POTENTIAL ANALYSIS OF ADDITIVE LAYER MANUFACTURING TECHNOLOGIES USED FOR PROCESSING POLYMER COMPONENTS

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ABSTRACT

In previous years, the usage of additive layer processing grew considerably. Different companies, including motor cars, aerospace, equipment, communications and medical devices utilize additional layer production. However, at present, processed additive layer products comprise less than one percent of all items manufactured. If the prices of additive layer processing systems decline, the manner in which customers communicate with suppliers will be modified. Additional development layer innovations provide the market and culture with different possibilities. It will make the personalized development of strong lightweight goods simpler, and prototypes that with past manufacturing techniques were not feasible. However, the application of this device may be hampered and delayed by numerous obstacles. Many situations require higher costs than conventional approaches for making a component utilizing additive layer production techniques. This study reviews the cost literature for the development of additive layer and attempts to recognize situations in which additive production may be cost-effective and also to identify new methods of minimizing costs in the usage of this technology.

Keywords: *Additive layer manufacturing (ALM), metal tools, rapid prototyping, modeling, polymers, SLM.*

I. Introduction

In today's speeches from numerous academic experts, responsible creativity is a familiar and yet problematic term. Europe's leaders fight to announce that their country or territory in all industries is more responsible and creative than their neighbors. However, corporations, trade associations and industries still argue that their laws, technical, sociological, and economic problems have not been subject to the correct conditions and actions at responsible innovation, and that everyone has a voice to understand what constitutes the secret to responsible innovation [1]. It is an ever-growing field which has attracted both political and scholarly interest (Grunwald, 2011). Smart, balanced and balanced development, which is targeted by the EU 2020 plan, becomes central to responsible science innovation (European Commission, 2010). Likewise, in additive layer technology, especially in aerospace, the responsible definition was often used [1, 2]. In general, the technology undergoes the industrial revolution leading mainly to considerable improvement in the manufacture of additive layers (ALM) (popularly named 3D Printing, 3DP).

II. Additive Layer Manufacturing Technology: Indian Perspective

Basic development practices ranged from 5000 to 4000 BC, according to the historian. The development operations are primarily concentrated on woodwork, ironwork and metalworking. Following that, some sculptures were made in the 2500 BC with earthenware, glass beads, wax and jeweler parts. During AD 600-800, steel output, casting sand from cast iron, during AD 800-1200 has been reported [2]. The manufacturing of ancient India began 3000 BC and the example of a casting that was found at Mohenjodaro of the 11 cm old bronze dance child. In the region of Delhi in 2000 BC iron bowls, daggers, nails, arrows and haoks were discovered (Hopkinson 2006).

A. History of Manufacturing

Manufacturing is the overwhelming majority of things in which we communicate in our everyday lives. This covers extremely complicated items such as our vehicles or machines, our clothing, our chair, the roof over our head and also food. The combination of fundamental processing processes (Beitz and Küttner 1995) can be used across all production measures required to produce this broad variety of goods. Six classes also use these strategies. The first is when a section of an entity is cut off. Boiling, sifting, folding, baking, turning and chiseling are typical examples. The second is that the characteristics of the products are evolving to enhance their properties [3, 4].

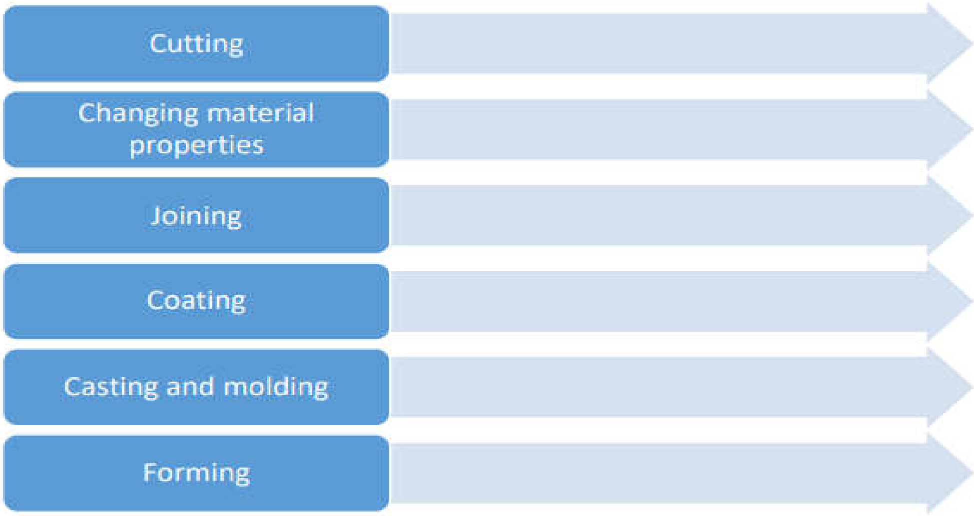

Fig 1: Fundamental manufacturing techniques [3].

B. Manufacturing with Technology

In addition, processing methods developed parallel to developments in culture and contributed to the early steps of the European industrial revolution. Because textiles were still the main part of manufacturing industry in addition to food production, spinning, weaving and knitting equipment were enhanced various [5]. These labor improvements were frequently criticized by employees and the government.

C. Additive layer Manufacturing - Market Growth

The manufacturing of additional layer applications appears virtually infinite. Early usage of 3D printing in the form of fast pre-production prototyping. But the production of additive layers is still used to produce consumer high tech (aerospace, pharmacy, automobiles, and electronics) and goods for customers (home and fashions) Nowadays not just polymers but metals and ceramics are part of our materials [6, 7].

D. Additive layer Manufacturing: Key Processes & Polymers

Seven areas are listed in additional layer production processes. The ASTM International Technical Committee F42 on the development of additive layer technology has established these classifications [7]. The Committee's function focuses on encouraging awareness, fostering research and the use of technologies through developing norms.

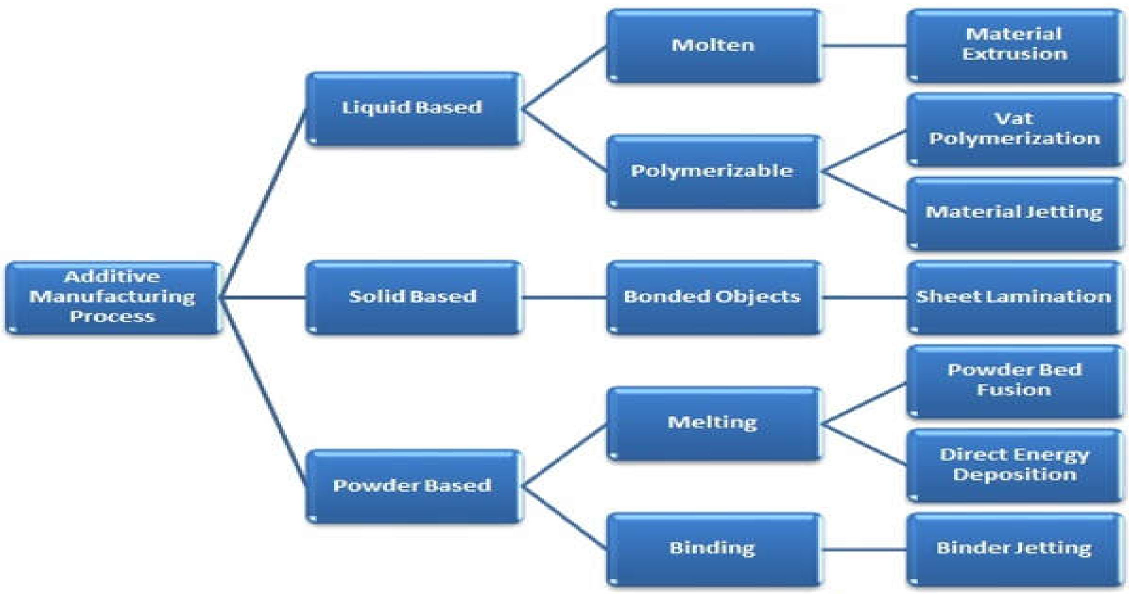

Fig 2: Consolidation approach and the applicable phase of additive layer development [7].

E. Photo polymerization Additive layer Manufacturing Process

The photopolymer's self-adhesive property lets the layers bind together and a full three-dimensional object is essentially preserved and hardened entirely. Designs will be sunk into a liquid bath to extract excess resin in an ultraviolet oven and post-cured. You may also print items "bottom up" with a vat with a slightly versatile transparent backdrop and concentrate UV upwards around the base of the vat [8].

F. Powder Bed Fusion

Powder fusion is similar to binder jetting, except for powder layers, such as a laser or a choice beam, that combine with a heat source. This method is known as SML or electron beam melting (EBM) while metal powder is used. This process is also known as SML. Sintering is an alternative way to liquefy the powder through fire [9]. The method of powder bed fusion includes the commonly used printing strategies: DMLS, Electron Shaft Smoothing (EBM), Selective Hot Sintering (SHS), Selective Laser Dissolving (SLM) and Selective Laser Sintering (SLS).

G. Stereolithography (SLA) and fused deposition modeling (FDM)

Overhaul-designing systems also involve specific support structures for the creation of other processes for added layer, such as stereolithography (SLA) and fused deposition modelling (FDM) [10]. Although SHS does not need a specific support material feeder, since the building component is still surrounded by uninterred powder, this enables previously impossible geometries to be installed.

H. Properties of Polymeric Materials for Additive layer Manufacturing

There is also minimal penetration in such sectors, and these limitations are primarily linked to usable content styles. The properties of new materials should be consistent with both the application and the deposition method. Any of the functionality for modern polymerized products are mechanical stability, chemical stability, thermal stability and biocompatibility [11].

I. Additive layer manufacturing growth trend and market status

AM techniques will easily, economically and efficiently construct any form of geometry as opposed to traditional production. This helps the AM method to blend into the numerous development fields. The AM technological concept was recorded by Chua et al. (2010) at the end of 1980. In 2012, the annual growth survey, the AM and 3D business state shows an annual increase to $1.7 billion for 2010-2011 and it is projected that the overall annual sales of the AM industry will raise to $3.7 billion by 2019 [12].

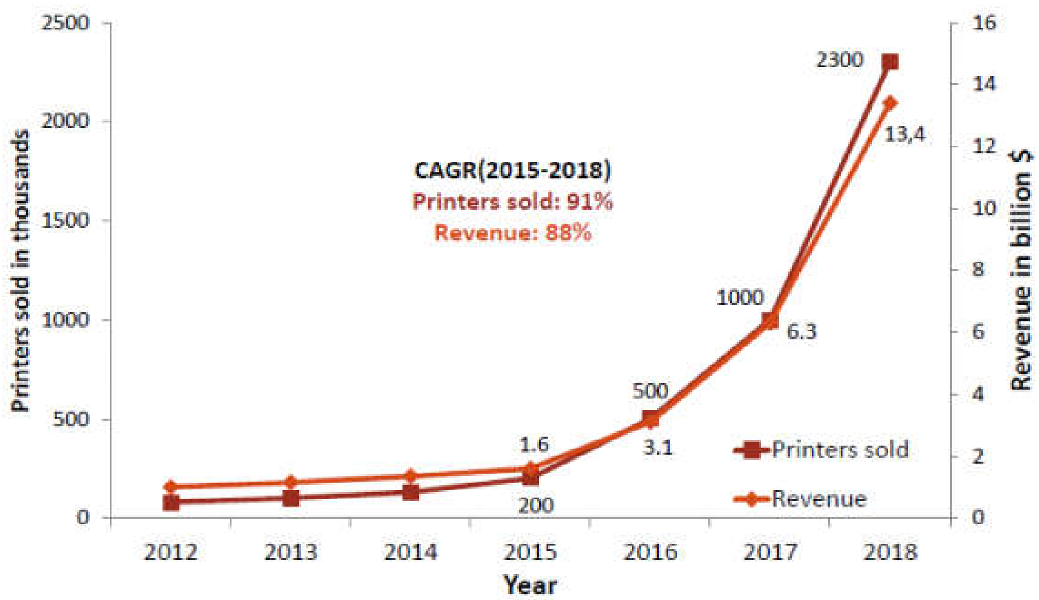

Fig 3: AM system unit sold till year 2015 [12].

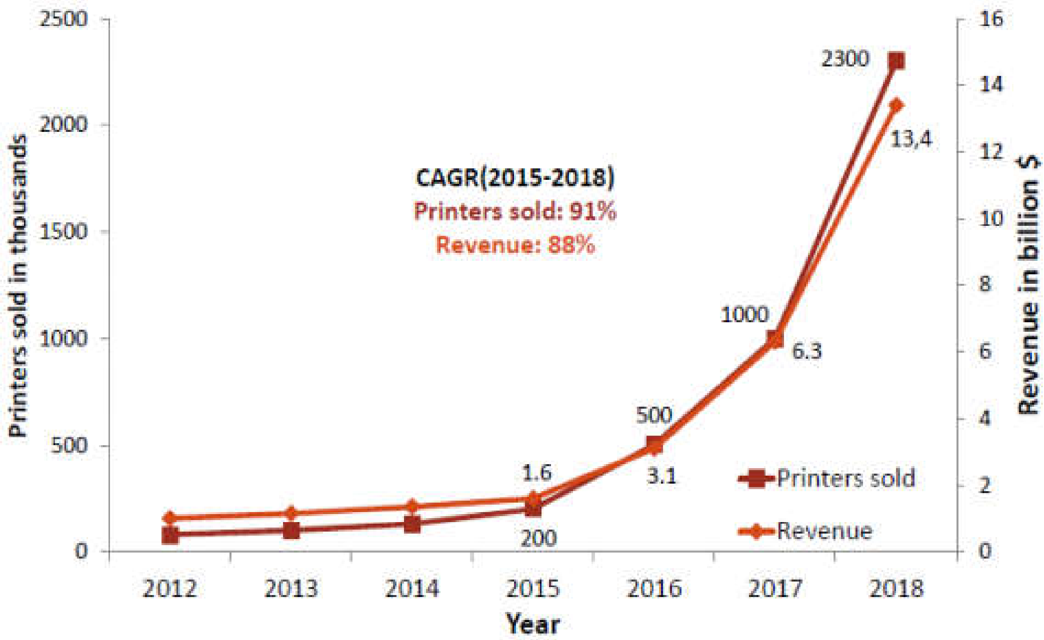

Fig 4: CAGR revenue analysis (2015-2018) [12]

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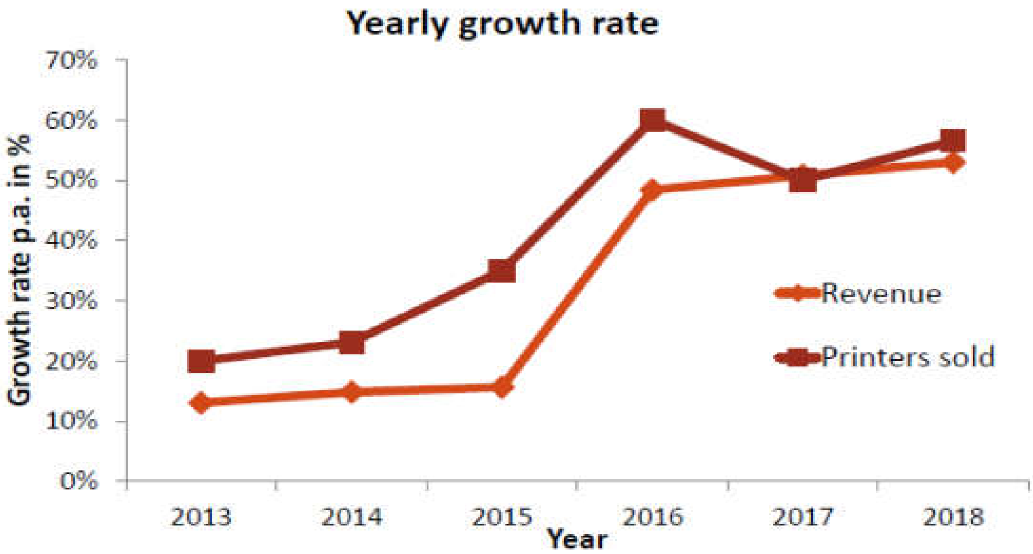


Fig 5: Growth rate per annum in percentage [12].

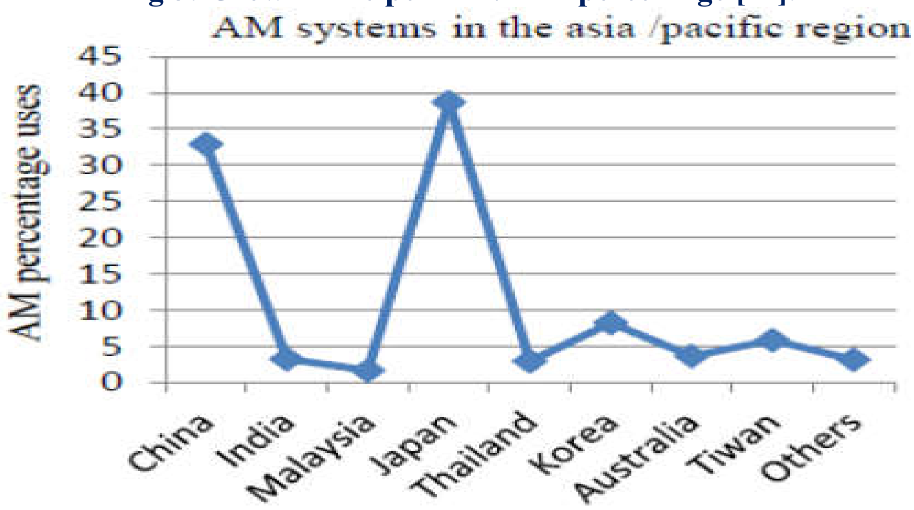


Fig 6: Approximate AM percentage uses in the Asia/Pacific region by the end of 2016 [13].

The laser spot has a smallest (D) diameter (α = 0, as seen in Figure 2.13), which enables the laser spot to concentrate on the scan floor more efficiently. If the value is α > 0, the laser spot diameter is D' = D/cos α on the scan field. The discrepancy between D' and D is seen as:

$$\delta = \mathrm{D}\,(\frac{1}{\cos\alpha} - 1)$$

D, however, is predicted to improve explicitly with α although the diameter increase is not expected to be drastic (about 5.4% with α 19 kin + 0.42 mm in highest value). The consequence of this increase is therefore usually overlooked.

III. Problem Formulation

There are some issues, and costs and pace of development include obstacles to implement an additive process. Very few companies in India are available, so the key problem remains costing. Also, a regular framework for additive manufacturing does not have a high output pace that is the key demand of major manufacturers. Another problem affecting the manufacture of additive manufacturing is also post production, when the stepping effect comes from the gradual creation of one layer on another or from often finishing layers. Some respondents have also been worried about issues of intellectual property, particularly copyright and rights design.

IV. Objectives of the Study

To sketch out the Landscape of Manufacturing Industry especially layer manufacturing Technology in India (a) Exploring the motivation of layer manufacturers in India (b) Exploring the motivation of layer manufacturers in India (c) To study about the production and Cost Effectiveness of Additive layer Manufacturing.(d) To explore the major obstacles and opportunities to adopt a layer manufacturing technology.

V. Research Methodology

The research utilizes the analytical structure of Conscientious Creativity to accomplish the study aims. In this sense, numerous scholars have provided responsible innovation structure (e.g. Scholten et al. 2015; Owen et al. 2013; Bluk et al. 2015). For example, Blok et al. (2015) "Responsibility is seen here as an add-on or extension to an innovation concept; responsible innovation = regular innovation + participation on ethical and social issues among stakeholders, by which processes of innovation will be more effective in achieving the balance of economic (profit), social-cultural (people) and environmental (planet) interests." Like that, Owen et al. (2013) 'Ethical innovation, by the successful stewardship of technology and innovation at present, is a shared contribution to the future.' The most commonly discussed scholarly work on RRI therefore leads to the need for collective commitment and reverence for decades to come [13, 14].

VI. Experimentation or Data Collection

The study is a small group whose principal properties are known and new material is studied (Webster, 1985). Sampling often used to deal with various topics and identified them as a community of respondents selecting for the study sample from the wider population. The study would be obtained by all participants using either random or non-random sampling processes. The calculation or production of sampling data for the whole community will be quite complicated [15]. Some individuals have little access to inmates, accident refugees, psychiatric disorders etc. and are really difficult to access. Also, the vast scale of data attributed to the high population raises testing expenses and times. Some tests could be less accurate than a study data gathered carefully.

A. Data Sources and Sampling Design

Data were obtained in two phases for this analysis. The researcher uses the interview process in the first step to gather data from 50 industry locations via the implementation of snowball sampling in the various state of India [16]. In the second step, the researcher gathered knowledge using the case study approach from three actors. The researcher used the interview approach to gather data from interviewees using a semi-structured interview. In step two, in-depth interviews were used for case studies. Deep interviews are a method that helps the scientist to capture the complexity of human sentiments, opinions and expectations [17, 18].

VII. Result and Discussion

The cost of output can be classified in two distinct forms, as stated in Young (1991)14. The first concerns certain "well-structured" costs such as labour, supplies and equipment costs. The second is "unstructured costs," including those linked to building collapse, system installation and inventory. The emphasis in the literature appears to be more placed on well-structured additive layer manufacturing costs than on unstructured expense; nevertheless, the badly structured costs which mask some of the major benefits and cost savings in additive layer manufacturing. It may also be helpful to recognize the output of additive layer in lean production.

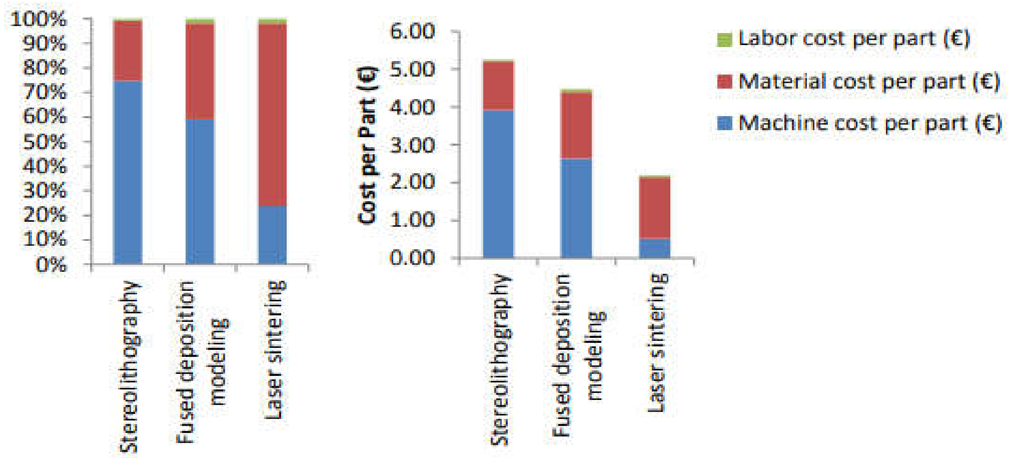


Fig 7: Cost Breakout Analysis.

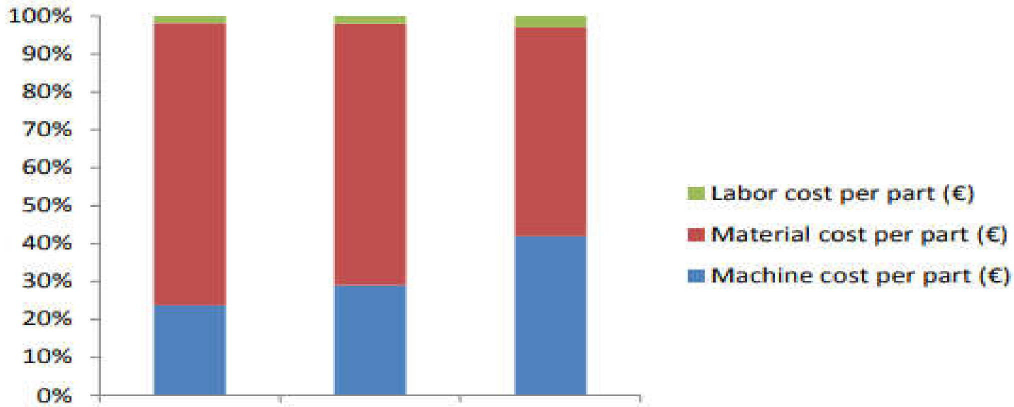
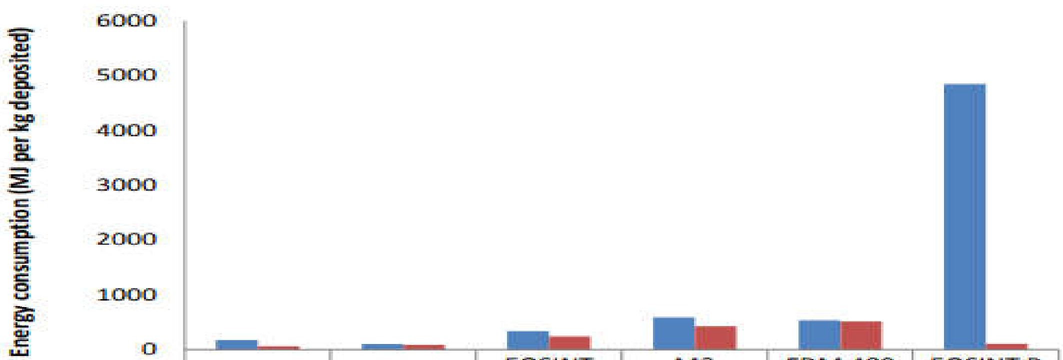


Fig 8: Cost Comparison for Selective Laser Sintering.



	A1 (Metal)	SLM250 (Metal)	EOSINT M 270 (Metal)	M3 Linear (Metal)	FDM 400 mc (Polymer)	EOSINT P 390 (Polymer)
Single Part	177	106	339	588	536	4849
Full Build	61	83	241	423	519	107

Fig 9: Energy Consumption per kg Deposited.

Components should potentially not be evaluated as conscientious creativity and not merely as a challenge to theoretical validity but also to descriptive validity rather than their particular institutional contributions. There are some constraints on describing the amounts of responsible creativity. In India, the mostly accountable facets of creativity can be distinct from other European contexts in that dimension. Many respondents declined to address the precise query of the disparity between the Indian and the Western view on responsible innovation. In addition, accountability blurred by the confusion over the extent to which responsibility in the Indian perspective is basically adequate.

VIII. Conclusion

The study's aim is to explore the reasons that inspire entrepreneurs to implement additive manufacturing and how it functions as a responsible innovation. The research often looks at particular opportunities and obstacles in the phase of adaptation, and identifies some market models that lead to sustainable innovation. The explanations why responsible creativity is established are the growth of the organization's common interest and its lack of arrangements. The visionaries and the corporation now and then play an important role in the national improvement.

References

1. Abid, M. (2009), ―Investigation of orange peel phenomenon related to powder deterioration and relevant process parameters‖, PhD Thesis, The University of Cardiff, U.K.
2. Agrawal, M., Bourell, D., Berman J., Marcus H. and Barlow J. (1995) ―Post-processing of selective laser sintered metal parts‖, Rapid Prototyping Journal, Vol. 1, No. 2, pp. 36-44.
3. Ajoku, U., Saleh, N., Hopkinson, N., Hague, R. and Erasenthiran, P. (2006), Investigating mechanical anisotropy and end-of-vector effect in laser-sintered nylon parts, Journal of Engineering Manufacture. Vol. 220 No. 7, pp 1077-1086.
4. Aldahsh, S.A. (2011), ―Development of new composite powder material of cement additive with polyamide 12 for selective laser sintering, PhD thesis, The University of Cardiff, U.K.
5. Alimardani, M. (2009), ―Multi-physics analysis of laser solid free form fabrication‖, PhD thesis, The University of Waterloo, Ontario, Canada. ALM, (Advanced Laser Materials) [online]. < http://almllc.com > (Accessed on January 05, 2013).
6. Athreya, S.R., Kalaitzidou, K. and Das S. (2011), ―Mechanical and microstructural properties of nylon-12/carbon black composite: selective laser sintering versus melt compounding and injection molding‖, Composite Science and Technology, Vol. 71 No. 4, pp. 506-510.
7. Atzeni, E., Iuliano, L., Minetola, P. and Salmi, A. (2010), ―Redesign and cost estimation of RM plastic parts‖, Rapid Prototyping Journal, Vol.16 No.5, pp. 308–317.
8. Azaroff, L. V. and Buerger, M. J. (1958), ―The Power Method in X-ray Crystallography‖, Mc Graw Hill, New York.
9. Agarwal, R., & Thiel, M. (2012). A Stratagem for Responsible Business in India and the US: Government Innovation or Constraint? Procedia - Social and Behavioral Sciences, 37, 490-503. doi:10.1016/j.sbspro.2012.03.314
10. Agarwal, R., & Thiel, M. (2012). IBM's environmental management system supplier requirements: corporate responsibility performance or deviation? International Journal of Business and Globalisation, 9(3), 225. doi:10.1504/ijbg.2012.050363
11. Agarwal, R., & Thiel, M. (2013). P&G: Providing Sustainable Innovative Products through LCA Worldwide. South Asian Journal of Business and Management Cases, 2(1), 85-96. doi:10.1177/2277977913480660
12. Albrecht, S. (2015). Responsible Research implementieren. Responsible Innovation, 357-368. doi:10.5771/9783845272825-357 Arcos-Novillo, D.

13. A., & Güemes-Castorena, D. (2017). Development of an additive manufacturing technology scenario for opportunity identification—The case of Mexico. Futures, 90, 1-15. doi:10.1016/j.futures.2017.05.001
14. Arentshorst, M. E., De Cock Buning, T., &Broerse, J. E. (2016). Exploring responsible innovation: Dutch public perceptions of the future of medical neuroimaging technology. Technology in Society, 45, 8-18. doi:10.1016/j.techsoc.2016.01.003
15. Armstrong, M., Cornut, G., Delacôte, S., Lenglet, M., Millo, Y., Muniesa, F., Tadjeddine, Y. (2012). Towards a practical approach to responsible innovation in finance. Journal of Financial Regulation and Compliance, 20(2), 147-168. doi:10.1108/13581981211218289
16. Arnaldi, S., Quaglio, G., Ladikas, M., O'Kane, H., Karapiperis, T., Srinivas, K. R., & Zhao, Y. (2015). Responsible governance in science and technology policy: Reflections from Europe, China and India. Technology in Society, 42, 81-92. doi:10.1016/j.techsoc.2015.03.006
17. Asveld, L., Van, D. -M., Swierstra, T. E., Lavrijssen, S., Linse, K., & Van H. (2017). Responsible Innovation 3: A European Agenda?
18. Ács, Z. J., &Audretsch, D. B. (2011). Handbook of entrepreneurship research: An interdisciplinary survey and introduction. New York: Springer.
19. Allen, Jeff. 2006. "An Investigation into the Comparative Costs of Additive Manufacture vs. Machine from Solid for Aero Engine Parts." In Cost Effective Manufacture via NetShape Processing, 17-1 – 17-10. Meeting Proceedings RTO-MP-AVT-139. Paper 17. DTIC Document.
20. Alexander, Paul, Seth Allen, and Debasish Dutta. 1998. "Part Orientation and Build Cost Determination in Layered Manufacturing." Computer-Aided Design 30 (5): 343–56. doi:10.1016/S0010-4485(97)00083-3.
21. Allen, Jeff. 2006. "An Investigation into the Comparative Costs of Additive Manufacture vs. Machine from Solid for Aero Engine Parts". DTIC Document.
22. ATKINS Project. 2007. Manufacturing a Low Carbon Footprint: Zero Emission Enterprise Feasibility Study. Project No: N0012J. Loughborough University.
23. Atzeni, Eleonora, Luca Iuliano, Paolo Minetola, and Alessandro Salmi. 2010. "Redesign and Cost Estimation of Rapid Manufactured Plastic Parts." Rapid Prototyping Journal 16 (5): 308–17.
24. Atzeni, Eleonora, and Alessandro Salmi. 2012. "Economics of Additive Manufacturing for End-Usable Metal Parts." The International Journal of Advanced Manufacturing Technology 62 (9-12): 1147–55.
25. Atzeni, Eleonora, Luca Iuliano, and AllessandroSalmi. 2011. "On the Competitiveness of Additive Manufacturing for the Production of Metal Parts." 9th International Conference on Advanced Manufacturing Systems and Technology.
26. Bassoli, E., Gatto, A. and Iuliano, L. (2012), ―Joining mechanisms and mechanical properties of PA composites obtained by selective laser sintering‖, Rapid Prototyping Journal, Vol. 18 No. 2, pp.100–108