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Characterization and Relationships between Manufacturing Flexibility for Productivity

***Piyush Raj*[*1], Dr.Manish Gangil*[*2]**

Research Scholar Department of Mechanical Engineering, SSSCE, RKDF University, Bhopal
Professor, Department of Mechanical Engineering, SSSCE, RKDF University, Bhopal
[1]rajpiyush748@gmail.com, [2] rkdfbhojpal@gmail.com

ABSTRACT

The Indian engineering industry has emerged as a dynamic sector in the country's industrial economy. From a modest beginning, the engineering industry now produces a very wide range of products like commercial vehicles, earth-moving equipment, machine tools, and a large number of other industrial goods and consumer durable. Today, the Indian engineering industry produces goods worth over Rs. 623 billion. It accounts for over 31% of total output of the country. This sector of industry employs over 2.4 million people. At present, investment in engineering industry is estimated to be around Rs. 389 billion. The engineering industry has been identified as one of the thrust areas for export promotion in the post- independence era, the industry has not only achieved significant enlargement of production capacity, but has also attained a high degree of technical competence, sophistication, and product diversification

Keywords: Manufacturing, Flexibility, Productivity etc.

1. Introduction

With liberalization in India, products and processes are undergoing a lot of changes. In today's industrial environment of unprecedented competition coupled with acute resource crisis especially of energy and material, resources need to be utilized economically. Enhancement in productivity is a key to success. To achieve this, there is a need to reduce set-up times and change-over times, and cut down the product cost by avoiding wastage of a kinds. Achieving higher productivity levels also requires analysis of the productivity trends, and their comparison with a productivity datum to have an assessment of the performance of each year. A large number of models are available for measuring productivity. [1] Applied various models like total productivity model (TPM), total factor productivity model (TFPM), and partial factor productivity model for measuring productivity of a manufacturing company. Having assessed the productivity levels and identified the reasons of low productivity, efforts can be directed to systematically achieve higher levels of productivity. The existing conventional techniques for productivity improvement have been fairly successful in the past. But these have their own limitations while dealing with the changed manufacturing systems. Owing to a large variety of products being made, the manufacturing systems have become very complex. A variety of materials, machines, tooling, and other inputs have to be employed in a production system. Still more, market uncertainties add to the decision-making complexities in the manufacturing systems. Emphasis is now shifting from mass production to production of small batches because of rapid changes in product design brought about by technological advancements. Due to short product life-cycles, firms have to quickly capitalize on narrow windows of market opportunities. Introduce new products in rapid succession, and respond in real time to remain competitive and market dynamic. This complex environment demands the system to rapidly adjust itself to complexities. [2]

2. Flexibility

Simply stated, flexibility is the capability of a system to react to and accommodate changes. To be truly flexible, the flexibility must exist during the entire life cycle of a product, from design to manufacturing to distribution. [3] State that flexibility of a manufacturing system is its capability to cope with internal and external changes effectively. Internal changes include breakdown of equipment, variability in processing times, workers' absenteeism, and quality problems Typical external changes are changes in design, demand, and product mix. A manufacturing system can have varying degree of flexibility depending on the versatility of the equipment and the way the equipment is managed. [4] States that flexibility is the ability to do things differently or do something else should the need arise. On one side, flexibility implies the ability to be versatile, while on the other side, flexibility refers to qualities such as 'robustness' or 'resilience' which enable an enterprise to endure when negatively affected by changes. All these different senses of flexibility are useful for the survival and success of a company. [5] Defines flexibility as the ability to change or react with little penalty in time, effort, cost, or performance. [6] advocates the concept of systemic flexibility, which is defined as 'exercise of free will or freedom of choice on the continuum to synthesize the dynamic interplay of thesis and antithesis in an interactive manner, capturing the ambiguity in systems, and expanding the continuum with minimum time and efforts.' [7] outline multiple types of flexibilities such as product flexibility, process flexibility, operation flexibility, volume flexibility, machine flexibility, routing flexibility, expansion flexibility, and production flexibility. [8] classify flexibility into a total of II elements - flexibility for sequential investment, flexibility for project abandonment, flexibility for new project adaptation, flexibility for continuous improvement, flexibility for trouble control, flexibility for workforce control, flexibility for work-in-process control, flexibility for changes in product mix, flexibility for new item introduction, flexibility for under demand control, and flexibility for over demand control.

3. Management of flexibility

The introduction of flexibility in manufacturing leads to higher machine utilization, improved operational control, reduced processing times, and lesser set-up times. These factors greatly contribute to reduction of product cost and enhanced productivity. Notwithstanding the fact that a higher degree of flexibility will lead to higher productivity, there is a limit put on the level of flexibility to be achieved and the way it is to be achieved. Cost-benefit analysis of the situation has to be carried out to justify the level of flexibility to be achieved. Generally, higher degrees of automated flexibility require large investments in the form of flexible machines, multi-skilled personnel, and flexible procedures and practices. This suggests a need for adopting a cautious, effective, and economically viable approach towards achieving flexibility for increased productivity. A review of the literature on different aspects of flexibility indicates that many enterprises are in the midst of fundamental changes in organizational design and management practices. Adler (1988) states that a shift towards greater flexibility generates challenges for management. The primary challenge posed by new flexible technologies is their higher 'knowledge intensity' and the management of knowledge has become the central task of the firms wanting to survive in a world of rapidly evolving technological possibilities. [9] Advocate that flexible manufacturing organizations will have the capability to be flexible in their response to unique customer demands. [10] Stresses that pioneering companies are experimenting with novel organizational structures and management processes. The impetus is towards flexible organizational forms which can accommodate novelty, innovation, and change. Other developments include delayering, team-based network, alliances and partnerships and a new employer- employee covenant [11] proposes a framework for management of flexibility which asks a manager to identify dimensions, time horizon, and elements of flexibility for effectively managing flexibility. [12] has discussed an evolving paradigm of flexible systems management, which revolves around the concepts of continuum, dynamic interplay, and freedom of choice. It contemplates the dynamic interplay on the continuum by exercising freedom of choice exhibiting 'systemic flexibility'. The flexible systems management paradigm has three components - situation, actor, and process. An industrial enterprise, which is the actor under consideration, exercises the freedom of choice to flexibly and systemically develop a management process for managing a situation. The literature review reflects the infancy of the subject of management of flexibility. Some conceptual and theoretical work has been evidenced. Practical aspects have not been dealt with in detail. The proposed work aims at collecting relevant information on the status, needs, and effects of flexible manufacturing and to work out an implementation plan considering the economic viability and competitiveness aspects.

4. Concept of Flexibility

The approach to manufacturing has undergone a considerable change in the past decade or so. Emphasis sometimes shifts from mass production to the production of small batches, because of rapid changes in product design brought about by technological advancements. Today’s market is determined by customers. For producers to exist, they must seek and produce what potential consumers require. The customers, these days, have many options available and only that product, which comes up to a customer's expectations may dominate the market. Industrial systems have become very complex owing to a large variety of products being made in a single manufacturing firm. A number of different types of materials, machines, tooling’s, skill levels, and other inputs have to be employed in a production system. Still more, market uncertainties, because of a scarcity of resources and rapid product innovations, add to the decision-making complexities in the manufacturing system. Achieving higher levels of productivity in this 1'/ complex environment requires a system to rapidly adjust itself to complexities, uncertainties, and changes. Thus, flexibility is required for increasing productivity. Simply stated, flexibility is the ability of a system to react to and accommodate changes. To be flexible, the flexibility must exist during the entire life cycle of a product, from design to manufacturing to distribution. Various researches have defined flexibility in different ways as follows:

Flexibility as the ability to respond effectively to changing circumstances. It observes that flexibility is used in two different contexts. One relates to situations like regional planning and plant expansion where decisions are made sequentially and without knowing what the future will bring, e.g., how fast the demand for product of plant will grow. He called this type of flexibility as 'action flexibility.' The other context in which flexibility is used is that in which the system considered is able to operate well in many different circumstances. He called it 'state flexibility' - the capacity to continue functioning effectively despite the change. The system has built in absorbency, robustness or tolerance to change.

A system has state flexibility if the capacity to respond to change is contained within the system while it has action flexibility if effective intervention required to respond to change must come from outside the system. Both types of flexibilities are desirable in manufacturing systems - State flexibility so that the system will operate effectively under a wide variety of circumstances without intervention from outside the system, e.g., by senior management of the firm; Action flexibility so that if, e.g., senior management decides to introduce new product lines or increase the production volume required of the system, then it would be possible for them to readily add new machines and tools to expand the capability of the system.

A flexible system is one that is able to respond to change, and flexibility is the ability of the system to respond effectively to change. The changing circumstances include both internal and external changes. Internal changes or disturbances include equipment breakdown, variability in processing times, worker absenteeism, and quality problems. External changes refer to changes in design, demand, and product mix. The ability to cope with internal changes requires a degree of redundancy in the system, whereas the ability to cope with external changes requires that the system be versatile and capable of producing wide variety of part types with minimal changeover times and costs to switch from one product to another.

The two types of flexibilities - 'job flexibility' and 'machine flexibility.' Job flexibility is the ability of the system to cope with changes in the jobs to be processed by the system. This can be achieved either at machine level or at system level. At the machine level, it can be achieved by increasing the capabilities of the machine, e.g., provision of numerical control (NC), provision of tool magazine and automatic tool changing, going from 3 axis to 5 axis capability etc. The machine is made more versatile, more complex, and provided with more sophisticated controls. At the system level, job flexibility can be achieved by distributing required capability among a variety of machines or work stations, each of which would then be specialized to do certain processing tasks. Sophisticated machining centers aim at achieving job flexibility at the machine level. A manufacturing system aims at achieving job flexibility at system level. Machine flexibility is the ability of the system to cope with changes and disturbances at the machines and work stations. As the machines are part of the system, the emphasis is on disturbances which result in failure to operate as specified by system controller. The most common approach to achieve machine flexibility is by providing process inventories (buffer storage) so that stoppage of one machine will not force the other machines down. In flow lines and transfer lines, with 110 inventories, any disturbance at a machine immediately affects all other machines. It suggests two measures of flexibility- application flexibility and adaptation flexibility. He defines application flexibility as the value of design adequacy. Design adequacy is the probability that the given structure of a production system will adapt itself to environmental conditions and to the process requirements, within the limits of the given design parameters. Adaptation flexibility is defined as the amount of time needed for the system to adapt to a change in the job task.

It considers flexibility as the ability of a system to adopt a range of states. A given production system is more flexible than another if it is capable of exhibiting a wider range of states. These states could be manifested in the system's ability to make a greater variety of products, manufacture different volumes, and so on. In addition, flexibility also depends on the ease with which it can move from one state to another. A production system which moves from one state to another, smoothly and economically, should be considered more flexible than a system that achieves the same change at a greater cost or organizational disruption. Slack has further distinguished the cost element of a system's flexibility on the basis of the cost of making the change, and the cost of providing the capability to make the change.

Conclusion

It is the cost of making the change that determines flexibility rather than the cost of providing the capability. The latter cost is not a direct element of flexibility; it is the price one pays for having the flexibility. Another factor contributing to system's flexibility is the time it takes to make the transition from one state to another. The time and cost elements of flexibility are inversely related in that the time taken to change from one state to another may be shortened at extra cost and the cost of making the change may be reduced by extending the time allowed for the change. Thus, flexibility has three dimensions - the range of states a system can adopt, the cost of moving from one state to another, and the time necessary to make the transition. Keeping these dimensions in mind, Slack has examined five types of flexibilities namely new product flexibility, product mix flexibility, quality flexibility, volume flexibility, and delivery flexibility it is suggests that the manufacturing system flexibility can be measured by two factors: the speed at which there is a response to a change, and the economic impact of the response to a change. Quickness, being an attribute, can be evaluated as the lead time between a customer’s order receipt and the completion of the product. For a quick response to change, the lead times must be minimized.

REFERENCES

1. Abraham, C., Dietrich, B., Graves, G.W., Maxwell, W.L., Yano, C., 1985. Discrete Manufacturing Taxonomy, working document. IBM Research, Yorktown Heights, NY.
2. Adelberg, A.H., 1984. An improved analysis of production-mix variances. Production and Inventory Management Journal 25 (4), 35–41.
3. Aiello, J.L., 1982. Production cost measurement and control in the process industry. APICS 25th Annual International Conference Proceedings, Falls Church, VA. pp. 542–544.
4. Allen, R.L., 1980. The applicability of standard manufacturing software to primary metals processing. APICS 23rd Annual Conference Proceedings, Falls Church, VA. pp. 85–89.
5. Allen, S.J., Schuster, E.W., 1994. Practical production scheduling with capacity constraints and dynamic demand: family planning and disaggregation. Production and Inventory Management Journal 35 (4), 15–21.
6. Anderberg, M.R., 1973. Cluster Analysis for Application. Academic Press, NY.
7. Armstrong, J.S., Overton, T.S., 1977. Estimating non-response bias in mail surveys. Journal of Marketing Research 4, 362– 402.
8. Alam Md Tawqueer and Gangil Manish cc Employees Skills Inventory using Deep Learning for Human Resource Management" Research Journal of Engineering Technology and Management (ISSN: 2582-0028) Volume 2, Issue 4, December 2019.
9. Shantilal Sonar Prashant and Gangil Manish "Warehouse Sales Forecasting using Ensemble Techniques" Research Journal of Engineering Technology and Management (ISSN: 2582-0028) Volume 2, Issue 4, December 2019.

10. Shantilal Sonar Prashant and Gangil Manish "A Review of Optimization-associated examine of Electrical Discharge Machining Aluminum Metal Matrix Composites" Research Journal of Engineering Technology and Management (ISSN: 2582-0028) Volume 2, Issue 3, September 2019.
11. Kumar Hemant Dave Kush and Gangil Manish "An Approach to Design of Conveyor Belt using Natural Fibres Composite" Research Journal of Engineering Technology and Management (ISSN:2582-0028) Volume 2, Issue 3, September 2019.
12. Kumar Hemant Dave Kush and Gangil Manish "An Assessment of Duplex stainless Steel pipe for Oil and Gas Application" Research Journal of Engineering Technology and Management (ISSN:2582-0028) Volume 2, Issue 3, September 2019.
13. Sah Ram Balak and Gangil Manish "Optimization Design of EDM Machining Parameter for Carbon Fibre Nano Composite" Research Journal of Engineering Technology and Management (ISSN: 2582-0028) Volume 2, Issue 3, September 2019.
14. Kantilal Patel Bhaumik and Gangil Manish "Scope for Structural Strength Improvement of Compressor Base Frame Skid" Research Journal of Encoineerinc Technology and Management (ISSN: 2582-0028) Volume 2, Issue 2, June 2019.
15. Kantilal Patel Bhaurnik and Gangil Manish "Recent Innovations for Structural Performance Improvement of Cotter Joint" Research Journal of Engineering Technology and Management (ISSN: 2582-0028) Volume 2, Issue 2, June 2019.
16. Tanel Hirenkumar Vishnubhai and Gangil Manish "Recent Innovations for Structural Performance Improvement of Plummer Block" Research Journal of Engineering Technology and Management (ISSN: 2582-0028) Volume 2, Issue 2, June 2019.