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Cost Affect on 3D Printing Technology and Its Scope in Future: a Study

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Cost effect on 3D printing technology and its scope in future: A study

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Abstract:

Three-dimensional (3D) printing (3DP) is a technology that offers a promising value proposition across multiple manufacturing industries with its precision model construction. Despite the variety of product benefits with the technology, its rate of adoption is not what was foreseen by the experts, and the opposite was promised in the industry predictions. 3D printing is only adopted by a handful of institutions/facilities and individuals for academic, research, and experimental purposes. In addition, multiple countries have invested heavily in encouraging the adoption and use of 3D printing in various industries including startups. Through this study, we find that the cost of building a basic 3D printer is no more than 12837 rupees (approx. 157 USD) including 1KG of filament and the differences in quality based on materials such as PETG and PLA. However, observations point out that the technology no longer faces a cost problem but more of a time efficiency problem.

Keywords: 3D printing, Filaments, PLA, PETG.

Objective:

- To build a 3D printer with cost as an important factor to evaluate the impact on the performance of the printer.
- To use PLA and PETG in the printer to evaluate if material cost and properties affect the printed models and printing itself in any manner.

Introduction:

3D printing was introduced as an effective method to create models with precision while giving its user complete control over the customization and precision, this property of 3D printing technology was predicted to have a very impactful factor in all sorts of industries.

PETG and PLA filament is one of the most commonly used filaments for 3D printing. Like most 3D printing filaments, both are thermoplastics. Meaning they soften above their respective temperature and become solid again once cooled down. Theoretically, the process can be repeated over and over again without degrading the material quality which in turn brings printing costs down significantly.

However, adoption rates vary across sectors. Companies within the aerospace, medical, automotive, and industrial goods industries are among the most mature adopters of the technology and also key contributors to the industrialization of 3D printing. In the meantime, the adoption of 3D printing is also uneven across geographical regions.

A clear comparison of various 3D printers can be seen in the data provided below across various varieties of 3D printers.

Name	Build Volume (mm)	Price
QIDI Tech X-Pro	230 × 150 × 150	$469
Creality CR-10 V3	300 × 300 × 400	$529
Flashforge Creator Pro 2	200 × 148 × 150	$799
Anycubic Mono X	192 × 120 × 245	$899
Prusa i3 MK3S	250 × 210 × 210	$999

Entry level 3D printer cost

Name	Build Volume (mm)	3D Printer Price
Dremel Digilab 3D45	254 × 154 × 170	$1,899
Zmorph Fab	250 × 235 × 165	$3,380
Formlabs Form 3	145 × 145 × 185	$3,499
Ultimaker S3	230 × 190 × 200	$3,850
BCN3D Sigma D25	420 × 300 × 200	$3,995

Reliable desktop 3D printer cost

Name	Build Volume (mm)	Price
Raise3D Pro2	305 × 305 × 300	$3,999
Makerbot Method	190 × 190 × 196	$3,499 - $5,499
Ultimaker S5	330 × 240 × 300	$5,499
Raise3D Pro2 Plus	305 × 305 × 605	$5,999

Professional 3D printer cost

*Source:-https://www.3dsourced.com/3d-printers/how-much-does-a-3d-printer-cost-price/

Literature review:

Thomas Campbell [1] in his studies concluded that 3D printing does have potential but is limited due to its precision, as industry requires speed and effectiveness he concluded that a 1.5-inch cube made by 3D printer took approximately an hour to complete and an injection mold could produce large quantities of same cube under a minute. Despite its slow process 3D printing has a great future in nanotechnology and scientific breakthroughs, it is also believed to maybe cause an industry manufacturing revolution and cause impact to global economy and create advancements in environmental protection. The pace of adoption is uneven across sectors as written by the author.

Kamrul Ahsan [3] concluded that among the most important challenge classes, technology related to production is vital. Respondents perceived that it will be extremely tough to overcome the standard problems shortly. It is expected that 3D printing technology would still improve this challenge associated with quality. For a brand-new technology like 3D printing, a lot of analysis and development is important to boost the standard of the merchandise in terms of preciseness, strength, and aesthetic view. The second vital challenge class is the business environment. Market demand for 3D printing products isn't enough for property businesses. Moreover, government policy and regulation ought to be in place to prevent piracy or intellectual copyright problems.

Amr Alaa El-din [4] concludes that the amount of finishing his research, The analysis provided background and deliberated potentials and challenges of the relevancy of 3DP in numerous cases

throughout the planet in order that future analysis might match native necessities and properties with the key factors that verify the relevance of 3D printing to several native contexts. As regards general 3D printing development, more work is required to explore ways in which of printing with multiple materials, develop new materials, use in-place resources, quicker printing, quality assurance, and mechanical property information, and mix 3DP with different processes like hybrid techniques to increase the potential of applying it as new building technology.

Another study [5] concluded the foremost fascinating application of three-dimensional printing, supported by the higher choices, is considered the application in Medical Technology, followed in trade, Education, Design & Construction, and Application within the Automotive trade. At lower rates is that the application in business enterprise, within the Arts, the printing of Edible food, and in conclusion within the Army systems. Three-dimensional printing has not reached the most purpose of acceptance, however, it definitely comes out of the shadows. shoppers feel a lot of and easier mistreatment of 3D print services over the net. This revolution of non-public construction is increasing year by year through social networks, and therefore the media.

Muhammad Fiaz and team [6] in their thorough analysis of 3D printing and narrowing the gap between Academia and Industry conclude that, factors like cost saving as it saves the cost because only the ideal material is used to make the model and that model can be modified if needed resulting in better cost reductions, only desired raw material is used which is also an effort to save money and it also saves time by giving the output in a desirable duration of time.

Finn Hahn and team [7] summarized the results of their study focusing on business opportunities that 3D printing may have alongside the impact that could be seen in the startup sector. The focus of the study is the analysis drawn from the empirical support for the understanding of the value proposition's level of disruption as a measure for assessing the commercial viability of emerging technological firms. They might be able to assess the competitiveness of particular features and benefits based on 3D printing technology using this information, and it might also be important to potential investors who might use the research's findings to support their investment choices.

A. Ramya and Sai Leela Vanapalli [8] have concluded that 3D printers have proven to be one of the most substantial technologies for the future growth of multiple industries. The latest 3D printing techniques have shown evident results that assist designers and engineers in easing the process end-to-end. In order for 3D printing to get adopted across multiple domains of industries it should improve the functionality so that it is easier for businesses to comprehend and can therefore be adapted at a rapid pace. A vast application of 3D printing can be seen in the medical field, construction, food industry, and also textile industry and a promising decrease in cost with an increase in quality can be witnessed at the same time as new materials and methods are implemented.

Research methodology:

1. **Building a 3D printer**
   - **1.1.** Gathering components

Part	Units	Cost(Rupees)
Printing bed	1	1,749
Extruder kit	1	740
Belt (5M)	1	449
Stepper motor	4	3500
Arduino mega 2560 kit	1	2349
Power supply	1	1850
Aluminum Frame	-	400
Total	9	11037

1.2. Assembling the printer

The parts listed above were assembled into one fully functional 3D printer and were ready to perform further testing.

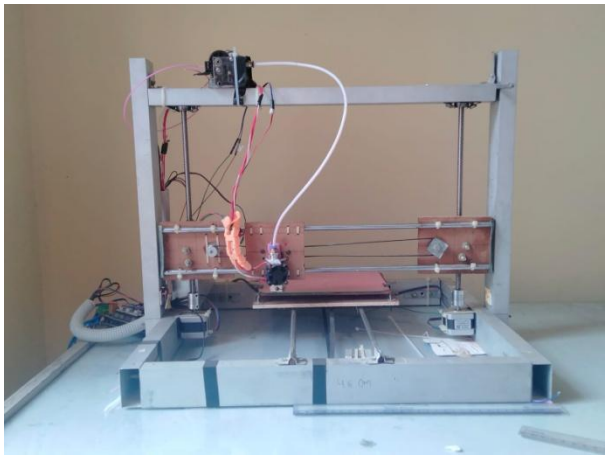

Fig.1: 3D printer front view.

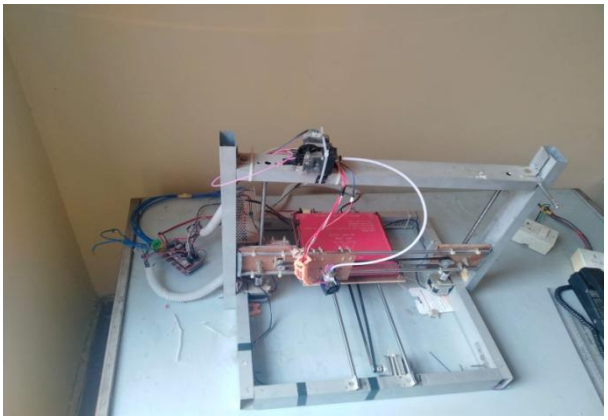

Fig.2: 3D printer top view.

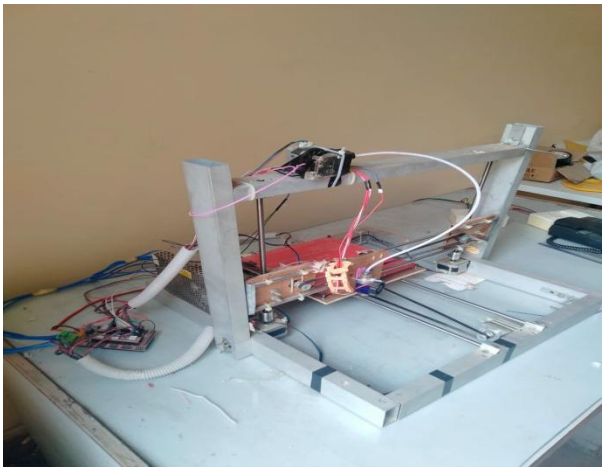

Fig.3: 3D printer side view.

2. Selecting filaments

For the purpose of this experiment PLA (polylactic acid) and PETG (Polyethylene terephthalate glycol) were chosen as they were available in the market. Both the materials cost 1800 rupees combine.

Fig.4: PETG(left) and PLA(right) filament

3. Choosing designs.

As no member of the team was able to design a model and due to a shortage of time it was decided to get the designs from online websites that were copyright free and made free to use by the creator of these designs for the experiment.

4. Choosing software.

In this experiment, we choose to use repeater host (v2.2.2), a software that acts as an intermediate between the 3D printer and the computer that stored the design files.

5. Printing the models.

5.1. Loading the design

The design file is loaded onto the software. On this stage, we can adjust the axis and size of our model and configure other various factors before we proceed to slicing the model.

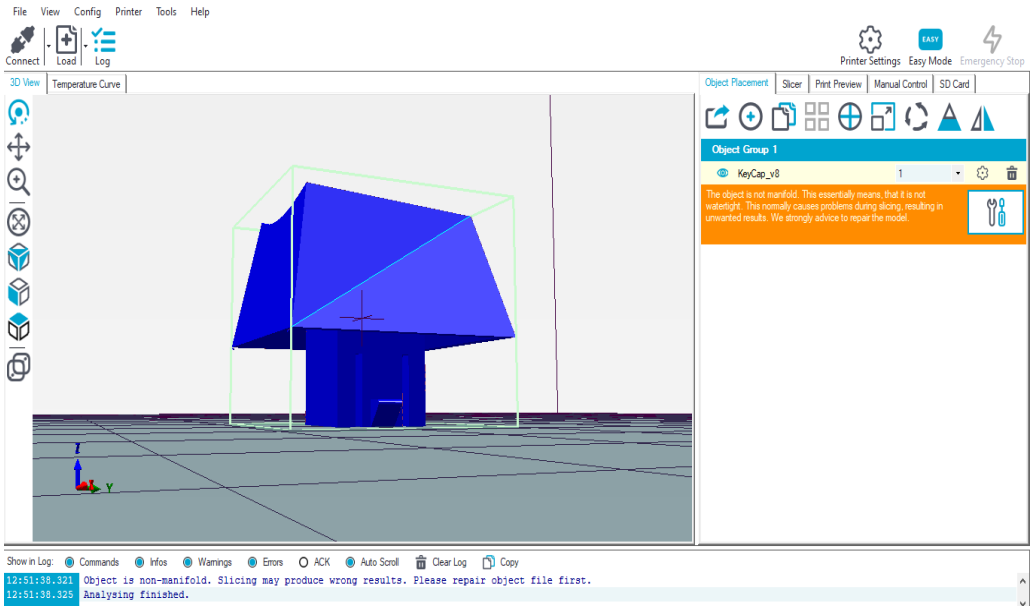

Fig.5: Load screen

5.2. Slicing

Slicing is the process of cutting our model into multiple thin layers in order to make it easier for the software to command the printer. Once we slice our model we can see the time and material required for the machine to build our model.

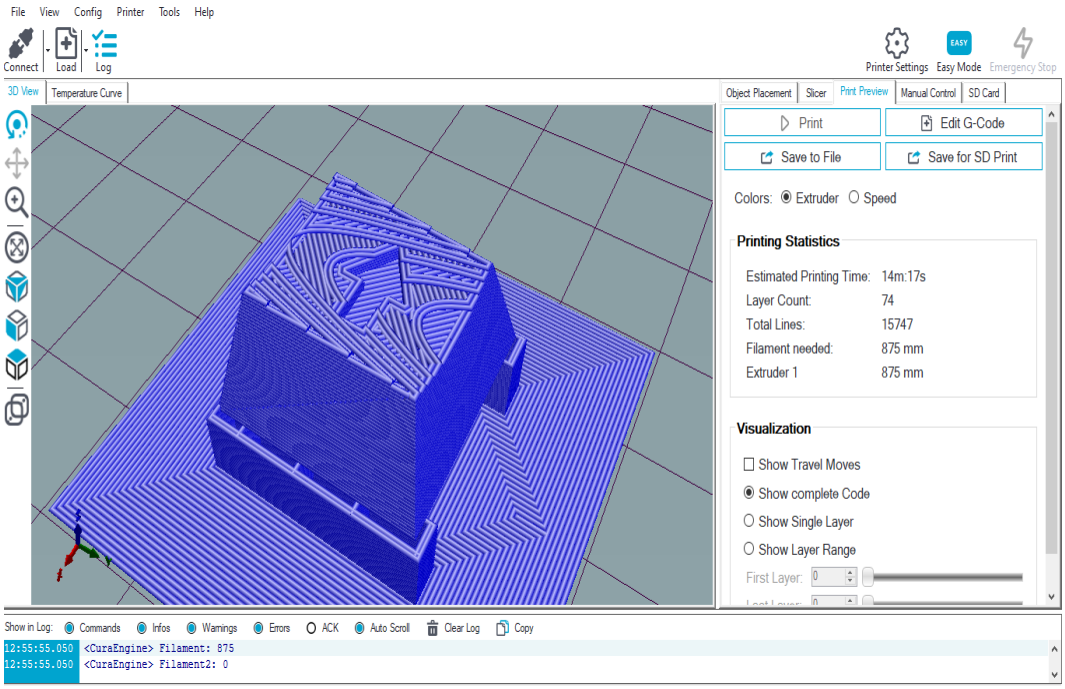

Fig.6: Slicing screen

5.3. Printing

Now we initialize the printing process by giving the print command and wait for the models to be built.

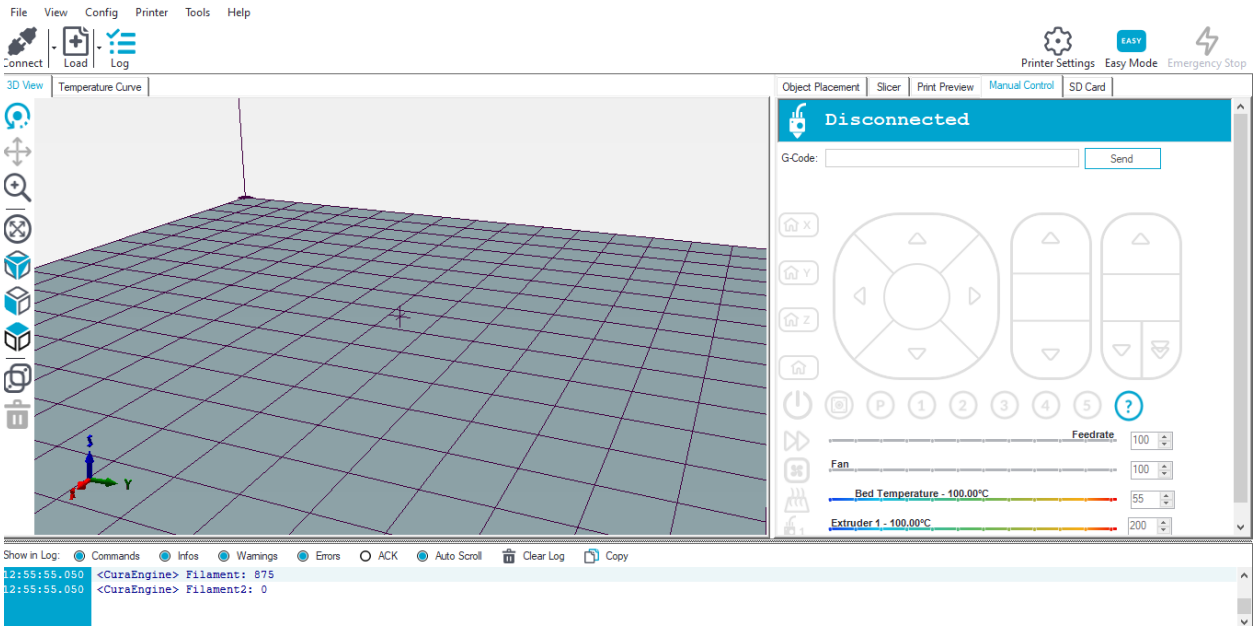

Fig.7: Printing Screen

These were the phases of the experiment that were carried out in this specific order to carefully note the cost of the entire process.

Results

After multiple calibrations and adjustments to the assembly quality models were printed. In order to understand if material cost affected printing two different types of filament were tested (PLA and PETG). However, the print quality had no major difference between the two.

Fig.8: Mouse body (PLA)

Fig.9: Mini laptop stand (PETG)

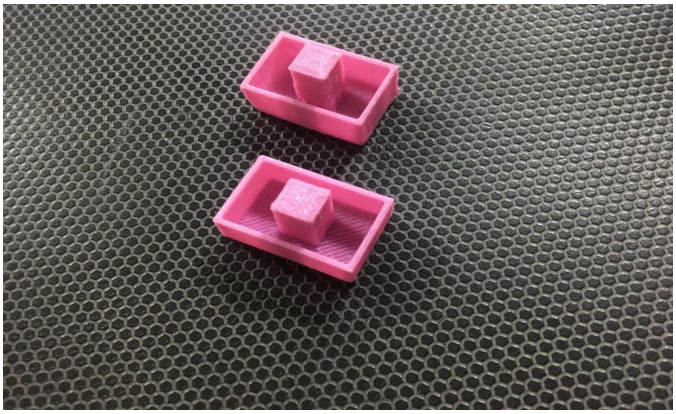

Fig.10: Keyboard keys (PETG)

Fig.11: Miniature guitar (PLA)

Conclusion and discussion:

It can be concluded from this experiment that 3D printing could prove useful for individual use at the current level and is in fact not expensive and can be acquired with minimal efforts, but even though the parts are easily available and anyone can build a 3D printer at the convenience the time taken to create models and perfect them with time may not be a compromised user may be willing to make, furthermore the technology needs an upgrade if it ever intends to meet industry requirements as time is a critical factor. Industries such as medicine, construction, food, engineering, jewelry, etc will sooner or later demand that the time reduction must also be focused and taken into account as much as cost resulting in even more adoption delay for the technology as it faces currently. If the problem of time efficiency is solved the opportunities from 3D printing technology can prove to bring the change and precision to the industry it was intended to from the beginning.

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