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CONTRIBUTION OF 3D PRINTING TECHNOLOGY TO E-BUSINESS CONCEPTUAL PERSPECTIVE OF YOUTH GENERATION

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ABSTRACT

The main purpose of the study is to highlight the importance and application of 3D printing, as well as its impact through various changes that it will cause in various areas of human life. Initially, two-dimensional printing technologies will be analyzed, and then we will deal with the techniques, the applications of three-dimensional printing, and the change that it caused in industrial production. In addition, there is focus on e-marketing, and e-commerce, and their association with 3D printing. The results of the present study suggest that three-dimensional printing is a great breakthrough, and has caused a huge revolution in technology which makes its use widespread nowadays and due to its elasticity, has succeeded in integrating into various sectors, triggering a new Industrial Revolution, and changing the way in which production has been operating until recently.

KEYWORDS: *3D Printing, Industrial Revolution. E-Business, Computational Methods*

INTRODUCTION

Three-dimensional printing is a great breakthrough, and has caused a huge revolution in technology, as its use becomes intense day by day. Although three-dimensional printing start was a bit strange, it managed to grow rapidly and apply to a variety of disciplines. In fact, due to its elasticity, it managed to integrate in various sectors, triggering a new Industrial Revolution, and changing the way in which the production functioned until recently. 3D printing has managed to reduce time and manufacturing costs, storage, create new and personalized products, and actively contribute to environmental protection. However, it has various disadvantages, most notably the risk of using it, as it can lead to an increase in crime, e.g. contribute to the illicit production of weapons.

LITERATURE REVIEW

In recent years, the evolution of technology has led to the emergence of three-dimensional (3D) printers, which instead of printing on paper, can make mock-ups of different items, but also food. Essentially, they do not belong in the same category as typography, as they are three-dimensional production devices. Specifically, 3D Printing or Additive Manufacturing is the process of manufacturing a 3D object of any digital format. In general, we can say that the three-dimensional printer is a miniature of an automated production line. Indeed, there are two kinds of three-dimensional printers:

- Those whose function is based on the heat developed in a special material, which, after taking the form given by the user, solidifies and creates the model of the object, and

- Those who form an existing object of special material, cutting it according to the user's instructions and thus creating the final model.

Three-dimensional printers, as their name implies, are used to print three-dimensional objects. For a complete understanding of the parts made up of a 3d printer, the three axes it prints must be taken into account. axes x and y relate to the movement of the floor printing, while the z axis is in the movement of the vertical axis. In fact, each axis is controlled by a motor. At the same time, the motor also has the extruder. In particular, the extruder is the component that draws or pushes the yarn as needed for printing (Oppong, 2016). The thread is advanced to the hot end, the warm place where it is heated by the heated block at suitable temperatures (170240c) until it melts. The molten yarn comes out of the mouth to a smaller diameter of 0.30.6 mm and is placed on the floor of the print. The print process is controlled by the computer, and the machine and computer are connected through the printer's main board.

E-Business Connection with 3D Printing

It is worth mentioning that in recent years, 3D printing companies have tended to apply e-business to a broader range of customers. Indeed, the services that a three-dimensional print service provider can offer are categorized as follows:

- Basic Printing services for users who have an idea to build an object, have it designed on paper, and want to print.
- Plans for sale where a purchase of designs is created and is intended to be printed by the buyer or a third-party manufacturer.
- Marketing & Business Promotion Services where fast and economical prototypes of products marketed by a business can be manufactured and given a complete picture without the need for large initial capital.
- 3d support & training services.
- 3D designing services where it can help users, ensuring a functional and even three-dimensional design
- Provide design and project modeling information where the use of e-business provides the ability to deliver lessons and information about creating and modeling a project.
- Each user can also be a manufacturer where allowing designers to sell customized 3D printed items directly to consumers, and allowing 3D websites of 3D printing companies to become real manufacturers.
- Making accurate copies where combined with 3D scanning, faithful copies of objects can be made at any scale desired by the user.
- Providing special molds where the strength of some materials used by the three-dimensional printers are such that they can be used to create special molds for molding materials with a relatively low melting point.
- Rent and 3D printing enables users to get acquainted, familiarize themselves with and use a 3D printer for a certain amount of time.
- Convert 2D Photo to a model where they can show the photographer how to use existing services and software, converting a two-dimensional photo into a 3D model.

Three-dimensional printing has not reached the main point of acceptance, but it certainly comes out of the shadows. Consumers feel more and more comfortable using 3D print services over the internet. This revolution of personal construction is expanded year by year through social networks, and the media *(Smith, 2017).*

3D printing, although it concerns physical creation, can be used in digital marketing. In fact, some innovative businesses have already begun to use 3D printing in their digital marketing campaigns. Thus, three-dimensional printing can offer a variety of creative marketing opportunities, where some possible uses are:

- Construction of 1m objects, each different
- Expanding an existing character
- Replace / repair
- Discover and print a new character or product
- Miniature of the new product for promotion & advertising
- Unique memorabilia
- Moments of major events
- Samples of products
- Add-ons to an existing product
- Gift boxes for cereal packs
- Coins, medals, awards

Although there are several suggestions for 3D printing, its use in the marketing mix of a business offers many opportunities for exploitation. The good news is that everything is evolving at a rapid pace, and three-dimensional printers are expected to be widely available to the public in the coming years. As business opportunities become more and more sustainable, a whole world of marketing opportunities opens (Charlton, 2015). However, despite the involvement of many major brands, 3D printing has not yet been fully integrated into a marketing program (Oppong, 2016).

METHODOLOGY

Research in Greek Companies

Having clarified the concept of 3D Printing, we will attempt through this research to make an approach to the widespread use of 3D printing in business as well as its application to them. More specifically, businesses have been asked to answer questions such as whether 3D Printing is functional, easy to use, cost-effective, and of course, whether they are safe to use.

In this research paper, we use a quantitative research methodology. The process of a quantitative research follows two distinct phases. Firstly, the phase of the design that we mention the objectives of the research and the assumptions may be considered. The implementation phase involves collection of data, analysis, and the interpretation of results. According to the existing research and the issue of usability, we use the questionnaire as a research tool for measuring the impact of 3D printing in E-Business (Morris, 2017). In this paper, an online questionnaire has been used by professionals through social networks. The purpose of the survey is to assess the impact of 3D printing in E-Business in Greek Area.

The questionnaire was created through the Google Forms application. The target was mainly Greek Students, but we also took a small sample in higher age groups. Specifically, we gathered 384 answers, from which we will analyze below.

The Questionnaire was Divided into 2 Groups of Questions, Where the Relevant Group Would Look at the Corresponding Group

- A case that "knew or had re-heard about 3D printing technology." [18 Questions]
- A case that "did not know or did not hear about the three-dimensional printing technology again". [9 Questions]

The survey was conducted over a six months period (September - December) in Greece in 2017 in a period of intense economic crisis, and the population we addressed was Greek companies.

Finally, by doing the research, the limitations we encountered were that we had a fairly small sample and that there was a non-response to several of the questions because of the specificity of the subject.

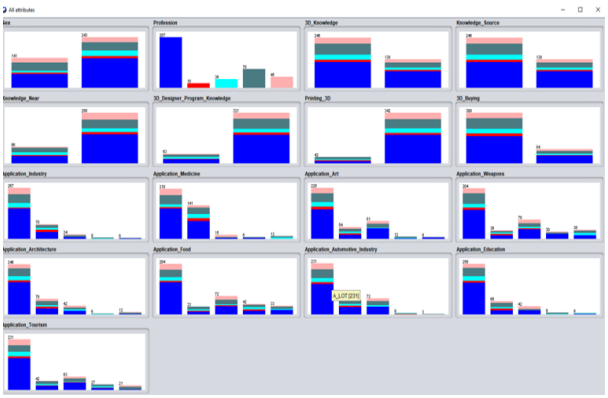

Figure 1: Descriptive Statistics.

From a Computational View

Data Mining is an emerging knowledge discovery process of extracting previously unknown, actionable information from very large scientific and commercial databases. It is imposed by the explosive growth of such databases. Usually, a data mining process extracts rules by processing high dimensional categorical and/or numerical data. Classification, clustering and association are the most well known data mining tasks. Classification is one of the most popular data mining tasks. Classification aims at extracting knowledge which can be used to classify data into predefined classes, described by a set of attributes. The extracted knowledge can be represented using various schemas. Decision trees, "if-then" rules and neural networks are the most popular such schemas.

A lot of algorithms have been proposed in the literature for extracting classification rules from large relational databases, such as symbolic learning algorithms including decision trees algorithms (e.g. C4.5) and rule based algorithms (e.g. CN2), connectionist learning algorithms (e.g. back{propagation networks), instance-based algorithms (e.g. PEBLS) and hybrid algorithms. Association rules can be used to represent frequent patterns in data, in the form of dependencies among concepts attributes. In this paper, we consider the special case, that is known as the market basket problem, where concepts-attributes represent products and the initial database is a set of customer purchases (transactions).

Classification methods aim to identify the classes from some descriptive traits. They find utility in a wide range of human activities and particularly in automated decision making. Decision trees are a very effective method

of supervised learning. It aims is the partition of a dataset into groups as homogeneous as possible in terms of the variable to be predicted. It takes as input a set of classified data, and outputs a tree that resembles to an orientation diagram where each end node (leaf) is a decision (a class) and each non- final node (internal) represents a test. Each leaf represents the decision of belonging to a class of data verifying all tests path from the root to the leaf. The tree is simpler, and technically it seems easy to use. In fact, it is more interesting to get a tree that is adapted to the probabilities of variables to be tested. Mostly balanced tree will be a good result. If a sub-tree can only lead to a unique solution, then all sub-tree can be reduced to the simple conclusion, this simplifies the process and does not change the final result. Ross Quinlan worked on this kind of decision trees.

Decision trees are built in "ctree (Conditional Inference Trees)" by using a set of training data or data sets. At each node of the tree, "ctee" chooses one attribute of the data that most effectively splits its set of samples into subsets enriched in one class or the other. Its criterion is the normalized information gain (difference in entropy) that results from choosing an attribute for splitting the data. The attribute with the highest normalized information gain is chosen to make the decision. During the construction of the decision tree, it is possible to manage data for which some attributes have an unknown value by evaluating the gain or the gain ratio for such an attribute considering only the records for which this attribute is defined. Using a decision tree, it is possible to classify the records that have unknown values by estimating the probabilities of different outcomes. Ctree builds decision trees from a set of training data in the same way as ID3 or C4.5, using the concept of information entropy.

The training data is a set $S = s_1, s_2, \cdots$ of already classified samples. Each sample s_i consists of a p-dimensional vector $(x_{1,i}, x_{2,i}, ..., x_{p,i})$, where the x_j represent attribute values or features of the sample, as well as the class in which s_i falls. At each node of the tree, "ctree" chooses the attribute of the data that most effectively splits its set of samples into subsets enriched in one class or the other. The splitting criterion is the normalized information gain (difference in entropy). The attribute with the highest normalized information gain is chosen to make the decision.

Association Rule Mining is a common technique used to find associations between many variables. In Data Mining, Apriori is a classic algorithm for learning association rules. Apriori is designed to operate on databases containing transactions (for example data collected from surveys in this case). As is common in association rule mining, given a set of item sets, the algorithm attempts to find subsets which are common to at least a minimum number C of the item sets.

Apriori uses a "bottom up" approach, where frequent subsets are extended one item at a time, and groups of candidates are tested against the data. The algorithm terminates when no further successful extensions are found. Apriori uses breadth-first search and a tree structure to count candidate item sets efficiently. It generates candidate item sets of length k from item sets of length k−1. Then it prunes the candidates which have an infrequent sub pattern. According to the downward closure lemma, the candidate set contains all frequent k-length item sets. After that, it scans the transaction database to determine frequent item sets among the candidates.

Association rules present association or correlation between item sets. An association rule has the form of A →B, where A and B are two disjoint item sets.

The Goal: studies whether the occurrence of one feature is related to the occurrence of others.

Three Most Widely Used Measures for Selecting Interesting Rules are:

- **Support** is the percentage of cases in the data that contains both A and B,
- **Confidence** is the percentage of cases con**t**aining A that also contain B, and
- **Lift** is the ratio of confidence to the percentage of cases containing B.

RESULTS

Classification Rules Visualization

The "ctree" algorithm then recurs on the smaller sublists. In order to specify the best result, it was necessary to fit the data to the model in a proper way. This task was carried away by changing and testing the controls of "ctree".

The Parameters in the Control Function that were Altered are:

- **Mincriterion:** The value of the test statistic (for test type == "Test statistic"), or 1 - p-value (for other values of testtype) that must be exceeded in order to implement a split.
- **Minsplit:** The minimum sum of weights in a node in order to be considered for splitting.
- **Mtry:** The number of input variables randomly sampled as candidates at each node for random forest like algorithms.
- **Maxdepth:** The maximum depth of the tree.

Tree Parameters

- Dependent variable: “”
- Independent variables: ""
- ‘mincriterion’ value: 0.01
- ‘minsplit’ value: 20L
- ‘mtry’ value: Inf (Infinite)
- ‘maxdepht’ value: Inf (Infinite)

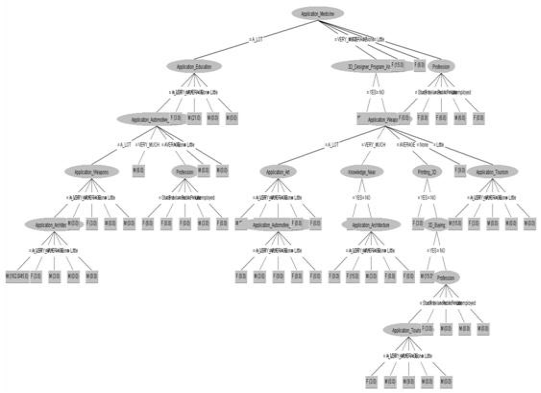

Figure 2: Decision Tree.

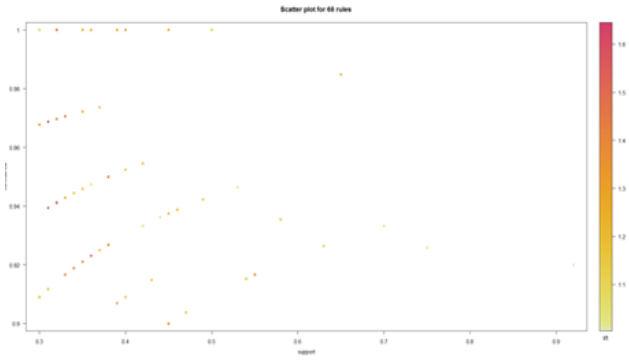

Figure 3: Scatter Plot.

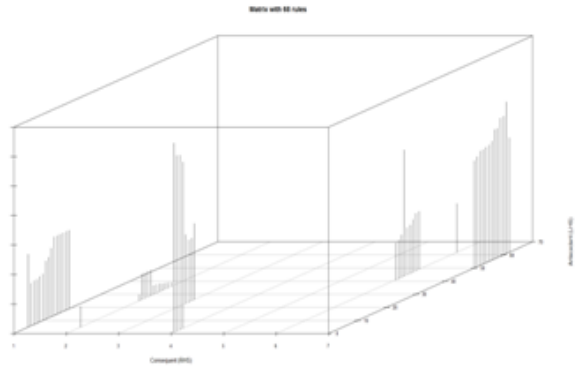

Figure 4: Matrix 3D.

Apriori Rules Visualization

- **Scatter Plot**

This visualization method draws a two dimensional scatterplot with different measures of interestingness (parameter "measure") on the axes and a third measure (parameter "shading") is represented by the color of the points. There is a special value for shading called "order" which produces a two-key plot where the color of the points represents the length (order) of the rule.

- **Matrix3D**

Arranges the association rules as a matrix with the item sets in the antecedents on one axis, and the item sets in the consequent on the other. The interest measure is either visualized by a color (darker means a higher value for the measure) or as the height of a bar (method "matrix3D"). Specifically of our use, the parameters that were altered are:

- measure = "lift"
- control = list(reorder = TRUE)

Apriori Rules

For the top 100 rules that were extracted from the apriori, the following parameters were altered:

- support: A numeric value for the minimal support of an item set
- confidence: A numeric value for the minimal confidence of rules/association hyperedges

Apriori

- Minimum support: 0.55 (211 instances)
- Minimum metric <confidence>: 0.9
- Number of cycles performed: 9
- Generated sets of large itemsets:
- Size of set of large itemsetsL(1): 13
- Size of set of large itemsetsL(2): 24
- Size of set of large itemsetsL(3): 9
- Size of set of large itemsetsL(4): 1

Best Apriori Rules Found:

- Knowledge_Near=NO 288 ==> Printing_3D=NO 288 <conf:(1)> lift:(1.12) lev:(0.08) [31] conv:(31.5)
- Knowledge_Near=NO 3D_Designer_Program_Knowledge=NO 273 ==> Printing_3D=NO 273 <conf:(1)> lift:(1.12) lev:(0.08) [29] conv:(29.86)
- Knowledge_Source=YES 246 ==> 3D_Knowledge=YES 246 <conf:(1)> lift:(1.56) lev:(0.23) [88] conv:(88.41)
- 3D_Knowledge=YES 246 ==>Knowledge_Source=YES 246 <conf:(1)> lift:(1.56) lev:(0.23) [88] conv:(88.41)
- 3D_Designer_Program_Knowledge=NO Application_Industry=A_LOT 237 ==> Printing_3D=NO 237 <conf:(1)> lift:(1.12) lev:(0.07) [25] conv:(25.92)
- Knowledge_Near=NO 3D_Buying=YES 228 ==> Printing_3D=NO 228 <conf:(1)> lift:(1.12) lev:(0.06) [24] conv:(24.94)
- 3D_Designer_Program_Knowledge=NO Application_Architecture=A_LOT 225 ==> Printing_3D=NO 225 <conf:(1)> lift:(1.12) lev:(0.06) [24] conv:(24.61)
- Knowledge_Near=NO Application_Industry=A_LOT 213 ==> Printing_3D=NO 213 <conf:(1)> lift:(1.12) lev:(0.06) [23] conv:(23.3)
- Knowledge_Near=NO 3D_Designer_Program_Knowledge=NO 3D_Buying=YES 213 ==> Printing_3D=NO 213 <conf:(1)> lift:(1.12) lev:(0.06) [23] conv:(23.3)
- 3D_Designer_Program_Knowledge=NO Application_Education=A_LOT 231 ==> Printing_3D=NO 228 <conf:(0.99)> lift:(1.11) lev:(0.06) [22] conv:(6.32)
- 3D_Designer_Program_Knowledge=NO 321 ==> Printing_3D=NO 315 <conf:(0.98)> lift:(1.1) lev:(0.08) [29] conv:(5.02)
- 3D_Designer_Program_Knowledge=NO 3D_Buying=YES 243 ==> Printing_3D=NO 237 <conf:(0.98)> lift:(1.1) lev:(0.05) [20] conv:(3.8)

- Application_Architecture=A_LOT 246 ==> Printing_3D=NO 237 <conf:(0.96)> lift:(1.08) lev:(0.05) [17] conv:(2.69)
- Application_Automotive_Industry=A_LOT 231 ==> Printing_3D=NO 222 <conf:(0.96)> lift:(1.08) lev:(0.04) [16] conv:(2.53)
- Application_Tourism=A_LOT 231 ==> Printing_3D=NO 222 <conf:(0.96)> lift:(1.08) lev:(0.04) [16] conv:(2.53)
- Application_Industry=A_LOT Application_Education=A_LOT 222 ==> Printing_3D=NO 213 <conf:(0.96)> lift:(1.08) lev:(0.04) [15] conv:(2.43)
- Printing_3D=NO Application_Architecture=A_LOT 237 ==> 3D_Designer_Program_Knowledge=NO 225 <conf:(0.95)> lift:(1.14) lev:(0.07) [26] conv:(2.99)
- Knowledge_Near=NO 288 ==> 3D_Designer_Program_Knowledge=NO 273 <conf:(0.95)> lift:(1.13) lev:(0.08) [32] conv:(2.95)
- Knowledge_Near=NO Printing_3D=NO 288 ==> 3D_Designer_Program_Knowledge=NO 273 <conf:(0.95)> lift:(1.13) lev:(0.08) [32] conv:(2.95)
- Knowledge_Near=NO 288 ==> 3D_Designer_Program_Knowledge=NO Printing_3D=NO 273 <conf:(0.95)> lift:(1.16) lev:(0.1) [36] conv:(3.23)
- 3D_Buying=YES Application_Industry=A_LOT 219 ==> Printing_3D=NO 204 <conf:(0.93)> lift:(1.05) lev:(0.02) [8] conv:(1.5)
- 3D_Buying=YES Application_Education=A_LOT 213 ==> Printing_3D=NO 198 <conf:(0.93)> lift:(1.04) lev:(0.02) [8] conv:(1.46)
- Printing_3D=NO Application_Art=A_LOT 213 ==>Application_Industry=A_LOT 198 <conf:(0.93)> lift:(1.34) lev:(0.13) [49] conv:(4.06)
- Application_Education=A_LOT Application_Tourism=A_LOT 213 ==>Application_Industry=A_LOT 198 <conf:(0.93)> lift:(1.34) lev:(0.13) [49] conv:(4.06)
- Printing_3D=NO Application_Industry=A_LOT Application_Education=A_LOT 213 ==> 3D_Designer_Program_Knowledge=NO 198 <conf:(0.93)> lift:(1.11) lev:(0.05) [19] conv:(2.18)
- Application_Medicine=A_LOT 210 ==>Application_Industry=A_LOT 195 <conf:(0.93)> lift:(1.34) lev:(0.13) [48] conv:(4)
- 3D_Designer_Program_Knowledge=NO Application_Tourism=A_LOT 210 ==>Application_Education=A_LOT 195 <conf:(0.93)> lift:(1.38) lev:(0.14) [53] conv:(4.31)
- 3D_Designer_Program_Knowledge=NO Printing_3D=NO Application_Tourism=A_LOT 210 ==>Application_Education=A_LOT 195 <conf:(0.93)> lift:(1.38) lev:(0.14) [53] conv:(4.31)
- 3D_Designer_Program_Knowledge=NO Application_Tourism=A_LOT 210 ==> Printing_3D=NO Application_Education=A_LOT 195 <conf:(0.93)> lift:(1.47) lev:(0.16) [62] conv:(4.82)

- Profession=Student 207 ==> Printing_3D=NO 192 <conf:(0.93)> lift:(1.04) lev:(0.02) [7] conv:(1.42)
- Application_Automotive_Industry=A_LOT 231 ==>Application_Industry=A_LOT 213 <conf:(0.92)> lift:(1.33) lev:(0.14) [52] conv:(3.7)
- Application_Tourism=A_LOT 231 ==>Application_Education=A_LOT 213 <conf:(0.92)> lift:(1.37) lev:(0.15) [57] conv:(3.99)
- Printing_3D=NO 342 ==> 3D_Designer_Program_Knowledge=NO 315 <conf:(0.92)> lift:(1.1) lev:(0.08) [29] conv:(2)

We noticed in the question "From where did you learn about this technology" (with the choice of more than one answer) that the 61.3 % of the answer is "Internet / Forum / Search engine / Youtube" Social Media Networks' with 40 %. As the third answer, the options come from 'Article in magazine / newspaper' & 'through friend' with 22.5 % both. The responses from 'Presentation to one event / exhibition' and 'Television' reached only 20 %, which shows us that there are still a few events happening on the subject of 3D printing and the reports on TV. Less than 17.5 % has the answer 'In my school' & 2.5 % some 'other' answer that was not on the list. We see that the internet has a great impact on the world to keep up with the news and developments.

In the next question, we see that a small percentage of 25 % to 50 responses know a CAD model, but a great deal of 75 % with 40 answers does not know. From the answers to the question if you were buying a home 3D printer, we notice that a large percentage of 66.3 % would like to buy a 3D printer, as opposed to 33.8 % not wishing to buy a printer.

According to the chart above, 17.5 % have been printed on a three-dimensional printer, compared with 82.5 % they have not printed.Of the 14 people who have printed, we notice that 21.4 % with 3 replies, they own a three-dimensional printer and the remaining 78.6 % with 11 people have used a third-party service to print their object.

Following the previous question, those who replied that they would buy a printer also answered the question of what they would print. We noticed that a large percentage would print Gadgets, household items, extras - accessories & entertainment items. Then follow the miniatures, the pattern patterns and the mock-ups. Less patterns and jewels are less preferred.

According to the replies, the Print Speed, Printer Cost, Size, and Security are considered important for the market. A very important feature that will affect the market is Print Quality, as an object.Of the 86 people, 87 %, would like to learn more about 3D printing. On the contrary, 13 % are not interested.

The most known methods are 'Fused Filament Fabrication (FFF) or Plastic Jet Printing (PJP)' with 23 options, followed by 'Selective laser sintering (SLS)' with 22 options, the third in the series is Laser Melting (LM), and Digital Light Processing (DLP) from 19 selections each. We noticed that the percentage is too large where they do not know anything about printing method. The most famous materials based on the answers are Nylon with 28 options, ABS with 24, Flexible with 21 followed by PLA with 19 and Ceramic filament with 17, the rest are less well known. There is also a large percentage, with 19 choices where they do not know any material.

CONCLUSIONS

To conclude, the most interesting application of three-dimensional printing, based on the above options, is considered the application in Medical Technology, followed in Industry, Education, Architecture & Construction and Application in the Automotive Industry. At lower rates is the application in Tourism, in the Arts, the printing of Edible food and lastly in the Army systems.Three-dimensional printing has not reached the main point of acceptance, but it certainly comes out of the shadows. Consumers feel more and more comfortable using 3D print services over the internet *(Diaz, 2013).* This revolution of personal construction is expanding year by year through social networks, and the media.

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