboard furniture design

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KEYWORDS:

Kirigami art#1, cardboard furniture design#2, recycling materials#3, eco – friendly materials#4.

ABSTRACT:

Kirigami is the art of folding and cutting paper, but with the addition of movement to change design shape, in addition to high strength and light weight. This paper-designed by kirigami is a super strong and lightweight material. Using the kirigami technique reduces weight in furniture with its various uses.

Green furniture is considered highly efficient as it fits into space, without depleting natural resources. Thus, it is described as a sustainable design, like a plant that grows in its place, as it benefits from the surroundings in which it is located to obtain its nutritional requirements. The longer the plant lives, the longer it grows until it reaches the stage of stability, so sustainable design is combined with green design.

The designer can design green furniture from recycled and reused materials to achieve long-term economic and environmental aspects.

The two terms are synonymous, but each term has different characteristics. Recycling is the conscious rationalization of eco-friendly materials such as paper and cardboard

described as a green design, like a plant that grows in its place, as it benefits from the surroundings in which it is located to obtain its nutritional requirements. The longer the plant lives, the longer it grows until it reaches The stabilization stage, so sustainable design was associated with green design ⁽²⁾

Thus, the designer was able to design environmental furniture from recycled and reused materials to achieve long-term economic and environmental aspects. The two terms are synonymous, but each term has different characteristics. Recycling is the conscious rationalization of eco-friendly materials such as cardboard, so the materials can be reused, social dimension is an important characteristic must take in consideration. This characteristic also reduces waste and rationalizes the economic value of materials. Reuse is the transformation of a piece of furniture from one function to another, which produce a new usage behavior, through dismantling, assembling, and replacing parts ⁽¹⁾.

The researcher is moving towards green cardboard furniture depending on the function it performs, whether outdoor furniture or indoors as (residential/commercial/administrative/sustainable environmental tourism), taking inspiration from the art of kirigami with environmentally, eco-friendly materials such as paper /cardboard, as it has become an ideal material for making furniture. At first, some believe that this the furniture cannot bear large amounts of loads ⁽¹¹⁾ because it is made of a weak material, but cardboard is characterized by its high durability, simplicity and sustainable economic cost as well . It can also be treated with additives to make it waterproof, fireproof, recyclable, and usable from one job to another. Since the paper can be folded, unfolded and re-folded to become ready for reuse more than once, the use of cardboard is a practical alternative to wood in furniture manufacturing ⁽¹²⁾.

While reuse is the transformation of Furniture function from one to another. A new user behavior produced through dismantling, assembling, and replacing parts.

The researcher is moving towards, green furniture depending on the function it performs, whether outdoor furniture or indoors one as (residential/commercial/administrative/sustainable environmental resort) inspired by the art of kirigami, from eco- friendly materials such as paper and cardboard, treated with additives to make it waterproof, fireproof, with high durability, low cost.

Simple and economical, it can be recycled from one function to another, as the paper can be folded, unfolded, and refolded to be ready for repeated reuse. Using cardboard is a practical alternative to wood and natural materials in manufacturing furniture.

The space with green furniture (paper/cardboard) is characterized as a different space filled with creativity and boldness, and it is also a source of inspiration and creative thoughts.

Introduction:

Kirigami is the art of folding and cutting paper, but with the addition of movement to change the shape of the design, in addition to high strength and light weight. This paper is designed with kirigami, a super strong and lightweight material. Using the kirigami technique helps the designer to innovate and be creative in design and reduces ⁽⁷⁾ weight in interior and exterior furniture.

Sustainable green furniture is highly efficient as it fits into space without depleting natural resources. Thus, it is

art of kirigami and how to apply it to green furniture, using eco-friendly materials.

Research Delimitation:

the research extends to studying the art of kirigami and its impact on green furniture design, sustainable indoor/outdoor furniture using eco- friendly materials that can be reused and recycled more than once for different functions.

1. The art of kirigami:

The word Kirigami consists of two syllables: “kirie” meaning cutting, and the second syllable of the word “kami” meaning paper. It is the art of folding and cutting paper, but with the addition of movement. The two-dimensional paper is crumpled and cut using two-dimensional prototyping techniques, and then transformed into pieces. In addition to high strength and light weight, kirigami is known as an expanded version of origami (paper folding). But rotation and twisting are added to it, to help the design move, allowing the creation of more complex 3D designs. It is also characterized by very low cost and high efficiency. Designs based on kirigami are inherently lightweight. (8)



Pictures (1, 2) shows the stages of three-dimensional shapes, by using kirigami art , using cardboard material <https://www.flickr.com/photos/methylum/5822586034/in/photostream-12/10/2023-10:40pm>

The space with green furniture using the material (cardboard) is characterized as a different space with creativity and boldness, and it is also a source of inspiration and creativity for thinking.

Research problem:

- Designers’ lack of knowledge of kirigami art, and how to use it in furniture design.
- Economic aspect: High prices for wood outdoor and indoor furniture (residential/commercial/administrative/resort).
- Environmental aspect: reducing the depletion of natural resources and using reusable environmental materials such as (cardboard).

Research hypotheses:

- Using the art of kirigami in designing indoor / outdoor furniture enhances towards green design trend.
- kirigami art supports sustainability in furniture design by recycling environmentally friendly materials.

Research importance:

The importance of this study lies in design creative thought, derived from kirigami art and green design (for outdoor/indoor furniture) by using sustainable and eco-friendly materials.

The aim of research:

- The researcher aims to emphasize the necessity of moving towards green furniture design.
- Consolidating the idea of using recycled materials and using them more than once in design.

- Shedding light on a type of creative art, as kirigami art, which helps the designer to be creative in furniture design with endless design thoughts.

Research Methodology:

The research is based on a descriptive and analytical methodology, inspired from the

seeks continuous integration and compatibility with the environment ⁽²⁾.

Sustainable furniture is a type of furniture that uses materials have a minimal negative impact on the environment. Sustainable furniture is commonly used:

- Materials that come from renewable, recycled, or reused sources.
- Materials that contain minimal chemicals that can pollute the environment and harm the user ⁽¹³⁾.
- Local materials or local manufacturing to provide economic benefits.

3.Green furniture design:

It is a trend that requires integrated thinking during design. This trend aims to achieve basic resistances such as durability, suitability to function, beauty, and economy. It also does not cause bad effects on the environment or on human health. It attempts to introduce environmental and humanitarian considerations into the design process. so environmental and humanitarian considerations have been described as “Green,” perhaps because Green are the secret of life and its manifestation in plants, because the green color is one of the colors derived from the environment, in addition to the fact that it suggests goodness.

Green furniture standards	
Use reusable materials more than once	use of raw materials and resources repeatedly, whether for the same function more than once, without undergoing any new manufacturing processes. Thus, reuse is considered one of the best ways to increase the lifespan of the material usage cycle and increase the life span of the furniture piece ⁽³⁾ through disassembly and reassembly methods. and can recycle it at the end of its period use.

This art spread during the 17th century and its fame increased when it was used in the design of temples and palaces in Japan and China. From here, this art became internationally recognized ⁽²²⁾, over the years, schools teach this sort of art. Indeed, it became one of the most important subjects. Study in engineering colleges in China and Japan.

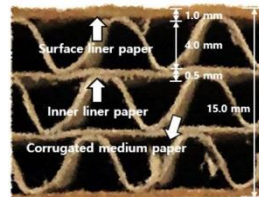
The art of kirigami depends on three determinants:

- 1- The material is processed cardboard and is a recyclable material.

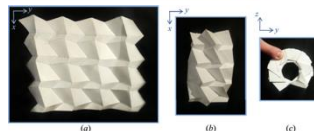


Pic (3) shows cardboard recycled material made of paper .
<https://recyclinginside.com/r-cycle-cardboard/13/1/2024-8:32 pm>

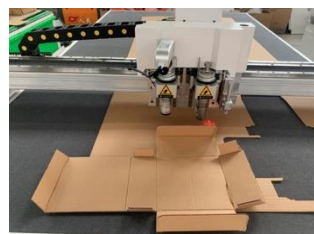
- 2- cardboard based on a set of ideas (folding - corrugation - cutting - hollowing out - drilling).



Pic (4,5) shows Triple wall corrugated cardboard structure or folded one .
<https://www.mdpi.com/2071-1050/13/10/5546/13/1/2024-8:49 pm>



- 3- implementation techniques tools used manually or by modern machines (use of computer programs as CNC & laser cutting) then gluing layers and assembly when necessary.



Pic (6) shows cardboard box CNC cutting creasing marking machine.
<https://www.youtube.com/watch?app=desktop&v=7wRwb2wzGnc-13/1/2024-8:28pm>

2.Sustainable environmental furniture design:

It is a design trend that appeared in its beginnings under the name green design. It focuses on the importance of the relationship between nature and design and

	<p>environmentally, friendly, and recyclable materials. Completely cutting the material and enter it into new manufacturing processes ⁽¹⁾, to obtain a new product, which maintains the sustainability of the material by giving it a new usage cycle.</p> <p>Recyclable materials are a good example of resource efficiency, but they require design innovation to perform the required function.</p>	<p>Flexibility in design</p>	<p>The possibility of folding and unfolding furniture pieces when needed, which increases functional efficiency. This design idea is characterized by small size, light weight, and high flexibility.</p>
<p>Use of low harmful emissions materials</p>	<p>The use of manufactured materials in the implementation of indoor/outdoor furniture leads to toxic emissions that negatively affect the environment and affect user health.</p> <p>The use of raw materials that contain volatile organic compounds (V.O.C), which are volatile compounds that are used in upholstery, paints and adhesives used in the construction of furniture, and other materials such as polyester used in upholstery, and polyurethane foam in upholstery as well.</p> <p>The research is moving towards eco-friendly materials that do not affect the environment or the health of the user.</p>	<p>Use of sustainable materials</p>	<p>The cardboard material used in the manufacture of indoor and outdoor furniture is eco-friendly material, with high durability, a simple and sustainable economic cost ⁽⁹⁾. The paper can also be folded, unfolded and re-folded until it is ready for reuse more than once, so using cardboard is a practical alternative to wood in furniture manufacturing as it saves up to 99% of water, energy by 50% and eliminates waste by 90%.</p> <div> </div> <div> </div> <div> <p>Pic. (7,8) shows outdoor/indoor furniture using treated cardboard material, waterproof, fireproof and highly durability. https://www.yankodesign.com/2021/08/26/cardboard-furniture-designs-that-prove-just-how-sustainable-versatile-and-easy-to-use-this-everyday-material-is/25-9-2023-9:57pm</p> </div>
<p>Use local raw materials</p>	<p>The research is moving towards using local raw materials in the furniture manufacturing process, as it supports the local economy, reduces the final cost of the product as it saves the costs of shipping and transporting raw</p>	<p>Use of recycled materials</p>	<p>The possibility of re-using raw materials after the end of their shelf life to achieve long-term economic and environmental aspects, which is the conscious rationalization of the use of</p>

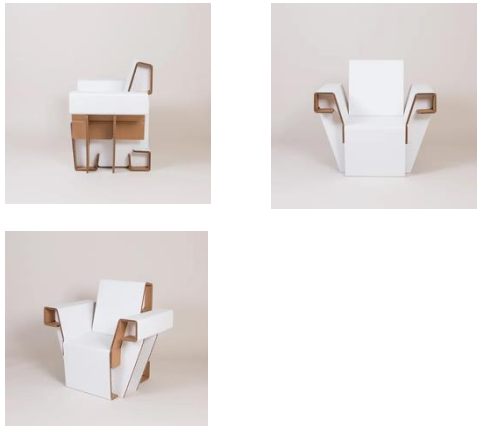
demand for paper that was being produced in Europe at that time from recycling cotton and linen. Then other materials entered, such as Straw and wood are now the most suitable materials for mass paper production.

The manufacturing process and designs of cardboard furniture help improve the condition and quality of production and improve the life cycle of the product.

5. cardboard furniture design in residential space:

Green residential furniture made of cardboard has become more widespread, despite the market for furniture made of wood and metal, so the user has become more aware of the benefits of cardboard furniture.

this type of furniture is characterized by endless designs. It is a material that can be reused more than once to achieve its function. The material can also be recycled. It is a material characterized by light weight, does not emit toxic emissions, and does not consume energy in its manufacture. It is a material that does not harm the environment.



Pic. (10,11,12) shows armchairs design made of cardboard, which are lightweight and easy to assemble. Its sizes 35"W x 26"D x 35"H <https://www.chairigami.com> 26/9/2023 – 1:02 pm

materials, and works to encourage the industry.

A table (1) designed by the researcher, showing the standards for green (environmental) furniture.

4.Eco - friendly paper/cardboard material:

Paper is a recyclable material used in the implementation of some types of permanent and many temporary spaces. It is also used in the design of interior and exterior furniture.



Picture (9) shows a waiting area consisting of chairs and a central table made of cardboard.

Cardboard can be used for folding. It is usually light and self-supporting and is often divided into geometric parts that are folded into a compact size. The model remains in the same configuration over time.

Maybe It can be spread but is fixed and is selected to achieve aesthetic or structural criteria ⁽⁵⁾ and These surfaces can easily assembled and disassembled without the need for additional. supporting infrastructure, and they are also, easy to store and transport.

The first people to know paper were the ancient Egyptians Five thousand years BC, when they prepared paper from thin slices of papyrus stems, but the paper known in its current form comes from China.

The paper industry entered Europe in the 21st century, but it was not produced in its modern form until the 15th century. With the challenge in 1456, the development of printing technology led to an increased

5-1. Cardboard furniture design supplements (light-unit):

The lighting unit is considered one of the most important elements that complement the interior design, functionally and aesthetically, but also environmentally, as the lighting units are manufactured from recycled or reused materials such as paper, as is explained in pic (21,22) & (23,24,25) whether ceiling lighting units or side lighting units⁽³¹⁾ (lampadir) .



Pictures (21,22) shows a side lighting lamp made of paper (lampadir).

<https://www.ikea.com/eg/en/search/?q=Paper%20lamp-10/6/2023-7:53> pm



Pictures (23,24,25) shows residential furniture accessories, eco- friendly lighting units, side lighting units and hanging one from the ceiling made of treated paper.

<https://www.ikea.com/eg/en/search/?q=Paper%20lamp-10/6/2023-7:53> pm

6. cardboard furniture design in commercial space:

Material is the soul of design, and using correct material, results in a functionally and aesthetically integrated design that attracts user eye and serves him. There is no doubt that it affects the economic cost and reflects on the environment. Cardboard is a sustainable green material that does not cause harm to the environment and aims for user comfort. Eco- friendly commercial furniture reflects the style of design and presentation. It also reflects the designer’s thought and



Pic. (13) shows multi-function furniture, the design of a library with a cardboard seating area attached to it. <https://www.linkedin.com/pulse/thinking-outside-box-rise-cardboard-furniture-design-farah-beaini-25/9/2023-9:53> pm



Pic. (14) shows the design of a bed made of recycled cardboard, designed by a Japanese company, Airweave. It is a company that is interested in paper pulp and a variety of different designs, and intends to launch a production line of paper furniture.

<https://www.decoist.com/2013-01-09/creative-cardboard-furniture-ideas/cardboard-bedroom-furniture-15/10/2023-11:31> pm



Pic. (15,16,17) shows the sofa and rocking chair made of cardboard, serving as residential furniture in an innovative and modern way.

Sizes range:23.5"W x 38"D x 32"H

https://morningchores.com/cardboard-furniture/?utm_source=imagepin%3Futm_source%3Dimagepin-15/10/2023-7:48 pm



Pic. (18,19,20) shows the design of a chaise longue made of cardboard, and its sizes 42"W x 72"D x 22"H.

<https://www.chairigami.com> 26/9/2023 – 1:02 pm

spaces that reduce the footprint of carbon dioxide emissions, the designer tries to create a workspace atmosphere that provides better quality for workers.



Picture (32) shows office space ,reception area, consisting of waiting chairs, a central table, and a partition made of cardboard material.
<https://cartonlab.com/blog/mobiliario-para-zona-de-descanso-15/10/2023-9:52pm>

emphasis on the environmental compatibility of furniture and work area space, by manufactured furniture with recycled materials, to support the green lifestyle offices.

Ecological furniture design improves and maintains the quality of indoor office space, which make it healthier and more productivity as well.



Pictures (33,34,35) shows the design of the administrative office -desk furniture made of cardboard, which is characterized by light weight and flexibility in use, its sizes: 60"-72"W, 30"-36"D, 29"-30"H
<https://www.chairigami.com> 26/9/2023 – 1:02 pm



Pictures (36,37,38) shows the perspective office library design, in the administrative space, made from sustainable cardboard material.
<https://www.chairigami.com> 26/9/2023 – 1:02 pm

emphasizes the global trend concerned with the environment and green design.

Cardboard is used as construction material & a cost-effective for exhibition and temporary installations and can be quickly installed and packed at temporary exhibitions, without the fuss of electric drills.

Not only commercial space made of cardboard material but also commercial furniture, as it is characterized by high flexibility in design, durability, and low economic cost.



Pictures (26,27,28) shows the temporary commercial spaces and furniture made of cardboard.
[https://www.linkedin.com/pulse/thinking-outside-box-rise-cardboard-furniture-design-farah-beaini-25/9/2023-9:53 pm](https://www.linkedin.com/pulse/thinking-outside-box-rise-cardboard-furniture-design-farah-beaini-25/9/2023-9:53pm)



Pictures (29,30,31) shows commercial display units for different activities made of treated cardboard.
<https://www.pinterest.com/pin/316940892544213582-12/10/2023-8:18pm>

This sort of design trend that works on reuse, characterized by simplicity, this simplicity highlights the innovative design, let user see the true beauty of the cardboard. Furniture made of cardboard has become easier than ever, as it does not require glue or any other materials that may affect its environmental credentials.

7. cardboard furniture design in office space:

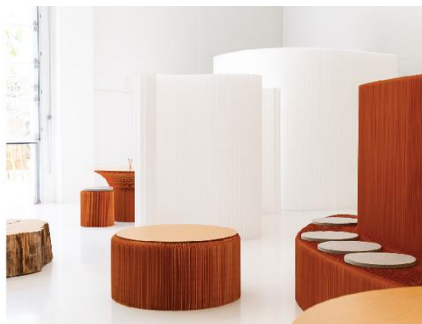
An eco-friendly office is called “green” office design. Aiming for administrative



Pictures (43,44) shows components of the administrative rooms from cardboard furniture.
<https://www.chairigami.com> 26/9/2023 – 1:02 pm

8. Eco- friendly furniture in resorts:

Eco-tourism is a process of learning and educating the components of the environment. It introduces tourists to the environment and optimizes the exploitation of raw materials in the tourist space. The concept of sustainable eco-tourism has become one of the most important concepts of sustainable development, as it achieves integration between the three elements of development: economy, society, and environment.



Picture (45) shows a fluid and flexible waiting area made of cardboard in lobby of resort.
<https://molodesign.com/collections/furniture/softseatin-g-folding-paper-stool-bench-paper-furniture/25/9/2023-10:06>

Environmental furniture design falls within the context of environmental tourism, as the designer considers the use of renewable materials, ensuring saving energy, and reducing environmental pollution as much as possible.

Environmental furniture in resort is not only a luxury, but also urgent necessity imposed by the current global environmental.

8-1. Sustainability of furniture in resorts through the following considerations:

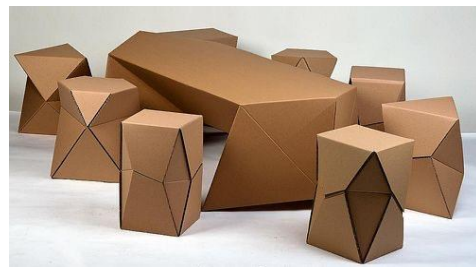
-The environmental sustainability of the resort space is achieved through the integration of three sub-axes: resources, energy, raw materials, and their reflection on furniture design in resorts ⁽⁴⁾.

-The economic sustainability of resort is achieved through awareness of the interior designer who emphasizes the importance of making optimal use of



Pictures (39,40,41) shows different designs of partitions in administrative interior space made of cardboard, as the use of sustainable materials in companies is a global trend towards green environmental design.
<https://casavogue.globo.com/Design/noticia/2015/11/m-oveis-de-papelao-tem-design-eco-chic.html-12/10/2023-10:26> pm

sustainable meeting table is made of corrugated cardboard. It is basically result from working on cutting and folding a sheet of paper. It is a furniture set made of corrugated cardboard and consists of two tables and 8 chairs.



picture (42) shows meeting table consisting of a conference table and chairs made of cardboard in a sustainable office.
<https://www.flickr.com/photos/methylum/5822586034/in/photostream-12/10/2023-10:40pm>

Each element is made of a single flat cardboard sheet which, creates a distinctive design after folding. that brings geometric shapes and durability together, the design of all elements is based primarily on geometric shapes such as triangles and trapezium. and is characterized by lightness and simplicity which are the features of this set. Each seat contains two asymmetric seats, which provides each user with a variety of arrangements. This furniture is eco-friendly, as the cardboard used, is obtained in the recycling process, and can be subjected to repeated processing.

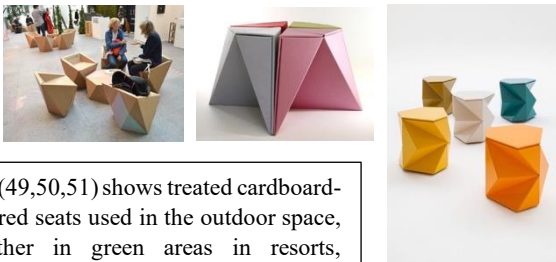
Pictures (46,47) shows shading and seating areas in public parks made of treated paper against humidity and temperatures and it's characterized by light weight and flexibility.

<https://www.designboom.com/design/saint-etienne-biennale-08-habiter-demain-at-the-musee-de-la-mine/>
22/9/2023-4:33 pm



Pic. (48) shows extendable outdoor furniture that is characterized by flexibility and multiple shapes design, it can be used in parks, in green areas at universities.

<https://molodesign.com/collections/furniture/softseating-folding-paper-stool-bench-paper-furniture/25/9/2023-10:06pm>



Pic. (49,50,51) shows treated cardboard-colored seats used in the outdoor space, whether in green areas in resorts, universities, etc.

<https://cartonlab.com/blog/mobiliario-para-zona-de-descanso-15/10/2023-9:52pm>

10.application framework:

office library designed by researcher, made of cardboard material ,design inspired by piet Mondrian .



Pic (52) abstract art Mondrian , used primary colors red , yellow and blue .

<https://www.tate.org.uk/ids/explore/who-is/who-piet-mondrian> 14/1/2024-6:05 pm

each resource, Energy, and raw materials, which ensure the survival of the resort and its ability to continue for long periods.

-**The social sustainability** of resort is represented by the designer's ability to find design solutions that respect the site's customs and traditions to ensure continuity and survival, and at the same time seeks design solutions. Thus, the cultural sustainability of resort is achieved through the behavioral level that includes customs and traditions. The intellectual level, which includes rituals and beliefs, and through a dual relationship between the behavioral level and the intellectual level, the design is affected and reflected to the structure and furniture of resort.

9. Eco-friendly cardboard outdoor furniture:

sustainable outdoor furniture design is the cornerstone of any quality artistic work, design express its function and requirements reflecting on the method of implementation, so it must meet these conditions.

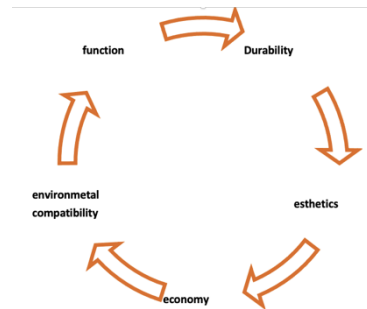


Fig. (1) shows the conditions that must be met in the design of environmental outdoor furniture.

To achieve sustainability, there must be radical solutions in design, to reduce the burden ⁽⁶⁾ of user psychological and physical health, by using renewable materials as cardboard, which analyzed in the research, as materials maintain air quality, Materials that produce emissions, materials that can confront natural conditions in the environment, materials that can withstand heat and variation in temperature and humidity not used in manufacturing outdoor furniture .



-Applying green furniture design methods contributes to increase the usage cycle of furniture compared to the purchasing value and contributes to the user's acceptance of these sustainable designs.

Research recommendations:

- Encouraging designers to use different arts, such as kirigami, to create innovations in furniture design (residential/commercial/administrative/tourism) and outdoor furniture.

-It is recommended to combine the various applied sciences that specialize in studying environmental industries to achieve compatibility between the protection of natural resources and the raw materials used in the furniture industry, which leads to the preservation of the environment and human health.

-The necessity of organizing design courses to learn how to use cardboard furniture as one of the principles of sustainability and green design.

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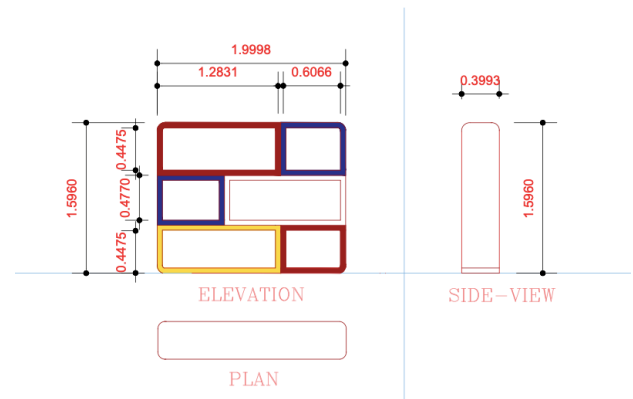


Fig . (2) illustrate design & dimension of office library
L:2m*W:40cm*H:1.6m.



Pic (53) office library cardboard material, inspired by abstract art , Piet Mondrian. Painted by primary color (red/yellow/blue).

Office library cardboard furniture inspired by abstract art , Piet Mondrian .characterized by sharp and simple lines style , considering function and aesthetic aspects of design , straight lines in furniture were balance and smoothness ,using color pallet of abstract art as primary colors red , blue , yellow .

Using kirigami art in execution of office library.

The material is considered as eco-friendly environmental material, cutting by CNC (laser cut), then gluing layers & finally painting with colors .

This type of furniture called office green one, which contribute to increase usage cycle of furniture.

Research results:

-Inspiration from kirigami art helps the furniture designer create infinite designs by changing the steps of the folding process. methods of designing by kirigami are characterized by ease and flexibility in formation (cutting - folding), ability to bear heavy weights, which increases the chances of innovation in design furniture. The only drawback is the manual folding process, as it requires extensive labor.

- using reuse, remanufacturing and recycling methods give the furniture a new cycle of use after the end of the initial function for which it was produced or after damage.

- designer role in linking furniture design with environment respect and preserving resources, access design solutions that have an aesthetic, functional and environmental dimension.

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