PROCESS IMPROVEMENT IN MANUFACTURING INDUSTRIES: A SYSTEM DYNAMICS PERSPECTIVE

B. GIRIDHAR KAMATH, RAJESH PAI, SUNITH HEBBAR, VASANTH RAO

1, 2, 3 Faculty – Manipal Institute of Technology, Manipal University, INDIA
4 PG Student -- Manipal Institute of Technology, Manipal University, INDIA

Abstract—Manufacturing firms worldwide are facing the challenges of increasing their outputs with minimal defect rates and excellent quality. Both the external and internal customer satisfaction is vital for a firm to win more orders. Lean manufacturing techniques are increasingly becoming popular and firms are paying more attention to total quality management processes. It is very evident that reduced rework can not only save time and money but also improve quality and enhance timely delivery to the customers. This paper explores the relationship between process improvement and process modelling. Simulations have been run using System Dynamics methodology and key parameters influencing process improvement have been identified.

Keywords—Defect rate, Process throughput, System Dynamics, Stock and Flow Diagram, Total Quality Management

I. INTRODUCTION

Manufacturing firms globally are constantly on the lookout for newer ways to improve the process constantly so that rework can be reduced. With the concepts of recycling and sustainability issues capturing the attention of customers worldwide, there is a lot of emphasis on the manufacturing firms to improve the process continuously and provide customers with quality products at competitive prices. Concepts like Business Process Reengineering (BPR), Six Sigma, and Total Quality Management (TQM) that are adopted by manufacturing firms are based on the basic ideas of lean manufacturing. This paper deals with the System Dynamics methodology to understand the impact of various variables that influence BPR and TQM. Manufacturing sector in Indian context has been the primary point of concern in this paper.

II. LITERATURE REVIEW

Business process management basically is an effective approach of management that primarily focuses on the customer needs. It encourages invention, innovation and newer ways to link technology with the manufacturing processes. The activities that are involved in business process management starts with the design followed by modelling, execution, monitoring and ends with optimization. Total Quality Management is a management philosophy that has been gaining popularity in the recent times with proven advantages to the firms adopting it successfully. TQM is a holistic approach that is not just related with process improvement or reducing lead times but also is very important in building relationships with suppliers, internal customers and external customers, thereby leading to overall organizational performance. This research paper mainly aims at the improvement of the stability of the process. An attempt has been made to identify various factors that affect the process improvement. Also the various TQM factors that affect the process improvement are studied. Dean and Bowen (1994) had pointed out that for organizations to sustain in the competitive markets and fulfill the growing demand of the customers, organizations must try and improve their basic manufacturing process. Research on TQM shows that firms must constantly look out for measuring customer satisfaction as it is prime for the organizations to improve. Christos and Evangelos (2009) argued that a decrease in customer complaints and increase in customer retention rate is an indication of customer satisfaction that can act in favour of the manufacturing firm. An organization mainly has three stakeholders namely owners, employees and customers and satisfying these three stakeholders largely depends on the organizational performance. Hence it is very important to understand what organizational performance means and how it can be measured.

According to Bititci et al., (2000), execution or accomplishment of tasks or goals to a definite level of satisfaction is performance. Bititci et al., (2000), defined organizational performance as the ability of an organization to satisfy the desired expectations of three main stakeholders comprising of owners, employees and customers.

- Owners’ satisfaction with financial returns or profits from organizational operations.
- Employees’ satisfaction with the conditions of work, such as wages and remuneration, style of supervision, rapid promotion and the
ability of the organization to guarantee job security.

- Employees’ desire to stay with the organization, i.e., the ability of the organization to retain its workforce.
- Customers’ satisfaction with the quality of the products of the organization.

III. METHODOLOGY

The methodology adopted in this research paper is the System Dynamics (SD) methodology. Sterman (2000) clearly enlists the 5 steps of the System Dynamics process that can help a modeller in developing a model that would help in studying a system under consideration. The steps involved are problem articulation, dynamic hypothesis, formulation, testing, and policy formulation and evaluation based on the simulation results. The basic model of this research is the model developed by Repenning and Sterman (2002).

An attempt has been made to add many other variables to the existing model based on the objectives of the study. A new stock and flow diagram is developed and is simulated after relating the variables with mathematical equations thereby generating graphs.

IV. RESULTS AND ANALYSIS

TQM is the qualitative technique which is taken in a scale factor from 0 to 1, where 0 is the minimum value (no TQM technique implemented) and 1 is the maximum value (all possible TQM techniques are implemented). For e.g.: If scale factor is 0.1 it means that 10% of the total available TQM techniques are implemented and this and so on. These improvements will increase the productivity which in turn influences the throughput which there by reduces the time taken for production and hence more time can be allotted to analyze the process problems. The model was simulated for 100 weeks and iteration has been carried out by varying the variable TQM techniques from 0 to 0.5 in the steps of 0.1 and is represented as TQM10%, TQM20%, TQM30%, TQM40%, and TQM50% respectively in the simulation graph. The influence of this on Process problems, Defects, Gross process throughput, Net process throughput, and Throughput gap, Allocation for production and Allocation for improvement were analyzed.

It is imperative from the figure 2 that there is a gradual increase in the defects over a period of time in the initial period because this is the time taken for TQM implementation. Due to this all the simulations follow the same pattern.

But after a period of time there is a considerable decrease in the defects as the TQM efficiency is increased. It can be noted that, till that efficiency is up to 20%, the defects are high but after this defect rates move very close to each other. It can be noted that there is almost 34% reduction in the defect level between 10% and 30%. So it is advisable that efficiency should be increased at least to about 30%.
It can be observed from the figure 3 that the gross throughput time increases drastically as the efficiency of TQM is increased. This increase will be up to 55 weeks after which it falls gradually over a period of time. This fall may be due to the dominance of other factors which are influencing the process. This necessitates the continuous upgradation of the TQM process.

As the efficiency of TQM is increased there is a drastic decrease in the throughput gap as shown in the figure 4. The gap goes to the lowest point by around 50 weeks. It can be absorbed that there is a decrease in the gap as the TQM efficiency is increased from 10% to 50%. It can be observed that the system stabilises at around 90 weeks and there is almost a 40% decrease in the throughput gap.

It is clear from the figure 5 that the allocation to production decreases as the efficiency is increased. There is almost a 40% decrease here which will be of great advantage in this highly competitive customer focused market.

CONCLUSION

This paper developed a system dynamics model starting from the base model developed by Repenning and Sterman (2002). Simulation results demonstrate that an increase in the goal for performance can lead to improved performance. For mild increases in the goal, the organization can achieve reasonable improvement. For drastic increases in the goal, the organization move towards a state of performance inferior to the starting point.

The purpose of this paper is to explore the relations between process improvement and process modelling. This paper attempted to produce such a model which related factors of quality and its impact on the process improvement parameters.

It is quite evident from the results obtained from simulation that the implementation of TQM had positive impact on various parameters. There was a decrease in process problems or defects. The gross process throughput increased. There was a reduction in the throughput gap and the allocations to production reduced to a large extent.

FUTURE SCOPE

The existing stock and flow diagram can be developed by adding various other variables and be related with valid mathematical equations and can be simulated to various realistic values so as to develop policies for the management to improve the processes constantly. As seen from the various simulations, there is ample scope in the processes for improvement. Instead of going for drastic improvements, a System Dynamics model incorporating Kaizen can be developed and its influence on process improvement can be studied by simulations.

REFERENCES


Figure 2: Stock and Flow Diagram