Improving Inventory Control in Production Process using Value Stream Mapping (VSM) and Production Line Simulation using Software Arena in urban economic centers (Case Study: Iran Bushing and Bearing Company)

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Abstract
Value stream mapping because of being able to understand process bottlenecks, as one of the most common tools for analyzing, identifying and eliminating various losses in operational and support processes are used. On the other hand, inventory management, precise control entry and exit of goods, accurate and timely information about the inventories status and planning, reduce product maintenance costs, including important issues organizations have a special look to it to consider the whole objectives and strategies, making procedures and policies that have a positive effect on the overall organization's economy. In this paper, the use of value stream mapping as a lean production technique, in a production process to improve inventory control is discussed. This is a tool seeks to reduce losses, especially losses related to inventory by mining a bearing manufacturer companies. In this study, the literature of value stream mapping considered. The current state and future state of the company drawn in order to improve production process and losses in the company's future status. In addition, after drawing the mapping, the results of the simulation software Arena and the final report suggests that the use of this technique has an impact on reduce losses and increase inventory turnover.

Key words: *value stream mapping, inventory control, losses, lean production*

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Introduction

Nowadays with incredible speed toward the future trying to get better and stay in the competition, many changes in organizations, companies and factories have created. In addition, one of the claims that have been formed in this era mass production has reached the end of its life cycle and new forms such as flexible specialization have been replaced. There are concepts, tools and techniques to increase productivity in many organizations. Production and lean thinking, which is one of the most important of which refers to an organization that without the resources wasted finish process, or that their products using fewer resources maximized. Management without losses or lean production is a new stage of production that benefits of manual production and mass production will combine with each other to internal and external changes, and in this regard also to gain competitive advantage. Over the product-oriented course and entering market-orientation and post-industrial era, concurrent management of costs and response time to customers is very important. Fluctuations in demand and changing market requirements are forcing organizations to design their processes in such a way that they can provide the lowest cost consistent with customer demand (1). In lean production, value stream mapping used to analyze the value stream (5) Value stream mapping as one of the main tools of lean production plays an important role in the removal of any production loss (10). Taichi Ohno first (1912-1920) introduced concept and classification from Toyota executives and in 1985 as part of the Toyota Production System was published by him (11). Ohno seven losses include:

1. Modify or inspection (Defects in Goods);
2. Overproduction (producing too much unnecessary goods);
3. Inventory (inventory or consumer goods that are waiting for further processing at a distance farther);
4. Unnecessary processing;
5. Unnecessary movement (human resource);
6. Unnecessary transfer (goods);
7. Waiting or delay the workforce (or to finish up their work requirements or to fulfill an activity at the top stream) (11), (4),(14).

Considering the importance of value stream mapping as one of the lean techniques in order to reduce losses, the inventory losses is also one of the seven losses, current and future state of value stream mapping for production of bearings so as strengths and weaknesses revealed in the process of production and inventory control.

Statement of the problem

In traditional production systems, planning all the processes already known and in any process work according to their schedule and independent of one another. In this system, if changes occur in demand, the program of all processes changed and problems brought into existence. Among them, the highest volumes of inventory had flown (20). In this study, we find the following questions:

1. To what extent the excess inventory and construction process reduced as compared to the current situation by drawing optimal stream mapping?

2. To what extent savings in maintenance cost by applying traction system and reduce inventory?

3. What is the impact of use this system on waiting time and occupied space of production hall?

Research Background

Elasticity of production that is a lean approach is frequently used over decades and has attracted the attention of many managers. Value stream mapping (VSM) is one of the key tools of lean production in order to identify opportunities as lean techniques used. In this part of the research studies in the areas of design lean system and improving production process using VSM, discussed:

Nomanbin, Peterson, and Bernard (2015) used value stream mapping (VAM) in two Ericsson products AB Sweden and ten workshops held

in the field. In their research to cover its limitations and shortcomings of VSM, process simulator modeling used. The framework of Neumann et al for better performance and more accurate VSM in their study did, that hrough analysis of variance were able to achieve a real improvement in reducing waiting times and stakeholders involved in the implementation of their plan (15). Taiji et al (2015) in a study for the exploitation of lean thinking to management, faster improvement and development of products carried out, the value stream mapping (SPM) used. They using VSM could find losses and inefficiency and value steps of the product development processes. They conducted a case study in the production of gas turbines. Taiji et al results showed that VSM in addition to the intangible benefits would help to development team reduces the waiting time of product development by 50 percent. Rouhani and Zahraei (2015) in a case study in the color industry used value stream mapping as the most important techniques for lean production.

According to value stream, mapping the results of the study showed that the expected time of production could be reduced from 8.5 days to 6 days. Taylor (2009) in a case study in the shoes industry discussed the application of value stream management to improve global supply chain. The study aim to identify losses and the problems that occur across the supply chain as well as it determined a set of key performance criteria to improve operations. Taylor in this article explain how to improve global supply chain performance by compression waiting time, reduced costs and improved customer service using value stream management techniques (21).

Motaghi and Arsalan (2011) in a case study in Maadiran Company assembly line, used value stream management approach as the best way for production planning and inventory control was used.

They choose the target value stream, drawing the map of current situation, calculation of performance indices, mapping the future state and Kaizen programs were examined to optimize the value stream and the results using ED software was measured (8).

Motaghi and Khazayi (2008) in another article in addition to selection of target value stream, mapping the current and future situation in Samand body assembly process, the results of the above steps with the Vensim software was measured (9).

Research methodology

The study in term of goal was applied and case studies and analysis of documents within the organization as well as through interviews with executives collection, required data collected. To represent current production and inventory control techniques, value stream mapping and ARENA simulation software is used. First, mapping the company's existing situation, value stream mapping in the current state map shows how inventory control between generating stations is and it is a base for changes future situation. In the next step, using lean principles and eliminating losses, value stream mapping in the ideal situation drawn and improved inventory control organization after the implementation of lean principles will show benefits. After value stream mapping, using the ARENA software, the production process simulated and compared with the final report is concluded.

Value stream mapping

Value stream mapping is a great tool for identifying the value of a stream and determining the right place to do any of the Kaizen of process and movement. With value stream mapping can be used instead of seeing a single process, see a movement and instead of seeing losses found their roots. The materials and information can move within a certain range, for example, from the entrance to the exit door factory was designed using lean production. For information on opportunities to improve the value stream map can be drawn at different times (Womack Janis). This map clearly show inventory, process time, waiting time and other

information in the process (16).

Value stream is the set of all the necessary actions for a given product in any business can be achieved through three key managerial tasks. The three tasks are:

1. The task of solving the problem that begins product "idea" until "entering the market" continues and through detailed scheduling, is done.

2. Task management information begins from order taking and product delivery will continue to be made through a detailed schedule.

3. The task of physical transformation begins from raw material to finished product ready for consumption and continues (11); (16).

Value stream mapping is usually show three types of activities takes place during the course of value stream:

1. Many steps that are clearly creates value

2. Many steps that are not create value, but due to technical knowledge of existing productive assets are unavoidable

3. Many additional steps that not create any value are removed immediately (11); (16)

Value stream mapping process can be arranged as follows:

1. Determine family of products (products that have similar steps in the process)

2. Value stream mapping to identify present states of waste and resources

3. Future state of value stream mapping to draw opportunities for improvement in certain future

4. Planning for the realization of value stream map in the future state (11).

VSM follows many benefits that are: VSM is not only the tools for identifying losses, but it also used to identify the root causes of mortality. Helping people instead of promoting and improve island processes improve the system. This tool is based on an analysis of the actual situation of material and information flows (5). Other benefits include reduced waiting times and reduce inventory noted during construction (16).

Simulation

It is a process helps organizations predict, compare and optimize results of the performance and their decision-making processes, without bear the cost and risk of change current processes and new implementation. In fact, simulation is a technique process that allows representation of processes, resources, product and services in a dynamic model. With this efficient tool can reduce cost and risk of incorrect decisions and improve the organization's processes and products. The purpose of the simulation as a tool to predict the impact of changes in the existing system and the new system is designed to predict performance (6).

Case Study

Iran Bushing and Bearing Company owned by Farzanegan Fars Industrial Group, located in Takestan city of Qazvin province since 1997 with the aim of supplying part of Iran automobile industry requirements has been established. The company produces a variety of light and heavy bearing. In this study, heavy bearing production line selected Arena software for value stream mapping (VSM) and simulation to review and then identify losses and non-value-added and added value activities, and the accumulated balance between work stations, mapping of desirable situation of heavy bearing production line in vsm and simulated in the Arena. To use value stream mapping, following data collected from company:

"Time stamp, duration of work and rest, points (location and quantity), the timing of activities, amount of deviation at each stage of production, post and transport schedules, package size (Pack) in each process, each stage of product diversity , inventory (WIP), scrap, rework, downtime, time switching, switching frequency, the size of the batch (batch size), plus."

After collecting data, required data as well as using vsm symbols mapping value stream:

Mapping the current situation using the VSM First, the status quo maps are drawn to identify the source of losses and the opportunity

to implement lean techniques is different (16). After mapping the current situation, map future situation on improving the program. The availability of information and lean tools can be applied to organizations during the actual implementation, incentive to achieve the desired results (16).

The highest amount of revenues is with production volume for the unit of production.

For its production used most production process. The highest-level casualties are possible. Cause the most customer complaints (5)

After selecting the product family and awareness of customer demand, process to determine the main process and filling the data box drawn. Then the flow of materials, including (drawing inventory triangles, delivery and shipping from suppliers), then the flow of information (process of how to realize that what needs to build) is drawn.

The entire production cycle time can be achieved and outlines discontinuous and discrete activities. The heavy bearing production process is examined. Iran Khodro as the customer is on the right top of the map is drawn. Russian companies are also suppliers of Bush and Bearing Company is shown on left side of the map and produce coils required for Bush and Bearing Company. Electronic flow of information is from the customer to Bush and Bearing Company and then to suppliers. Product family in this case, is heavy bearing of UMB and IMB.

The number of working days in the month, excluding Fridays, was 26 days. Bush and Bearing Company did its operations in one shift. A shift is 8 hours. A 10-minute time to relax and stop during a shift is intended. Manual processes are stopped during break time; When eating is not part of the working hours.

Control unit tasks in Iran Bush and Bearing **Company**

Customer demand (IKCO) forecast for 30, 60 and 90-day by the control unit based on this demand orders for suppliers (Russia's) will be sent. MRP requirements for each week based on customer orders, inventory levels WIP, downtime and predicted losses determined. Scheduled weekly production processes, pressing, edge cutting, milling, drilling and logging, chamfered, Broach, inside the masonry, packing and posting. Time line is drawn in the bottom of the map. The total number of days of waiting and processing time determined. In pressing station, imported coils are pressed, the conversion time of 90 minutes 3 seconds cycle time by allowing one operator to ensure 100% machine. Station of masonry side, time does not become a cycle time of 4 seconds with an operator's ability to make the car 100%. Milling station, time does not become a cycle time of 4 seconds, an operator and machine reliability is 100%. Drilling and logging station has a cycle time of 6 seconds and no time become one operator and machine reliability is 90%. Beveled station has a cycle time of three seconds, no time conversion, allowing a machine operator is 100%. Broach station and within a cycle time of 4 seconds and masonry without an operator when converting the machine reliability is 100%. Sending and packing station, without conversion time and cycle time is 5 seconds and one operator and 100% reliability.

As well as the value and worth of software extensively specified. The total processing time is 29 seconds sum days of waiting 16 days. To calculate the number of days of waiting, you must first 90,000 monthly demands for the number of working days, including 26 days we split.

3461.5 = 26/90000

Then each bin values divided by the magnitude of 5/3461, we achieved the expected number of days.

1:44 = 3461.5 / 5000

0.028 = 3461.5 / 100

0.144 = 3461.5 / 500

0:23 = 3461.5 / 800

0:26 = 3461.5 / 900

3.64 = 3461.5 / 12600

Total time waiting for each stage of processing

■ 266 ■

time due to the long cycle of steps (C / T), obtained

Mapping the value of the company at favorable conditions using VSM:

To map the future status of the seven commands or instructions are recommended:

1.   Time-Ticket (production rate should be in accordance with the sales rate);

2.   Wherever possible, try to establish continuous motion;

3.   When you cannot generalize continuous motion over the stream, to control the production use supermarket;

4.   Timing customers not only to a production process;

5.   The process speed of construction, the production of various products over time to evenly distributed (Smoothing compound);

6.   Smoothing output;

7.   Try the above process flow in produce all kinds of products (18).

In drawing ideal situation, overproduction will be deleted. As additional material must be moved, counted and have been stored therefore, increases additional activity. Added production is leading to shortages because the processes involved in making something that is not needed. Ticket time is calculated to harmonize speed production with sales and inventory in the warehouses. By designing a pure stream, increasing the value of increased activity and reduced value activities. Production is done only in accordance with the customer's order. Reduce time to replace and increase the time it happens. It also reduced the number of operators.

A shift: 8 hours * 3600 = 28,800 seconds

We have 10 minutes to relax:

10 * 60 = 600 seconds

600-28800 = 28200 seconds

26/90000 = 3461.5

The most important step after outlining the current state value stream, calculating the time stamp (the rate of customer demand) and the balance is based workstations. To draw a future state value stream map, wherever there is the possibility of continuous motion, we do it and otherwise to control the production and twitch from the supermarket (standard inventory between stations) will used (11)

Time tickets = 3461.5 / 28200 = 8.14

In fact, by dividing the total available production time daily ticket to gain time (7) (1)

Ticket time depends on demand production. (16) By dividing the number of operator workload on the ticket are determined.

3 = 3.19 = 8.14 / 26 number of operator is 3

As we can see in the map waiting time convert 3 days while the status quo was the number of days waiting 16 days. The processing time become to 24 seconds but in the current situation lasted 29 seconds. In the current situation, we predicted six months, but the ideal situation takes place weekly orders up because the materials are not exposed to material inventory. However, the daily order in this factory is not possible. As well as to control the production supermarket and Kanban used:

 Supermarket is required to run a lean elasticity system (18) the objective of the supermarket elasticity system of production control process is 60% loss of production due to inventory systems. The inventory is classified into three classes (raw materials, goods in process and goods made). With the increase in commodity during construction (WIP) waiting time increases production (16) to reduce the flow control process and increasing the value of the WIP (17). Kanban elasticity production systems and lean production component of the WIP control (16) Use Kanban improves productivity and reduces waste production (14) also reduces WIP and inventory costs can be reduced (14); (18).

Simulation of the current situation and the ideal situation with Arena:

In this section, an overview of the status quo by Arena simulation software is shown. The facade belonged to heavy bearing production process. The product line is linear type. The number of operators is high. High transport costs and completion time for the movement
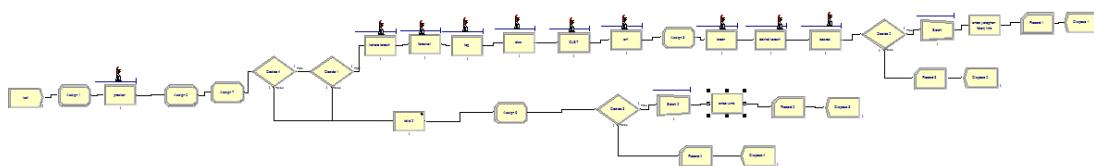
▲ Diag 1. Simulation of status quo by Arena software
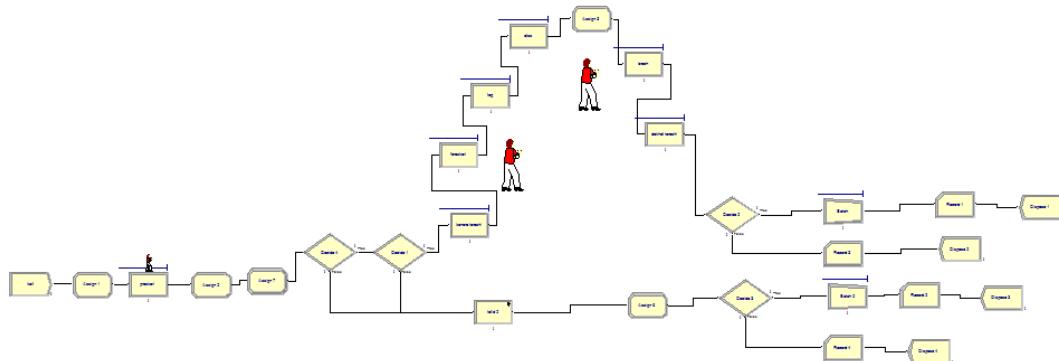
▲ Diag 2. Simulation of status quo by Arena software
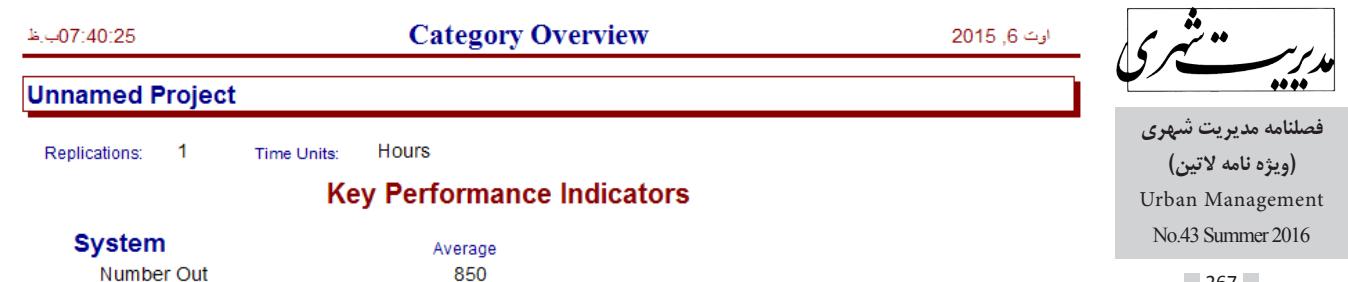
▲ Report 1. Arena on the status quo-report number of production

in its manufacturing process. Reforms in good condition: U-shaped cell production line, the trucks are close to the process. Reduce the number of workstations, improving line balancing, communication, quality, the flexibility of movement. In the ideal situation for heavy bearing cell line for the production of U-shaped raised and lower the number of operators in less time and lower cost to produce according to the customer's order. In line 2 in the ideal situation, 95 percent of coils packed into the station. The production process is according to customer's order; once module for storage bearing-type numb in the warehouse is removed. As a result, ump type bearings after the package are delivered; however, inventory control is done at lower cost because the cost

of maintaining the inventory is reduced.

The in-line bearings type Imb are also stored the bearing flange is removed because the value of non-modulating Imb. After production according to customer requirements and customer orders, do not store bearings. In addition, Imb type bearings are delivered after packing once again led. So ease of process control becomes available. Three processes for Pakh also intended to act in the fold making do with angles of 45 degrees. Merged and the merger is that all three are doing a similar task for pakh. Another change in the ideal situation inspection has eliminated because such store, the value of non-modulating and losses. While the ideal situation inside the station after cutters, inspection took place With the removal of

Unnamed Project

Replications: 1   Time Units: Hours

Key Performance Indicators

System   Average

Number Out   973

▲ **Report 2. Arena on the status quo-report number of production**

Unnamed Project

Replications: 1   Time Units: Hours

Entity

Time

VA Time	Average	Half Width	Minimum Value	Maximum Value
Entity 1	0.01942003	0/000201783	0.00931521	0.02101285

NVA Time	Average	Half Width	Minimum Value	Maximum Value
Entity 1	0.00184641	0/000111123	0.00	0.00277778

Wait Time	Average	Half Width	Minimum Value	Maximum Value
Entity 1	0.9818	0/418214030	0.00	97.4476

Transfer Time	Average	Half Width	Minimum Value	Maximum Value
Entity 1	0.00	0/000000000	0.00	0.00

Other Time	Average	Half Width	Minimum Value	Maximum Value
Entity 1	0.00	0/000000000	0.00	0.00

Total Time	Average	Half Width	Minimum Value	Maximum Value

▲ **Report 3. Arena on the ideal status**

Unnamed Project

Replications: 1   Time Units: Hours

Entity

Time

VA Time	Average	Half Width	Minimum Value	Maximum Value
Entity 1	0.01575395	0/000154662	0.00738951	0.01915029

NVA Time	Average	Half Width	Minimum Value	Maximum Value
Entity 1	0.00	0/000000000	0.00	0.00

Wait Time	Average	Half Width	Minimum Value	Maximum Value
Entity 1	0.9208	0/343924333	0.00	91.0579

Transfer Time	Average	Half Width	Minimum Value	Maximum Value
Entity 1	0.00	0/000000000	0.00	0.00

▲ **Report 4. Arena on the ideal status**

Unnamed Project

Replications: 1   Time Units: Hours

User Specified

Counter

Count

                           Value

Record 1   553.00
Record 2   245.00
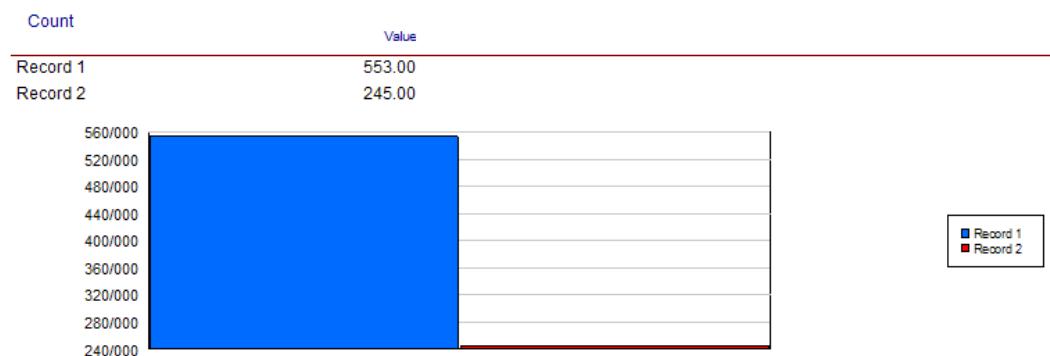
▲ **Report 5. Arena on the status quo**

Unnamed Project

Replications: 1   Time Units: Hours
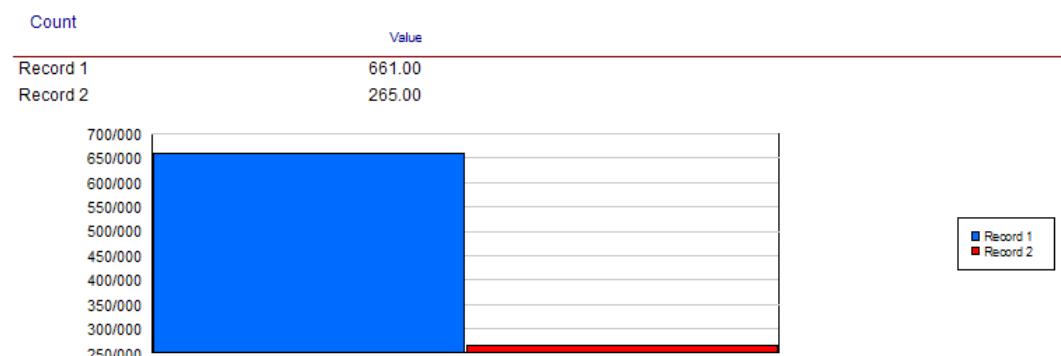
User Specified

Counter

Count

                           Value

Record 1   661.00
Record 2   265.00

▲ **Report 6. Arena in the ideal situation to separation of bearing heavy type with a different width and diameter**

the checkpoint also done faster.

Conclusion

Thus, value stream mapping show correlation of material flow and the flow of information on good and provides a common language to discuss manufacturing processes. In this study, improved inventory control process for the production of bearings at the Bushing and Bearing Company, value stream mapping techniques and simulation software ARENA was used to depict the current situation and the future situation. Using value stream map, the

philosophy of lean production and simulation techniques, managers and engineers can learn about the processes of production are analysis that is more accurate. By eliminating loss and high volume of activity and strengthen the value-added activities, increase efficiency of the organizations. So losses lies the inventory in process manufacturing process was marked by outlining the status quo, and improvements to future status will be determined clearly. Reports produced software could also be evidence of the claim. Software reports show that inventory during construction, waiting time, are non-value time and days of waiting in the desired increase company declined and increased production of bearings. In addition, this show of reducing loss and increase value for the company. Also, by reducing setup time and become smaller in the production of high-flow producing batches, these processes will be able to more quickly streaming down their changing needs. That process in turn will need to balance the less in supermarkets and to maintain a large inventory of them will not be needed. If data related to the current situation and the future situation compared in the Bushing and Bearings Company, it characterized by smoothing of production in some workstations; Bushing and Bearings Company can still reduce the bearing volume parts inventory in the supermarket. Of course, to achieve this must be hard, equipment reliability and predictability of production based on the time stamp always be maintained. Bushing and Bearings Company by reducing waiting time in the palm of workshop production, operation speed the process of construction at the time of ticket and fix problems quickly will be able to significantly reduce easily into the existing volume of the finished product. If your customer orders smoothly is able to reduce the size of your final product further. In other words, the entrance to the station inventory reduction and elimination of waste, waiting time input devices bearing to the station, the space occupied by production hall in current

level of the construction and maintenance costs are minimized inventory. As a result, faster inventory turnover occurs. So it is suggested to the company to the expected results in inventory control achieved by identifying the strengths and weaknesses of the production process can used value stream to achieve higher quality with the use of tools like Kanban, supermarket, smoothing times, the cell lines U-shaped, ticket pull production and lead time to inventory turnover to ease. Suggestions for future research will be presented: In the future, we may have different assumptions about the number of orders and MRP added to the problem. It can be parameters such as maintenance costs, ordering costs and low cost using fuzzy models and simulation results are compared. Alternatively, the traditional model and new inventory control with value stream mapping and cloning companies compared and reconciled in the status quo.

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