

Inventory Management Techniques: Optimizing Plant Operation in a Manufacturing Industry

Shivaji Sagar*

*Mechanical & Automation Engineering Department, Amity School of Engineering & Technology, Amity University, Mumbai, India

e-mail: somashivajisagar@gmail.com,

*Corresponding Author: somashivajisagar@gmail.com,

Available online at: <http://www.ijcert.org>

Received: 08/June/2018,

Revised: 06/June/2018,

Accepted: 12/June/2018,

Published: 15/June//2018

Abstract: - The main objective of this paper was to study the inventory management techniques and analyze the pros and cons of the existing technique and if needed, suggest a better-suited technique. The paper also sketches a background on the various costs involved and general inventory management techniques followed. The study uses a descriptive research design. The area of the study was a mechanical industry which produces valves, located in Chennai which is located in the Ambattur Industrial Estate. The inputs from the respondents were collected using a questionnaire and an interview guide. Secondary information was collected from different sources like; textbooks, internet, newspapers, magazines, and journals. The researchers obtained information from the staff and some clients who order directly from its premises. The sample size consisted of 50 respondents. The gender and age compositions of the respondents were established to eliminate any bias, in case of any. The results from the questionnaires and personal interviews were tabulated and analyzed and a relationship between the inventory management technique employed and performance was established based on the opinions of the respondents. A majority of the respondents agreed to positive relationship between the technique and performance of the company. A few respondents indicated inventory management as having a negative relationship on the performance. These same respondents believed that, inventory management involves a lot of costs, inconsistency as there is overcharging of customers, use of highly skilled workers in charge of managing inventories, theft, obsolescence among others all of which increase on the costs hence reducing much of the on the performance of the organization in question especially in the production department.

Keywords: Inventory Management, EOQ, Management, Optimization, Plant Operation.

1. Introduction

Inventory can be defined as "a stockpile of goods an organization is offering for sale and components that are used in the manufacturing process."It includes Finished goods, Raw materials (work in process), Supplies. Some of the principal reasons for obtaining and holding inventory are predictability, fluctuations in demand and supply, unreliability in supply, price protection, quantity discounts

and lower ordering costs. Inventory Control is defined as the supervision of supply, storage and accessibility of items in order to ensure an adequate supply without excessive oversupply. The objective of inventory management is to have the appropriate amounts of materials in the right place, at the right time, and at low cost.

Leaders/Fearon (1997), points out purchasing systems as one of the techniques of controlling inventories.

Stockless purchasing systems are a special sub set of systems contracts where the purchaser's stock is taken over by a supplier. The supplier's delivery system is so reliable and fast that there is no need for any safety stock on the purchaser's premises. Determining order quantities and inventory levels is another technique. In the following sections, some relatively simple theoretical models used to determine order quantities are discussed. The application of these models depends on whether the demands or usage of the inventory is dependent or independent. According to the van Horne (1989), a company should introduce policies to reduce lead time, regulate usage and thus minimize safety status. Therefore the finance manager should ensure that only an optimum amount is invested in inventory to achieve the trade-off between profitability and liquidity (Pandey 1995). Inventory recording is undertaken to reduce the error relating to inventory accountability and accuracy in a firm's investment in inventories. Wood Frank (1996) indicates the stock accounting is essential in any firm as it registers the changes in the level of stock held to realise maximum value and avoid tying up funds. Inventory recording may take stock taking, and sports checks which are processes of physical counting, weighing or otherwise measuring the quality of each item in stock and the recording system should reduce the discrepancies between inventory in the record and the physical commodity.

Inventory management essentially involves two aspects, planning and control. The plan consists in prophesizing regarding the quantity of items to order, the time for placing the order and the lead time. Control involves following the accepted procedure, assigning responsibilities and periodic monitoring of stock levels. The primary objectives of inventory management are to minimise the possibility of disruption in the production schedule of a firm for want of raw material, stock and spares and o keep down capital investment in inventories. The aim of inventory management thus should be to avoid excessive inventory and low inventory and to maintain adequate list for smooth running of the business operations. Efforts should be made to place orders at the right time with the right source to purchase the right quantity at the right price and quality.

2. Inventory Management: Definitions and Concept

There is a need for proper management of the inventory in any industry. Inventory management,

according to Garry, J.Z, (1997), involves the planning, ordering and scheduling of the materials used in the manufacturing process. It exercises control over three types of inventories, i.e. raw materials, work in progress, and finished goods. Inventory control refers to the process whereby the investment in materials and parts carried in stock is required within pre-determined unit set following inventory policy established by management.

2.1 Terms used and Pre-requisites

Inventory Control: Inventory Control is defined as the supervision of supply, storage and accessibility of items in order to ensure an adequate supply without excessive oversupply.

Inventory costs:

- i. Ordering cost: Cost of procurement and inbound logistics costs form a part of ordering cost.
- ii. Carrying cost: Inventory carrying involves Inventory storage and management either using in-house facilities or external warehouses owned and managed by third-party vendors.
- iii. Storage Cost: Inventory storage costs typically include the cost of building rental and facility maintenance and related expenses.
- iv. Cost of Capital: Includes the costs of investments, interest on working capital, taxes on inventory paid, insurance costs and other costs associated with legal liabilities.

Reorder Level: It is a point at which order for supply of material should be made. It is also known as 'ordering level' or 'ordering point' or 'ordering limit'.

Economic Order Quantity: The purchasing department should determine the most economical buying quantity or the optimum quantity by considering the factors such as the cost of ordering, holding or carrying.

$$Q = \frac{\sqrt{2AS}}{I} \quad \text{-----} \quad (1)$$

Q: Quantity per order;

A: Annual requirements of an item regarding rupees;

S: Cost of placement of order in rupees; and

I: Inventory is carrying the cost per unit per year in rupees.

2.1 Inventory Management Techniques:

2.2.1 ABC Analysis

-Always Better Control

In 1907, an Italian sociologist and economist by the name of Vilfredo Pareto (1848–1923) wrote his belief that 80 to 85 per cent of Italy's money was held by only 15 to 20 per cent of the country's population. He called the small, wealthy group the "vital few" and everyone else the "trivial many." This ultimately came to be known as the "80–20 Rule" or Pareto's Law. The concept stands for the proposition that within any given population of things, approximately 20 percent of them have 80 percent of the "value" of all of the items concentrated within them, and that the other 80 percent only have 20 percent of the value concentrated within them. ABC analysis is based on Pareto principle (80-20 rule) which states that 80% of the overall consumption value (expense) is based only on 20% of the total items i.e. small portion of the items may typically represent the bulk of money value, while a relatively large number of items may form a small part of the money value. ABC analysis is a method for dividing on-hand inventory into three classifications A, B, C based on annual consumption unit.

- "A" items: money value is highest (70%), represent only 10% of items
- "B" items: money value is medium (20%), represent about 20% of items
- "C" items: money value is lowest (10%), represent about 70% of items

Management policies for ABC categorization:

ABC classification shows that not all the inventories need to be controlled with equal attention. ABC analysis for prioritization allows the management to decide which items

require most effort in controlling.

- A-items should have tight inventory control under more experienced management. Re-orders should be more frequent.
- B-items require medium attention for control. An important aspect of class B is the monitoring of potential evolution toward class A or, in the contrary, toward the class C.
- C-items require minimum attention and may be kept under simple observation. Re-ordering is less frequent.

2.2.2 Economic Order Quantity

The EOQ has been previously defined by Dervitsiotis (1981), Monks (1996), Lucey (1992), and Schroeder (2000) as the ordering quantity which minimizes the balance of cost between inventory holding costs and re-orders costs. The EOQ refers to the order size that will result in the lowest total of order and carrying costs for an item of inventory. If a firm places random orders it will incur unneeded order costs.

The constraints and assumption followed:

1. Demand is known-- Using past data and future plans a reasonably accurate prediction of demand can often be made. This is expressed in unit sold in a year.
2. Sales occur at a constant rate-- This model may be used for goods that are sold in relatively constant amount throughout the year. A more complicated model is needed for firms whose sales fluctuate in response to their seasonal cyclical factors.
3. Cost of the running of goods are ignored-- Cost associated with storage, delays or lost sales are not considered. These costs are considered in the determination of safety level in the re-order point subsystem.
4. Safety stock level is not considered-- The safety stock level is the minimum level of inventory that the firm wishes to hold as a protection against running out. Since the firm must always be above this level the EOQ need not be considered the safety stock level.

$$\text{Total Ordering Cost (TOC)} = (A/Q)*O \quad (2)$$

$$\text{Average Inventory} = Q/2 \quad (3)$$

$$\text{Total Carrying Cost (TCC)} = (Q/2) * C \quad (4)$$

$$\text{Total Inventory Cost} = \text{TOC} + \text{TCC} \quad (5)$$

$$\text{Total Cost} = (\text{AO}/2) + (\text{QC}/2) \quad (6)$$

Where

A: Total annual demand

Q: Quantity order in units

O: Order cost per order

C: Carrying cost per unit

$$EOQ = \frac{2(U)(OC)}{CC\%PP} \quad (7)$$

Where

U: Units sold per year-a forecast provided by the marketing department.

OC: Cost of placing each order for more inventory-provided by cost accounting.

CC%: Inventory carrying cost expressed as a percentage of the average value of the inventory- an estimate usually provided by cost accounting.

PP: Purchase price per each unit of inventory -supplied by the purchasing department.

3. Methodology

3. 1 Methods of Data Collection

The research data was collected through a combination of primary and secondary sources at the company which includes:

- i. Interview with some key personnel involved with inventory management, the store supervisor, the plant manager and some senior production department personnel.
- ii. Visual observation of the flow of materials in the plant from its arrival as raw material to storage as a finished component.
- iii. Analysis of data obtained from the accounting and finance department of the company.

- iv. Background information on the company and review of literature on inventory management.

3. 2 Methods of Data Collection

The collected data was analysed using quantitative research instruments. The EOQ Model and ABC analysis were employed for data interpretation. The EOQ Model was used to determine the optimum inventory level per year and the ABC Analysis was performed to identify the raw materials commonly used and how they were stored in the warehouse.

4. Data Presentation, Analysis and Findings

4. 1 Inventory Policy and Store Functions at Organization

The inventory policy of the Company can only be appreciated in the context of the field specialisation of component manufacturing undertaken by the company. Most of the products manufactured are unique and the raw materials utilized are specially procured and stored. An optimum level has to be ordered to avoid wastage and prevent expiry of raw materials. So the policy employed is that raw materials are only ordered after a job is contracted and no safety stock is maintained as raw materials may not be used again before expiry. The inventory policy employed is then incorporated into the company's overall objective. The main determinant of this policy is the demand for the product. Some raw materials which are common to all jobs are stored at the plant.

The company's objective is to maintain quality and increase profitability. This implies that enough inventories should be available to enhance continuous production. This fact also determines the levels of inventory, which the company keeps.

The company maintains three sets of stores, the raw material stores, the finished goods stores and the spare parts machinery stores. The store manager operationally works in conjunction with the production manager. Inventory is tracked inside the plant via the use of software developed in-house by the company called SARVAM (Sound Architecture for Valve Manufacturing). The finished goods store is headed by the sales manager assisted by the stores manager. The spare parts store is headed by the Plant Engineer. This store houses commonly used raw materials such as SS316 Stainless Steel, Blanks of various high-temperature steel and some commonly used

support assemblies such as screws, bearings, nuts and bolts etc.

4.2 Data Presentation and Interpretation

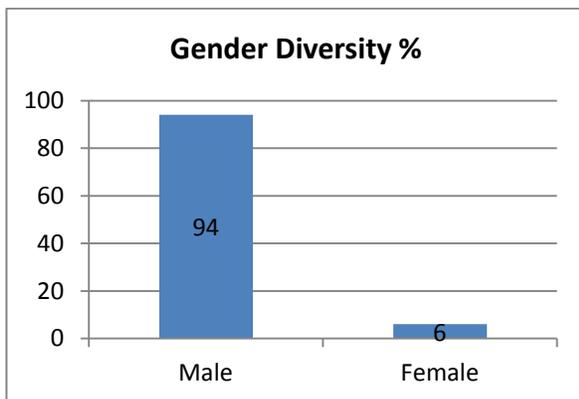
The preceding section dwells on quantitative information of the plant. In this section, the data are entirely quantitative as collected from the accounts department, production department and the store.

4.2.1 Background Information on respondents:

The background information of the study was considered by the study so as to establish how different characteristics of the people could differently understand the relationship between inventory management and performance. The following data was revealed by the study. Firstly, the gender of respondents was established. This aimed at knowing how males and females as community members actively participate in private organizations.

Table 4.1: Gender Diversity in the Sample Pool

Gender	Frequency	Percentage (%)
Male	47	94
Female	03	6
Total	50	100



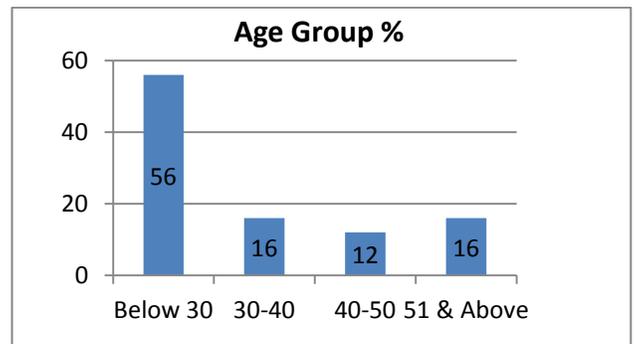
Graph. 4.1 Shows the percentage of Gender Diversity

As illustrated in Table 4.1, the majority of the respondents were male as compared to the female. The number of males who participated in the study was 47 (94%) as compared to a lesser number 3(6%) of the female respondents. This discrepancy between the number of male and female employees can be attributed to the field of operation.

Next, the age composition of the respondents was established. The age composition of the study respondents was deemed an important factor in the process of understanding the relationship between inventory management and performance because different age groups were assumed to understand the study variables differently yet considered vital to the study. According to the study findings the respondent's views were:

Table 4.2: Age Variation of Sample Pool

Age range	Frequency	Percentage (%)
Below 30	28	56
30 -40	8	16
40 – 50	6	12
51 & above	8	16
Total	50	100



Graph. 4.2 Shows the percentage of differentiation of Age group

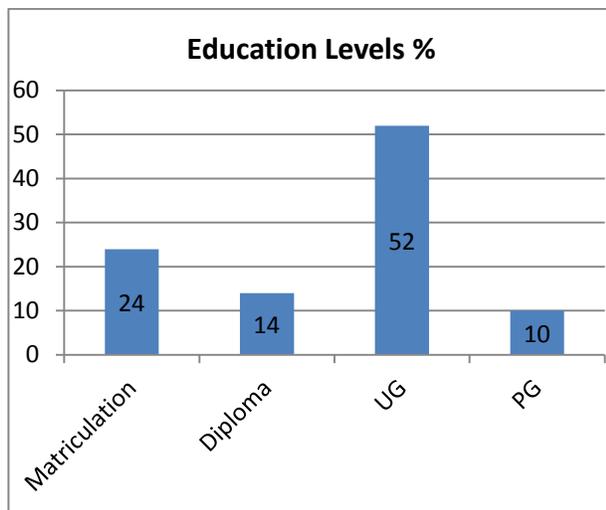
Table 4.2 shows that most of the respondents were below the ages of 30 accounting for 56% of the sample pool. This implied that they were likely to understand the relationship between inventory management and performance. The other category of the respondents were in

the age range of 30-40 a reported 16% of the study respondents and these respondents' views were important for the study as most of them were participating in the managing of inventories at the company. Moreover, 16% of the study respondents were in the category age of 51 & above. These respondents' views were vital in the process of analysing the study variable and helped understand the problem. The age composition of the study respondents could, therefore, be an important factor in generating valid information concerning the issues in inventory management and performance.

Lastly, the level of education of the respondents was established.

Table 4.3: Education Levels of the Sample Pool

Level of education	Frequency	Percentage (%)
Matriculation Level	12	24
Diploma Level	7	14
Undergraduate Level	26	52
Postgraduate level	5	10
Total	50	100



Graph. 4.3 Shows the percentage differentiation of Education Level

Table 3 above shows that most of the respondents

nearly 52% had attained an undergraduate level of education, followed by 24% of the study respondents who had attained a matriculation level of education and a postgraduate level as was indicated by 10% of the respondents, finally 14% of the respondents cited that they had attained a diploma level of education. The study showed that all the study respondents who had attained secondary and primary levels of education were mostly people in the production department and some were also performing different tasks like offloading and loading the truck at the company. The above findings show that secondary levels take a lead in participating in the company as compared to those with primary level, tertiary levels and University level of education. This is a manifestation that the information was from literate people and who understood the relationship between the study variables.

4.2.2 Techniques used:

According to the study findings, all (100%) of the respondents were able to understand the term inventory management. Further, some of the study respondents indicated that inventory management can also mean managing of stock in the organizations setting. After confirming that the respondents knew of the term materials handling, the study went ahead to establish whether the industry was taking part in inventory management and findings from the survey reported that the company was taking part in managing its inventories despite using different techniques of inventory management as shown in Table 4.

Table 4.4: Response of Sample Pool to the Questionnaire

Techniques of Inventory Management	Yes	No	Frequency	Percentage (%)
The arrangement of inventories based on importance	40 (80%)	10 (20%)	50	100
Purchase of raw materials after the client order	27 (54%)	23 (46%)	50	100
Produces inventories as per client requirement	17 (34%)	33 (66%)	50	100

A permanent record of Inventory	21 (42%)	29 (58%)	50	100
Enhancement of Security System in the store	50 (100%)	0 (0%)	50	100

As illustrated in Table 4.4, the study sought to know whether the industry was arranging materials in stores according to their importance. The respondent's views are as indicated in the table above. Nearly 40 (80%) were in agreement as compared to the 10 (20%) who were in disagreement. This meant that the Company management paid attention to the inventory management of material in the store to a higher extent. From the above results, the arrangement of elements at the industry for improved Company's performance especially in the production department was still wanting.

The study also sought to understand whether the Company was purchasing raw materials after the customers have ordered for goods. Results from respondents' views indicated 23 (46%) disagreement with the statement and 27 (54%) responses of the agreement. These study findings showed that industry is purchasing raw materials after the customers have ordered for goods from the Company as the majority of the study respondents indicated. This is because most of the components manufactured by the company are client-specific and need particular raw material as per requirement.

From respondents' views, the company records inventories purchased and sold. Agreement reflected this to the statement by 50(100%). The results above can be interpreted that records inventories bought and sold at all times and that it was using a recording of stockpiles as one of the inventory management techniques for improved performance of the company. This was substantiated by a view of respondents who were personally interviewed that the company issues different documents like invoices, goods received a note, goods returned note and still that the company had a general book for recording all the company transactions concerning the materials produced, received and issued at the company.

Qualitative results as obtained from the interview further confirmed the common techniques of materials handling, used were to include an integrated system

(System Application and products), responsible for management information system which helps to make serious decisions on stock, material requirement points, and overstock brands for the fast moving products, plus recording of all the purchased and issued materials to the production and operations department of the Company.

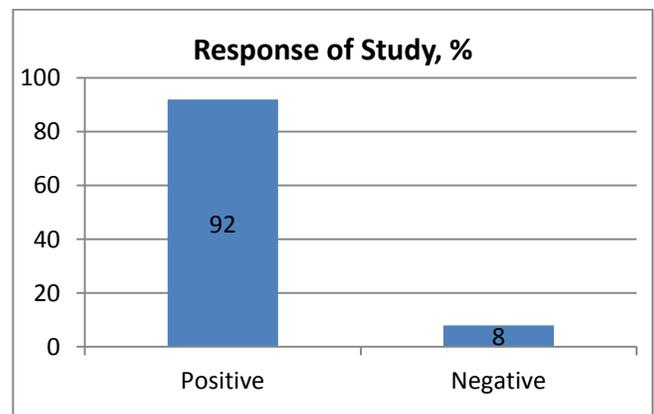
4.3 Relationship between Inventory Management and Performance

The study also looked at whether there is a relationship between inventory management and performance. The views as per the study respondents revealed that all of them believed that inventory management techniques are related to performance of the company.

Respondents from the study reported the relationship between inventory management and performance can be either negative or positive depending on the way how the method/technique is applied in the management inventories.

Table 4.5: Response of Study Pool to the relationship between inventory management and performance

Relationship	Frequency	Percentage (%)
Positive	46	92
Negative	04	08
Total	50	100



Graph. 4.4 Shows the percentage of differentiation of response

of study between inventory management and performance

From the Table 4.5 above, the majority of the respondents 46 (92%) said that materials handling techniques have a positive relationship between inventory management and performance. The study respondents who claimed that inventory management techniques has a positive influence on the execution went ahead and said that as such methods of managing inventories help in proper planning of the materials needed by identifying the gap between the desired and the actual level of materials, allocation of resources, purchasing, sales and employment of staff and everything concerned to human resources management all of which reduces the costs incurred by the organization. However, some of these respondents said that the positive relationship of the inventory management techniques on the performance depends on how the users use the methods at the company plus the prevailing conditions, like power.

When the researcher inquired on issues related to the recording of inventories at the company and whether it was helping in proper decision making, there was a high level of agreement that record of stocks at the Company was helping inappropriate decision making. In conclusion, results indicate that almost all the decisions made by the company management in the process of managing inventories aim at influencing the production department of the company for better results.

Qualitative results from a majority of interviewed participants on the matters about whether inventory management techniques have any influence on the performance of production department of the company revealed that such a relationship exists. The respondents, further, explained that good management of inventories maintains the quality of the company products produced from the production department, controls time management especially during the production process and that materials can be easily identified primarily in the store department when need be in the production section of the company. Most of the respondents still argued that proper materials handling reduces labour and associated costs for improved performance of the company.

Also, 4 (8%) of the respondents indicated inventory management as having a negative relationship on the performance. These respondents believed that inventory management involves a lot of costs and

inconsistency as there is overcharging of customers, use of highly skilled workers in charge of managing inventories, theft, obsolescence among others all of which increases the costs. These same study respondents further cited that purchasing of raw materials after the customers have ordered for goods influences the company's performance negatively regarding profitability level because most of the study respondents indicated that this does not help to maintain the company customers.

However, basing on the most of the study respondents as eluded in the table above, the study, therefore, established that there is a positive relationship of inventory management on performance as was revealed by majority 46 (92%) of the covered respondents during data collection process.

5. Conclusion and Recommendations

Inventory management has become highly developed to meet the rising challenges in most manufacturing companies in response to the fact that inventory is an asset of highest importance. The inventory management at Mechanical Industry, Chennai has been analysed using the EOQ model. It was also seen that the company through a well-built policy is able to handle its idle stock without incurring unnecessary costs. A basis for inventory planning and control was also provided in this study.

- Analysis of the inventory policy of the company has revealed the need to remedy some situations in the company's inventory management.
- The study thus suggests some recommendations to remedy certain shortcomings overlooked in the company inventory policy and if these recommendations are implemented, the company's inventory management situation will be more efficient.
- Firstly, more importance should be placed on the economic order quantity model because it will in the best interest of manufacturing companies to maintain an optimal level of materials in store. To implement this successfully the various costs associated with inventory should be segregated and arranged in such a way that EOQ can be easily determined.
- Secondly, though a positive relationship between inventory and sales and between inventory and production cost was mentioned in the analysis, this does not imply that inventory levels determine the production costs or sales and vice-versa. However, it shows that inventory levels can be a useful indicator of

sales level. So in our opinion, the sales and marketing departments should pay closer attention to the inventory usage and growth pattern and incorporate it into their operation.

- Lastly, materials management unit should also pay attention to sales growth and take into consideration the relevance of sales and production cost in deciding with regards to inventory.
- It is also recommend updating of the inventory management software based on user inputs and increase in the frequency of updating of the database.

References

- [1]. Alvesson, M. (2001); The Structuring of Organizations: Prentice-Hall, *Englewood Cliffs*, N.J.
- [2]. Leenders/ Fearon (1997); Purchasing and Supply Management 11th Edition.
- [3]. Malcom Saundrers (2005); Strategic purchasing and supply chain management 2nd edition, *Pitman Publishing*, 128, Long Acre London.
- [4]. Gary J. Zenz (1997); Purchasing and the Management of Materials Florida State University, 7th edition, simultaneously, Canada, USA.
- [5]. Ronald H. Ballow (1997); Business Logistics Management International Edition, Prentice Hall International Inc., USA.
- [6]. Michael, E. Porter, (1994); Competitive Advantages of Nations, *Mc Millan*.
- [7]. Peter, D. (1983); The Practice Management Heinemann, *Professional Publication*.
- [8]. Peter J. And Waterman. R. (1988); In Search of Excellence; Lessons from American Best-Run Companies, *Harper and Row*.
- [9]. Hellen C. (1993); Human Resources Management Personnel Policies and Procedures.
- [10]. Lau A., & Snell R. (2006); Structure and Growth in Small Hong Kong Enterprises. *International Journal of Entrepreneurial Behaviour & Research*, 2 (3), 29-47.
- [11]. Lei, D, Slocum, J.W., & Pitts, R.A. (1999); Designing Organizations for Competitive Advantage: The Power of unlearning and Learning. *Organizational Dynamics*, winter, 24-38.
- [12]. Likert R. (2003); The New Patterns of Management: *Mc Graw-Hill*, New York.
- [13]. Colvin, J. G & Slevin, D.P (2007); The Structures in Fives: Designing Effective Organizations, *Prentice-Hall*, Englewood Cliffs, N.J.
- [14]. Halachmi, A., & Bouckart G. (2005); Performance Measurement, Organizational Technology and Organizational Design. *Work Study*, 43 (3), 19-25.
- [15]. Dervitsiotis KN 1981. Operations Management. USA: *Mcgraw-Hill Series in Industrial Engineering and Management Science*.
- [16]. Drury C 1996. Management and Cost Accounting. London: *International Housan Business Press*.
- [17]. Keth L, A Muhlemen, J Oakland 1994. Production and Operations Management. London: *Pitman Publisher*.
- [18]. Kotler P 2002: Marketing Management. 2nd Edition. The Millennium Edition. New Delhi: *Prentice Hall Of India*
- [19]. Lucey T 199: Quantitative Techniques. 4th Edition. London: *Ashford Colour Press*.
- [20]. Lucey T 1996. Costing. 5th Edition. London: *Ashford Colour Press*.
- [21]. Monks JG 1996: Operations Management.
- [22]. Schaum's Outline of Theory and Problems. 2nd Edition. USA: *McGrawHill Companies Inc*.
- [23]. Morris C 1995. Quantitative Approach in Business Studies: London: *Pitman Publisher*.
- [24]. Rosenblatt BS 1977. Modern Business- A Systems Approach. 2nd Edition, Boston: *Houghton Mifflin Co*.
- [25]. Schroeder RG 2000. Operations Management- Contemporary Concepts and Cases. USA: International Edition.
- [26]. Thomas CK, Kenneth LB 1990. Principles of Marketing. 3rd Edition, USA: Scott Foresman And Co.

Authors Profile:

Mr. Shivaji Sagar

Assistant Professor,

Department of Mechanical and Automation Engineering,

Amity School of Engineering and Technology,

Amity University Mumbai,

Panvel, Maharashtra.

Email: somashivajisagar@gmail.com