

Effectiveness of Advanced Manufacturing Technologies in SMEs of Auto Parts Manufacturing

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Abstract

In the present turbulent times, survival and success of any organization increasingly depends on competitiveness. The Small-Medium Enterprises (SMEs) play an important role in both developed and developing country economies. To remain competitive, SMEs must adopt strategic technologies and innovative management practices to survive. In finding ways to increase competitiveness and productivity, the use of advanced manufacturing technologies (AMTs) is one alternative for SMEs to become or remain competitive. This paper presents the detailed survey carried out to find out the contribution of AMTs in SMEs. This paper reveals the motives of implementing AMTs and its benefits to SMEs. The survey shows that the most important motive of SMEs is to attain customer satisfaction.

Keywords

SMEs, AMTs, motives, benefits.

1 Introduction

Manufacturing has been evolving over the years as different needs and technologies arise. The customer of the twenty-first century, demands products and services those are fast, right, cheap and easy. To lower operating costs, improved manufacturing efficiency and effectiveness has forced a large number of manufacturing firms to embark on advanced manufacturing technologies. Advanced Manufacturing Technologies (AMTs) refer to computer-aided technologies used in manufacturing companies. AMTs have been defined as new technologies which are used directly by the firm in the production of a product [1]. These can be distinguishing hard-based from soft-based AMTs [2, 3]. Hard-based refers the mainly to physical technologies used in engineering, processing and administration such as computer aided design (CAD), computer aided manufacturing (CAM), robotic etc. On other hand soft based technologies are just in time (JIT), total quality management (TQM), material requirement planning (MRP-I), manufacturing resource planning (MRP-II) etc.

AMTs have been referred to manufacturing process technologies that use computers to store and manipulate data [3, 4, 5, 6]. AMTs can also be defined as technologies concerned with the application of mechanical, electronic, and computer-based systems to operate and control production. It encompasses a range of programmable machinery that executes, monitor, and connect the production process [7]. More specifically, AMTs can be described as a group of computer-based technologies, including computer-aided design (CAD), computer numerical control (CNC) machines, robotics (RO), automated material handling systems (AMHS), material requirement planning (MRP), manufacturing resource planning (MRP II), Group Technology (GT), and Computer Aided Process Planning (CAPP) [8]. In finding ways to increase competitiveness and productivity, the use of advanced manufacturing technologies (AMTs) is one alternative for a small firm to become or remain competitive. AMTs can provide it with the tools and techniques required to accommodate the increasing demands of its customers [9]. It enhances a firm's ability to simultaneously lower costs, increase quality, and provide rapid delivery of customized products, and therefore has become the cornerstone of many new manufacturing strategies [10]. This paper is an attempt to explore the use of AMTs in Small-Medium Enterprises of Punjab. This study explores the motives of implementing AMTs, barriers faced during implementation and benefits achieved after implementation of AMTs.

2. Small Medium Enterprises

The small and medium scale industries (commonly called as SMEs) play an important role in both developed and developing country economies. These are often the vehicles that facilitate the birth and expansion of large- scale industries. A unique definition of SMEs is not possible; the concept varies from country to country and from sector to sector. According to the newly enacted Micro, Small and Medium Enterprises Development Act 2006, enterprises are classified into Micro, Small and Medium as shown in Table1.

Table 1: SMEs classification according to investment

Type of enterprise	Investment in plant and machinery
Micro enterprise	Does not exceed Rs. 25 Lac.
Small enterprise	More than Rs. 25 Lac, but does not exceed Rs. 5 Crore
Medium enterprise	More than Rs. 5 Crore but does not exceed Rs.10 Crore

The benefits of AMTs can be classified as tangible and intangible [11]. The tangible benefits include inventory savings, less floor space, improved return on equity (ROE) and reduced unit cost of production. Some of the intangible benefits are enhanced competitive advantage, increased flexibility, improved product quality and quick response to customer demand and so on. The potential benefits which can be accrued from investments in AMTs, have become increasingly evident with growing global competition [12, 13]. SMEs are the lifeblood of modern economies. The need for them to remain competitive and produce high quality outputs is important not only at a national employment level but also at industry level, where SMEs are often suppliers of goods and services to larger organizations [14].

Since many years, SMEs are adopting AMTs as a mean to improve the quality of products and to become more customized. This paper presents the study conducted to identify the motives behind the use of AMTs. It also reveals the benefits to SMEs after implementing AMTs.

3. Methodology

This study is purely a survey to find out the effectiveness of AMTs in SMEs. The survey is carried out to the issues concerning the mostly used AMTs, benefits to SMEs and barriers to implementation of AMTs. Based on literature survey a questionnaire was developed which consists of mainly two parts.

- 1) First section of questionnaire was related to general information about the organization such as type of industry, since when they are using AMTs./
- 2) Second section was designed to know the benefits acquired by SMEs and barriers faced during AMTs implementation.

Experts in this field were consulted to modify the questionnaire as per their suggestion and validate the content of questionnaire. A five point likert scale (from 1=Not at all and 5=Very high) was chosen for all questionnaire items. SMEs were randomly selected from the industrial directory, Punjab. The questionnaire was sent to 95 SMEs of auto-part manufacturing sector. The questionnaire was filled up by different respondents of selected SMEs. The respondent characteristics are given in Table 2. Only 26 valid responses were received, thus a response rate of 27.36 % with all possible efforts.

Table 2: Positions of Respondents

Position	Frequency	Percentage
Deputy GM	01	2.8
Vice-President	01	2.8
C.E.O.	01	2.8
Manager	10	28.6
Senior Engineer	02	5.7
Plant Head	02	5.7
Production In-charge	01	2.8
Proprietor	17	48.7

It has been found that 11.5 percent industries are using AMTs since less than one year, 15.5 percent since 1-3 years and 3.8 percent since 3-4 years. The percentage of industries using AMTs since 4-5 years is 26.9 percent. The rest of industries are using AMTs since more than five years. The percentage of these industries is 42.3 percent. Table 3 shows the various AMTs taken in the study and their current status in the visited SMEs.

Table 3: AMTs and their current status in the SMEs

AMTs	No. of industries	Status of AMTs (in %)
Computer Aided Design (CAD)	21	80.8
CNC Machines	26	100
Computer Aided Process Planning	10	38.7
Automated Material Handling System	11	42.3
Robotics	00	Nil
Group Technology	06	23.1
Material Requirement Planning (MRP)	16	61.5
Manufacturing Resource Planning (MRP-II)	11	42.3
Just In Time	14	53.8

4. Results and Discussion

In order to analyze the effectiveness of AMTs in SMEs, a thorough examination of status of AMTs in SMEs, benefits to SMEs were carried out. The survey also attempted to determine most important barrier to implementation of AMTs. Statistical analysis was carried out to find out the significance and correlation of different parameters.

4.1 Motives of implementing AMTs in SMEs

The main motives that lead SMEs to implement AMTs are taken from literature review. SMEs were asked to rate different motives on five point Likert scale. The survey reveals that most important motive is customer satisfaction which leads to sale of companies and companies try to become more customized. The second motive considered is to increase production. The third motive identified from findings is competitive pressure. It means SMEs are under pressure of market scenario and want to implement AMTs. Intensity of influence of each motive is given in Table 4.

Table 4: Motives of SMEs to implement AMTs

Motives	Mean	S.D.
Customer Satisfaction	4.19	0.68
Production Rise	3.95	0.74
Competitive Pressure	3.71	0.94
Market Advantage	3.57	0.95
Cost Reduction	3.10	0.98

4.2 Benefits of implementing AMTs in SMEs

The respondents were asked to rate the benefits that AMTs had brought to their companies after implementation. The survey evaluated the six main benefits in terms of organizational achievements, productivity, quality, cost, sales and delivery. The mean of the sample is calculated and checked from t-statistic value whether it is lying in acceptable region or not. The significance of the various benefits is checked up to sub benefit level in range of 5% significance level.

Table 5: Benefits achieved from AMTs

Benefits	Mean	S.D.	t-statistics
Organization Achievements	3.6730	0.8412	-0.2311*
Productivity	3.6692	0.7407	-0.2889*
Quality	3.7967	0.7487	0.5822*
Cost	3.3974	0.7420	-2.1559**
Sales	3.7692	0.6629	0.4462*
Delivery	3.9615	0.7911	1.6133*

*Significant at 5% level, **Significant at 1% level, ***Not Significant

Table 5 shows that sample statistics (*t*-statistics) of the benefit ‘Improvement in image of company’ and ‘more rapid new product introduction’ falls in a rejection region, which means that claims are not justified. The benefit ‘Delivery’ is considered most important and the benefit ‘Cost’ is considered least important. The results reveal that AMTs are helpful in decreasing the production lead times and increases the production rates, so that the products can be delivered in time to customer to achieve better customer satisfaction and least effective in decreasing the cost related to production.

SMEs are gaining return on the investments that have been done for the implementation of AMTs. It varies from company to company. In terms of productivity ‘enhanced production rates’ and ‘improvement in efficiency and effectiveness’ are considered most important benefits. Because after implementation of AMTs, cycle times have reduced and the production rate as well as the efficiency and effectiveness of machinery increases. AMTs have also lead to less operator mistakes due to which the efficiency of the machinery increases. The increase in production rates leads to higher productivity which is a great benefit achieved by the companies after the implementation of AMTs. ‘Decreased material and operator movement’ is considered as least important benefits in terms of productivity. The unnecessary movement of operator and material is highly controlled after AMTs implementation, which have reduced the set-up time. The results show that companies have achieved better material handling and the movement of the operator has also been decreased after the implementation of AMTs.

The result shows that use of AMTs have reduced the operator mistakes up to elimination which results in less rework on jobs. It reveals that AMTs have effectively reduced the total percentage defective of products and are helpful in maintaining quality of products. The benefit ‘increased sales’ is considered most important, which reveals that as AMTs are highly helpful in maintaining quality of the products, the quality leads to increase in sales of products. The benefit ‘customization of products and services’ is considered least important. AMTs have made SMEs more customized and companies are producing the products according to the demand of their customers; and providing better services to them. Hence, implementation of AMTs in SMEs highly aims in boosting sales of products and SMEs are moving towards their goals with AMTs in the world of competitors.

The benefit ‘customer satisfaction at the time of delivery of the product’ is considered most important, which means that AMTs are highly important in providing satisfaction to the customer by providing delivery of the products in time. The results indicate that after the implementation of AMTs, SMEs are providing faster delivery to their customers. AMTs are highly helpful for giving each type of benefit to SMEs. The findings alarms that SMEs, which are using AMTs can be withstand with competitive world. SMEs which are not using advanced manufacturing technologies those can not get the above discussed perceived benefits with conventional technologies and can not remain in race of the competitors to gain desired goals. SMEs in Ludhiana who do not using AMTs are continuously vanishing.

4.3 Ranking of benefits

Figure 1 shows the benefits in descending order of their importance. The order follows Delivery (Mean=3.9615), Quality (Mean=3.7967), Sales (Mean=3.7692), Organization achievement (Mean=3.6730), Productivity (Mean=3.6692) and Cost (Mean=3.3974).

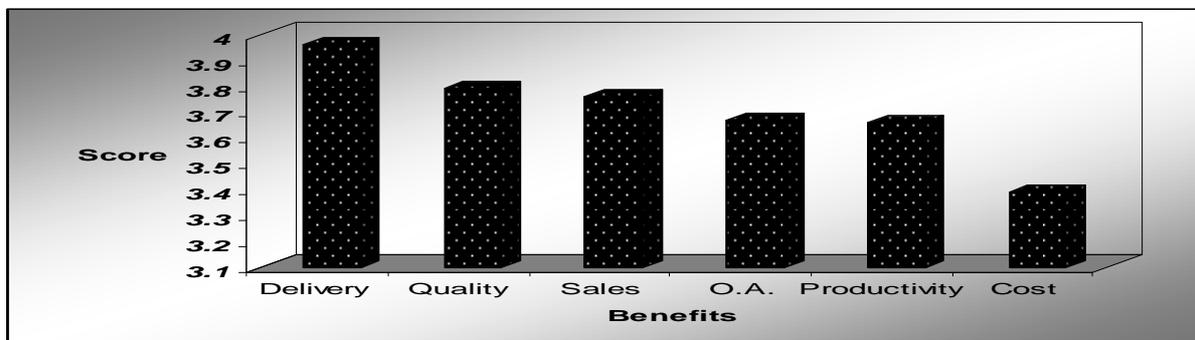


Figure 1: Ranking of benefits achieved after implementation of AMTs

4.4 Correlation analysis

The correlation analysis reveals that how the benefits of AMTs are related to each other. The positive correlation shows that the one benefit has positive effect on the different benefits of AMTs. The values of Karl Pearson coefficient of correlation have been calculated for the different benefits including Organization Achievements (OA), Productivity (P), Quality (Q), Cost (C), Sales (S) and Delivery (D). The highest positive value of correlation coefficient has been tested at the level of significance adopted

Table 6: Correlation matrix between benefits of AMTs

O.A.	1					
Productivity	0.770	1				
Quality	0.736	0.479	1			
Cost	0.415	0.259	0.426	1		
Sales	0.870*	0.629	0.662	0.240	1	
Delivery	0.720	0.677	0.554	0.199	0.675	1
	O.A.	Productivity	Quality	Cost	Sales	Delivery

*Significant at 5% level

Table 6 shows that the highest positive values of correlation coefficient are significant at 5% level, which means that the claims are justified. The highest positive correlation is found between the benefits 'sales' and 'organizational achievements' ($r = 0.870$). It reveals that the customer satisfaction achieved by providing the faster delivery of the products to customer, increases the sales of the company. The correlation shows that benefit 'sales' is directly related to the 'organizational achievements' of the companies. So working on faster delivery of products i.e. customer satisfaction plays an important role in achieving the goals of organizations.

4.5 Barriers faced during implementation of AMTs

From the literature review, some barriers were listed and companies were asked to rank the problems faced by them during implementation of AMTs. The findings of the barriers are documented in Table 7. The mean scores of all the barriers are compared and one with highest score is a main barrier.

Table 7: Barriers to AMTs implementation

Barriers	Mean	S.D.	t-statistics
Worker's resistance	2.2307	1.1066*	0.4683*
Lack of prior planning	2.3846	1.3878*	0.9386*
Deficiency of skilled professionals	2.3076	1.1231*	0.8106*
Increased maintenance cost	2.5384	1.1038**	1.8908**
Lack of information/knowledge on AMTs	2.1538	1.1896*	0.1059*
Difficulties based on government rules	1.6153	0.9413***	-2.7827***
Lack of appropriate sources of finance	1.6538	0.9774**	-2.4793**

*Significant at 5% level, **Significant at 1% level, ***Not Significant

The results revealed that 'maintenance cost' affects AMTs and is considered most important barrier. The emphasis on maintenance cost of AMTs is an indication that these are treated like maintenance cost related to conventional technologies, justifying based on tangible benefits rather than intangibles. It means SMEs have to spend more on maintenance of AMTs and it increases the working capital of the companies. Barrier 'lack of appropriate sources of finance' is considered less important because the funds can be arranged by the financial assisting organizations, which is significant at one percent level.

A deep understanding of technology is required for appropriate planning to be carried out. It has been found that 'lack of prior planning' and 'worker's resistance' are most important barriers to AMTs at five percent level. It signifies that AMTs promote automation which decreases the labour requirement and therefore workers resist to the implementation of AMTs. For take effective benefits from AMTs, proper short term and long term planning is required. Thus to make AMTs successful, a carefully defined plan is required which includes financial and non financial, long and short term performance indicators. An effective plan can minimize the risks of failure and

reduces the workers resistance. 'Deficiency of skilled professionals' is considered another important barrier to the use of AMTs. The results show that SMEs of Punjab have less educated and literate workers, they are less adaptable to AMTs. The SMEs surveyed have also indicated that major problem faced in worker selection, training and recruitment is the deficiency of skilled workers. Highly skilled work professional are required for the proper functioning of any one of AMTs.

5. Conclusions

AMTs have tended to be successful in auto part manufacturing SMEs. The current study shows that CAD, CNC machines and CAPP are the most commonly used AMTs in SMEs of Punjab. This study obtained the data from twenty six SMEs and identified motives for implementation, benefits achieved and barriers faced during implementation of AMTs. Few point concluded from the study. Firstly, the main motive of implementing AMTs is customer satisfaction. Secondly, it is proved that AMTs are highly beneficial to SMEs adopting. With the use of AMTs customer satisfaction can be achieved by providing the faster delivery and quality of products. AMTs help SMEs to be more customized.

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