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ADVANCED MANUFACTURING TECHNOLOGIES: LITERATURE REVIEW

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Abstract: *With the emphasis on reducing costs and increasing efficiency, a record number of companies are embarking on different forms of advance manufacturing technologies (AMT). AMT are broadly defined by many authors (small and chen, Sheppard and stock) as “an automated production system of people, machines and tools for the planning and control of the production process, including the procurement of raw materials, parts and components and the shipment and service of finished products” In particular, AMT is defined as any new manufacturing technique, the adoption of which is likely to lead to changes in a firm’s manufacturing practice, management systems and approaches to design and production engineering of the product. Advanced Manufacturing Technologies are split into: Pure Technical tools (hardware) and Management tools(manufacturing practices software)*

Keywords: AMT, WIP, CNC, CAD/CAM/ ROBOTICS.

I. Introduction

AMT represent a wide variety of modern manufacturing systems, mainly computer based that are devoted to the improvement of manufacturing operations. There is a continuum of possible AMT that can be implemented by a firm. This ranges from stand-alone units such as a robot, to more integrated systems such as flexible manufacturing systems and ultimately to fully integrated systems called Computer integrated Manufacturing (CIM). The amount of integration of AMT is one of the key determinants for organizational changes that are complementary to the implementation process. The implementation of AMT changes the characteristics of any manufacturing plant. The degree to which a plant will change is dependent on the number of AMT implemented as well as the level of integration. Goldhar and Jelinek (1985) summarize the operating capabilities of the advanced factory as follows:

1. The economic order quantity approaches one.
2. Variety has no-cost penalty on the factory floor.
3. Revenue per unit is highly sensitive to total production volume (not volume for this design only) because fixed conversion costs approach 100% of all conversion costs.
4. Joint-cost economics obtain: the value of system (its potential returns on investment) is a function of the bundle of products it produces, the range of processes it can perform.
5. Rapid response to changes in product design, market demand, and production mix are possible.
6. Unmanned and continuous operation is standard.
7. Closely-coupled and highly integrated production systems and close supplier-user links will result in minimal inventory levels- and greater vulnerability to error:
8. Consistently high levels of quality, accuracy and repeatability will be demanded, as well as permitted by the technology.

It has been shown that flexibility often reduces the engineering cost of design changes and the attendant system modifications. However, these savings are normally offset by increased cost for programming the equipment. The labor changes are also normally offset, as there will be a decrease in unskilled labour requirements but an increase in those for skilled labor (Sanchez, 1996). An implementation of AMT normally results in a decrease in total human resource costs, because AMT reduce turnover rates by increasing employee satisfaction (thus decreasing recruiting and training costs). AMT have also been shown to reduce the amount of rework and scrap, which translates into improved quality and reliability for the customer. This decrease has been attributed to the elimination of the operator (the process is automated with AMT), as well as the elimination of operator fatigue and boredom (Troxler, 1990).

In order to demonstrate the importance of AMT to firms, the current literature focusing on the organizational factors critical for the successful implementation of AMT as well as their impact on the market structure and competitive advantage of the firms. This section will set the foundation for the complimentary analysis to be performed by introducing some of the components already known to aid in the successful implementation of AMT. It will also demonstrate the impact that AMT can have in a plant, firm and even industry in order to aid in the justification of the importance of the results from this study.

II. Organizational Factors Critical for Success

Certain organizational factors are necessary conditions for the implementation of AMT. The first of these factors is a team based project management approach (Small and Yasin, 1997). This approach is necessary because of the complementary nature of AMT with so many different departments in the organization. The more integrated the system, the more critical the need for input from multiple departments during the planning stages.

A second factor for determining the successful of an implementation of AMT is commitment from both a project champion and from the organization as a whole. It has been found that without solid commitment from the management and workers the full potential of AMT cannot be achieved. The faith of the organization in AMT affects many types of benefits derived from the implementation such as return on quality, level of enhanced competitiveness, amount of cost reductions works conditions and improvement in control (Udo and Ehie, 1996).

The employees are the third focus of organizational factors. Employee empowerment defined as giving workers more responsibility and control over the manufacturing process, was shown to be positively correlated to increased AMT performance (Boyer et al, 1997). Worker empowerment also requires training so that workers are able to take on added responsibility and become comfortable with the new technology. Furthermore, it is important that training occur before, during and after the implementation of AMT (Frohlich, 1998). The increase in employee empowerment requires a complementary change in hiring and training policies as well as a change in the incentive structure of the firm. With increased responsibility, workers will expect and demand, increased salaries and other benefits. All of the human resource policies must be set to agree with the changes to the new expectations placed on the workers (Chung, 1996; Sun and Gertsen, 1995).

Frohlich (1995) also found that increased coordination of worker's efforts through non-technical means (e.g. facilitating communication) was positively correlated to increased performance and growth with AMT. This increase in communication facilitates the required interaction between the various groups of the organization to help solve problems more efficiently. It is also critical to the integration of the systems so that the entire organization is able to achieve the maximum benefit from AMT.

III. Research Methodology

A specifically designed comprehensive questionnaire was used as a basis of extracting information from the companies. The questionnaire was based on recent developments in the subject and was designed after a thorough study of international literature. A set of management activities performed during the process of Implementation of AMTs in the Manufacturing Industry were examined followed by an investigation and qualification of the impact of AMT on a comprehensive set of company performance indicator grouped as competitive priorities and manufacturing parameters.

Competitive priorities are the features and characteristics of the products that are visible to the customer and attract him to buy it. These include price quality consistency product performance, delivery lead time, delivery performance product design flexibility and volume flexibility.

Manufacturing parameter is that parameter in the production environments that affect directly the competitive priorities and are expected to be influenced by the introduction of AMT in the manufacturing environment. these includes the quotation and design the lead times, the design to manufacture the lead times, the ability to design and manufacture the products, the manufacturing through put time, the changeover time, the manufacturing lead times, the batch size, the direct labor cost, WIP (work in progress), the average level of product quality etc.

Based on impact of AMT on the above indicators which was measured on a 10 point scale, the level of success of each technology was established the success was identified using a purpose development formula which takes into consideration the impact of the technology on the specific indicator, the degree of influence this indicator had on the introduction of the technology as well as the importance level of the indicator on the company performance. Based on the level of success and the management activities identified in the process of Implementation, a regression analysis was carried out to determine the factors contributing to the success or failure of the implementation of AMT. After a critical examination of the success and failure factors and the influence level of AMTs on the above mentioned indicators, an integrated planning model was devised to provide the frame work and all the necessary information for the manufacturers to identify their needs, justify and select the most appropriate AMT to satisfy their strategic plans and competitive priorities.

A. Questionnaire Administration

As stated before the questionnaire was based on the recent developments in the subject and was designed after a thorough study of international literature. It's a structure includes four sections. Each one addressing separate issues. Section A and B deal with the general characteristic of the companies and the application of advanced manufacturing technologies. Section C determines the impact of AMT on the company products, competitive priorities and manufacturing parameters. While section D and E examine the management process followed during the introduction and the operation of AMT in the manufacturing environment.

Section A: General Characteristic of the Companies:

This section includes questions which aimed to extract information of a general nature, and related to the introduction and implementation of advanced manufacturing technologies. In detail it yields information on :

1. The employment characteristic of the companies.
2. The manufacturing characteristics
3. The operational characteristics
4. The production plant characteristics

Section B: Advanced manufacturing technologies: Present and Future Applications

This section examines the level of application of AMT in the surveyed companies. In particular it investigates the present and future applications of CAD systems, NC and CNC machines, CAD/CAM systems, robotics, flexible manufacturing systems (FMS), Automatic Guided Vehicles (AGVs), Manufacturing resource planning systems (MRP) etc...

Section C : Impact of AMT on Company Competitiveness – Success and Failures of AMT

This section examine the impact of MT on company competitiveness. In detail, it extracts information on:

1. The impact of AMT on product – Market characteristics
2. The impact of AMT on the company's competitive priorities
3. The impact of AMT on the manufacturing parameters and
4. The estimated and the real situations as to the level of competitive priorities a company should possess.

Section D: AMT Planning Factors.

This section examines the level of planning for the implementation of AMT . In detail the following are addressed:

1. The factor influencing the decision to introduce AMT
2. Problems in financial justification of AMT
3. The planning level of the AMT transfer process
4. The planning level of the AMT implementation process

Section E: AMT operational factors

This section examines the management process followed during the transfer and implementation of AMT in the manufacturing environment. Specifically, it addresses the following:

1. Technology selection and transfer issues
2. Infrastructure preparation issues

B. Research Design

A research design is a type of blueprint prepared on various types of blueprints available for the collection, measurement and analysis of data. A research design calls for developing the most efficient plan of gathering the needed information. The design of a research study is based on the purpose of the study. A research design is the specification of methods and procedures for acquiring the information needed. It is the overall pattern or framework of the project that stipulates what information is to be collected from which source and by what procedures.

C. Research Strategy

The strategies that are of interest to our study are surveys and a multiple case study. We feel that individually using surveys or case study (by interview) will not reveal a clear and honest enough picture. So I will use both parameter of study: first one use for upper or mid management employees and second one use for lower Management and labour class employees.

D. Research Method:

Case studies are suitable for practical problems and they are often thought of as being problem-centered, small-scaled, and entrepreneurial. Moreover, one of the strengths of a case study is its unique ability to use a lot of different empirical evidence . The research strategy that is best suitable to our thesis is therefore a multiple-case study. We designed our study in such a way that the research findings will represent comparative cases. They are comparative in the sense that the interviews are semi-structured, thus inviting the interviewees to enlighten additional areas of importance.

Survey studies are satiable for inherent problem which are not show in the interview and lower management employees do not understood typical type interview question. So by the structured questionnaire method we collect real information of current circumstances about our research. These structured questionnaires must be designed to relate to objectives in the evaluation process; they must cover the issues, and the data must be able to be collected and analyzed.

E. Data Collection

- Our data collection is identifying comparable theories through various books and journals. Moreover, annual reports from the various cases are reviewed in order to have a more detailed understanding of the case study companies. There is no single source of information that can provide a comprehensive and complete perspective on the study. It is therefore important for case study research to use multiple sources of data to get as broad a view as possible about each specific case.

F. Data Analysis

In our attempt to collect and organize data in such a way that we later will be able to conduct an analysis, we structure our analysis according to the steps presented by Merriam. The first step is to organise the data in topical or chronological order so it can be presented in a descriptive manner. The next step is to classify the data into categories, themes, or types. The final step involves making conclusions, developing models, or generating a theory. All empirical data was organized in topical order according to the design of the interviews and presented case by case. The classification of the empirical findings constituted the next step, which we also based on the questions found in the interviews conducted. In the final step, our aim was to enlighten factors that are general across the research study. However, individual findings that we felt were of interest and of importance to our study.

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