Innovative modern furniture inspired by Egyptian identity made from palm fronds and digital printing trendy Upholstery designs

Heba Mohamed Okasha Abu Elkamal Elsayegh [1], Naglaa Ezzat Ahmed Mahmoud [2]

1- Assistant Professor at the Faculty of Applied Arts , Department of Textile Printing,Dyeing and Finishing (BenhaUniversity), Egypt

2- Lecturer, Department of interior design and furniture, Faculty of Applied Arts , 6 October University, Egypt

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ABSTRACT:

Egypt is ranked in the first place among the top five date producing countries in the world according the latest report 2020. The leaf (jarid in Arabic), which is (palm fronds) is one of the most important and untapped local resources that, (through recycling, Up cycling, re-use and all the sustainability development strategies and tools), could produce many environmentally friendly products such as manufactured wood, carina, furniture ... and others.

Furniture produced from palm leaves is one of the small industries scattered throughout Egypt, this paper focuses and outlines the utilization of (palm leaflets and fronds) mixed by trendy digital printed upholstery fabrics in making innovative modern furniture inspired by Egyptian identity according the international fashion trends. The paper aims to increase using palm leaves and fronds mixed with printed upholstery to make high end modern furniture. Also, It carries the characteristic of the Egyptian identity in terms of shape and composition and is characterized by low cost compared to the factory equivalent of natural wood, which gives an advantage High competitiveness with the possibility of achieving excellent profits in addition to the possibility of reducing import rates make Zero waste from palm, when spreading and circulating fronds and palm leaves furniture in different types of spaces as until now production is limited to structural furniture such as seats and tables, which will return to the Egyptian economy with many benefits, including The material benefit, the provision of job opportunities for small entrepreneurship and start-ups , the exploitation of local materials, the reduction of pollution rates by using palm leaves and fronds and digital printing textile which is eco-friendly printing, Also, the provision of a green-friendly final product made of local materials with an Egyptian identity.

1 Introduction

Although palm fronds are by-products of Palm pruning, they represent a real wealth that provides a source of raw material all year round (Egypt consumes only 10% of agricultural waste such as fronds in small industries) which is used in small craft industries such as furniture, accessories, temporary light installations, fruit cages, arbesk, building materials and finishing... And others that contribute to the added value of the local production of eco-friendly furniture, which helps to preserve natural resources of wood and reduce environmental pollution resulting from the disposal of fronds by burning [1], the manufacture of furniture from palm trees is an industry associated with the Egyptian heritage since ancient times and inherited through generations.

2 Palm fronds

The frond is the plant organ found at the terminal tip of the palm and it protects the growing tip of the palm from environmental vagaries.

They are feathery leaves of large size, ranging in length from 2.5 m to 6 m or more, according to the type and age of the palm. It consists of a middle vein known as the leaf. It has a broad base (from 20: 15 cm) known as the base of the frond and surrounded by a number of fibers, then followed by an area The thorns and then the wicker area (leaves) that emerge from both sides of the leaf alternately, palms are pruned to remove dry fronds in July and October of each year. [2].

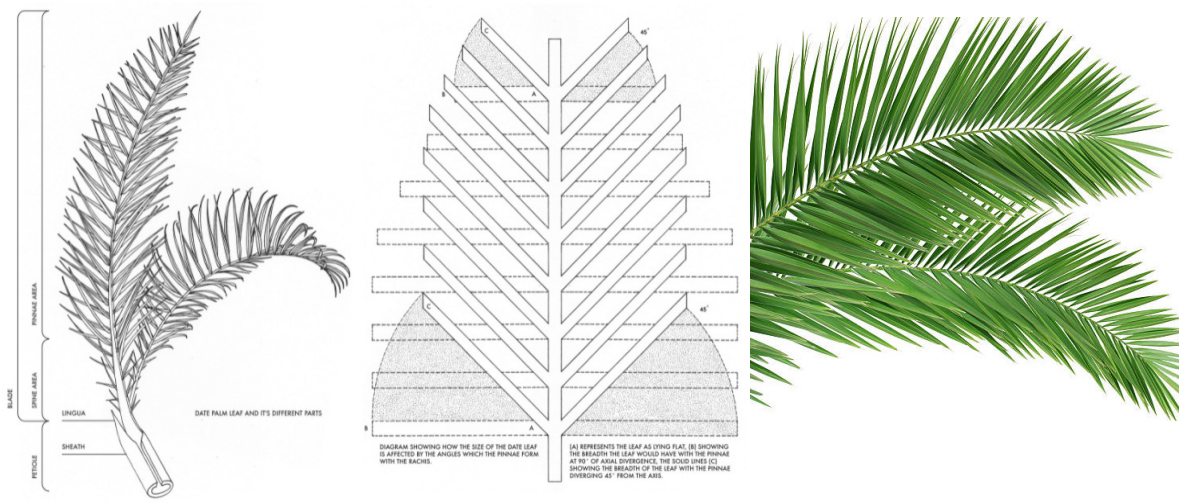


Fig. 1: components of ringworm. [3]

The average ore produced annually from the leaves: one palm gives a palm aged 50 years from 18:10 fronds with a length of approximately 373 cm, while it gives a number of 9:8 fronds with a length of approximately 311 cm for an average palm aged 20 years.

2.1 Natural and mechanical properties of the leaf

The natural composition of palm leaf is 44% cellulose fibers, 30% hemicellulose, and 26% lignin. Palm leaf fibers consist of fibro vascular bundles, resembling blood vessels, whose purpose is to transport nutrients to the tips of the leaves; The wall of these bundles is filled with fine cellulose fibers. [4]

1- A clean sustainable material that can be reused or recycled to produce new manufactured products or raw materials.

2- Low biodegradability and therefore does not constitute a burden on the environment.

3- Lightweight and durable.

4- It can reduce carbon emissions and energy consumption. [5]

5- Fire resistance, sound and shock absorption

6- Resistant to water, moisture and insects

The degree of quality of the leaves is directly proportional to the quality of the produced date fruits and according to the type of palm, its age and the land of cultivation

The leaf can be used in two ways, either through recycling or reuse, and the following diagram Fig2 shows the difference between them.

This research paper focuses on the furniture produced by reusing the leaf directly without using wood resulting from reuse, where the palm, which is the source of the leaf material, is spread in a large number of Egypt's governorates, but there is a difference between the locations of the material and the places of practicing the craft, and the following table shows the difference in the distribution Geographical between the source of the material and the spread of the craft.

3 Furniture from leaf

3.1 Furniture from leaf as a handicraft industry

The leaf is one of the agricultural and vegetable waste on which one of the small handicraft industries is based, which is the furniture industry from the leaves, which is concerned with the study in this research. The creative aesthetic value, which until now depends on the vision of the manufacturer, in addition to the environmental value, where the consumption of leaf in these industries reduces the damage to the environment and energy consumption, and this leads to a long-term economic value resulting from the use of raw materials resulting from environmentally friendly agricultural waste. [6]

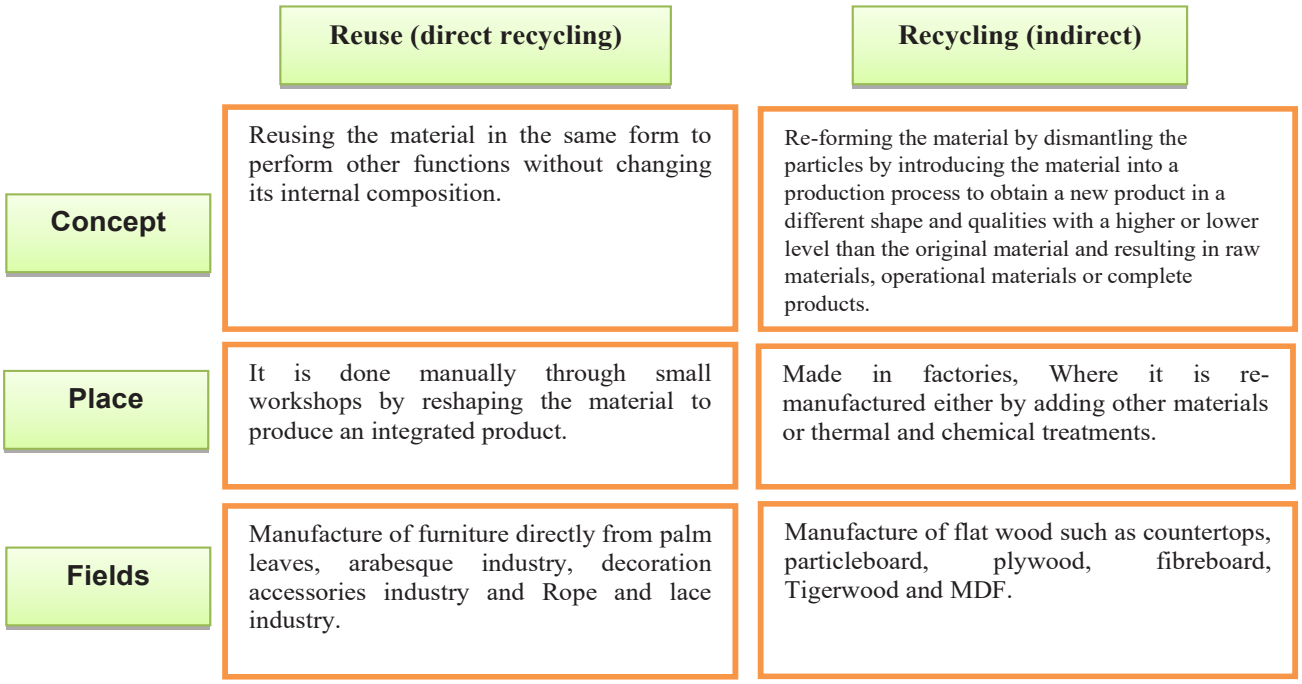


Fig. 2: A diagram shows the difference between Reuse (direct recycling way) and the Recycling (indirect way) [1], [7].

Table 1: Analysis of the geographical distribution of the source of the material and the areas of spread of the craft of the furniture industry [8]

	The locations of the material	The locations of the craft
The largest percentage	includes the five oases (Dakhla, Kharga, Bahariya, Siwa and Farafra) more than 60%.	**Fayoum ranks first in Egypt in terms of production volume and number of practitioners.**
The average percentage	The remaining percentage in Fayoum, south of Giza, south of Upper Egypt and Rashid	**The dakhla oasis, only in the city of mot, Qena and Nag Hammadi Village**
The least percentage	In Al-Arish and Al-Marj	**Al-Marj and Al-Khoss and Toukh**

Interior designer must have an active role in that industry, where the designer represents the link between the environment and the user and can achieve sustainable thought by developing plans that contribute to the adaptation of this neglected local wealth, in terms of aesthetic and plasticity by developing forms and types of furniture The product from the leaf so that the base of the types of furniture produced is expanded to include types other than chairs and tables with an overlap of other materials such as cloth and leather to produce different and varied forms of furniture for different purposes for different spaces in order to support the consumer market and the Egyptian environment and to expand the marketing base internally and regionally And globally, and the furniture produced from the leaf is used in many public spaces such as hotels and tourist resorts for entertainment and treatment, sports and social clubs, restaurants and cafeterias. Residents mainly need to furnish their homes in full due to its low cost compared to a counterpart of natural wood, which is compatible with Low level of per capita income in those governorates

Fig. 3: Pictures of types of furniture from the fronds

3.2 Manufacturing stages:

Which is summarized in the following three stages, the first is the stage of obtaining the raw material and its preparation (cleaning, removing the outer shell and drying), followed by the operation and assembly stage, and the last is the sanding and painting stage. ....) [7]

All stages are carried out using simple hand tools (such as sickle, saw, file, hammer, angles, wings ....) [7], [8]

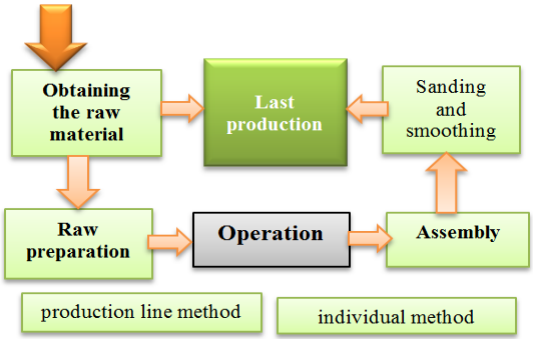


Fig. 4: Manufacturing stages Diagram

4 Design and execution style

The overall design is based on straight, longitudinal, transverse or oblique lines, which are performed with palm grits, curved lines and arches are used by folding the stems with opposite dissection or perforation as shown in Fig. 6

The design style of the seats is very similar to the design style of the seat of the funeral ceremonies of Tutankhamen where the reinforcement of the seat with a longitudinal back combined with the legs and separation between it and the tilt of the back. Shown in Fig. 7

The method of installation and assembly is based on the division of the piece into a group of parts among themselves a set of ties illustrated by shown in Fig. 8 in which the piece of furniture is turned into a large grid, which is installed together in a traditional way through holes or what is known as the button and the tongue visible and penetrating with linking with belts of Palm leaves and fixing with nails and glue in a few cases.

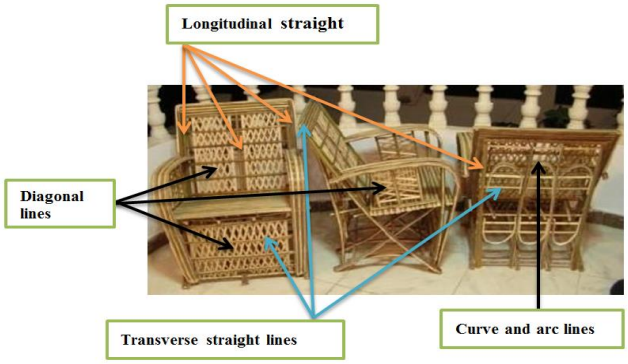


Fig. 6: Analysis of a seat design combining longitudinal, transverse, diagonal and curvilinear straight lines

The seat made of leaf combines style and heritage, as it is similar in design and composition to the funerary ceremonial chair of King Tutankhamun - the 18th Dynasty, the modern state in terms of back installation, back tilt and lower support

Fig. 7: Comparative analysis between the design of a seat from the leaf and the seat of King Tutankhamun - the 18th Dynasty, the modern state in terms

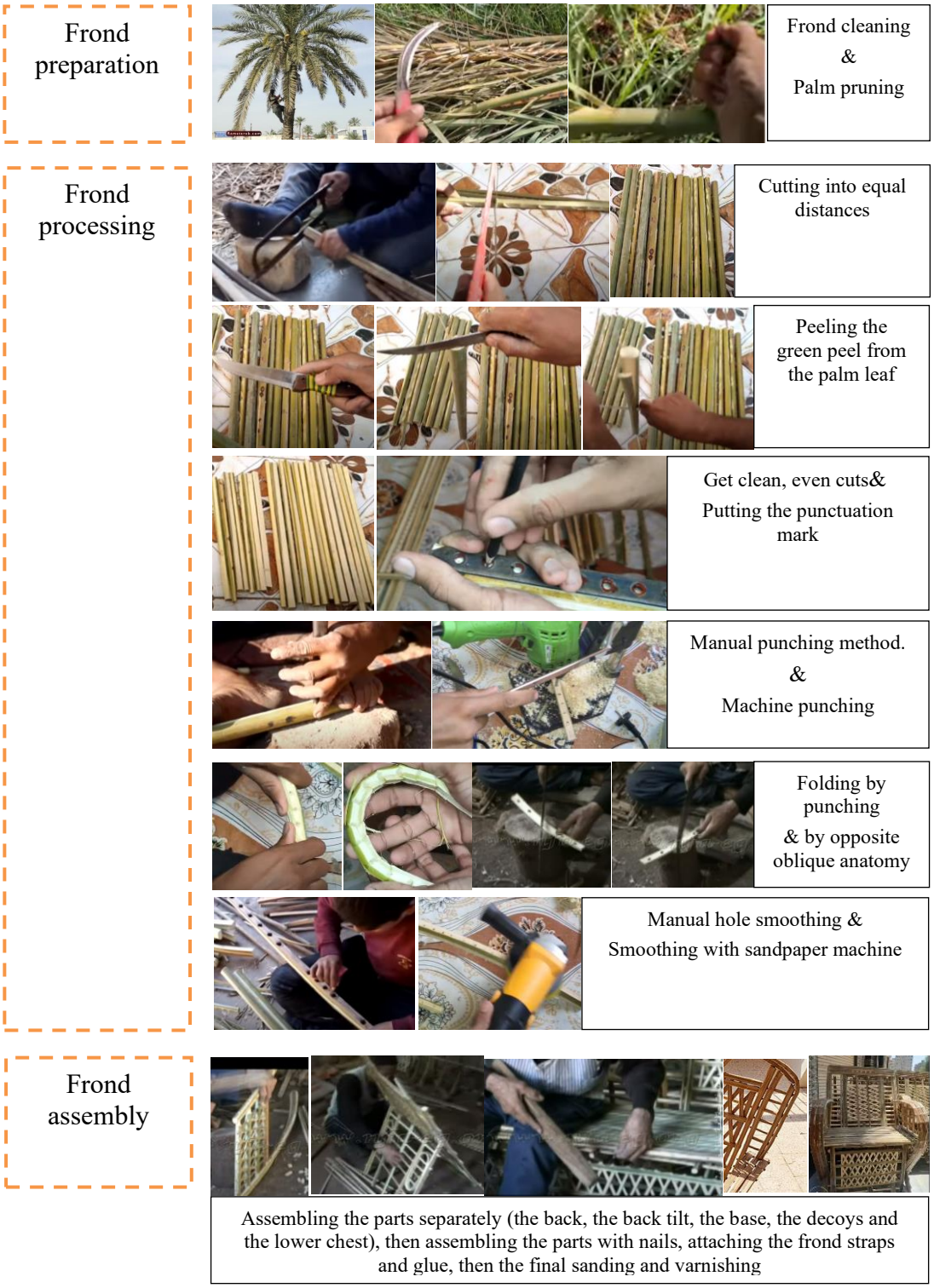


Fig. 5: An illustrated analysis of the different operational stages of manufacturing a palm leaf seat. [6], [9], [10], [11], [12].

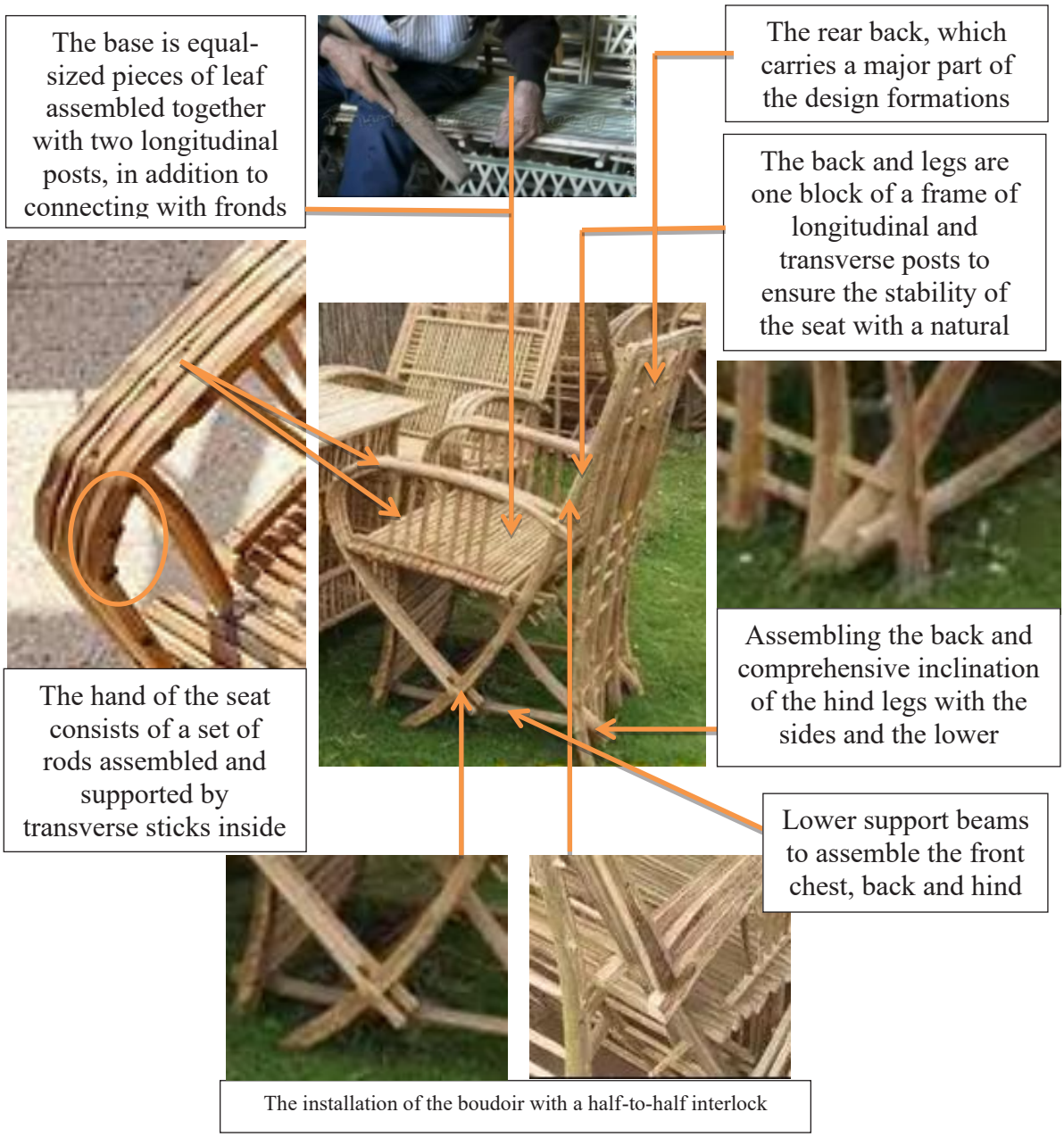


Fig. 8: Illustrative analysis showing the design and installation of a palm leaf seat

4.1 Fashion trends in interior and Upholstery textile printing 2022

Fashion refer to the latest and the most popular styles of clothing, hair, decoration (Upholstery), or behavior……., while Trend refers to what is popular at a particular point in time[13].

Fig. 9: Clarify the international fashion trends in interior textile designs

We have many directions in Fashion trends in Upholstery & interior textile printing 2022- 2023 like:

One of the trends is "Rethink Heritage". There are several influences but mainly from historical sources [14], our heritage is ancient Egyptian heritage so we use in our research the symbol and motifs of ancient Egypt with spirit and colors of fashion trends 2022-2023 in interior and Upholstery printing textile.

Fig. 10: Clarify the design of Upholstery printing textile inspired by the ancient Egyptian heritage and identity according the international fashion trends

4.2 Digital printing in Upholstery textiles

Digital textile printing can be defined as process of adding colorful designs to many kinds of fabric by using digital inkjet printing technology. It was patented in 1968 and popularized in the 1990s nowadays; it is fact that Sustainability is no longer an optional extra; the consumer and the planet demand change." The digital textile print market is set to reach $266.38 billion dollars by 2023**[**15**]**, that is because of many reasons:

- Digital Printing can achieve Zero Wastewater, (Waterless).
- Reducing Carbon footprint.
- Reduce waste in Consuming energy, rather than the traditional methods of printing.
- It is Eco-friendly printing.
- Digital printing makes sustainability as mindset, not a passing trend.
- Digital printing is on-demand or tailored to meet customer need **[**16**]**.

In this paper research, the upholstery textile printing designs which will be implemented in **Innovative modern furniture** to make unique designs and to meet **(A+)** customer's requirements needs, who concern with Sustainability, Environmental resources, totally green products…….etc., will be executed by using digital printing because this kind of printing is an eco-friendly choice.

5 APPLICATION MODELS (METHODOLOGY OF IMPLEMENTATION)

5.1 Description and Objective:

To reach the design of innovative furniture models that combine originality and contemporary and achieve sustainable thought by integrating environmental materials from palm leaf and textile printed with environmentally friendly 3D printing technology, which contributes to the exploitation of the local wealth of palm leaf (as vegetable waste material Which helps to preserve the environment and increase the domestic product of environmental furniture and raise the economy.

5.2 Target spaces

Residential and social spaces, tourism and medical treatment, restaurants ... and others (local spaces - the possibility of export).

5.3 Design methodology

By analyzing the traditional leaf furniture in Egypt to reach different ways to employ formations and the method of installation and assembly of pieces with textile printed with environmentally friendly 3D printing technology.
Furniture models have been designed for a number of purposes, such as a vertical divider (partition), console, dining table, chair and living library

Table 2: Analysis of the Application models

Design 1 - Partition - Entrance Zone	
Description	A repeating structural unit with a width of 70 cm and a height of 2 m has two sides to combine a simple and modern design of palm leaf and printed fabric.

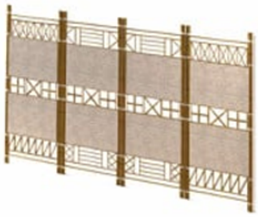


Fig.11 : Front Elevation

Fig. 12: Back Elevation

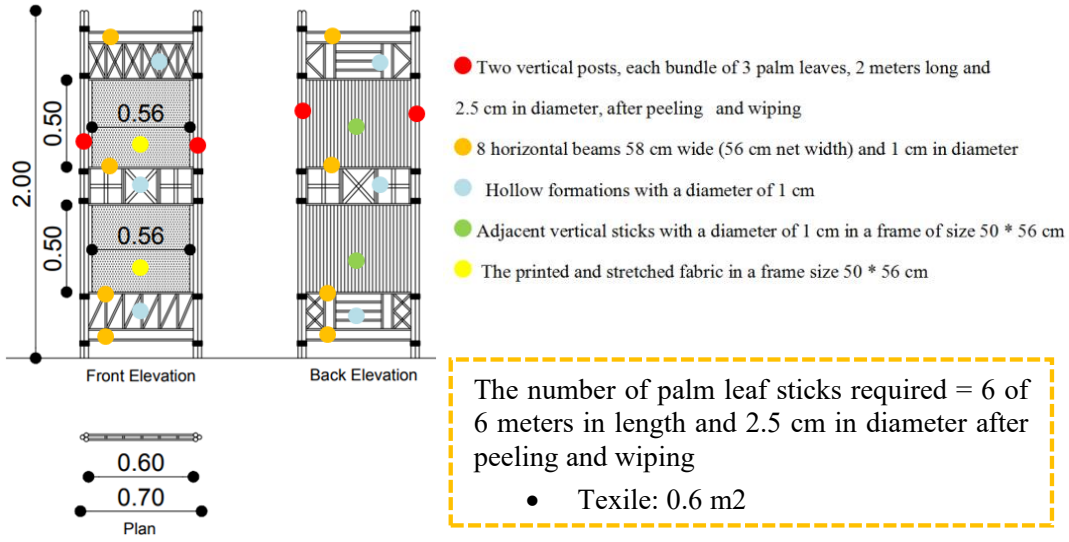
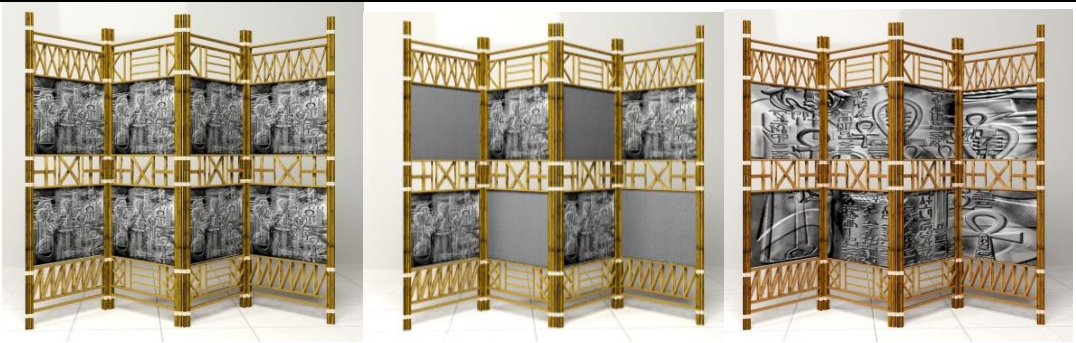
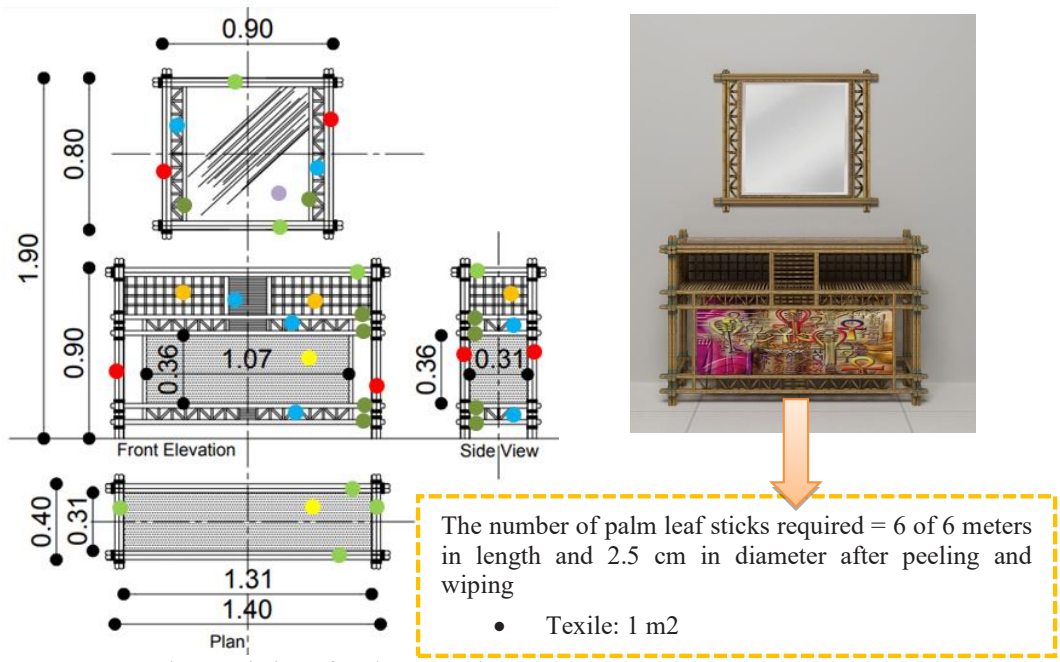
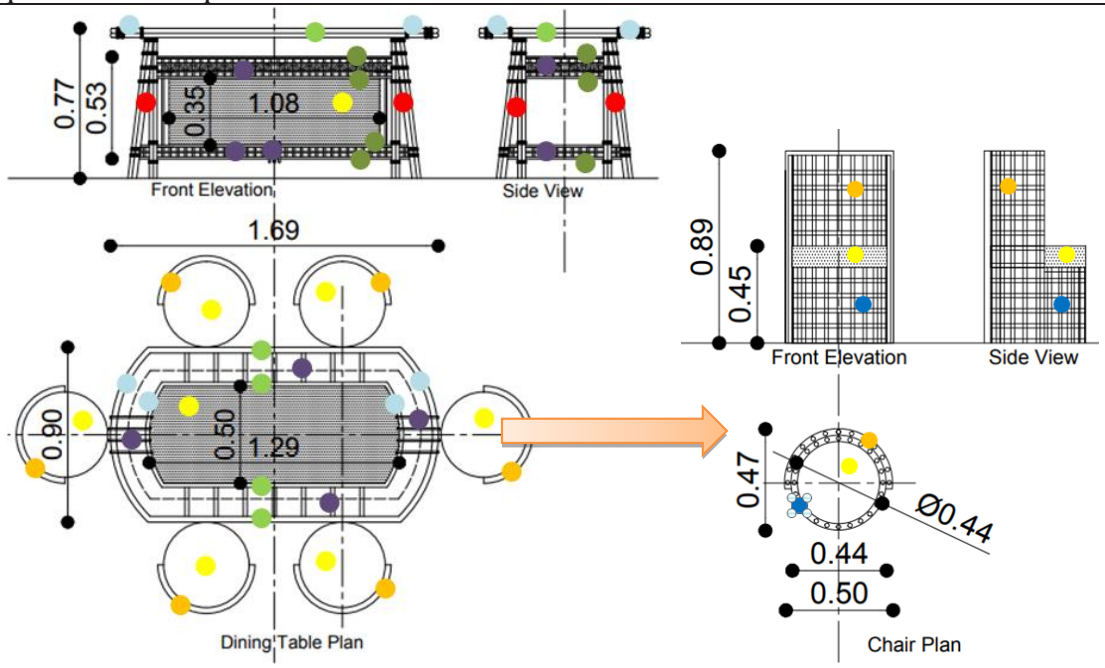
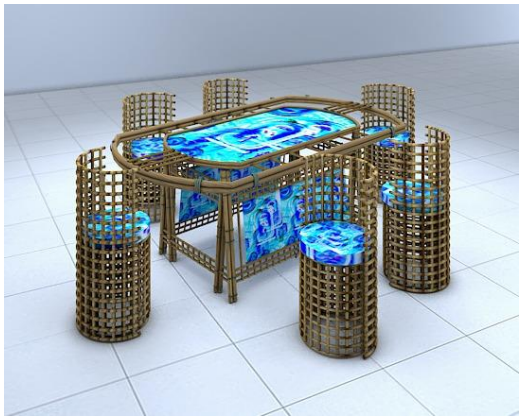
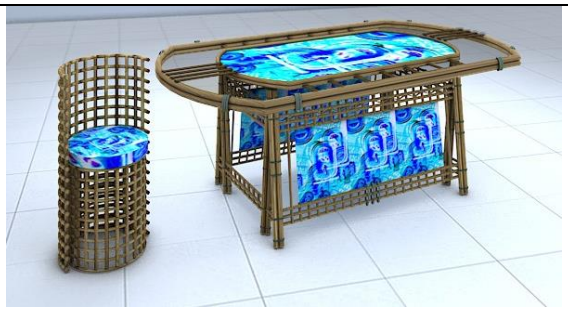
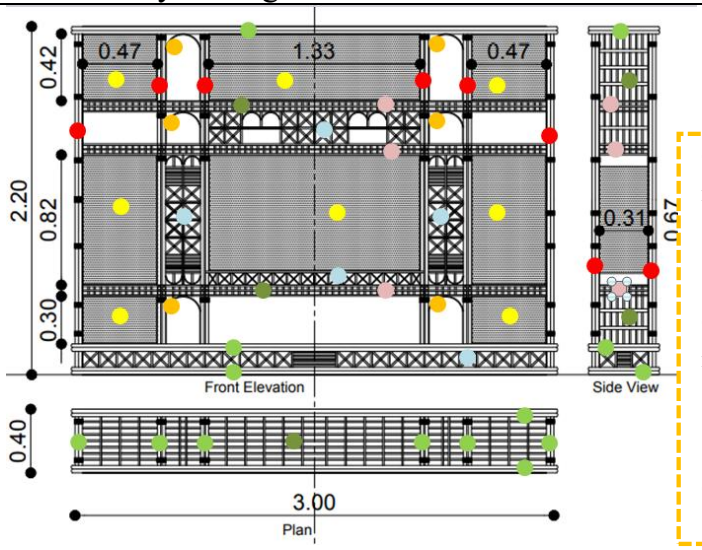
parts and structures	 **Fig. 13:** Drawing and sizes for the partition unit
	The assembly is carried out with hidden and visible coils and nails, with binding with strips of fronds
design philosophy & textile design	Combining the straight lines in design of the palm leaf structure with a heritage design of the textile inspired by the Ankh (the ancient Egyptian key to life) in a modern style with the latest international fashion lines Textile uphlostery designs. This design is created aacording the international fashion trends 2022-2023 in colors, themes, printing uphlostery trend.  **Fig. 14:** Uphlostery printing textile design
Design alternatives Group A	

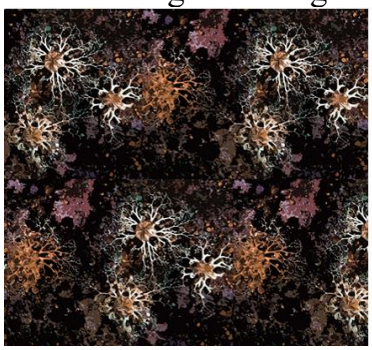
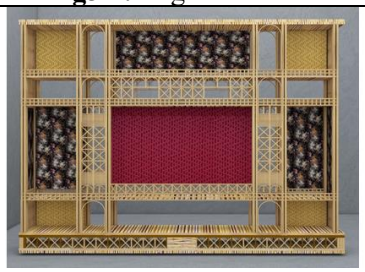
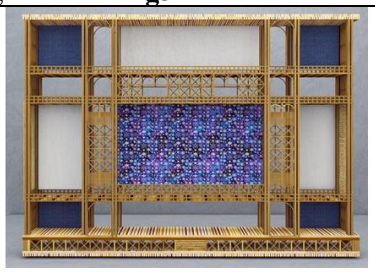
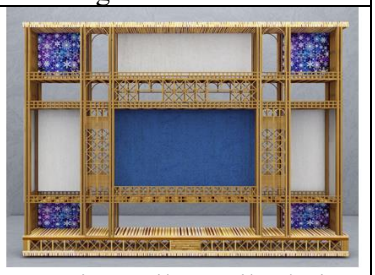
	 **Fig.15:** Using the fabric design in the same color group alternately, completely or intermittently
Group B	 **Fig. 16:** Use the fabric design in a cool color palette interchangeably completely or on a complementary singular
Group c	 **Fig. 17:** The use of the black and white fabric design in a repetitive, interchangeable, complete or singular manner
Design 2 – Console –Entrance Zone	
Description	It is a structural hollow box of palm leaves that is confined between its front and back shawls with printed fabric stretched to cover the horizontal surface and then covered with transparent glass

parts and structures	 **Fig18.:** Drawing and sizes for the console Four vertical legs form the console structure with a height of 93 cm + 2 vertical posts for the mirror, height 85 cm and 2.5 cm in diameter after peeling and wiping, and each stand consists of two sticks of palm leaf. 2 beams with a length of 1.40 m + 4 with a length of 40 cm to form the console structure + 2 with a length of 95 cm for mirror, all with a diameter of 2.5 cm, and each beam consisting of two sticks of palm leaves 4 beams with a length of 1.40 m + 4 with a length of 40 cm to form the console structure + 2 with a length of 75 cm for mirror, all with a diameter of 1 cm. Skeletal box open on one side (shanks) of legs and struts, thickness of 1 cm Hollow formations with a diameter of 1 cm between the horizontal and vertical shapes The printed and stretched fabric in a frame size 36 * 1.07 cm + 36 * 31 cm A mirror inside a frame of palm leaf size 80 * 80 cm The assembly is carried out with hidden and visible coils and nails, with binding with strips of fronds
design philosophy & textile design	Reshaping the traditional structural systems of palm leaf furniture to obtain an innovative design with different combinations that combine fabric with palm leaf. The same fabric used in the partition unit was used with the same color groups, due to the presence of the partition with the console in the same space (the entrance space). *Fig 18,19, 20,21*

Design alternatives	   **Fig 19 (A)** **Fig 20 (B)** **Fig 21 (C)** Unity and harmony in the use of fabric design with the same color combinations used in the partition
Design 3 – Dining Table + 6 chairs – Reception Zone	
Description	Semi-oval dining table with six round chairs a simple and modern design of palm leaf and printed fabric
parts and structures	 **Fig. 22:** Drawing and sizes for the dining table and chair 4 standing legs for the table + 4 inclined as the edifice of the ancient Egyptian temple. The stand consists of 2 palm leaves, 74 cm high and 2.5 cm in diameter after peeling and wiping 2 rafters of 1.3 cm in length and 2.5 cm in diameter + 2 rafters of 1.16 cm in length and 1 cm in diameter to make the table pinch 4 upper beams + 3 lower beams to connect the legs to make the body of the table frame 1.2 cm long and 1 cm in diameter after peeling and wiping The seat back structure consists of a net of posts and beams with a

	diameter of 1.5 cm and a height of 0.90 cm on a circle with a diameter of 0.46 cm The curved parts of the table pinch and wrapped by the internal dissection method 2 length 1 m diameter 2.5 cm + 2 length 0.57 cm 1 cm The printed and stretched fabric in a frame size 1.29 * 0.50 cm + 0.35 * 1.08cm Upholstered in a cylindrical shape with high-density foam 33 cm high and 0.44 cm diameter Brackets for attaching the body of the table pinch with a diameter of 1 cm and a length of 0.22 and 0.15 cm + brackets between the perforations with a diameter of 1 cm A lower structural mesh box represents the seat body of uprights and beams with a circumference of 0.44 cm and a diameter of 1.5 cm • Table : The number of palm leaf sticks required = 4 of 6 meters in length and 2.5 cm in diameter + The number of palm leaf sticks required = 5 of 6 meters in length and 1.5 cm in diameter after peeling and wiping • Chair : The number of palm leaf sticks required = 5 of 6 meters in length and 1.5 cm in diameter • Texile: 3 m2
	The assembly is carried out with hidden and visible coils and nails, with binding with strips of fronds - a separate upholstered sheet in a cylindrical shape
design philosophy & textile design	An innovative design that employs palm leaf material to produce furniture in the spirit of heritage that expresses the Egyptian identity, inspired by the shape of the ancient Egyptian cartridge and this design has been reinforced by using fabric inspired by the same element in a modern way with the use of different color alternatives in line with international fashion lines.  Fig 23: Table and chairs Design  Fig 24: Uphlostery  Fig 25: Inspiration Source printing textile Design

Design alternatives	  **Fig 26 :** A The main design is in shades of blue **Fig 27 :** B orange color palette   **Fig 28** : C Green color palette **Fig 29** : D Beige color palette
Design 4 – Book and TV unit – Living Zone	
Description	An open library made of palm leaf structure that can be used for several purposes such as books, antiques or TV. It is considered an aesthetic unit due to the harmony of its geometric formations with the background canvas.
parts and structures	 The number of palm leaf sticks required = 16 of 6 meters in length and 2.5 cm in diameter after peeling and wiping. The number of palm leaf sticks required = 30 of 6 meters in length and 1.5 cm in diameter after peeling and wiping Texile: 3.5 m2 **Fig30 :** Drawing of lib.for living 12 posts, 2.20 m high, made up of two palm-leaf sticks that are fastened together with coils, nails and fastening. The main beams, which are 6 with a length of 3 m + 10 with a length of 0.4 cm, consist of two sticks of palm leaves and together form the main library

	structure The secondary beams, numbered 18, are 3 m long + 18 are 0.40 cm long, and shelves are confined to each other by longitudinal grooves of palm leaves with a diameter of 1 cm to form the structure of the shelves. Geometrical ornaments of palm leaf sticks with a diameter of 1 cm Horizontal and vertical brackets between the secondary beams to support the shelves from palm leaf sticks with a diameter of 1 cm Arched ornaments of thin ragid, 0.5 cm thick, were dissected from one side of an oasis in two directions to obtain the curvature Fabric with different design alternatives different sizes 0.47 * 0.42 * 2 + 0.30 * 0.42 * 2 + 1.33 * 0.42 + 1.33 * 0.82
design philosophy & textile design	A different method for employing palm leaf material and the various geometric formations resulting from it and uphlostery printing textile design to produce an unconventional unit for a large library for living and exploiting the back of the library to show a large area of cloth while diversifying between the use of an organic and geometric design.   **Fig31 :** Organic textile design **Fig32** : Geometric textile design
Design alternatives	   **Fig 33 :** (A) using the organic design **Fig 34 :** (B) using the geometric textile textile design

6 Conclusions

We can use the waste of palm fronds and leaves, to create and make Innovative modern furniture inspired by the Egyptian identity and we can mixed with upholstery textile printing design using digital printing to make green innovative final furniture products.

The Recommendation

We should increase the studies, applied and implemented research in the field of creative industries and handicrafts that related with using the waste of the palms, to achieve zero waste and highly end user innovative product.

Summary

The research paper focus in innovative furniture which can be created and implemented by using waste of palm (palm fronds) and textile printing designs. This focus and aim gives us a road map to an interdisciplinary area of study between furniture and textiles printing to create and produce green and eco-friendly product. Furniture models have been designed for a number of purposes, such as a vertical divider (partition), console, dining table, chair and living library. Every model has many design alternatives by using many color themes of upholstery printed textile design according the international fashion trends in upholstery and interior design to meet the client requirements. Design methodology: by analyzing the traditional leaf furniture in Egypt to reach different ways to employ formations and the method of installation and assembly of pieces with textile printed with environmentally friendly digital printing technology. Also, the design methodology focus in creating and innovative designs with Egyptian identity according the international fashion trends in this field to contribute in achieving zero waste in palm tree.

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