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Smart Integrated Approach for Future E-Commerce Jewelry Business using 3D Printing

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Abstract

Jewelry business has a considerable share in the global market and significant growth is expected in fashion jewelry business in the future. The demand for customized and personalized jewelry is slowly increasing and predicted to be the major expectation of the future customers. This future demand can be fulfilled by using the advanced new materials and manufacturing technologies like 3D printing. The 3D printers are now accepted by jewelry manufactures because of many advantages compared with traditional manufacturing methods. Nowadays, 3D printers are capable to handle various materials used for jewelry manufacturing. Major four 3D printing technologies with different materials can be integrated with smart technologies to manufacture customized and personalized jewelry, which could be the considerable solution for the future. The major tasks involved in integration as per the objective of this research work are manufacturing, supply chain management of raw materials and finished products, buyer interface, data mining and machine learning. In order to integrate these tasks, some smart models are developed and discussed in brief. These models include smart model of jewelry manufacturing unit, smart supply chain model for manufactured jewelry, smart supply chain model for raw materials for jewelry manufacturing, smart integrated e-commerce model for buyers and smart comprehensive model integrates these all.

Keywords: *3D printing, e-commerce, jewelry manufacturing, jewelry materials, supply chain management*

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INTRODUCTION

Jewelries are the integral part of our society. Common metals used for jewelry are gold, platinum, palladium, titanium, silver, tungsten and stainless steel and non-metals such as wood, glass, pearls, carbon fiber, plastics, stones, resin, lather, etc. Investment casting, die casting and hand fabrication are the three major traditional jewelry manufacturing techniques. The various limitations summarized for these manufacturing processes are durability, porosity, cost, complex shape manufacturing ability, skilled labor and low production rate.

The jewelry manufacturing industry is also demanding the use of technological advancements in material science, manufacturing and computer networks and accepting 3D printing technology slowly. The 3D printing technology offers the advantages like manufacturing of complex parts, customized manufacturing, less tooling and environmentally friendly manufacturing.

Today, 3D printers have capabilities to manufacture jewelries using many traditional materials including gold and silver. This is a positive sign of evolving business of jewelry manufacturing. Most of the limitations of traditional jewelry manufacturing can be resolved using recent 3D printing technologies [1, 2].

Additionally, the market demand is continuously changing and people are always demanding for new products [3, 4]. The global trend of online shopping of the jewelry is continuously increasing and expected to reach at 4878 billion USD by 2021 to 3.7 and 1.7

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times fold that of 2014 and 2018 respectively [5]. As per The Global Costume Jewelry Market report published in October 2018, (MCP 2785) following are the six facts of future jewelry markets as shown in Figure 1 [6, 7].

Use of the virtual visualization offers trial of various jewelries is yet limited and soon becoming an acceptable trend across the globe. Few users are looking for jewelry customization and personalization and this demand will increase in the near future.

Due to technological advancement, the demand of future jewelry business can be fulfilled by integrating 3D printing technology, online visualization, online sale, smart supply chain management, internet of things and artificial intelligence.

This paper presents an integrated approach for future e-commerce jewelry business using 3D printing assisted by smart technologies. In this research work, future needs of buyers are identified and based on predicted technological advancements, an integrated business model is proposed.

PROPOSED SMART MODELS

The major tasks involved in integration as per the objective of this research work are manufacturing, supply chain management of raw materials and finished products, buyer interface, data mining and machine learning. In order to integrate these tasks, following models are developed:

- Smart model of jewelry manufacturing unit.
- Smart supply chain model for manufactured jewelry.
- Smart supply chain model for raw materials for jewelry manufacturing.
- Smart integrated e-commerce model for buyers.
- Smart comprehensive model (integrating manufacturing unit, supply chain management of raw materials and manufactured jewelry and buyer interface).
- Connecting central and sub-data centers.

Smart Model of Jewelry Manufacturing Unit

Following are the four basic 3D printing techniques [8, 9]:

- Stereo Lithography (SLA);
- Selective Laser Sintering (SLS);
- Fused deposition Modeling (FDM); and
- 3D Ink Jet Printing.

The 3D printing involves following essential stages of the manufacturing of parts:

- Create a CAD model of the design.
- Convert the CAD model into STL format.
- Slice the STL model into thin cross sectional layers.
- Construct the model one layer atop another.
- Clean and finish the model.

The printing material, the strength of the manufactured part, the size of the part to be manufactured, speed, accuracy and surface finish obtained are the parameters considered during selection of the 3D printing techniques. As per the order placed by the buyer, the materials and 3D printer will be selected in the manufacturing unit as shown in Figure 2. During selection of 3D printer orders in queue, manufacturing time, delivery schedule, etc. factors will be considered and a decision will be taken using suitable algorithms. Manufactured parts will move to the assembly line for assembly if required. After assembly, the jewelry will be tested, packed and dispatched to the required location. Material storage unit, 3D printers, assembly line, testing and packaging devices are connected to each other through internet. IoT and artificial intelligence system will take care to make jewelry manufacturing unit smart. All major systems in this unit are connected by the Data Sub-Centre$_1$ and all activities are recorded. Inspection, testing, packaging and dispatch activities are performed using automatic systems. Manufacturing unit may comprise of human interface and few non-IoT devices. This manufacturing unit is connected to smart supply chain model for raw materials and smart supply chain model for manufactured jewelry. For the 3D printer used in this unit, virtual software are available in smart integrated e-commerce model for buyers.

Description	Stats	Year
Retail value of Unbranded jewelry in the global jewelry market	69.5 %	2020
Share of working women highest in Hong Kong	49 %	2017
Share of female population highest in the central Europe and the Baltics	51.7 %	2017
Teen population (14-25) largest in India	229.5 million	2017
Middle class population and spending to be the largest in Asia Pasific	3230 million people spending USD 35.8 Trillion	2030
Time saving and convenient payment push mCommerce sales of fashion jewelry	Mobile transaction account 34% of Fashion and eLuxary Commerce	2018

Fig. 1: *Facts of Future Jewelry Markets.*

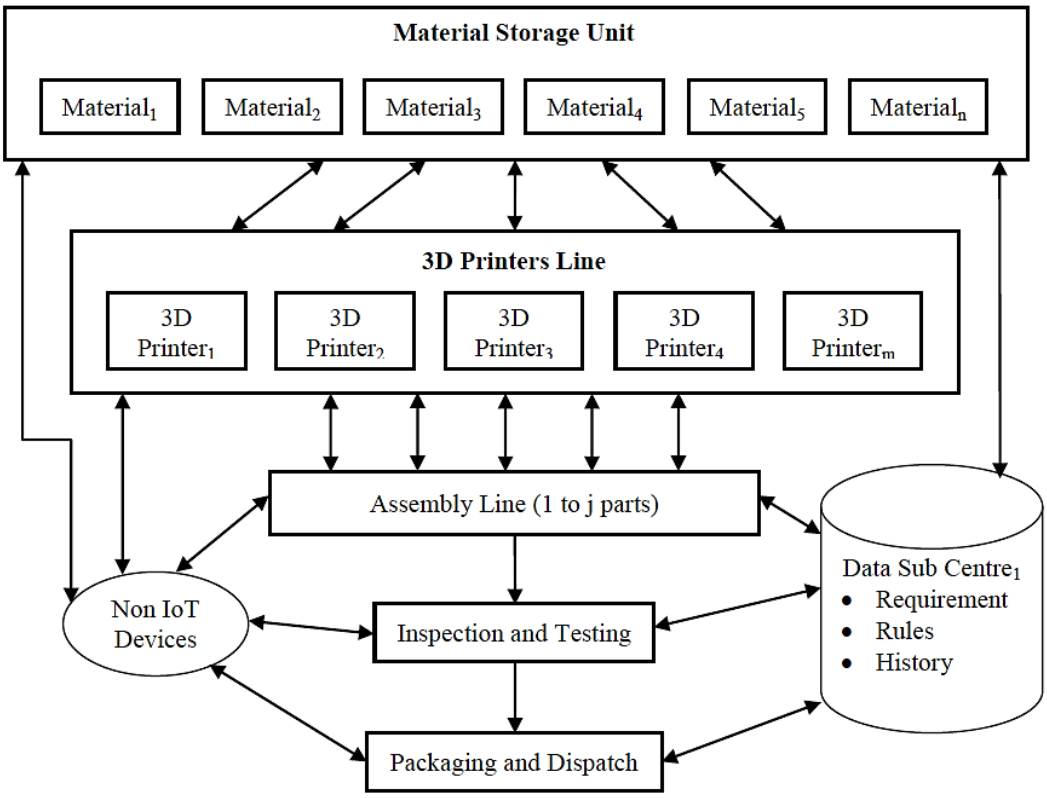

Fig. 2: *Smart Jewelry Manufacturing Unit.*

Smart Supply Chain Model Raw Materials for Jewelry Manufacturing

The demand of the material used for jewelry depends on the cost, characteristics of the manufactured parts, machining time, use of the jewelry, etc. The data mining makes it possible to guide the raw material supply chain management through smart computational techniques. The availability of raw materials at various manufacturing units will be

continuously recorded and supply will be managed according to it from raw material suppliers. Figure 3 shows that Data sub-centers$_4$ and Data sub-centers$_5$ are interconnected and decision about raw material supply will be taken. The trend of the cost of raw material will also be recorded and utilized during purchasing the raw materials.

Smart Supply Chain Model for Manufactured Jewelry

The manufacturing units are available across various locations in the country. The selection of manufacturing unit is based on the jewelry design, material, specifications of 3D printers, buyer's location, etc. Hence, it is required to deliver the manufactured jewelry at the desired buyer location. The transportation model as shown in Figure 4 is decided at the time of placing order. The transportation model and manufacturing unit are interconnected through the data sub-centers$_2$ and data sub-centers$_3$. The status of the part manufacturing and moving location during the delivery will be continuously tracked by the system administrator and buyer. This model is connected to all the manufacturing units through the internet.

Smart Integrated E-Commerce Model for Buyers

As stated earlier, the customized and personalized jewelry will be the need of the future. The factors considered during jewelry will be the design, material and cost. The smart, integrated e-commerce model for the buyer includes unlimited options to purchase the jewelry of various designs and materials and cost depending on selected design and materials. This integrated model is shown in the Figure 5.

Jewelry may consist of one or more parts. The buyer has the option to select the jewelry from existing design library$_1$ and material from material library. Jewelry consisting of more than one part can be formulated for online visualization by combing the sub-parts from library$_2$. This model will also facilitate the creation of customized library$_3$ and library$_4$. Complete designs of jewelry can be added to library$_3$ and sub-component design can be added to library$_4$. These jewelries or subparts can be added in the form of image, CAD file or video. The help of artificial intelligence can be demanded to formulate customized libray$_5$. The jewelry experts can help the buyers formulate libray$_6$. After selecting the jewelry from various design libraries, the buyer can select the material from material library.

For the selected combination of jewelry design and material manufacturing, feasibility is checked by virtual 3D printers using artificial intelligence. If it is accepted for manufacturing feasibility, then it will add for comparison, else the issues for selected combination will declare to the buyer for further modifications. The comparison is optional for the buyer. If buyer wishes to know the manufacturing cost of selected jewelry, then it will be available on the screen. The buyer can add number of possible jewelries for comparison and then costs can be displayed. The next process is of online visualization of selected jewelry or jewelries for the person who is going to use the jewelries. The buyer may opt for two dimensional or a three-dimensional online visualization. The photo or video of the buyer can be added to the online visualization system. Hence, buyer can visualize the jewelry with user and take further decision. Further, the buyer can fix the jewelry and purchase it by placing the order. Additionally, buyers can take an opinion from the inbuilt artificial intelligence system for matching of jewelry with user considering various factors such as user and jewelry combination, recent trends. If required, an artificial intelligence system can suggest the changes to jewelry. The buyer can repeat the process and take final decisions through a number of iterations about the selection and purchasing of the jewelry. While accepting the order, the manufacturing unit along with transportation management for manufactured jewelry is finalized and intimations are sent to respected units.

Smart Comprehensive Model

As the activity considered in this work involves various dependent and independent systems, it is required to integrate them. The smart integrating model comprises of manufacturing units, supply chain management of raw materials and manufactured jewelry and buyer interface and allied subsystems as shown in Figure 6.

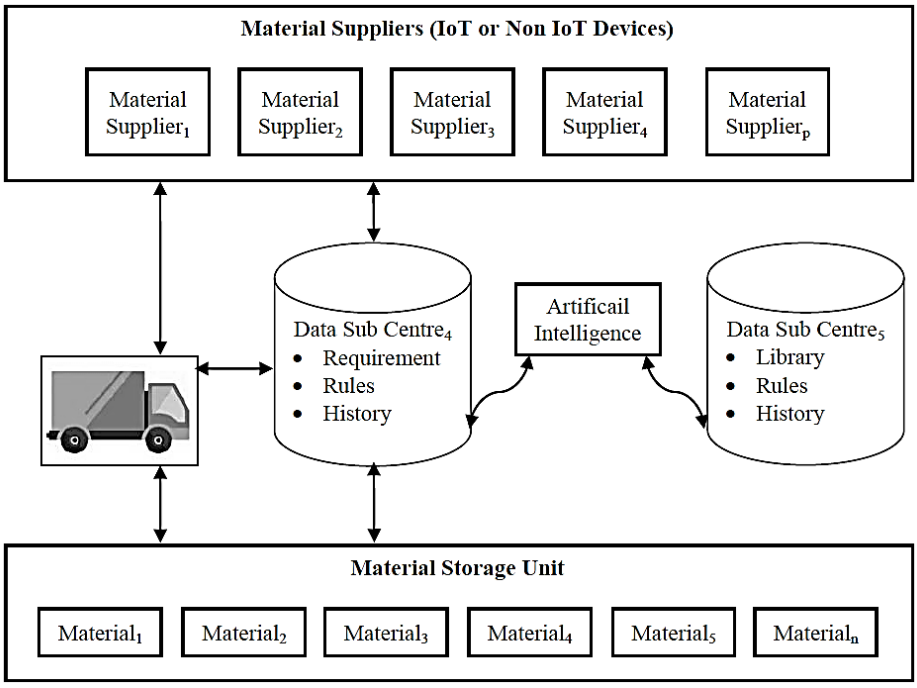

Fig. 3: *Smart Supply Chain Model Raw Materials.*

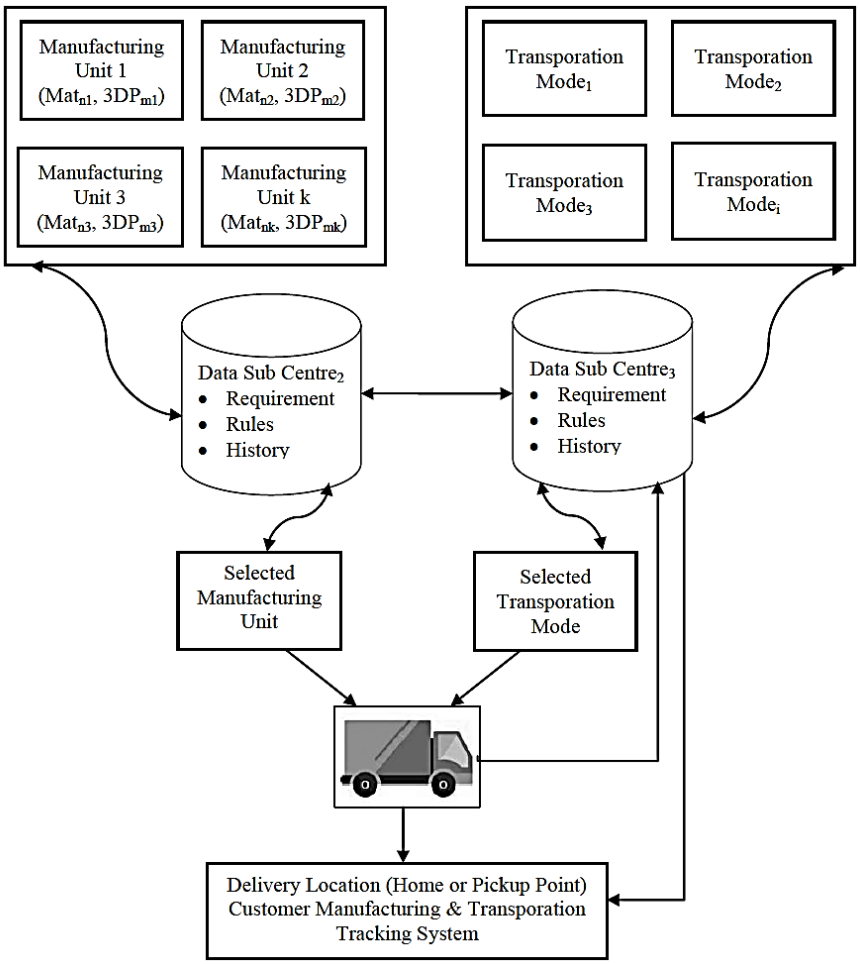

Fig. 4: *Smart Supply Chain Model for Manufactured Jewelry.*

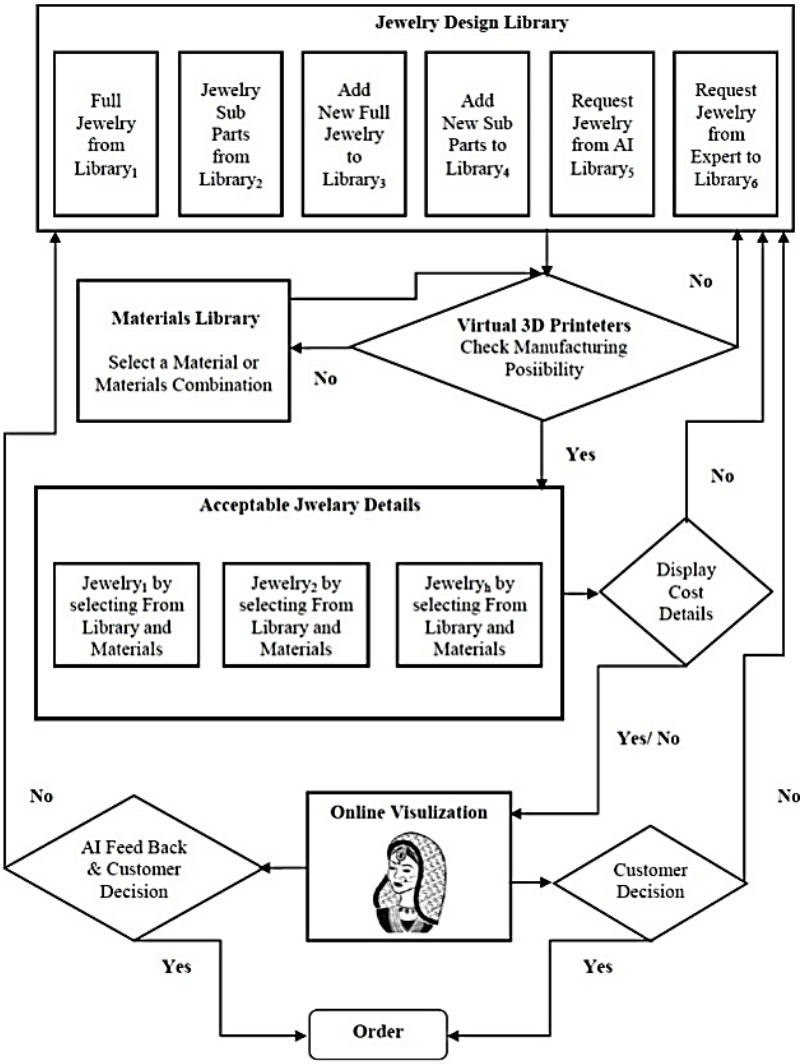

Fig. 5: *Integrated E-Commerce Model for Buyers.*

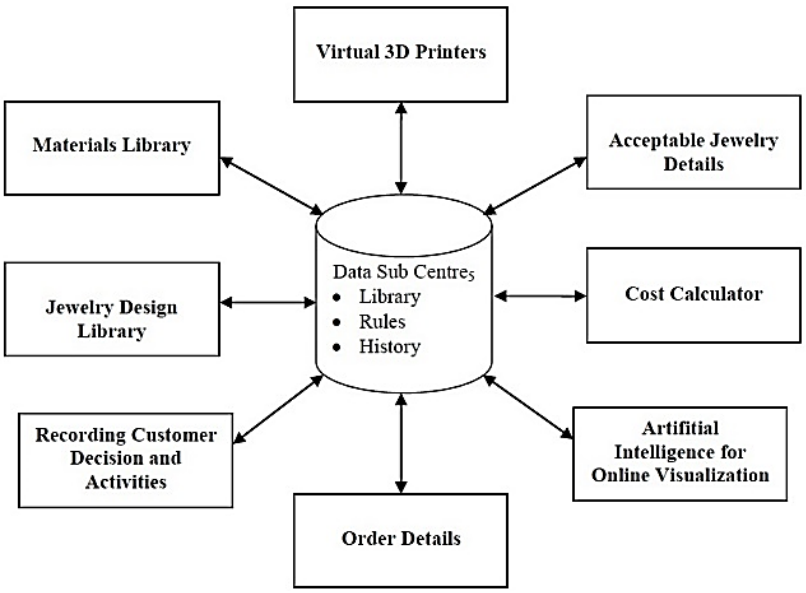

Fig. 6: *Smart Comprehensive Model.*

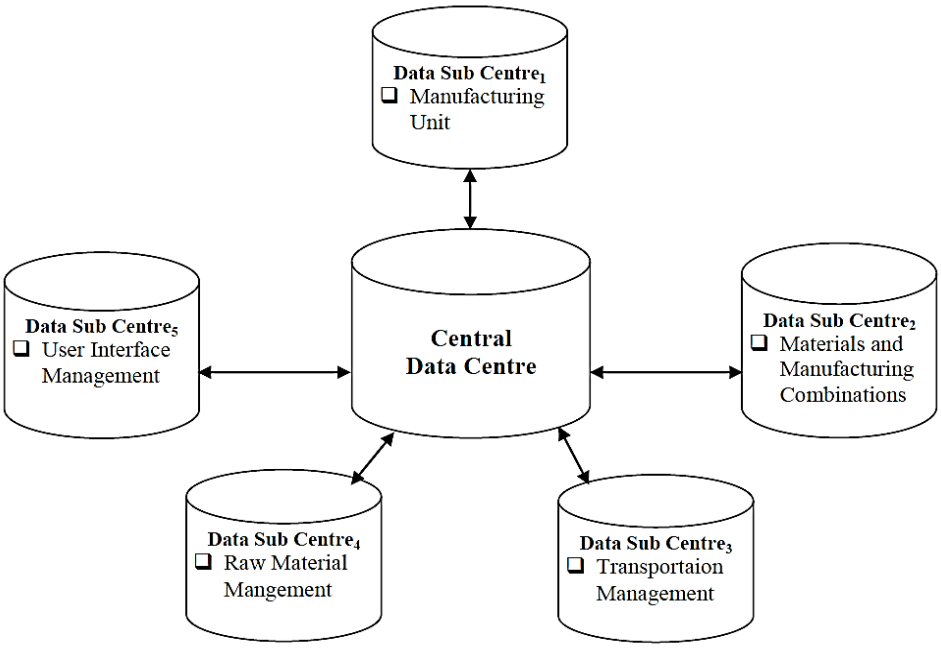

Fig. 7: *Connecting Central and Sub Data Centers.*

Connecting Central and Sub-Data Centers

The overall process of integration involves various stages and decisions. Hence, all systems and subsystems need to connect with each other. The data transfer among all these systems and subsystems is an important aspect to make this activity successful. In this model, Central Data Centre is connected to various data sub-centers$_{1\text{-}5}$ for manufacturing unit, manufacturing and material combinations, transportation management, raw material management and buyer interface as shown in Figure 7. The proper data management and handling is significant activity during all process and activities involved.

CONCLUSION

This paper presented an integrated approach for future e-commerce jewelry business using 3D printing. The brief models presented in this paper give an overview and will prove useful for the near future jewelry business. These models include all the major process and activities at all stages in a systematic manner. The detailed aspects of smart technologies required can be added to these models.

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