


# Additive Manufacturing Technology: Realities and Strategic Perspectives From India

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## ABSTRACT

The authors studied strategic aspects pertaining to adoption drivers, challenges and strategic value of Additive Manufacturing Technology (AMT) in the Indian manufacturing landscape. An exploratory qualitative study with semi-structured in-depth personal interviews of experts was completed and the data was content analysed. Indian firms have identified the need for AMT in R&D and prototype generation. AMT implementation helps Indian firms in mass customization and eases the manufacturing of complex geometric shapes. This study insights would help AMT managers in emerging economies to enable adoption drivers, overcome challenges and add strategic value with AMT. This is one of the very first studies on AMT with theoretical perspectives on the Miltenberg framework, adoption drivers, challenges and strategic value in the Indian manufacturing landscape.

## KEYWORDS

Additive Manufacturing Technology (AMT), Adoption Drivers, Business Value, Short-Term and Long-Term Technology Strategy

## 1. INTRODUCTION

Additive Manufacturing Technology (AMT) or 3D Printing is a manufacturing process where the final object is manufactured by addition or deposition of the material layer by layer to build an object from a 3D Computer Aided Design file (Rayna and Struikova, 2015). AMT can be classified into seven types: (1) Stereo Lithography (SLA) (2) Digital Light Processing (DLP) (3) Fused Deposition Modelling (FDM) (4) Selective Laser Sintering (SLS) (5) Selective Laser Melting (SLM) (6) Electronic Beam Melting (EBM) (7) Laminated Object Manufacturing (LOM) (Vasquez, 2015). These typologies differ on the basic principle of functioning that is the method in which the layers are added over each other (Vasquez, 2015).

AMT has extensive benefits in terms of providing a vast range of design opportunities to the manufacturing companies using it (Klahn, Leutenecker and Meuboldt, 2015). One of the main advantages of AMT is that it provides a flexibility towards production of engineered to order parts without incurring heavy wastage of material while manufacturing (Koren, 2006; Dolgui and Proth, 2010; Berman, 2012). With AMT, the limitations of conventional manufacturing do not constrain

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designers. The designers get a better level of flexibility with geometry and shape of the final object (Schumpeter, 2012). AMT can reduce the production life cycle material mass, energy, and water consumption by eliminating scrap (Cozmei and Caloian, 2012). Further, Cozmei and Caloian, (2012) argued that AMT has a positive impact on sustainability and is a step towards green manufacturing. AMT also provides a certain degree of repairing and refabrication of old and worn out parts thus enhancing the cause of sustainability (Kakati, 1997). Further, AMT helps in sustaining higher mechanical and thermal stresses (Klahn, Leutenecker and Meuboldt, 2015).

AMT literature is also rich with nuances of AMT adding business value. AMT adds value in different industries in different manners. AMT adds value in the aerospace industry by increasing the performance efficiency by weight reduction (Cozmei and Caloian, 2012). Similarly, AMT also is beneficial in military applications as more complex and dynamic life-saving tools can be manufactured without high risk (Cozmei and Caloian, 2012). Application of AMT has been successful in the field of space technology as it enabled manufacturing of parts with different composites and alloys (Koren, 2006; Dolgui and Proth, 2010; Berman, 2012).

AMT in the world of manufacturing has been christened as a disruptive technological innovation (Campbell & Olga, 2013). Disruptive Technologies (DT) are such innovations which have the potential to create both new market and new value network (Christensen, 1995). Further, Christensen (1995) argued that DTs eventually over a period will alter the current market scenario favourably (Christensen, 1995). AMT carries the potency to bring revolutionary changes in both business models and ecosystems (Rayna and Struikova, 2015). AMT is one such manufacturing technology which can disrupt the existing manufacturing field and orient it in a different path altogether (Englyst, 2007). In the early 2000s, 3D printing was used only for manufacturing prototypes (Ortt, 2017). Through subsequent advancement in technology, slowly AMT is becoming the mainstream manufacturing in companies (Ortt, 2017). AMT has provided the ease of printing as a ready to use 3-D object for manufacturers. This can disrupt the traditional manufacturing process. Thus, it is argued that AMT would have great impact on the way companies design their long-term and short-term strategy on technology and manufacturing (Kakati, 1997).

The authors in this research aim to explore the strategic value of AMT. Strategic value is defined as the benefit that a firm may receive from the extant consumer because of the strategic initiatives undertaken by the firm over and above the costs incurred by the company in long-term (Mellor, Hao & Zhang, 2013). It is argued that the current political, economic and administrative scenario in India is favouring the manufacturing sector. National level initiatives like 'Make in India' are a boost for manufacturing industries (www.makeinindia.com, 2017) At such juncture where AMT is being adopted by various companies across the globe, Indian manufacturing firms can also utilize the opportunity to include AMT in their manufacturing process.

Indian companies have started to adopt AMT, but AMT application is still in its nascent stage. The authors in this study explore the strategic value, drivers and strategy implementation challenges that firms are confronting with respect to adoption and application of AMT. It has been widely advocated in the developed countries that manufacturing firms should incorporate AMT in their manufacturing process.

This motivates authors' for conducting this research on AMT. There have been very few attempts to study AMT and its impact on business strategy till now. Thus, this paper is one of the first attempt to contribute about strategic imperatives of AMT in the expanding Indian manufacturing landscape.

## **2. LITERATURE REVIEW AND RESEARCHABLE GAPS**

The introduction section mentioned that there is lack of available research material in AMT domain with respect to Indian industries. To study literature on strategic value with respect to additive manufacturing, the authors consulted online journal databases like Emerald Insight, ProQuest, Google scholar articles, Ebsco search host and IEEE. The author used 'and logic' and AMT keywords

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