Implementation of Advanced Manufacturing Technology as Tool for Manufacturing Industries

Ghulam YasinShaikh, H.B Marri, R.A Sohag, M. AslamUqaili, Shaheen Aziz and ShakeelShaikh
Department of Industrial Engineering and Management
Department of Electrical Engineering
Mehran University of Engineering & Technology
Jamshoro Pakistan

Abstract

During past several years, manufacturing industries have witnessed extensive implementation of advanced Manufacturing Technologies (AMTs) in their infrastructure throughout the globe, and presently these systems have become an integral part for their effective business promotion across the international business**.** Although, the full implementation of these systems appears to be far behind in the developing economies to cultivate full potential benefits from the market due to various reasons but the stakeholder are trying to evaluate the entire phenomena to rationalise the environment in its favour. This research paper outlines the progress of AMT systems, which has low application due to economic and other constraints during implementation. Although these systems are partially implemented in small to large scale manufacturing enterprises in the province of Sindh in particular and manufacturing industries of Pakistan in general.The major concern appears to be implementation of AMT based technologies with major constraints. In this regard, the conceptual model has been designed to address these aspects which are, Top Management support, Economic Aspects, and Technical aspects. The results show that these systems are partially implemented in the manufacturing companies with less support and technical expertise.

Keywords
Advanced Manufacturing Technologies, Pakistan, Investment, Implementation

1. Introduction
During the past several years, manufacturing enterprises have witnessed extensive implementation of advanced Manufacturing Technologies (AMTs) in their infrastructure in developed economies, and these countries have reaped the potential benefits too' Dangayatch (2007). Presently, AMT systems have become an integral part of sustainable business and the effective business promoting tool for developed and developing economies throughout the globe**.** Advanced Manufacturing Technologies (AMT) are generally considered as a automated set of manufacturing tools by integrating various functional areas to assist and improve the overall performance of manufacturing enterprises. According to Goldher and Jelineck (1983). AMT is a kind of major resource that generally enables a firm to efficiently produce variety of products with the appropriate assets thereby the companies can achieve the economic scope. Tracey M, Vonderembse and lim (1999) emphasized that "AMT is the application of computer-enhanced applied science to a firm's production system. However, the knowledge and experience are significant tools to run the organization in this competitive world, found by Day (1994).

The use of AMT directly increase plant productivity and thus survivalibility as this claim isalso supported by Griliches and Siegel (1991) and Brynjolfson and Hitt (1994).AMT has developed the strong relationship with design manufacturing integration(DMI)when measuring the manufacturing performance as observed by Morgan swink,(2007), but thesesystems are partially understood and practiced as argued by Zahir Irani et al (2007). It is an appropriate time for the developing economies to cultivate potential benefits from the international market and the stakeholder must initiate their efforts to evaluate the entire phenomena to rationalise the environment in its favour. Framework for Advanced Manufacturing Technologies is shown in Figure 1.

2. Literature Review

Throughout the literature review, the term investment appears to be a great hurdle in a smooth implementation of AMT system in manufacturing enterprises. According to, Zhou et al,(2009), "The biggest barrier to effectiveness is demontrating the value of IT investment" Chief information officer of a fortune 100 companies recently stated. It is bit difficult to conclude the IT investment and long term value generation Brynjolfsson and Hitt, (1996), Investment in AMTs results in better firm performance such as growth and profit may enhance firm performance as described by Small and Yasin (1997). "Technological barriers to justify, plan, value these are risk-bearing assets described by Benaroch and Kauffman, (1999). By investing in IT, there is strong need to evaluate organizational and technological components that generate business outcome, Bharadwaj, (2000). Tracey. Michael, (1999), claims that "the organizations that invest in advanced manufacturing technology and develop mechanisms for manufacturing managers to participate in strategy formulation, will have improved competitive capabilities and better performance than those firms that do not invest in the advanced manufacturing technologies systems". Many researcher Doll,, (1987), Roth,(1992) and Handfield (1995), have foud that investment in AMT such as computer aided design and computer numerical control machines have provided a new platform to the firms to quick respond to rapid market change with shorter lead time product life cycle and produce quality products desired by the customers. Amoako and Maffei (1989), emphasised that " investment in advanced manufactuirng technologies may be quantifiable provided it is made in hardware, software, planning,training and operations but their benefits are difficult to estimate", also supported by wabalickis ,(1988) Yoo, S-H,(2003), has strongly emphasised that "investment in information Technology significantly contributes to the economic growth in developing world.Park *et al.* (1990) stated that implementation of automation technologies entails a large initial investment under a long-term, uncertain environment. They also observed that the decisions to implement AMT must be determined by expectations concerning factors of demand such as the breadth of the variety of products, the quantity of demand, and also the quality of products. Literature reviews carried out by various scholars' also indicates that investment in AMTs would be a great source of strengthen the competitive edge. For example, Small and Yasin, (1997); Schroder and Sohal,(1999

2.1 Questionnaire and Data Collection Pocedure From the Manufacturing Companies

The major portion of quesionnaire was designed on seven and five point likert scale, it was than sent to the indegenous Manufacturing (Small to large scale) companies by courier service and the researcher also got an opportunity to visit few of these industries . In order to collect their response, the manufacturing organization have shared the following information which is consist of qualitative(through interview) and quantitative (by questionnaire) in nature (Table 1).

Table 1.Background of the companies

Serial No. of Companies	Classification of Companies	Age of Companies (years)	AMT (Implementation)	Number of Employees
1	Garments industries	10-30	AMT COMPONENTS OPERATIONAL ENVIRONMENT STRATEGIC ALLIANCE HUMAN RESOURCES MANGEMENT	50 to 500+
2	Electrical goods industries,	10-30		50 = 100
3	Food processing industries	10-20		50 = 100
4	Auto Parts Manufacturing industries	10-40		50 = 300
5	Confectionary factories	5-15		20 = 200
6	Leather Products	20-40		50 = 100
7	Cement based products	05- 30		10-50 =
8	Chemical Industries	10-30		20 = 100
9	Plastic Industries	10 -30		20 = 50
10	Glass Industry	10-40		10 = 100

Figure 1: Conceptual framework for the implementation of AMT system

2.2 Economic Constraints of Advanced Manufacturing Technologies

For sustainable growth of the organization in business and competition, the economic strength appears to be one of the unavoidable features in today's competitive world. Presently most of the organization increasingly relies on the information technology (IT) to enhance and improve their manufacturing to supply chain process effectively in business. The increasing value and potential of new technologies has forced many industries to go for huge investment in order to compete globally. Since the new inception in technology has also augmented the interest amongst the stakeholders in developed countries for cultivating more business opportunities and competition in the new emerging business society. Although, economic downturn is also a massive setback for most of the industrial unit on one hand and the continuous rise in the direct and indirect cost on the other. This may be the lesson for the developing economies to move their system on automated manufacturing system. Many research studies have reported that mix response of its success in both the manufacturing areas such as SMEs and large scale manufacturing enterprises.

3. Research Theme

The main theme of this research study is to investigate the Small to large scale manufacturing companies while facing the constraints such as investment in AMT, Top management support, and Technical constraints while implementing the advanced manufacturing technologies.

3.1 Research Methodology.

The research questionnaire was designed from the PhD research work and the same was sent to the various manufacturing industries for their response. In this regard SMEs are major source of augmenting to get the data from indigenous manufacturing companies in the light of survey questionnaire.

Table 2. Investment in Direct AMTs systems

Direct AMTS

		CNC	DNC	FMS	ASRS	AMHS	R.P	AGVs	ROBOTS
CNC	Pearson Correlation	1	.147	.018	-.109	-.042	-.051	-.128	.109
	Sig. (2-tailed)		.263	.891	.408	.749	.700	.329	.409
	N	60	60	60	60	60	60	60	60
DNC	Pearson Correlation	.147	1	.281(*)	.240	.010	.106	-.087	.226
	Sig. (2-tailed)	.263		.030	.065	.939	.420	.510	.082
	N	60	60	60	60	60	60	60	60
FMS	Pearson Correlation	.018	.281(*)	1	.062	.145	-.159	.317(*)	.078
	Sig. (2-tailed)	.891	.030		.637	.270	.224	.014	.556
	N	60	60	60	60	60	60	60	60
ASRS	Pearson Correlation	-.109	.240	.062	1	-.125	-.074	-.075	-.137
	Sig. (2-tailed)	.408	.065	.637		.341	.575	.569	.295
	N	60	60	60	60	60	60	60	60
AMHS	Pearson Correlation	-.042	.010	.145	-.125	1	.087	-.114	.117
	Sig. (2-tailed)	.749	.939	.270	.341		.509	.385	.372
	N	60	60	60	60	60	60	60	60
R.P	Pearson Correlation	-.051	.106	-.159	-.074	.087	1	-.013	.309(*)
	Sig. (2-tailed)	.700	.420	.224	.575	.509		.924	.016
	N	60	60	60	60	60	60	60	60
AGVs	Pearson Correlation	-.128	-.087	.317(*)	-.075	-.114	-.013	1	-.150
	Sig. (2-tailed)	.329	.510	.014	.569	.385	.924		.253
	N	60	60	60	60	60	60	60	60
ROBOTS	Pearson Correlation	.109	.226	.078	-.137	.117	.309(*)	-.150	1
	Sig. (2-tailed)	.409	.082	.556	.295	.372	.016	.253	
	N	60	60	60	60	60	60	60	60

Correlations

* Correlation is significant at the 0.05 level (2-tailed).

3.2 Investment in AMTs.

Those companies investing in CNC are also preferred to invest in DNC, FMS, and ROBOTS. Although it appears that there is no significant relationship with all the technologies with CNC.

3.2.1 DNC. The manufacturing companies which are investing in DNC, they prefer to invest in CNC,FMS, only show significant findings with relationship of .281.

3.2.2FMS. The companies prefer to invest in AGVs more, but not to invest in RP technologies particularly.

3.2.3 ASRS. ASRS and DNC technologies have +ve relationship with non significance value of .065.

3.2.4 AMHS . AMHS and FMS are +vely related with each other so the companies are interested to invest in AMHS also prefer to invest in FMS technologies with non significance value of .145

3.2.5 Rapid Production
Those companies, interested to invest in AGVs, are also preferred to invest in ROBOTS. **AGVs** Those companies which are investing in AGVs also prefer to invest in FMS.

3.2.6 ROBOTS term investment is important since research has extended its dimensions in manufacturing to service industry. Research indicates that companies have emphasized proper documentation for the purchasing of new technology" as narrated by Currie W 1988 in PhD thesis. Over the years, advanced manufacturing technologies implementation requires more investment in the systems and infrastructures to offer more financial benefits.

Table 3. Reason for investment in AMTs

Approach (Benefits)	**Description**	**Source**
Investment	Can results better firm Performance?	Brynjolfssom and Hitt 1996
Investment	In Information Technology may results More business outcome.	Beanarch,2000 1999 Beanarch& Kauffman
Investment	In AM Twill develop mechanism for Managers and it will increase competitive capabilities	Traccy,1999 Bharadwaj, 2000
Investment	In CAD/CAM,CNC have offered new platformtoFirm for rapid, quick respond to rapid market change with shorter lead time and offers productquality	Doll,, (1987),) Handfield (1995)
Investment	Information Technology significantly contributes to the economic growth	Wabalickis ,(1988) Yoo S-H,(2003),

4. Top Management Support

In manufacturing perspective, the Top Management support means any assistance received in any form (whether from technical, non technical or professionals within or outside the company), can be a great source of inspiration for the company to meet the overall goals as observed by Marri H.B (2000). The full understanding, support and leadership of an organization's top management emerge as a crucial factor in almost all the studies for the successful implementation of manufacturing systems. According to Chroda (2002), top management offers strategic direction, adequate management of technology and innovation. The importance of top management support goes far beyond the allocation of resources. It sets the priorities for the whole organization. Market provides new direction of redefining business, its user's potential, and capacities of the firm and shared entrepreneurial vision as emphasized by Mc Dermott and Stock ,(1999). Top management should focus on long-term strategic decisions based on quality, flexibility, and responsiveness (Marri and Sohag, (2004).

Table 4. Statistical overview of Top Management support

Top Mgt Support.

The mean value of (x =3.98) and Std. Deviation (1.909).
No of companies = 60.
Based on Likert scale 7 (St: Agree to St: Dis Agree)

Descriptive Statistics

	Mean	Std. Deviation	N
Comp: Culture	3.98	1.909	60
Lack of Committment	3.82	1.751	60
Performance	4.07	2.049	60
In-house, Exp	4.17	1.941	60
Vision	3.93	1.803	60

Table 5. Sstatistcal analysis of Top Management support

Correlations

		Comp: Culture	Commit	Performance	In-house Exp	Vision
Company Culture is unfavourable	Pearson Correlation	1	.065	.100	.019	.147
	Sig. (2-tailed)		.622	.447	.885	.261
	N	60	60	60	60	60
Lack of Commitment Of Top Management	Pearson Correlation	.065	1	-.039	-.270*	.114
	Sig. (2-tailed)	.622		.767	.037	.385
	N	60	60	60	60	60
Performance measures used to evaluate to management	Pearson Correlation	.100	-.039	1	.312*	-.260*
	Sig. (2-tailed)	.447	.767		.015	.045
	N	60	60	60	60	60
Lack of In-house Exp	Pearson Correlation	.019	-.270*	.312*	1	.119
	Sig. (2-tailed)	.885	.037	.015		.363
	N	60	60	60	60	60
Top Mgt has clear vision	Pearson Correlation	.147	.114	-.260*	.119	1
	Sig. (2-tailed)	.261	.385	.045	.363	
	N	60	60	60	60	60

*. Correlation is significant at the 0.05 level (2-tailed).

The above analysis provides the matrix of the correlation coefficients for the five variables. Underneath each value of Coefficient correlation , significance value and sample size (N=60) Each variable is perfectly Correlated with itself and hence (r=1) as shown in the table. Performance is positively related to in-house experience with a Pearson correlation coefficient r=0.312 at the significance value of $p<0.05$. this shows that as the performance increases, the amount of is in house experience will also increase . It means that if the organization is committed to implement the systems in the companies than performance of the workers may decrease because of their lack of knowledge and in-house experience of the AMT systems.

5. Technical Aspects / Constraints

Better utilization of resources is considered as a great achievement on the part of manufacturing companies. However, the technical aspects of manufacturing companies have always been issues of scholars as emphasized by Voss, C.A., (1988). Vrakking, W.J.,(1989), Suggest that "plants that implement generally AMT systems for the improvement of their firm performance, these systems are only evaluated for their technical performance. Taking these considerations in mind the questionnaire was developed and despatched to the various organization so as to understand their technical aspects one hand and their proper utility on the other.Organization are confronting various technical problems while implementing the AMT systems as reported by s Boer et al. (1990), in his study it indicates that "manufacturing companies are not benefiting from AMT owing to the following reasons such as technical problems (engineering faults, problems with standardization and integration of both hardware and software)-occurring after installation; changes in the marketplace during the implementation process; he further emphasized for acquisition of proper knowledge and care.

6. Technical Constraints

The mean value of ($\bar{x}$=3.27) and Std. Deviation (1.339).
No of companies = 60.
Based on Likert scale 7 (St: Agree to St: Dis Agree)

Table 6. Descriptive Statistics

	Mean	Std. Deviation	N
Disruption in AMT implementation	3.27	1.339	60
Lack of Integration across (Mgt/Staff)	3.38	1.391	60
Adverse Affects on work flow	3.83	1.404	60
Problem in Interconnection of equip:	3.85	1.363	60
Failure in FinancialTargets	3.38	1.474	60
AMT Skill Deficiencies	3.42	1.565	60

Table 7.Correlations

		Disruption during AMT	Lack of Integration across (staff/Mgt)	Adverse Effects on work flow	Problems in Interconnection Of Equipments	Failure in Financial targets	AMT Skill Deficiencies
Disruption during AMTimplement.	Pearson Correlation	1	.044	-.021	.078	-.061	-.102
	Sig. (2-tailed)		.737	.873	.554	.642	.436
	N	60	60	60	60	60	60
Lack of Integration across across(staff/Mgt)	Pearson Correlation	.044	1	.051	-.067	-.147	-.005
	Sig. (2-tailed)	.737		.701	.608	.261	.973
	N	60	60	60	60	60	60
Adverse Effects on work flow	Pearson Correlation	-.021	.051	1	.075	.236	-.068
	Sig. (2-tailed)	.873	.701		.568	.069	.605
	N	60	60	60	60	60	60
Problem, Interconnection Of Equipments	Pearson Correlation	.078	-.067	.075	1	.113	-.224
	Sig. (2-tailed)	.554	.608	.568		.388	.085
	N	60	60	60	60	60	60
Failure in Financial targets	Pearson Correlation	-.061	-.147	.236	.113	1	-.034
	Sig. (2-tailed)	.642	.261	.069	.388		.798
	N	60	60	60	60	60	60
AMT Skill Deficiencies	Pearson Correlation	-.102	-.005	-.068	-.224	-.034	1
	Sig. (2-tailed)	.436	.973	.605	.085	.798	
	N	60	60	60	60	60	60

The table shows that some extent, firms face disruption problems while implementing AMT. In addition to that there is lack of integration and management information system is also observed. According to data, the organizations are facing some financial problems that is why larger no of firms are not sound to invest in AMT hence not achieving their financial targets. The data shows that there is AMT skill deficiency.

9. Conclusion

Manufacturing enterprises throughout the globe face tremendous constraints pre and post implementation phase. The companies provided the data shows that they are also facing these issues when the top Management has low concentration on the manufacturing enterprises. These companies also need proper training of their workers and adequate support for the AMT systems. The data further shows that their is appropriate need to address the technical issues before the AMT systems are introduced. The manufacturing enterprises also face the disruption when these systems are implemented there appear to financial support for the proper implementation of such systems

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