Simulation study and analysis of inventory stock taking in manufacturing industry

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Abstract: Staying ahead with their competitors and to satisfy the customer is not an easy task in today’s competitive world. Hence manufacturing companies are searching for new ways to improve industry operations. Inventory is an important asset for any organization and inventory plays a crucial role in smooth running of any organization’s activities or processes. Inventory forms include raw materials, WIP (work in progress), finished and unfinished goods. For calculation of holding cost of an inventory, maintaining accurate records is essential. There is always a mismatch in physical v/s system stock. To cross verify it, it’s always a time consuming and may result in production loss. The main objective of this study is to find an appropriate way of doing the things. Managing the production loss from small or large scale industries is a difficult task. Study has been carried out at forged products and equipments manufacturing industry, situated in Hubballi, Karnataka, INDIA. Simulation software has been used for conduction of the experiment and hence results obtained are analyzed. Based on the obtained results necessary changes have been proposed in the existing warehouse layout.

Keywords: One part one location; Warehouse layout; String diagram; Simulation experiment.

1. INTRODUCTION

The Industry considered for the present study is a medium scale industry and is capable of producing more than 500 numbers of products per day. Study has been carried out at forged products and equipments manufacturing industry, situated in Hubballi, Karnataka, INDIA. It requires a well structured warehouse to store multiple numbers of parts in its location. Inventory forms include raw materials, WIP (work in progress), finished and unfinished goods. Aashna Sharma and Vivek Arya have explained study of inventory management in manufacturing industry [1]. Poor inventory management leads to wastage of time, impossible to track inventory, increased costs, decreased warehouse organization. Through the observation it was clear that the “Bought Out” parts where stored at multiple locations in the warehouse. It was time consuming for the stock associates to search the parts lying at different locations in the warehouse. Hence requirement of parts for the production purpose was delayed due to time consumed in physical stock taking. Two ways of managing the stock in the company are Stock taking and stock checking. People believe that both are same, but there is a major difference which sets them apart. Physically verifying the quantity and quality of the inventory on hand is a stock taking process. It is done to check the conditions in the inventory. Whereas stock checking process ensures that the levels of the stock are sufficient to meet the demands of the customers without a delay in the delivery. There is a legacy system available in the industry for the stock taking. But there exists a certain problem i.e. mismatch of system recorded stock and physically recorded stock. Until there is a human interference, it is a must for the industries to check the
availability of stocks through system as well as physical. Simulation is a powerful modeling and analyzing technique and it is a highly profitable method and a tool for testing new processes without having to carrying out actual experiments. The objective of this study is to improve the warehouse storage location through detailed analysis of the existing warehouse. Simulation tool was used to build the system model by running real time simulation [2]. Some researchers have worked on simulation study and analysis of different manufacturing and service sectors [3-5]. Figure 1 shows the cause and effect diagram of inaccurate inventory. This is also known as fishbone chart. The main purpose of this chart is to identify the root cause of the problem.

![Diagram showing cause and effect of inaccurate inventory](image)

**Figure 1.** Cause and Effect diagram of Inaccurate Inventory

2. METHODOLOGY

Purpose of this research is to conduct the detail analysis of the warehouse layout through simulation method. The information regarding the warehouse resources are recognized and reported. Distance travelled by the individual associate from one part location to other location, and the time spent in stock taking has been recorded. Once the data has been recorded simulation model has been built with the use of different modules using simulation software. And the model should be verified and validated. Once an authorized model is built, experiment is conducted to check for the feasible solution. Simulation study is carried out with all the detailed information regarding the warehouse processes. The model emulates the behavior of the absolute system considered. Ultimately the built out model is utilized to explore the real system behavior. And the simulation results are authentic and can be implemented. Figure 2 shows the steps involved in simulation study. Figure 3 shows flow chart for inventory process.
3. WAREHOUSE LAYOUT ANALYSIS

The warehouse process of the forged products and equipment manufacturing industry, Hubballi has the following stages as mentioned in figure 4. This is the existing process carried out in the warehouse layout for the stock taking of parts. Figure 5 shows analysis of existing warehouse layout.

Figure 2. Steps in simulation study

Figure 3. Flow chart of Inventory process
Figure 4. Stages of the Inventory stock taking

Figure 5. Analysis of existing warehouse layout

For your reference, the parts shown in the existing warehouse layout are mentioned with different colors such as P1 Red color — Shafts, P2 Brown color — Rear gear, P3 Blue color — Drop forged top cup, P4 Yellow color — Scaffolding Clamp, P5 Green color — Axle gear. With an analysis of the existing layout, parts stored at multiple locations lead a stock taking associate to move around number of times searching for the parts and it is very laborious and time consuming. Once the manual stock taking process is done, it is cross verified with the system stock (receipt), hence most of the times there is a mismatch. Sometimes the parts to be moved to the production line are delayed. This results into a huge loss for the company. The distance travelled by an associate at multiple locations for the stock taking process can be seen further in a string diagram shown below.
3.1. String diagram of existing warehouse layout

Figure 6. String diagram of existing warehouse layout

A1 A2, A3 (Associates) --- Product (P1, P2, P3, P4, P5)

It is one of the simplest approaches for method study. String diagram is the pictorial representation of motion of man and materials during a specified course of events [6]. It is very useful to deal with complex movements and the plant layout. Measuring tape and stop watch was used to measure the distance travelled and the time taken by an associate while stock taking at multiple locations. String diagram helps in tracing existing paths of movements. Specifies the pattern of movements and thus helps in determining the most efficient routes to perform a particular operation. In this diagram the path of the motion of an associate involves several unnecessary movements.

Figure 6 shows that an associate in an industry spends half of this time in searching of parts at various locations. To minimize the distance travelled and the time taken in stock taking there is a necessary for the standard method. Table 1 below shows the distance travelled and total times in existing warehouse layout.

Table 1. Distance travelled and total times in existing warehouse layout

| Sl no | No of parts | Distance (meters) | Time taken for stock taking (minutes) From Unloading area Rack system storage items Pallets Time taken(minutes) To A B C Total times(minutes) |
|-------|-------------|-------------------|----------------------------------------|--------------------------------------------------------|-------------------------------|----------------------|-------|
| 1     | Associate   | P1                | 14.0                                   | 5                                                      | 5                             | 1                    | 1     | 1     | 13          |
| 2     | P2          | 8.5               | 3                                       | 2                                                      | 1                             | 2                    | 1     | 9     |
| 3     | Associate   | P3                | 4.0                                     | 2                                                      | 1                             | 1.5                  | 0.5   | 1     | 6           |
| 4     | P4          | 10.0              | 5                                       | 2                                                      | 2                             | 1                    | 1     | 11    |
| 5     | Associate   | P5                | 8.0                                    | 44.5meters                                             | 3                             | 1.5                  | 1.5   | 2     | 9           |
|       | Total       |                   |                                         |                                                        |                               |                      |       | 47 minutes |
4. PROPOSED WAREHOUSE LAYOUT

Figure 7a and 7b shows the proposed warehouse layout and storage racking system to be used. It is a modified form of a warehouse layout. Varieties of parts are received at unloading area. There is a dashboard placed near the receiving area for the employees to make sure the parts to be kept in exact location. The physical facility in the warehouse should have a different location name. Rack system has been standardized with unique identification number. Standard method has been introduced i.e. ONE PART - ONE LOCATION. And the pallet storage system has been eliminated. Were each storage zone has been divided into number of sections labeled A, B, C, D, etc. Warehouse storage zone is named as “S”. Sections correspond with shelves. When naming the exact location with section, it’s good to use numbers starting with a lowest number at highest location.

Unique identification number for the racking system made the system flexible to locate and easily identify the parts without consuming more time spending at multiple locations. This system made to eliminate unnecessary storage at various locations which lead to space utilization. And the manpower has been reduced.

Figure 7a. Proposed warehouse layout

Figure 7b. Storage racking system
4.1. String diagram of proposed warehouse layout

Figure 8 shows the pictorial representation of string diagram. Now you can make out the number of paths are reduced eliminating unnecessary storage location (here pallets are eliminated) and rack systems are utilized with unique identification number. And the time taken for stock taking has been reduced. This has minimized the inaccurate stock. And the physically recorded stock items have been verified with the system recorded items. This eliminates the unnecessary searching of parts in the warehouse.

Figure 8. Proposed string diagram

| Sl no | No of parts | Quantity | Distance (meters) | Time taken for stock taking (minutes) | Total times(minutes) |
|-------|-------------|----------|-------------------|--------------------------------------|---------------------|
|       |             |          |                   | Unloading area | Rack system storage items |                      |
| 1     | A1          | P1       | 1000              | 2                      | 2                  | 4                    |
| 2     | A1          | P2       | 800               | 2                      | 2                  | 3                    |
| 3     | A1          | P3       | 400               | 2                      | 2.5                | 3.5                  |
| 4     | A2          | P4       | 200               | 2                      | 1.5                | 2.5                  |
| 5     | A2          | P5       | 300               | 2                      | 1                  | 2                    |
| Total |             |          | 10 meters         |                        |                    | 15 minutes           |
Table 2 shows the distance travelled and total times in proposed warehouse layout. Revised warehouse layout shows the distance travelled by an associate for stock taking has been reduced from 44.5 to 10 meters. And the time taken has been reduced from 47 to 15 minutes as per the string diagram.

5. SIMULATION STUDY

Through analysis software the study of simulation has been carried out. There are various modules available in this software with which we can enhance a model of the system we want to study. It is a highly profitable method for examining new processes without having to carry out the real system. All the data related to warehouse has been collected. And the model built here shows the behavior of the real system as shown in figure 9.

![Figure 9. AS-IS Simulation model](image)

The existing simulation model has been simulated. Figure 9a shows the utilization rates of associate 1, 2 & 3. Simulated as per the time consumed by each associate as shown in the table 1.

5.1. Verifying and validating

For verification, the movement of entities in the warehouse layout is same as in the existing layout. Authentication of the simulation model is concluded; the BOP (Bought out parts) arrives at every 1 hour. These details should be specified while building a model.
5.2. Simulation runs and experiment

As it has been already suggested the revised warehouse layout which minimizes the distance travelled at each storage location and the time taken for stock taking. Figure 10 shows the proposed TO-BE simulation model where all the parts are decided with the 50% ratio among two associates. Here the associate 3 has been eliminated.

![Proposed TO-BE Simulation model](image)

**Figure 10.** Proposed TO-BE Simulation model

![Utilization graph 1](image)

**Figure 10a.** Utilization graph 1

Figure 10a shows the utilization rates of associate 1&2. With the 50% ratio and the time taken by each associate is 20 minutes each. And the utilization rates for associate -1 is 0.1695 and for associate -2 is 0.1653. This can be suggested. The more the processing time they take, there utilization is less. The smaller the product processing time there utilization rates goes up.

![Utilization graph 2](image)

**Figure 10b.** Utilization graph 2

Figure 10b is one more proposed to be considering the simulation. With the 50% ratio and the time taken by each associate is 15 minutes each. Associates utilization rates are 0.1272 and 0.1240. This can also be suggested.
6. CONCLUSION

The purpose of this study is to match the physical stock versus system stock and reduce the distance and the time taken for stock taking. Simulation results showed the proposed warehouse layout reduces the time and distance travelled. And eliminates the multiple storage location and thereby standardizing the rack system with unique identification number to the storage shelves. Simulation model was built to check their feasibility. And hence the proposed warehouse layout made the parts easily available as and when required from fixed location for production. This is achieved by “one part – one location” system. This will result in continuous running of production line without any delay. So “one part – one location” system resulted in free space which can be utilized for other warehouse requirement. Process training will enhance the knowledge and skills of employees and will result in high productivity and efficiency.

REFERENCES

[1] Sharma, A. and Arya, V., 2016. Study of inventory management in manufacturing industry. *International Journal of Advanced Engineering and Global Technology*, 4(03), pp.2012-2021.

[2] Kämpf, M. and Köchel, P., 2006. Simulation-based sequencing and lot size optimisation for a production-and-inventory system with multiple items. *International Journal of Production Economics*, 104(1), pp.191-200.

[3] Pattar, M.V., Kulkarni, V.N. and Gaitonde, V.N., 2019, October. Simulation study and analysis of plant layout in tin container industry. In *IOP Conference Series: Materials Science and Engineering* (Vol. 561, No. 1, p. 012034). IOP Publishing.

[4] Pattar, M.V., Kulkarni, V.N., Kulkarni, S.V. and Kotturshettar, B.B., 2020. A Study on Implementation of Simulation at Operational Level in Manufacturing System. In *Emerging Trends in Mechanical Engineering* (pp. 115-121). Springer, Singapore.

[5] Kulkarni, R.G., Kulkarni, V.N. and Gaitonde, V.N., 2018. Productivity improvement in assembly workstation of motor winding unit. *Materials Today: Proceedings*, 5(11), pp.23518-23525.

[6] Pandey, R., Ameliorating Productivity in lubricant Industry using industrial engineering tools. *International Journal of Business Management & Research (IJBMR)* ISSN (P): 2249–6920; ISSN (E): 2249–8036 Vol. 9, Issue 5, Oct 2019, 1–12.