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# Advance and Green Manufacturing Technology Adoption: Classification and Literature Review of Issues

**Saeed Tavakkoli moghaddam***

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**Abstract:** Purpose – The actual benefits of the AMT solidarity to the manufacturing system, classified as systemic, will only be acquired and identified if the current design and organizational structure become compatible with the change being introduced. The purpose of this paper is to present a review for the organizational design development related to AMT assumption and the green manufacturing (GM) involved in every aspect of manufacturing processes. The objective factors of decision-making problems are usually two: quality and cost, but as opinion of the GM, environmental impact (E) should also be considered. Design/methodology/approach – The developed theoretical composition integrates two refined and tested frames: the organizational design and the strategic selections of AMT. Qualitative analysis of success factors critical to AMT adoption and implementation has been dealt with extensively in the literature. Research limitations/implications – The generated framework is theoretical in nature and needs to be tested, although the theoretical exercise integrates tested frameworks. Practical implications – The understanding of the relationships between the process of AMT authorization and the required changes in the organization contribute to the acquisition of the benefits related to those technologies.Finally, this paper aims to address this issue, and a brief overview of the development process of AMSs.

**Keywords:** Advanced manufacturing system (AMS), Advanced manufacturing technology (AMT), Green manufacturing (GM), Flexible manufacturing systems (FMSs), Environmental impact..

## 1. Introduction

Progress in human society has been fulfilled by the creation of new technologies. The last few years have witnessed unparalleled changes throughout the world. Rapid changes in the markets demand drastically shortened product life-cycles and high-quality products at competitive prices [1]. Customers now prefer a large variety of products. This event has inspired manufacturing firms to look for

*. Young Researcher and Elite Club, Faculty of Engineering, Islamic Azad University of Zahedan, Zahedan, Iran.
Manasloo_8191@yahoo.com

advance computerized automation in various processes. Thus mass production is being exchanged by low-volume, high-variety production. Manufacturing firms have recognized the importance of "flexibility" in the manufacturing system to meet the rivals posed by the pluralistic market [2]. The concept of flexibility in manufacturing systems has arrived significant importance in meeting the challenges for a variety of products of shorter lead-times, together with higher fertility and modality. [3], have reported that flexibility is the underlying concept behind the transmission from traditional methods of production to the more automated and integrated methods. They stress that firms implementing automation projects should classify their needs for different flexibilities for long-range strategic landscapes.

1- Those which have frequently do not scythe the advantages these technologies can offer.
2- There are difficulties in implementing the expensive, complex systems.
3- There are inexpressive internal skills.
4- There are often difficulties in implementing computerized systems.
5- There is a multiplicity of implementation directions.
6- AMT involves incremental skill building.
7- AMT requires different support texture.

[4], observes that implementing AMT is one of the most lengthy, expensive and complex tasks a firm can undertake. He discusses various issues such as commence the automation project, project planning, project implementation, controlling the project, and the post-audit analysis for managing automation projects.

[5], have identified some of the issues and problems arising from implementing a cellular manufacturing (CM) project and discuss the following issues, namely scope of CM projects, simulation modelling, cell design, cell operational logistics, and work issues in CM.

Derivation of advanced manufacturing technology (AMT) involves major enterprise and a high degree of doubt and hence, verdicts considerable attention within a manufacturing firm at the strategic level [6]. As a result, issues involving selection and explanation procedures capture greater importance. [6], states that companies can attain considerable competitive advantages through AMT such as flexible manufacturing systems (FMSs), computer-aided design and robotic systems. He also observes that many companies are unwilling to install these technologies because:

They also suggest a framework for design and implementation of a CM project. [7], discusses various issues in developing an implementation framework.

[8], have observed that rapid development and high primary costs of AMT have drawn attention to developing procedures involving installation and implementation of equipment. [9] and [10], agree that the full benefits are not realized because of, for example, economic, technical and organizational problems.[11], has reported that most AMT defeats are due to organizational problems, and has also identified the following emerging issues: technological (formation, computability); economic (explanation, government support);

manpower (skills, industrial relations, number); and organization (new strategies, need for change, new methods). [12], reports guidelines for developing and implementing strategic plans for AMT. He also discusses the concept of strategic and utilizable planning. [13], report that manufacturing companies are not benefiting from AMT owing to:

1- Technological problems (engineering errors, problems with grading and integration of both hardware and software) occurring after installation.
2- Changes in the marketplace during the implementation process.
3- Insufficient knowledge of and attention to the organizational prerequisites for the effective operation of FMSs.

[14], studied five flexible manufacturing installations in the UK. The study disclosed that companies are paying attention to the selection problem from opinions such as marketing, manufacturing strategy, production cost reduction method, industrial relations, and government support.[15] have identified 12 attributes for appraisal of FMSs using analytical hierarchy process. Researchers have appreciated the major factors which influence the implementation process of AMT as a wide eyesight of issues.

[16], reports that implementation is a vital issue which must be considered prior to any major introduction of AMT, and that strategic considerations have a major influence on the success of post-installation implementation. Voss also proposed a three-level model in which objectives should be set and control exercised in planning and implementing manufacturing technologies. Other researchers have proposed implementation frameworks using various implementation issues to varying degrees. For example, [17], have developed an integrated framework for strategic inception of new manufacturing technology – a three-stage evaluation procedure for strategic attainment of AMT. [18], have discussed various strategic issues, such as finance position, technology situation, market location, product conception and resources, and developed a four-stage framework for implementing of FMSs. [19], have also developed a framework for implementing AMT. They considered various justification accosts and implementation issues and then integrated them through a conceptual framework. [20], stated that implementation of automation technologies requires a large initial investment under a long-term, uncertain environment. They also observed that the decisions to implement AMT must be determined by prospects concerning factors of demand such as the expanse of the variety of products, the quantity of demand, and also the quality of products. [21], described planning, designing and implementing a computer-aided manufacturing (CAM) system through a case study. The objectives of this article are to:

1- Highlight various implementation issues involved in AMT.
2- Classify the available literature from the viewpoint of practitioners.
3- Provide an encapsulated view of AMT's implementation problems.

The article is organized as follows. In the next section, a general list of issues is identified and classified. This is followed by a discussion of the issues raised by the researchers. Finally, some concluding remarks are provided.

### 1.1. Classification of issues

Manufacturing firms will face large-scale issues in their implementation of AMT. [22], demonstrates that successful selection and implementation of AMT requires a thorough understanding of various issues. Researchers have identified and classified these qualifications. For example, [23], have divided AMT issues into two categories, tangible benefits, and intangible (hidden) benefits.[24], have identified considerable size-of-implementation issues under three categories: strategic, tactical and pecuniary (economical) issues.[25], have discussed the procedures used for acquiring FMSs and identified seven necessary factors:

1- System quality;
2- Productivity;
3- System reliability;
4- System diagnostics;
5- Flexibility;
6- Material management; and
7- Economics.

Implementation issues

| Tangible attributes | Intangible attributes |
|---|---|
| 1. Preproduction Cost factors | 1. Human factors |
| 2. Indirect production Cost factors | 2. Social factors |
| 3. Direct production Cost factors | 3. Technological factors |
| | 4. Strategic factors |

***Figure 1. Classification of implementation issues***

## 2.Literature review

GM is a modern manufacturing strategy, which is imperative for the 21st century manufacturing industries, integrating all the issues of manufacturing, with its ultimate goal of reducing and minimizing environmental impact and resource expenditure during a product life cycle, which includes design, compound, processing, packaging, transportation, and the use of products in continuous or distinct manufacturing industries. [26] and [27]

The manufacturing industry has been playing a very important role in the progress of the modern society. With the evolving process of manufacturing paradigms from proficiency production, mass production to mass customization and personalization. These AMSs have greatly promulgated and influenced the related manufacturing technologies, management techniques and economic advancements. Before the 1960s, with the introduction and use of early factory automation technologies and related automated production equipment, manufacturing shop floors have been transformed gently into rigid automated production lines from the original skill production manual workshop. It has helped the manufacturing enterprises to reduce costs and achieve the economy of scale through mass production.[28]

As a typical interdisciplinary research direction, AMSs have attracted the attention of a large number of researchers in manufacturing, information and management fields. The existing research studies are mainly focused on the specific theoretical research of each AMS. Since the specific requirements of these AMSs in different areas and different periods are various, the linear research emphasis of each AMS is preferable. For example, the related works of FM and RMS focus on using the modular resources to realize and improve the flexibility and re configurability of systems [29]. Since the early 1990s, the appearance of AM [29], has prompted manufacturing enterprises to enter into the organizational mode of enterprise integration. In an environment with growing customized demands, computer network technology (CNT), supply chain management (SCM), and other related technologies have been developed rapidly. They enhance the alacrity, globalization and intelligence of manufacturing operations. In addition, sustainable development has received increasing attention and some AMSs [e.g., green manufacturing, RMS, and global manufacturing (GM)] were proposed and developed.

For instance, a FMS is referred to as a manufacturing system which aims at increasing the variety and volume-mix of parts/products produced according to the manufacturing requirements of product diversification, low cost, and short cycle [30], and to absorb large-scale changes. In a FMS, there is some flexibility (primarily including machine flexibility and routing flexibility) that allows the system to react in the case of changes, whether predicted or unpredicted. The main advantage of a FMS is that it has higher flexibility in managing resources to manufacture a new product and reduce parts rosters, as well as greater labor productivity and machine efficiency. A FMS can realize resource sharing among different types and volumes of parts/products within an enterprise. The best application of a FMS is found in the production of small batches of products like those from a mass production.

### 2.1. Economic issues

Economic issues involve cost-borne analysis of AMT. They include cost-benefit analysis and economic analysis strictly in venal terms. [22], placed economic cost factors under two categories – preproduction cost factors and direct production cost factors. Preproduction cost factors include investment on equipment, plant and building, software, etc., while production costs include material, work, inventory, maintenance, operating costs etc. [23], have classified economic issues under two categories – direct cost benefits, and indirect cost benefits. The economic factors are either estimated, based on certain obligations, or are actual cost-borne figures. It is beheld from the literature that economic attributes play a major crucial role for selection and vindication of AMT.

**Table 1.**
***Economic issues***

| **Researchers** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** |
|---|---|---|---|---|---|---|---|---|---|---|
| Young and Murray [25] | | | x | | | | x | x | | x |
| Fry and Smith [1] | | | | x | x | | | | | |
| Troxler and Blank [33] | | x | | x | | | | | | x |
| Afzulpurkar et al. [6] | | | | x | | | | | | |
| Mohanty [22] | x | x | x | x | x | | | x | x | x |
| Sambasivarao and Deshmukh [18] | | | | x | | | | | x | x |

| Key: | |
|---|---|
| 1. Consumable | 6. Maintenance |
| 2. Design | 7. Material |
| 3. Inspection and control | 8. Material handling |
| 4. Inventory | 9. Modification |
| 5. Labour | 10. Quality |

## 2.2. Human issues

Employees play a most vital role in implementing AMT [32]. It may be evident that one of the objectives behind the innovation of AMT is to reduce human intervention. In developed countries like the UK, Germany, France and the USA, more efforts are put in to reducing human intervention in manufacturing as the industry appears to be capital-intensive. Human factors play a very significant role, especially in many developing countries where AMTs are at the critical early stages of implementation.

**Table 2.**
***Human issues***

| Researchers | Employee cooperation | Employee relations | Employee Manpower | morale / motivation planning |
|---|---|---|---|---|
| Young and Murray [25] | | | | |
| Voss [11] | | x | | x |
| Troxler and Blank [33] | x | x | | |
| Tayyari and Kroll [23] | | | | |
| Mohanty [22] | x | x | x | x |
| Sambasivarao and Deshmukh[18] | | x | x | |

## 2.3. Strategic issues

The strategic impacts have long-term implications for the organization as a whole. It is necessary to consider the effects of AMT on other functional departments of an organization. [33], has discussed the effects of AMT on manufacturing strategy. These effects are reflected in decisions like replacementwith improved technology, expansion of entire plant and plant modernization projects. [31], have provided a comprehensive list of potential strategic effects of AMT, which includes investment, growth, technology position, employee relations, market position, workforce composition, organization structure and operations management. [16], observes that those who had taken no steps to adopt AMT in their organization, or had computerized traditional roles, experienced greater difficulty in realizing the full benefits of the technologies than those who had taken action in this area.

**Table 3.**
***Strategic issues***

| Researchers | Finance position | Government policy | Management development | Market position |
|---|---|---|---|---|
| Young and Murray [25] | | | | |
| Voss [11] | | x | x | |
| Troxler and Blank [33] | x | | | x |
| Tayyari and Kroll [23] | | | | |
| Mohanty [22] | x | | x | x |
| Sambasivarao and Deshmukh[18] | x | x | x | x |

## 2.4. Technological issues

the AMT to improve manufacturing performances. The following issues describe the compliance of manufacturing systems. [34], report that changed markets require flexible manufacturing. The researchers have described procedure and methodological aids such as technological performance, and economic evaluation used for planning and sue realization of a CAM system.

**Table 4.**
***Technological issues***

| Researchers | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| Young and Murray [25] | | | | x | | | x | x | | |
| Voss [11] | | | | | x | | | | | |
| Fry and Smith [1] | x | x | | x | | | | | | x |
| Troxler and Blank [33] | | | | x | | | | | | |
| Tayyari and Kroll [23] | x | x | | x | | | | x | | |
| Mohanty [22] | x | x | x | x | x | x | x | x | x | x |
| Afzulpurkar [6] | | x | | | | | | | | |
| Sambasivarao and Deshmukh [18] | | x | | | | | | | | |
| Key: | | | | | | | | | | |
| 1. Availability | 6. Manufacturing engineering planning | | | | | | | | | |
| 2. Capacity utilization | 7. Management information | | | | | | | | | |
| 3. Compatibility | 8. Productivity | | | | | | | | | |
| 4. Flexibility | 9. Reliability | | | | | | | | | |
| 5. Hardware | | | | | | | | | | |

## 3. Concluding remarks

Green manufacturing can lead to lower raw material costs, production efficiency gains, reduced environmental and occupational safety expenses, and improved corporate image. The relationship between green practices and performance outcomes has been subject to numerous studies but the results are not conclusive. From the tri-view analysis of AMSs, three findings are stated in this paper. Accordingly, either in resource sharing or in value creation and user participation, the trend of socialization is apparent, such that the development and evolution of AMSs have also revealed and adapted to the significant socialization of manufacturing.

However, detailed socialized evolution of AMSs still need to address the following issues and challenges: it needs to bring out the social sharing of MRs & Cs in order to achieve the social creation and social differentiation of value of products and services, and to realize social manufacturing with universal participation and full customization in the entire production process. Therefore, existing and further research and development of AMSs would still require much support of the related theories and technologies, in spite of the advancement of IoT and additive manufacturing. It is necessary to address the critical issues of social manufacturing resource supply demand matching and management [35], in the practical dynamic application of these AMSs.

From the literature it may be observed that a large number of issues are involved in implementation procedures, and a useful approach can be summarized as follows:

1- Identify specific objectives for the long term, medium term and short term.

2- Match with corporate objectives and goals.

3- Involve key employees in the implementation effort.

4- Formulate the major plans and sets of procedures.

5- Allocate responsibilities and tasks to divisions, functions and individuals.

6- Assess the resources required and ensure their availability.

7- Specify the data information required.

8- Specify standards or targets of performance for corrective actions.

9- Set the time-frame for the implementation.

10- Identify the motivational elements and introduce incentive rewards.

11- Educate and train the employees for specific needs.

Various attributes are addressed and used by researchers for procedures involving selection and justification of AMT. In this article a comprehensive list of attributes have been identified and classified under two categories – tangible and intangible attributes.

Economic issues alone are inadequate to justify new manufacturing systems because traditional evaluation methods are inadequate for the purpose. Noneconomic benefits could not be included in the justification procedure, while the direct cost factors are insufficient to justify the AMT because AMT offers a large number of intangible benefits. The problem lies not in the level of technology, but rather with its implementation. It is important to note that, instead of rushing to invest in AMT, a manufacturing company must reassess its direction, strengths and weaknesses, and develop a strategy for successful implementation accordingly.

The present literature review and classification scheme suggested have brought several elements to the fore. These can be summarized as follows:

1- The suggested scheme would benefit researchers studying the adaptation and implementation problem by focusing on issues of specific interest.

2- Advanced manufacturing technologies involve a set of quantifiable and non-quantifiable attributes. There is need to evolve an integrated framework for comprehensive appraisal of AMTs using these attributes.

3- Implementation barriers are work-culture specific. This perspective needs to be taken into account while trying to learn from the experiences of others, especially from the countries which are at early stages of implementation.

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