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Journal of Military and Information Science
Institute of Science

Project Report

Storage Process Improvement and an Implementation

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Abstract- The basic function of storehouses is volume and time management. Under present market conditions, businesses minimize cost and maximize profit by developing efficient material transportation methods. At a time when an infinite number of goods is produced and marketed, every second is valuable; especially in today's economy and industry, the main goal is to minimize obstacles in production and management to increase profits, and to keep time losses and related financial losses to a minimum. Transportation of materials to warehouses, form warehouses to the production sites or consumers involves many procedures. As these procedures usually do not create added value, they need to be eliminated as much as possible. Thusly, the purpose of this study is to eliminate loses to save time and to increase productivity. The present study was conducted in the storehouse of a factory producing military goods. Using the Analytical Hierarchy Process (AHP) method, the simulation program to be used for modelling the improvements for the current situation and procedures in the firm was selected. The current situation was analysed with ARENA. Based on performance indicators, recommendations for improvement of the system were made. The resulting improvement in performance was calculated to be 2% in delivery reception and 4% in inspection.

Keywords- Warehouse Management, ARENA, Simulation, Efficiency Improvement

1. Introduction

The purpose of optimizing and streamlining the storage process is to gain benefits for customers (Duranik et al., 2013). Storage is an element in the production chain where production is halted for a variety of reasons. It can be considered as the use of a reserve to prevent confusion and arrange the production flow. Storehouses are a cost component, yet they are indispensable in the optimization of the production chain as they are of help in economizing and increasing productivity in the operations that precede or follow them. The basic function of storehouses is to manage time and volume. The processes and activities in the enterprise, which show signs of inefficiency, are necessary to be analysed and then it is essential to find and apply the appropriate method or methods of optimization. Thus, optimization of manufacturing processes is currently one of the most common tasks (Jodlbauer, 2008, Vavruška, 2008, Baylan, 2014).

Today storehouses function as centers where several value added services are provided and consumers are reached quickly, in contrast to places where goods are mainly stored and protected. Materials and goods that arrive at a business generally go through the stages: goods reception, storage, order processing, and transportation, a process that applies to virtually all production businesses when goods arrive.

The number of processes or the implementation of these processes depends on business type.

In the first part of this study, information on the functions of the storehouse, its characteristics, and design features are presented. The second part introduces the Analytical Hierarchy Process, which is a technique that employs many criteria to decide on the selection of a simulation program, followed by its implementation. The fourth part includes the delivery reception and inspection processes modelled with ARENA and the bottlenecks of the system under the current conditions. In the fifth part, improvements to be made are determined and ARENA models formed. Process simplification and process merging was done to minimize the bottlenecks in the delivery reception and inspection processes in the current situation. As another improvement measure, one standard material inspection employee was transferred to subcontract inspection.

2. Storage

Storage as a procedure and the need for it dates back to ancient times. Storage first appeared in the form of storing basic commodities and foods in closed places to protect them from environmental and climatic damage. As civilization developed, storage practices, scope and aims evolved and humans started storing the commodities they needed for longer periods of time (e.g., to use in winter) (Amirhosseini et al., 2000).

Being informed about available storage systems, how different types of goods need to be stored, allows business owners to save valuable time and energy while storing and transporting goods (İmrak et al., 2005). Storehouses are an essential element of the logistic systems of firms, which are generally used for the storage of products and materials. A warehouse can be characterized by three variables: Processes (Functions), Sources,a and Organizational Decisions.

Upon arrival at the warehouse, products go through a series of processes. The sources consist of the labor (personnel), required equipment, and tools and instruments involved to carry out the processes in the warehouse. Finally, organizational decisions refer to all the planning and control procedures used to operate the system (Rouwenhorst, et al., 1999).

To carry out the procedures, some rules and principles apply (Bartholdi et al., 2006). During the processes, continuous material flow needs to be ensured. All stages requiring decision making need to be reviewed, and consumer demands need to be met rapidly. Basically, the organizational decisions involved in storage systems are taken by developed computer systems, such as Oracle, Sybase.

2.1. Storage Activities in the Firm

The storehouse is divided into 5 main areas, namely, the goods reception area, storage area, junk area, stock recording area, and shuttle area. In a firm where production density increases, the demand for materials increases as well. Therefore, materials supply for production becomes problematic and gains importance. To sustain production, intra-firm material supply needs to be efficient. To facilitate the storage processes, the firm categorizes materials by type and source. Thus materials are classified by source as domestic (sub-industry) and foreign (customs) materials, and by type as consumables, standard material, or raw.

2.1.1. Problems Observed in the Storage Area.

Within the scope of the study, the below listed problems were observed in the storage system of the firm.

- A customs area-related problem
- Problems in the delivery reception process
- Problems in the inspection process
- Problems related to the manufacturing and supply firms
- Problems caused by operators

Figure 1. shows source of problems on the fishbone pattern.

Arslan, G., Özyörük, B.(2015). Storage Process Improvement and an Implementation, Journal of Military and Information Science, Vol3(4),113-118.

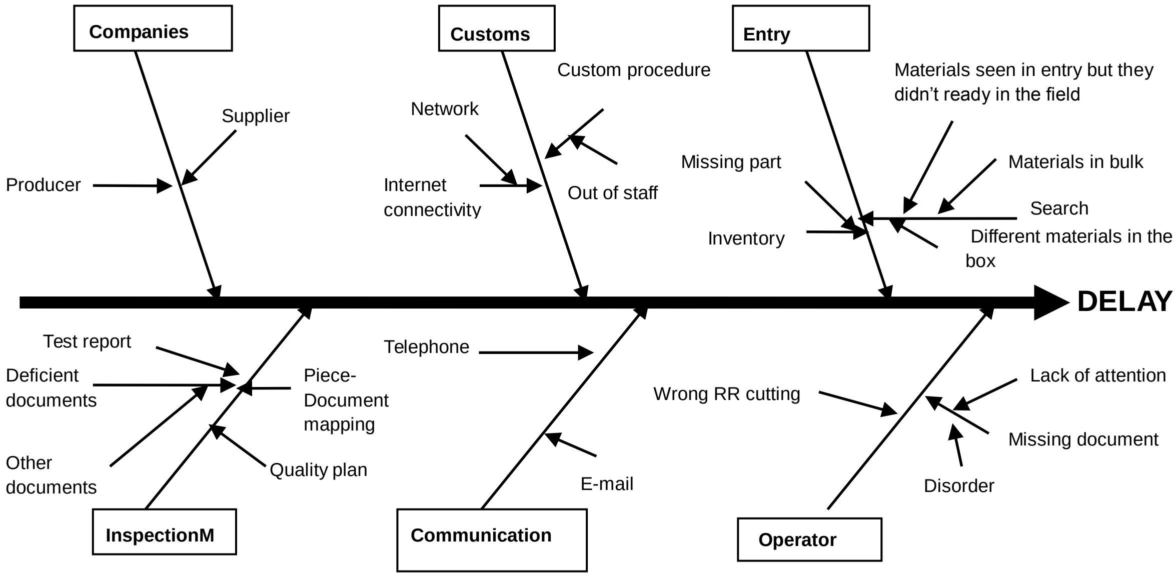

Fig.1. Source of problems (Fishbone Pattern)

To first decide on a simulation program with which to model the present situation in the firm and the improvements to be made in the processes, the Analytical Hierarchy Process method was used. The results (60.65%) indicated that the simulation program used should be ARENA and thus, ARENA was used to simulate the current situation.

3. Modelling the Current Situation with Arena

To analyse the current system, ARENA13.5 Professional Edition was used. Using ARENA, two separate models were formed- one for the delivery reception and one for the inspection process- because the system was large and a detailed analysis of the two processes was aimed at.

3.1. Modelling the Delivery reception Process with the ARENA Simulation Program

To model the process with ARENA, first the process distribution times were required. To this purpose, observations were conducted so as to obtain the distribution times. The obtained periods were used to derive distribution times using the Input Analyzer component of the ARENA program. To be able to model the system, some percentage values are needed alongside distribution times. These percentages were obtained from the observations and the information provided by authorized engineers. In the analysis, work time was determined to be 24 days per month, including over time. Daily work was 8 work hours per day. The report obtained after 24 days of system operation showed that 4011 items entered the system. Of the exiting items, 619 were urgent, while 2489 were non-urgent. The total number of items taken over was 3108, 748 of which were chemical material and 1279 of which were subcontract material. The remaining 1081 items consisted of other materials. The number of items rejected at delivery reception was 13, and 60 items had to wait for documents after communication with the purchasing department (Table 1).

Table 1. Delivery reception process quantities

Items	Value
urgent	619
non-urgent	2489
other materials	1081
chemical material	748
rejected at delivery reception	13
wait for documents after communication with the purchasing department	60

- The total number of items taken over (exit) = 3108
- Items entered the system (entry) = 4011
- The system performance based on exit/entry was found to be 77.49%.

3.1.1. Improvement of the Delivery reception Process

The item-document matching step is repeated separately in both the delivery reception and inspection processes and this repetition needed to be eliminated. The changes implemented in the delivery reception process in the ARENA model were creating extra time in the "material item-document matching process" and eliminating the "Receiving Report" step from the process.

Under the new conditions, the total number of items entering the system was 3943, of which 2518 were non-urgent, and 599 urgent items the delivery reception of which was completed exited the system. In general, 782 were chemical materials, 1302 were subcontract materials, and the remaining were others (Table 2).

Table 2. After improvement of the delivery process quantities

Items	**Value**
urgent	599
non-urgent	2518
other materials	1033
chemical material	782
rejected at delivery reception	90
wait for documents after communication with the purchasing department	71

- The total number of items taken over (exit) = 3117
- Items entered the system (entry) = 3943
- Under the new conditions, the exit/entry ratio based system performance was found to be 79.05%, indicating a 2% improvement.

3.2. Modelling the Inspection Process with the ARENA Simulation Program

In the inspection process, the standard materials are within the responsibility of 6 operators, one of which deals with chemical materials, two with subcontract material, and three with other standard materials. To eliminate a bottleneck in the inspection area, the work of the 6 operators was analysed by forming an ARENA model. In the inspection process, 2 operators are responsible for the delivery reception of subcontract material, 1 of the delivery reception of chemical material, and 3 of the delivery reception of other materials.

The report obtained for the system after 24 days of work showed that 3792 items entered the system. The exiting items were 881 urgent and 2529 non-urgent items. The total number of items exiting upon completion of inspection was 3410, of which 836 chemical material, 1493 subcontract material and the remaining 1082 of which were other materials. While 29 items were rejected due to incomplete documents, the inspection of 157 items with incomplete documents were completed through communication. The total number of rejected items at inspection was 199 (Table 3).

Table 3. Inspection process quantities

Items	**Value**
urgent	881
non-urgent	2529
other materials	1082
chemical material	836
rejected at delivery reception	29
wait for documents after communication with the purchasing department	157

- The total number of items taken over (exit) = 3410
- Items entered the system (entry) = 3792
- The system performance based on the exit/entry ratio was found to be 89%.

In the results of the model, the distribution of labor is noteworthy. While in the other standard material inspection area, the load per person is 17%, this is 28% for subcontract materials and 41% for chemical material. The fact that chemicals constitute the least incoming material and that only one employee is assigned there accounts for this high load per person percentage. However, while two workers are assigned to incoming subcontract material, which holds the largest share in incoming materials, three are assigned to incoming standard material, which holds a smaller share than subcontract material. This situation results in problems such as a fifty percent difference in capacity ratios.

3.2.1. Improvement of the Inspection Process

The improvement in the inspection process was aimed at reducing the loss of time resulting from the fact that information in the delivery reception and inspection processes were entered separately. If the "RR cutting" process in delivery reception was merged with the “RIDP” process in inspection, two workers would not have to be assigned to two different computers and information entry to the system would be faster.

The first change made to improve the inspection system was to eliminate the item-document matching process. In this manner, subsequent communication with the purchasing department, if a document was missing or incomplete, was eliminated as well.

With this improvement, inspected non urgent items increased from 2529 to 2912, and total exiting items increased from to 3638 to 4019. An important point to be considered while improving the system is defined in Stage 2. In the inspection process, the Creates define the withdrawal of materials from the area. Therefore, after the improvement, increasing amounts will increase the entries in the Creates. Another change implemented while forming the model to improve inspection was to add the increased exit amount after improvement to the inspection process create time.

The last improvement was made in the labour distribution. While in other standard material the load per person was 17%, it was 28% for subcontract material, of which the entry percentage is higher. Therefore, the transfer of one operator from other standard materials to subcontract materials was tried out because of the imbalance in load per person ratios between subcontract and standard materials. However, the improvement was not enough to restore the load per person balance. Therefore, another operator was transferred from other materials to subcontract materials as an improvement. This time load distribution of the sources was restored. The load per person of the workers in subcontract materials was reduced from 32.77% to 22.5%, while the load percentages of 17.96% of the other standard materials workers was increased to 26.99%.

While the total number of exiting items in inspection in the current situation was 3638 per month, after stage 3 improvement this was raised to 4254 items/month. That is, a net increase of 616 items/month occurred. The performance of the current system based on the entry-exit ratios was 0.95. After stage 3 improvements, the system yielded a performance of 0.99 based on exits. The improvements led to an increase of system performance by 4% and an existing item increase of 616 items/month.

4. Conclusion

In the warehouse department of the firm, improvements in the amounts of materials waiting, average waiting times, average material processing times, and the amount of items exiting to production were made by using process simplification, process merger, and workload balancing techniques in the material delivery reception and inspection areas.

Within the framework of this study, the problems were first analysed using the fish bone technique. Then, the system was modelled with a simulation. The simulation program alternatives were determined to be ARENA, ProModel, and Flexsim. To select the program to be used for the simulation, criteria were formed to satisfy the needs of the current situation. These criterias were the absence of the need to write codes, ease of access to information about the program, visual features and availability of the total version. Using the multifaceted decision making technique Analytical Hierarchy Process (AHP) in combination with the criteria resulted in a decision to use the ARENA simulation program to simulate the current situation.

Improvements are possible to enable further growth by implementing the necessary project for the organization of production with new evaluation systems (Duranik et al, 2013:191, Shingo, 1990). After the improvements, the RR (Receiving Reportprocess was taken from the operators in delivery reception and given to the inspection operators. The item-document match process in inspection was given to delivery reception operators. Another improvement was to transfer one standard material inspection worker to subcontract material inspection. As a result of these improvements, performance increased by 2% in the delivery reception area, and by 4% in the inspection area of the warehouse. While an 86 exiting item/month increase occurred in the delivery reception process, an increase of 616 items occurred in the inspection process. These increases are likely to reduce the waiting lines in the delivery reception and inspection areas, and increase the item exits to production. In future studies, the current situation can be analysed, a mathematical model may be established and optimal results can be evaluated for new researches.

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