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Reduce waste by using lean Manufacturing: Case study in Yarmouk complex

Mohammed Sirelkhatim Abdelwahab[1], Prof. Hassan Khalifa Osman[2]
Dept.of Mechanical Engineering
[1]Faculty of Post Graduate Studies, University of Nile Valley, Sudan, sirelkhatim@hotmail.com
[2]International University of Africa, Khartoum Sudan, DRHASSANKHALIFA@gmail.com

***Abstract*-The aim of this paper is to study the gap of applying lean philosophy in production lines in one of Yarmouk industrial complex factories(A22) to achieve some goals summarized in changing production management from traditional manufacturing concepts to lean manufacturing concepts. Selection one of products mix in factory A22 to apply lean principles. The methodology of this research is to investigate the effect of batch size, inventory between processes and time spend due to transportation in total throughput and mean life time of the product.**

***Keywords*- lean manufacturing, simulation, Reduce waste.**

I.INTRODUCTION

The researcher run two simulations one by the current situation with the data collected and call it current study repeated thee time with deferent batches (30 pcs, 10 pcs and one-piece flow). The second group of simulation done by using takt time for the product as stated and call it future proposal.

II. PURPOSE

The purpose of this paper is to investigate the use of lean philosophy in one factory producing mechanical parts to find the effect of batch size on total throughput and the lead time through the production line.

III.DESIGN/METHODOLOGY/ APPROACH.

The methodology applied to better understand the effect of applying lean thinking in the production line to explore two types of waste waiting of parts to be processed and to be delivered and transportation of parts between stations.The time available in the factory is 225 days one shift five working day and six and a half real working hours per day so the total Annual working hours is 1462.5 which is equivalent to 87750 minute per year.

IV.LITERATURE REVIEW

1. Lean Manufacturing:

Womack et al. 1990 defined Lean as a "dynamic process of change, driven by a set of principles and best practices aimed at continuous improvement." [1].

John Nicholas &AviSoni also defines lean principles as a set of beliefs and assumptions that drive operational decisions and determine actions about products and processes. Specifically, principles are fundamental rules that manage proper implementation and operational in a lean process. In essence, the test of true lean process improvement is the organizational culture and principles that undergird change [2].

The root of Lean lies on Toyota Production System (TPS) which was established shortly after the Second World War in 1940s in Japan by TaiichiOhno according to Womack et al., 1990, **Womack and Jones 2003, Maleyeff et al. 2012 [1,3,4].** As a result of the publication of the book named (The Machine that Changed the World) written by Womack in 1990[1], TPS has been adopted by the Americans and known in the western countries as Lean manufacturing.

Womack and Jones, 2003[3] believes that Lean focused on elimination of non-value added activities and waste (or "muda") in industry.

According to [5, 6] the seven wastes to be eliminated are:

- **Over – production Waste:** producing more than is needed, faster than needed or before needed.
- **Wait Time Waste:** Idle time that occurs when codependent events are not fully synchronized.
- **Transportation Waste:** Any materials movement that does not directly support immediate production
- **Processing Waste:** Redundant effort (production or communication) which adds no value to a product or service.
- **Inventory Waste:** Any supply in excess of process requirements necessary to produce goods or services in just in time manner.
- **Motion Waste:** Any movement of people which does not contribute added value to the product or service.

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- **Defect Waste:**Repair or rework of a product or service to fulfill customer requirements as well as scrap waste resulting from materials deemed to be unrepairable or unreworkable. [5,7,8]. In addition, two more types of waste have appeared in literature recently as stated by Vinodh et al.,2012 underutilization of people's creativity and environmental waste [9].

2. Lean Principles:
Womack, Jones, and Roos 1990[3] identified five key principles for achieving a lean production system which are [1];

2.1 Specify Value: Identify what customers want (and/or are willing to financially support).
2.2 Identify the Value Stream: Identify activities that, when performed correctly, satisfy customer wants (activities that provide value).
2.3 Flow: Create continuous, interruption-free work processes across value-adding activities.
2.4 Pull: Produce only in response to customer demand.
2.5 Continuous Improvement: Generate, test, and implement process refinements in an ongoing drive for perfection.

After that, Womack and Jones, 2003 [3], Karlsson and Ahlstrom 1996 identified nine lean principles [3, 7] which are:

- Elimination of Waste.
- Continuous Improvement.
- Zero Defects.
- Just-in-Time.
- Pull Instead of Push.
- Multifunctional Teams.
- Decentralized Responsibilities.
- Integrated Functions.
- Vertical Information Systems.

Principles are operationalized through a set of practices, which are activities aimed at improving an organization.

3. Lean Practices:
Lean principles are implemented by applying lean practices and performance measures to improve process flow and overall performance of the methods through which fundamental lean rules are applied.

And the most cited lean practices from the literature are:

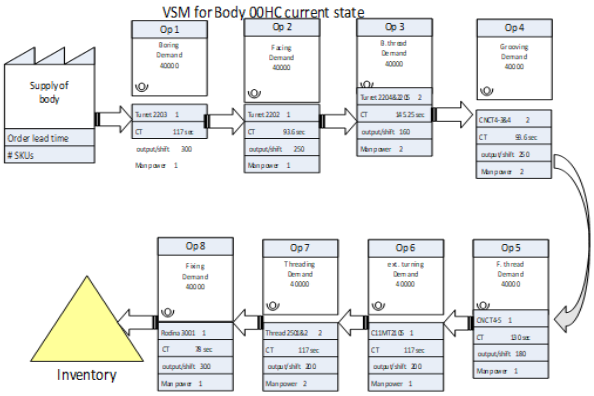
- Total productive maintenance.
- Setup time reduction (SMED).
- Cellular manufacturing.
- Kanban.
- Standard work.
- Small lot sizes.
- Mistake proofing (poka yoke).
- 5 S.
- Total quality management.
- Quality circles.

V. SIMULATION

Simulation is a process of designing an operational model of a system and conducting experiments with this model for the purpose either of understanding the behavior of the system or of evaluating alternative strategies for the development or operation of the system. It has to be able to reproduce selected aspects of the behavior of the system modelled to an accepted degree of accuracy [10].

A simulation software was used to explore the production line for product 00HC with deferent batch size (30, 10 and one-piece flow) with the current data collected from work shop as current situation study. Then another future proposal with takt time was carried out again with three deferent batches (30 pcs, 10 pcs and one-piece flow).

1. Current State Map:



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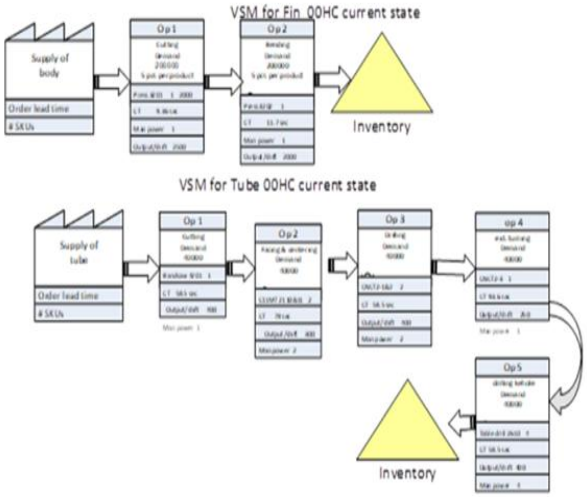

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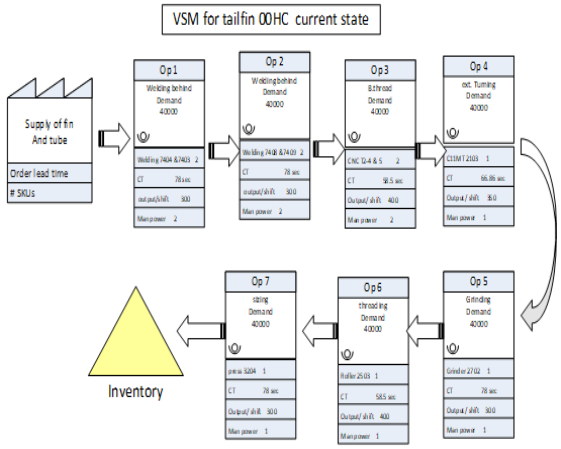

(c)

Fig 1.Current State Map.

2.Production Simulation:

The production of this product is carried out in four lines. Fin line have two presses, tube line with five stations, tailfin line with seven stations and the body line with nine stations. The time used for simulation is (28:10:30:00 days: hours: min: seconds).

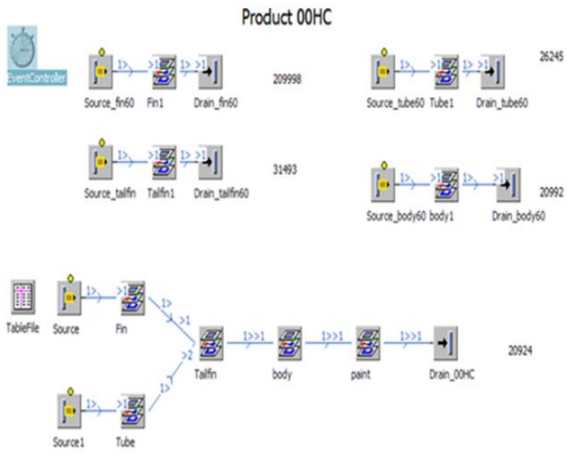

Fig 2. Product simulation lines.

Table 1. Batches Scenarios Current Study.

Batch	Mean Life Time	Throughput	Production	Transport	Storage	Value added
1 pcs	270	20925	22.50%	56.55%	20.95%	9.05%
10 pcs	276	20921	23.27%	55.36%	21.37%	8.71%
30 pcs	20072	1165	3.15%	32.98%	63.87%	0.12%

From table (1) it is clear that the best scenario of the current study for product 00HC is one pcs flow since it achieved 20925 pcs with 270 min mean life time and also achieved a good value added percentage of 9.05%while the batches of 10 pcs, 30 pcs get lower throughput with lower value added than one pcs.

3. Simulation Details:

From simulation run as tabulated in table (2) for product 00HC the bottleneck line is the body line since it can only produce 31 pcs per hour.

There is a big opportunity for improvement in product line since the added value is only 9.05% and a big challenge in transportation percent 56.55%.

Table 2.Simulation Details.

Name	Mean Life Time	Throughput	TPH	Production	Transport	Storage	Value added
product00HC	4:30:38	20925	31	22.50%	56.55%	20.95%	9.05%
Fin60	0:02:32	209998	308	23.08%	38.46%	38.46%	13.85%
tailfin60	0:24:25	31493	46	57.22%	21.49%	21.29%	33.84%
tube60	0:21:34	26245	38	51.52%	27.83%	20.65%	26.82%
body60	0:18:59	20992	31	88.69%	9.34%	1.97%	68.06%

4. Machines Utilization:

The machines utilization was investigated for the main waste factors (waiting for parts to be processed and blocking of parts due to full occupation of the machine.

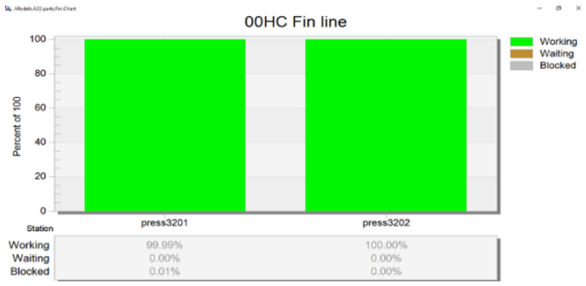

Fig 3. Fin Line Machines Utilization.

In this line two machines were used to produce this part. The utilization of the two machines are almost 100%. The throughput of the line in the available time (40950 min) is 209998 pcs where the planned production is 200000 pcs achieving over production of 9998 pcs fig (3).

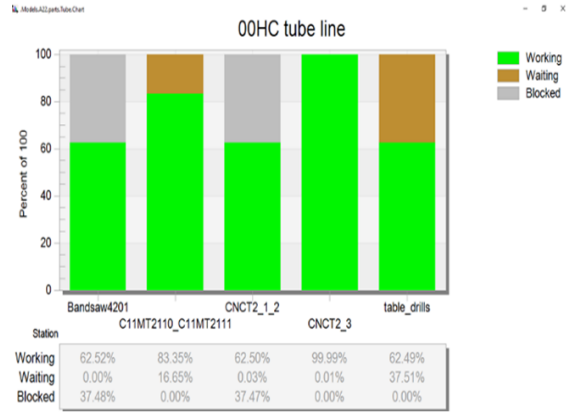

Fig 4.Tube Line Machines Utilization.

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Five machines are used in the tube production for product 00HC fig (4). There is a waiting time 16.65% in the second process accumulating due to the blocking in the predecessor process.

Another blocking time in machines CNC2-1-2 with percentage 37.47% due to machine CNC2-3 processing time. The total throughput of the line is 26245 pcs though the planned is 40000 pcs.

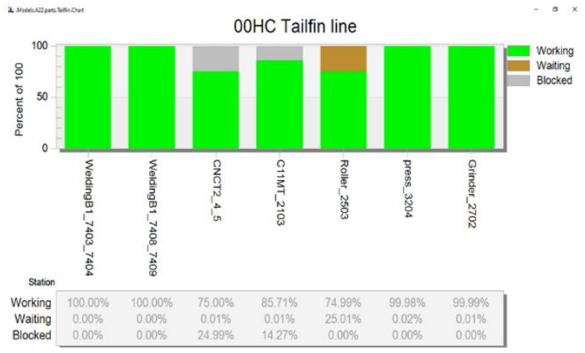

Fig 5.Tailfin Line Machines Utilization.

From fig (5) for the tailfin line there are seven machines used to produce the tailfin. The simulation showed a waiting time of 25.01% in the fifth process due to the accumulation of parts caused by the blocking in the predecessor. This is also affected by another blocking of 24.99 due to the full utilization of welding process. The total throughput of the line is 31493 pcs and the planned is 40000 pcs.

In the body manufacturing line for product 00HC fig (6). There are nine machines used to produce the body. There is a waiting time in seven processes out of nine ranging from 20% up to 50.02 %. This is due to full occupations of the first and third processes.

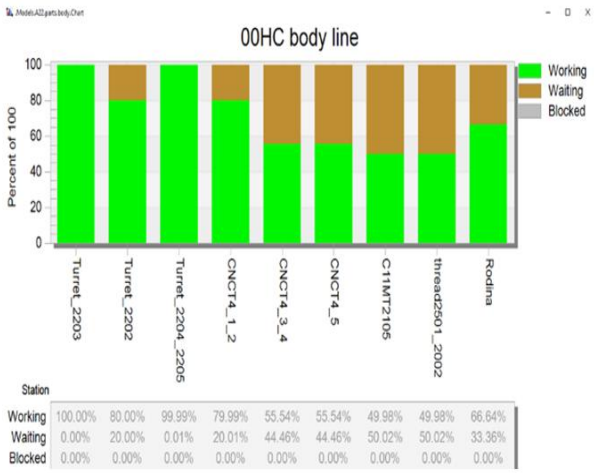

Fig 6.Body Line Machines Utilization.

Table 3. Overall Result.

product	production	Transport	Storage	value added
00HC	22.50%	56.55%	20.95%	9.05%

5. Future Proposal:

Simulations of Future proposal with takt time were carried out with the three same batches size. The results were collected and as represented below.

Table 3.Batches scenarios Future proposal.

Batch	Mean Life Time	Throughput	Production	Transport	Storage	Value added
1 pcs	4:33:13	5923	22.69%	56.19%	21.12%	8.73%
10 pcs	4:33:13	5923	22.69%	56.19%	21.12%	8.73%
30 pcs	13:18:11:27.9212	1165	3.33%	34.08%	62.59%	0.12%

From the results table (4) the best scenario of future proposal for product 00HC is 1 pcs flow since it achieved 5923 pcs with 273 min mean life time which also achieved a good value added percentage 8.73%. And the detail is shown in table (5).

When comparing simulation results with that from capacity study for product 00HC it is clear that the effect of waiting and transportation of parts between processes is visible. Only 192 pcs per day could be achieved comparing with 350 pcs tabulated from capacity study.

Table 5. Simulation details future proposal.

Name	Mean Life Time	Throughput	TPH	Production	Transport	Storage	Value added
product00HC	4:33:13	5923	30	22.69%	56.19%	21.12%	8.73%
Fin60	0:03:08	11427	59	97.91%	2.09%	0.00%	65.27%
tailfin60	0:17:29	11421	59	64.40%	18.04%	17.56%	41.00%
tube60	0:09:41	11421	59	68.73%	25.98%	5.29%	52.87%
body60	0:13:06	11417	59	74.43%	17.76%	7.81%	54.70%

VI. CONFIDENCE OF SIMULATION

The researcher run a confidence test for null hypothesis that the mean life time for product 00HCis 270min. and the alternative hypothesis is mean life time is not equal to 270 min. After running the test for 20925 products with standard deviation of 23 min and from the test data the p value is equal to 0.134 which is greater than 0.05 so we accept the null hypothesis that the MLT of product 00HC is 270 min as in Fig. (7).

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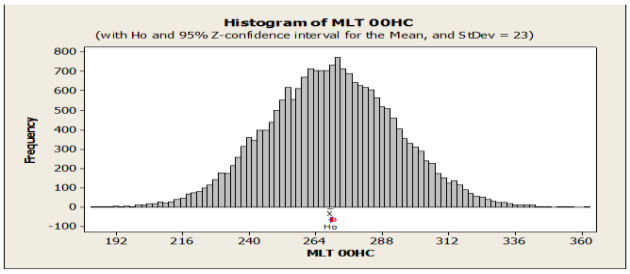

Fig 7. product 00HC is 270 min as in Fig. (7).

1.Short Term Improving:
Since the body line is the bottleneck in the hole system 20991pcs, and when we drilling down on this line we found that the starting machines (Turret 2203) is the bottlenecks in this line. By improving the processing time from 117 second to 58.5 second (adding second shift or improving process through work study) we can get total throughput of 26239 pcs.

VII. CONCLUSIONS

This study is carried out in Factory A22 in Yarmouk industrial complex. The factory specialized in production of product 00HC.The total number of parts in each product is three. When focusing in production plans for three years, the researcher observe that demand could not be reached. For this reason, this study is aim to use the resources in optimal way, increase productivity and determine the best batch size to feed the production lines.

The researcher in this paper use modern management techniques to get the maximum possible out of the production lines by controlling the flow of materials in the production lines rather than only controlling machines utilization. The researcher proposed to change production methodology from traditional (batch and queue) to new one lean production. Principles of lean were applied to control the flow of parts through the lines and the two main waste factors were investigated, reducing of batch size as much as possible lead to improving the materials flow, decreasing inventory between processes and transportation waste.

All data needed to complete this study was gathered, tabulated and analyzed to investigate the main reason behind the waste.The best scenarios for materials flow and batch size were determined for product 00HC was one-piece, to achieved total throughput of 192.Future proposal and Short actions for the current state were done, with the best batch size according to simulation results to achieve annual production.

For product 00HC three parts were used to assemble this product. The annual demand for this product was 40000 pcs. The best scenario with the current data could achieve 20925 pcs. By short term for improving the throughput will reach 26239 pcs.The study concluded that the use of scientific methods leads to better results in improving the production processes.

VIII. RECOMMENDATIONS

- Directing the technical departments in the Yarmouk factories on the necessity of applying modern scientific foundations in planning and manufacturing products.
- Encouraging and financing joint scientific research between the industrial sector and universities.
- Strengthening ties and cooperation with regional and international scientific centers.
- Subscription and follow-up to periodic and urgent scientific journals and studies.
- Providing training opportunities for senior management internally and externally in intensive courses for the purpose of accompaniment.
- Holding joint workshops and seminars in specialization in universities and with experts to discuss problems and find solutions.
- Disseminating the results of research and studies on Yarmouk and distributing them to the competent authorities and persons.
- The state's adoption of modern scientific methods improves its performance and results, raises its staff units and makes it an example for the rest of the sectors.
- The state should reduce fees and taxes for books and magazines and print them so that they are accessible to all.
- To seek the help of specialists from inside and outside the country to evaluate the performance of the units at intervals for the purpose of development and improvement.
- The necessity of directing towards adopting modern methods in management and production, especially in government sectors, to be a pioneer and the volume of investments in them.
- That there are periodic reviews every four years in light of the plans, capabilities and what has been achieved in order to keep up with and improve performance.
- The necessity of developing long-term plans to guide the path and form a framework that guides the annual plans.
- Paying attention to planning and involving everyone in it.
- Cooperation with universities through technical teams and higher studies, as it has been proven to improve performance and have made appreciable additions.
- Paying attention to the technical and administrative training process to keep up with the global.
- Improvement and control of the supply and supply methods of the complex and between operations.

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- Providing integrated programs that serve the design, production and monitoring the production process in the complex.
- Appling Kaizen project on bottleneck machines for more improvement to reduce processing time.
- Use this simulation to monitor the production in work shop day by day by using real time setting.
- More study to include setup time for lines to program the production of all products at the same time in the factory.
- Appling this technique in all production factories in Yarmouk complex.

REFERENCE

[1] James P. Womack etal. The Machine that Changed the World (1990)
[2] John Nicholas &AviSoni, The Portal to lean production, Auerbach Publications, (2006)
[3] James P. Womack and Daniel T. Jones, LEAN THINKING, FREE PRESS, 2003.
[4] John Maleyeff et al.: The continuing evolution of Lean Six Sigma, TQM, Revised 11 January 2012, www.emeraldinsight.com/1754-2731.htm.
[5] Nadia Bhuiyan and Amit Baghel, An overview of continuous improvement: from past to the present, Management Decision Vol.43 No. 5, 2005 pp. 761-771.
[6] Vinodh, S., Arvind, K.R. and Somanaathan, M. (2011), "Tools and techniques for enabling sustainability through lean initiatives", Clean Technologies and Environmental Policy, Vol.13 No. 3, pp. 469-479.
[7] Karlsson and Ahlstrom, Assessing changes towards lean production, International Journal of Operations & Production Management, Vol. 16 No. 2 pp. 24-41. (1996).
[8] Michael L. Pinedo , Planning and Scheduling in Manufacturing and Services, second edition 2009.
[9] Vinodh, S. and Joy, D. (2012), "Structural equation modeling of lean manufacturing practices", International Journal of Production Research, Vol. 50 No. 6, pp. 1598–1607.
[10] Thome, B. (Ed.), 1993. Principles and Practice of Computer-based Systems Engineering, Wiley Series in Software Based Systems. John Wiley & Sons, Chichester.

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