

Barriers and Enablers in Agile Manufacturing of Product

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Abstract— With the rapid growth in advancement of manufacturing technologies, it is becoming necessary for all manufacturing industries to adopt new technologies so as to compete in the market. Due to increasing competition, the manufacturer must provide necessary product/service to customer in minimum duration of time. Agile manufacturing is a new concept and has many advantages as compared to other technologies. It is advancement over other manufacturing technologies such as Flexible Manufacturing Technology (FMS), Lean Manufacturing etc. Agile manufacturing concentrates on fast response to customers for their requirements as well as the quality production of product. Organizational agility is the best way of survival and progress now a day. Still most of the manufacturing industries face difficulties in implementation of Agile manufacturing technology. Hence it becomes necessary to identify enablers and barriers in the implementation of Agile Manufacturing.

This paper reviews the principle of Agile Manufacturing, its enablers and barriers. The outcomes of this paper will be helpful to the industries for successful implementation of Agile Manufacturing technology as well as further research in this field.

Keywords— Agile manufacturing, Agility, Drivers, Enablers, Barriers.

1. INTRODUCTION

The term Agile Manufacturing was first time introduced in USA with the publication entitled '21st century manufacturing enterprise strategy (Iacocca institute 1991). Agile manufacturing is different than Quality Management or Business Process Reengineering. The term agility means different way of doing business. [1] According to Nelson and Harvey, 1995, Agility is a capability of organization to respond rapidly and effectively to various business opportunities. It is about proactive development of solution for customer needs. The great potential is offered by agility for business growth. Now a day the customer demands are continuously changing and also there is lot of increase in sophisticated demands by customer. Goldman *et al.* (1995) has outlined four major principles of agile manufacturing,

- Enriching the customer.
- Enhance the competitiveness
- Mastering the change and uncertainty.
- Leveraging people and information.

Agile Manufacturing works on the basis of a mixture of techniques as well as various manufacturing strategies. The intention of applying these techniques and strategies is to become flexible. This paradigm of flexibility and responding quickly to the changing demands is now becoming a very important strategy for survival in turbulent and volatile market. [2] Irrespective of this we find lot of difficulties in the successful implementation of Agile Manufacturing technology. Thus there are certain important issues and questions in the implementation of concept that has to be addressed. This is required to clarify the purpose, focus and goals of Agile Manufacturing. [3]

The main purpose of this paper is to review the concept of Agile Manufacturing. The potential advantages and disadvantages are also reviewed so as to increase the competitiveness of manufacturing industry. Author has also reviewed the barriers and enablers in the implementation of concept.

2. LITERATURE REVIEW

The Agile Manufacturing technology should respond quickly to needs of customer with the help of technologies such as information technology, customizable modular products etc. The concept of agile manufacturing was first presented by scholars Iacocca institute [4], Lehigh University, in 1991. There were many senior executives involved in the process they wanted to describe various aspects of manufacturing during their investigation. The main purpose of study was to improve the competitiveness of US industries in the global manufacturing order. The executives have concluded that USA will play the leading role in manufacturing if such a technology is adopted. This has pioneered the concept of agile manufacturing. The concept is welcomed by various authorities of country.

However Burgess [5] argues that still the concept is not properly defined and needs some more work to be done on this. He also concluded that before transition from existing to new paradigm of manufacturing various hurdles has to be found out and attempt has to be made to overcome them. A Gunasekaran [6] also added with justification that there is a need to redefine the agility. He also explained the Agile Manufacturing paradigm as shown in figure 1 and said that achieving agility requires strategic planning.

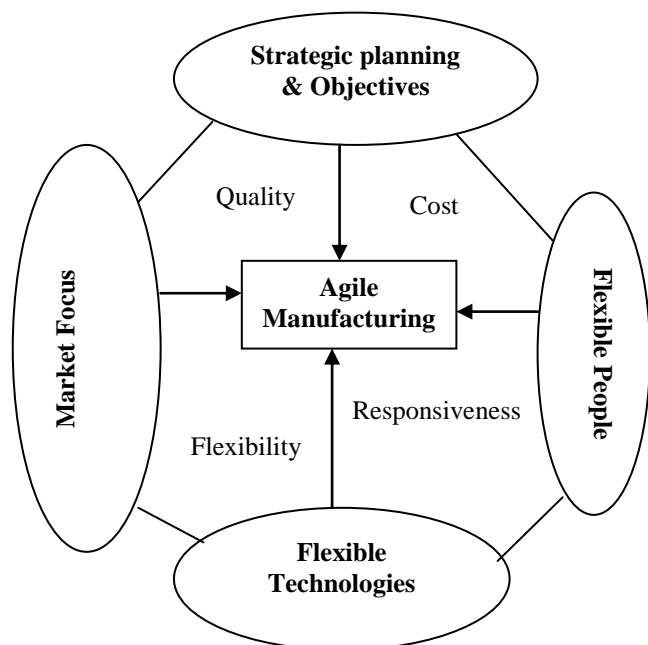


Figure 1: Agile manufacturing paradigm. [6]

Youssef [7] says that agility should not be only correlated with speed. He further added that if we do so then that will be incomplete understanding of agility concept. Whereas Kidd [1] says that agility includes both speed as well as flexibility and also more than that. Agility consists of well-developed technology and methods of manufacturing. During past few decades many changes have been experienced in manufacturing technology from mass production to agile manufacturing. The changes are shown in figure 2.

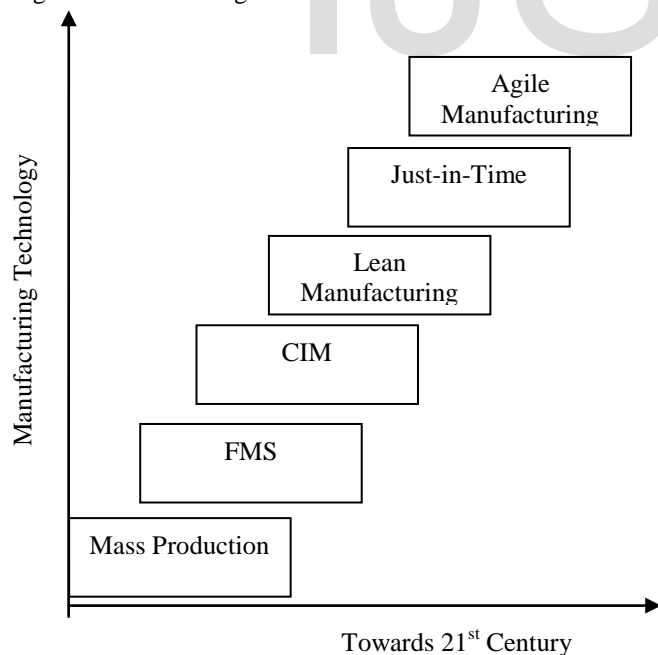


Figure 2: Changes in Manufacturing Technology [8]

There are so many changes that took place in the requirements of customer like cost, quality requirements, performance etc. These changes took place on the basis of market survey, customer feedback, change in technology etc. All these factors have great impact on the above said changes. [8] According to Sharifi and Zhang (1999, 2000), Agility is defined as a basic ability of any organization for sensing, perceiving and anticipating the necessary changes in the business. He has further classified the various types of changes such as changes due to market change, changes in customer requirements, technological growths and also social factors. Thus the agility increases the capability to react to unanticipated changes and it must be a structural property of system. From this we can summarize that following are the main drivers of agility,

- i. Changing customer expectations.
- ii. Increasing competition in market.
- iii. Technological growth.
- iv. Globalization.
- v. Various social and cultural factors.
- vi. Turbulent and dynamic market.
- vii. Growth in information technology.
- viii. Human resource factors.
- ix. Constant innovations in market
- x. Cost benefit analysis by customer
- xi. Business networks

All these factors (drivers) are influencing on manufacturing environment. It is as shown in figure 3.

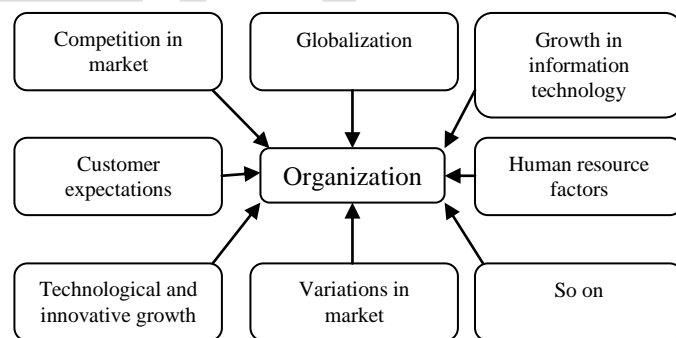


Figure 3: Factors influencing Manufacturing Environment [9]

Thus a manufacturing company needs to integrate various activities such as design activities, engineering activities, information activities and communication technology.

Barriers to agile manufacturing:

A product when produced has many features and the values of these features are determined by the customer. To produce these features it may need material, equipment, facilities, manpower, utilities, expenses, motion, and other activities. There are several barriers to agile manufacturing. We arrive at 14 barriers typically affecting agility and agile manufacturing adoption. These 14 barriers [10, 11] are as follows:

- 1) Lack of top management support and commitment
- 2) Fear of and resistance to organizational change
- 3) Inappropriate measurement approaches for qualitative benefits and agility
- 4) Lack of methodologies to enhance agility
- 5) Lacking in customer feedback systems integration
- 6) Insufficient training, education and rewards system
- 7) No sound appraisal technique to justify high investment in Advanced Manufacturing Technology (AMT)
- 8) Poor design–manufacture interfaces
- 9) Poor partnership (supply chain) formation and management
- 10) Poor incorporation of flexibility measures into management
- 11) Unavailability of appropriate technology.
- 12) Mismatches
- 13) Putting on the brakes
- 14) Allergic reactions

1 Lack of top management support and commitment

Adoption of agile manufacturing requires radical changes including reengineering business processes and adopting new organizational policies and even a change of the culture. Support and commitment of top management is necessary from organizational, technical and financial perspectives.

2 Fear of and resistance to organizational change

The main driving force behind adoption and implementation of agile manufacturing principles is ability to change. To manage this, organizations have to willing accept significant internal changes in the area of structural and infrastructural.

3 Inappropriate measurement approaches for qualitative benefits and agility

The axiom that ‘you cannot manage what you cannot measure’ is something that is true for agile environment. Appropriate measures for adaptability and change are needed for agility. There is a need to identify and measure intangibles in agile enterprises. The other dimension of this issue is the ‘how’ to measure and measurement systems’ capabilities including systemic approach to develop, acquire, evaluate and improve upon, these measures.

4 Lack of methodologies to enhance agility

Methodologies and frameworks to assist manufacturing companies (of all sorts) are needed to enhance agility. Studying and establishing relationships between the concept of agile manufacturing and manufacturing best practices will provide the ground for a practical approach to achieving agile manufacturing.

5 Lack of customer feedback systems integration

The role and importance of customer feedback systems, is undeniable. Without appropriate tools, business processes and technology integrating the customer, and thus the supply chain, becomes virtually impossible. There is a need to develop mechanism which will incorporate customer requirements and satisfy immediate customer needs. This is necessary for success of agile manufacturing.

6 Insufficient training, education and rewards system

Human and behavioral factors play a significant role in the successful development and implementation of agile manufacturing. Agile manufacturing has a number of characteristics that may alter workforce requirements when compared to that of traditional manufacturing. One should see that agile companies are committed to continuous workforce training and education and see it as an investment rather than a cost.

7 No sound appraisal technique to justify high investment in Advanced Manufacturing Technology

Agile environment requires significant operations and production technology innovations. Organizations require that these innovations be justified before they are acquired. The appraisal process for many organizations still relies on traditional short-termed appraisal techniques. Even though in recent years more advanced appraisal techniques have been developed, adoption of these more complex tools has been slow.

8 Poor design–manufacture interfaces

New product innovation and development requires a strong inter-functional relationship between design and manufacturing functions. There are numerous barriers or causes of a poor interface and include organizational, language, behavioral and physical barriers that must be overcome to improve this relationship. A Collaborative approach is necessary in order to achieve product and process design optimization, high quality products. In agile situations, this interface may not only be intra-organizational, but encompasses inter-organizational relationships.

9 Poor partnership (supply chain) formation and management

Supply chain and network relationships will need to be managed efficiently and effectively for rapid formation response and flexibility. Lack of trust, commitment and standardization in practices, policy and technology can damage badly to supply chains and ultimately agile manufacturing.

10 Poor incorporation of flexibility measures into management

Flexibility, the core concept in agile manufacturing, requires special attention to its implementation and removal of its barriers. The management of flexibilities is an issue that is pervasive and needs to include decisions at all levels of management.

11 Unavailability of appropriate technology

To aid the organization maintain its agile capabilities, technology plays a critical role. These technologies range from product and process technologies including Robotics, Automated Guided Vehicle Systems (AGVs), Numerically Controlled (NC) machine tools, Computer-Aided Design (CAD)/Computer-Aided Manufacturing (CAM) and Rapid Prototyping tools, to supply chain management, information technology, electronic commerce, Internet of things (IOT) These systems require integration, multifunctional support and skilled workers to manage them.

12 Cultural mismatches

Culture is one of the barriers. Cultural issues of organization play important role for success of agile manufacturing. If your organizational culture is highly controlled, it's difficult to gain support for the agile concept of self-managed teams. "Inability to change organizational culture." acts as barrier. As agile puts the outcomes which matter to the customer first, that often means creating the minimum amount of documentation necessary to be effective. Some organizations are heavily invested in documentation, and these companies may find an agile manufacturing process difficult to integrate with their culture.

13 Putting on the brakes

General resistance to change acts as barrier. Agile concepts are often misunderstood or used to justify cutting a lot of corners. While documentation and project management aren't the main focus in agile manufacturing, they're still necessary.

14 Allergic reactions

Organization's particular needs and circumstances determine which agile methodologies and practices apply. "Trying to fit agile elements into a non-agile framework" is a barrier. To overcome these barriers and start integrating agile concepts into your organization, start by identifying areas that most

readily align with agile methodologies. These are typically areas that already have a project-based point of view.

Enablers to agile manufacturing:

The enablers are the methodologies, technologies and tools that support agile manufacturing. Gunasekaran (1999) describes as enablers of agile manufacturing: the strategies, the technologies, the systems and people. These factors endow the ability of the company to respond to changing market conditions. Various enablers [12] to agile manufacturing are listed below.

1. Funded training programs

Human resource management based on employee empowerment is important. Continuous training and development of the staff for skills, capacities are today's need. Financial support for such activities acts as enabler to agile manufacturing.

2. Performance evaluation

Applying proper models to measure the staff performance and creation of a total performance management system in the Organization promotes the organization towards agility. A reward plan along with performance evaluation acts as motivator.

3. Continuous improvement system

Iterative process of planning, changing, evaluating and improving elements within the organization. This process may also take place in conjunction with external supplier, customers to promote the level of agility in the organization.

4. Team working and Concurrent engineering (CE)

Organizing and doing the tasks as concurrent teams in order to compress the time of each duty and speeding up of activities. Cross functional teams and concurrent execution of activities acts as enabler.

5. Machine Stewart

In team training there is a responsible "machine steward" for each two or three equipments. This steward is responsible for management of time and tasks in manufacturing.

6. Virtual companies to address an issue

Breaking the organizational borders down even in operational levels. Joint venture with the other companies and organizations which have the complementary key competencies. Integrating with different organizations for

using their resources and competencies to develop the organization.

7.Clients and Suppliers are integrated in design

Both clients and suppliers are integrated from design stage. This helps in error reduction, decrease in time to market, and constant innovations for delivering new products.

8. ERP systems open to suppliers

An ERP system integrated with suppliers is useful to control production and stocks. This helps in keeping the suppliers updated from time to time.

9.Co-location

It enables the teams to facilitate rapid design iteration which enables flexibility and innovation.

10.New technology especially Information technology (IT)

Real acceptance and implementation of IT in the organization Facilitate information flow in organization and accessibility of the precise and updated information for employees.

11.Customer Relation Management

Strategic relationship with customer, focus on customer satisfaction is of vital importance. Enriching the customer by offering solutions to his problems. Aligning the customer services with business processes.

12.Organizational culture

Developing a flexible and innovative organizational culture is important.Organisational flexibility provides place for improving the change.

13.Change management

Process of de-initiating an organizational culture from traditional values and practices. Changing these to reflect new ideas and beliefs. The ability to change, Implementations of the changes quickly, and with the least costs.

14.Leadership

Applying the participative and team-based leadership method. Selecting the appropriate leadership style in order to forecast and response the turbulences, changes and uncertainties before they happen.

15.Knowledge management

The method to obtain, improve, transform and application of the knowledge in the organization. Providing the strategy of knowledge management, and directing the organizational movement in knowledge management.

16.Innovativeness

Promoting the innovation and invention in the organization to reach the advantages of competitive market.

17.Risk taking

Encouraging risk take in organization align with converting to an agile organization.

18.Top management support

The support of top management in order to exploit the profitable opportunities in changing market.

19.Human resources management

Implementations of encouraging and motivational systems aligned with the promotion of agility.

20.Core competence management

Recognition and nurturing the special abilities in organization which leads towards developing agility in organization.

21.Leverage use of the resources

Leveraging the impact of people and information in organization for survival and progress in the competitive environment.

Discussion and conclusion

The term “agile” is a describer of the responding speed and power in facing with internal and external organizational problems. An agile organization has to response to current changes, in addition to provide a proper ornament to obtain competitive advantages. The agile institutes think of more than conformity with the changes and tend to use the potential opportunities in a turbulent environment and reaching a tenacious position on their competencies and innovation. The agile organizations think differently of their customer needs, satisfaction. Such organizations not only sell their products, but also offer the solutions for real customer needs. They believe that their products are not complete, and try to enrich them to increase the received values from the customers or creation of value added. This may cause the position of the agile organization inaccessible for the competitors.

Furthermore, agile organizations focus on design or develop the products which enable them to respond especially to the individual customer demands.

To consolidate research the principles of agile manufacturing and the elements that define it were studied. Enablers and barriers are studied. The providers or enablers also help the organization to deal with change, chaos, uncertainty. They are the tools through which the agility is obtained. Based on the studies, factors were determined as the barriers or enablers, of agility.

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