IJCRT.ORG **ISSN : 2320-2882**

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

Implementing Lean Manufacture to Enhance Performance In Gas Valve Production Line

Eng. Khaled Hassan Soufi,
PhD Researcher at Faculty of Graduate Studies for Statistical Research, Cairo University, Egypt

Prof. Abdul Hadi Nabih Ahmed,
Faculty of Graduate Studies for Statistical Research, Cairo University, Egypt.

Prof. Abd El Hakim Al Manhawy
Faculty of Graduate Studies for Statistical Research, Cairo University, Egypt

Abstract

The purpose of this study is to address that Lean Manufacturing is the most suitable technique which can be used in developing countries like Egypt, mostly past Covid-19 era, lean is cheap easy and has positive quick effect on quality and productivity in shop floor in order to achieve the latest trend in quality management (Lean, 6δ and supply chain). Lean manufacturing has been the buzzword in the area of manufacturing for past few years. The concept originated in Japan after the Second World War when Japanese realized they could not afford the massive investment required to build facilities similar to those in the USA. lean manufacturing aim is to reduce waste in human effort, inventory, time to market and manufacturing space to become highly responsive to customer demand while producing quality products in the most efficient and economical manner. Nicholas (1998) found that waste takes many forms and can be found at any time and in any place. Waste consumes resources and not adding any value to product. Russell and Taylor (1999) define waste as anything other than the minimum amount of equipment, effort, materials, parts, space, and time that are essential to add value to the product. Lean manufacturing combines the best features of both mass and craft production: the ability to reduce costs per unit and dramatically improve quality while at the same time providing an ever wider range of products and more challenging work (Womack et al., 1990).
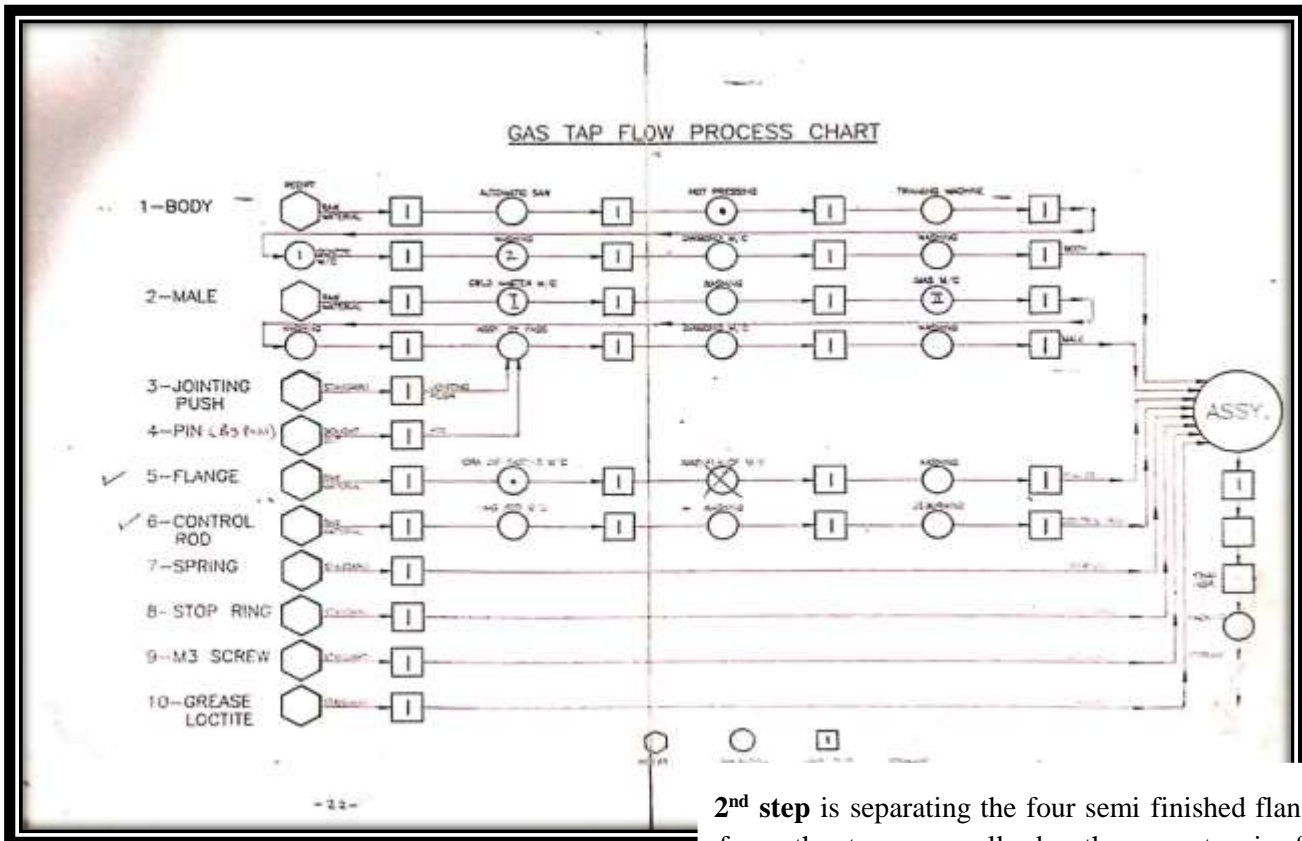
Keywords

Lean manufacturing, Value Stream Mapping, and Gas valve production line.

Introduction

Improvement and mass production are the key words to develop industrial sector in Egypt which is facing great challenges more than ever in Covid-19 pandemic era which will create great questions about the future of Egyptian economy, especially in the industrial sector, which may have the opportunity to boom after this world crisis.

Egypt has a great opportunity to get the most benefit out of the current crisis, whether at the level of exporting or lo
ch
w
er
qu
ca
m
ec
m

Theoretical background

The gas valve is one of the most sophisticated components in the cooking stoves industry due to the complicated production steps and the high safety measures that need to be accomplished in the final product, using Lean manufacturing will improve performance and consequently save money, time.

The present study is carried out in XYZ gas valve production line located in Cairo, Egypt. The production

Fig (1): Gas Valve Process Chart

Study problem

Negative feedback through management review and internal audit reports showing long production time and large scrap rate in flange production which passes through two steps automatic mould casting to produce four semi finished flanges on a tree and each flange should go through machining one by one creating a bottle neck in the production line, applying lean manufacturing will enhance performance of the production line.

Two types of machines used in the conventional method of the flange production:

- Automatic Molding Machine and Machine Center through 5 steps:

2nd **step** is separating the four semi finished flanges from the tree manually by the operator in five seconds.

3rd **step** is visual inspection of the semi finished flanges to insure that the flange is free from any damage or defect in ten seconds.

4th **step** is feeding the semi finished flanges to two stations machine center manually to adjust the final dimensions of the flange in seventeen seconds. 5th step is final inspections of the flange to the final shape to check the dimensions using go/no-go gauge in ten seconds for each piece by one operator each shift.

Current State Flange Production Flow Chart

Quality tools (flow chart and value steam mapping) were used to identify the current state of the processes and activities as shown in figure (2) & (3).

Fig (2): Current State Flange Production Flow Chart

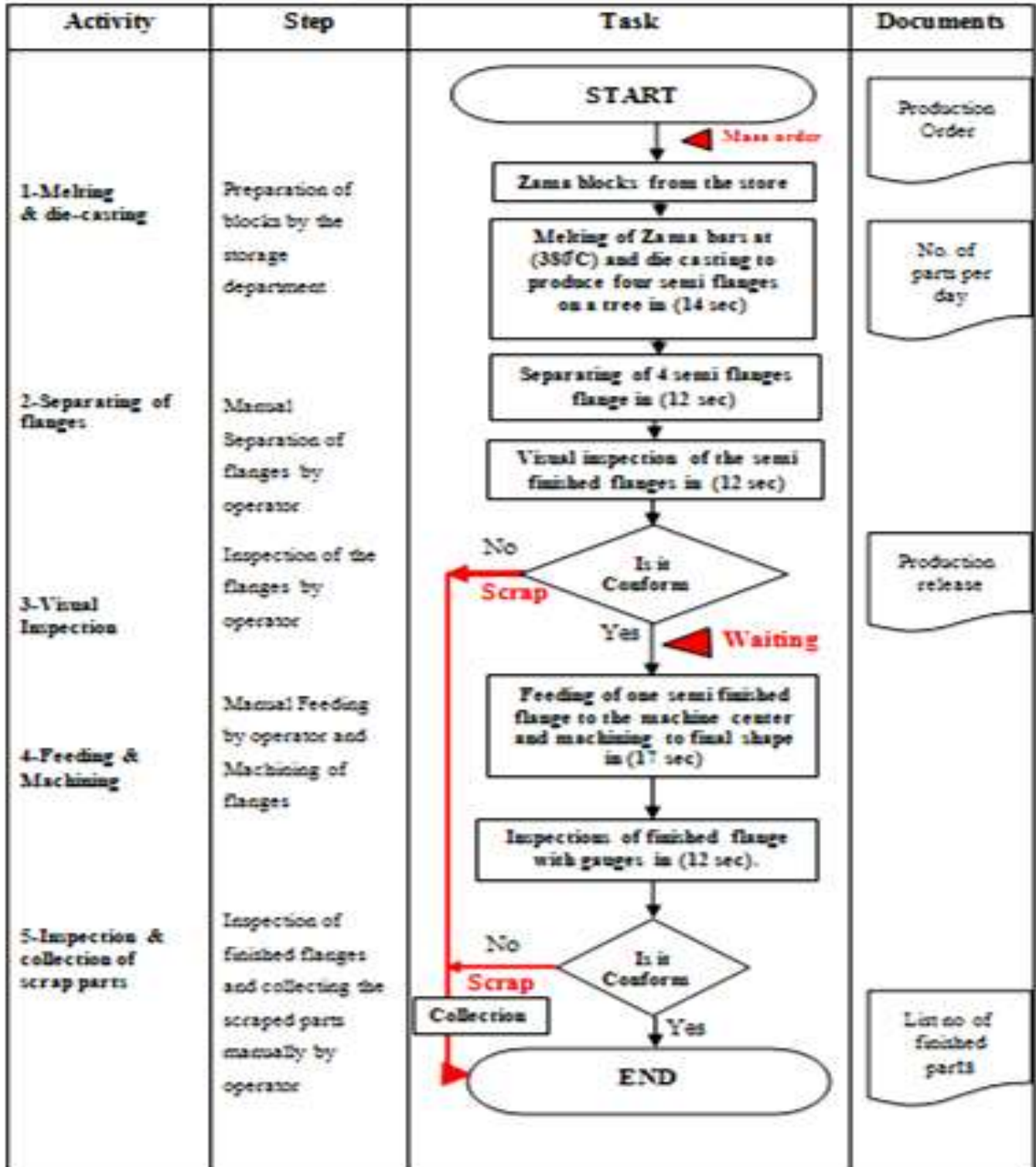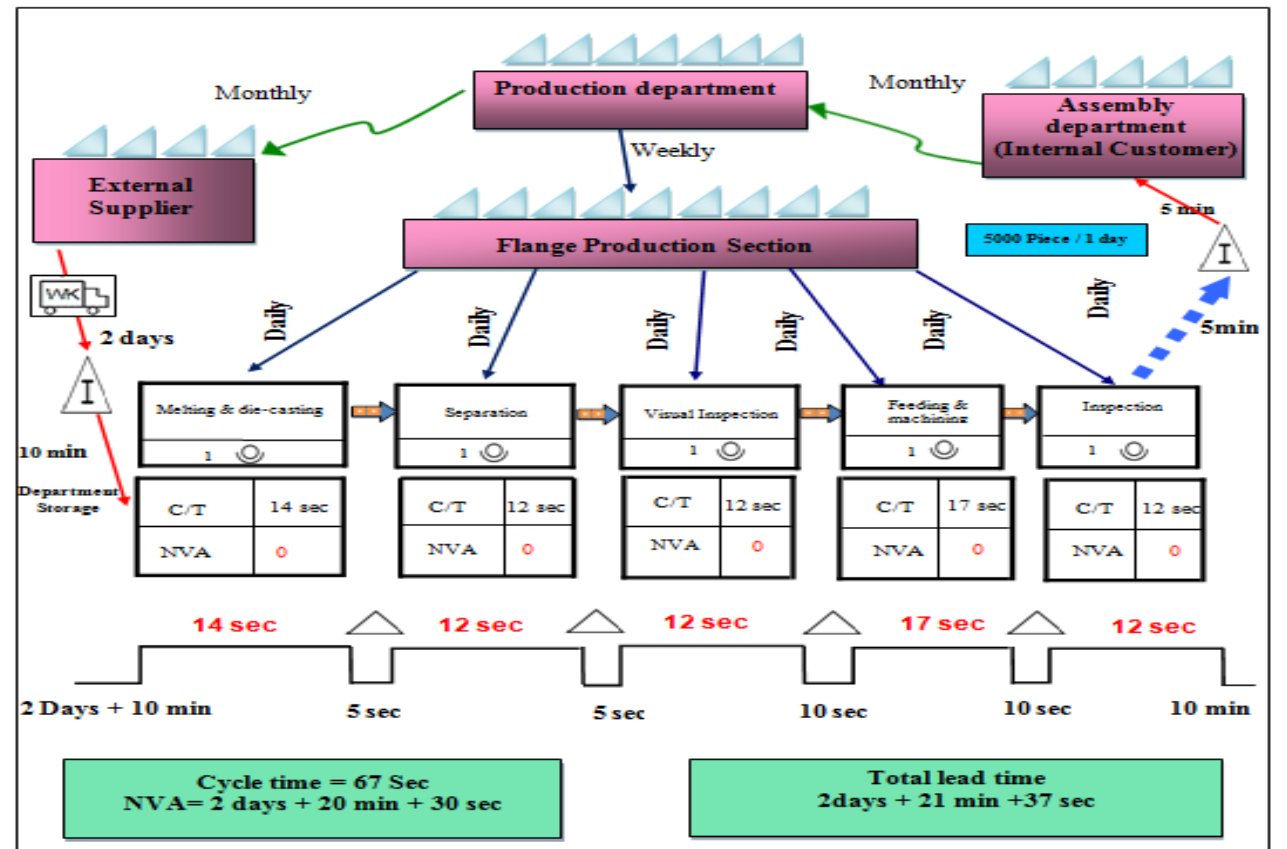| Activity	Step	Task	Documents
1-Melting & die-casting	Preparation of blocks by the storage department	START Mass order Zama blocks from the store Melting of Zama bars at (380°C) and die casting to produce four semi flanges on a tree in (14 sec)	Production Order No. of parts per day
2-Separating of flanges	Manual Separation of flanges by operator	Separating of 4 semi flanges flange in (12 sec)	
3-Visual Inspection	Inspection of the flanges by operator	Visual inspection of the semi finished flanges in (12 sec) No — Scrap ← Is it Conform — Yes — Waiting	Production release
4-Feeding & Machining	Manual Feeding by operator and Machining of flanges	Feeding of one semi finished flange to the machine center and machining to final shape in (17 sec) Inspection of finished flange with gauges in (12 sec).	
5-Inspection & collection of scrap parts	Inspection of finished flanges and collecting the scraped parts manually by operator	No — Scrap — Collection ← Is it Conform — Yes — END	List no of finished parts

Fig (3): Value stream mapping represents flange production current state.

Studying the flow chart and VSM for flange production, production steps are performing a bottle neck due to the accumulation of the semi finished flanges before machining and forming high scrap after the machining. The accumulation of semi finished flanges before the machining step is due to the sequential production way, where the 1st finished flange was produced in 67 sec production time equation according to sequential production method is $(38+n \times 17)$ sec, where (n) is the order of the flange in the production sequence, also there is 10% scrap after the machining step due to the miss feeding by the operator, it is around of the daily produced quantity. The team started studying the types of waste in the current flange production method, there are three types of Muda in the flange production method where Muda is any activity the does not add value to the process as follows:

● **waiting time**

Casting cycle time is 14sec to produce four semi finished flanges connected on one tree.

After the casting and separation process the flanges are finished by the machine center sequentially where one flange is processed to be finished mean while the other three flanges are waiting to processed consecutively. Each four flanges needs to wait for fifty one seconds to be finished by the machine center, where the machining of one semi finished flange cycle time is seventeen seconds to adjust one flange into the final dimension.
• Machining considered bottle neck for the operation creating Muda (waiting time) for the flange production.

● **Scrap**

The semi finished flange is relatively small in size, manually fed into machine center and due to small size of the parts and miss adjustment due to human error, 10% of the daily production for the semi finished flanges are scrap after the machining step.

● **Excess motion**

5000 semi finished flanges are produced each day by the casting machine transferred in specific containers to the machining area for ten meters which lead to excess motion as another type of Muda

Using lean manufacture to reduce flange production wastes in the current state.

A team was formed and brain storming exercise was conducted to generate creative solutions for waste reduction in the current state of flange production, realizing that:

Machining process for the semi finished flange is the root cause of all problems in the flange production because of the sequential production method; the team suggested two solutions to solve the problem:

Add another three machine centers to the production line to substitute the sequential production by simultaneous flange production.

Cancel the machining step and try to produce the flange in the final shape directly through precision casting.

The first solution was rejected due to the high investment needed and in the same time it will increase the scrap, the team started to study the second solution as follows:

● Team started to study the second solution as follows:

Mould consists of two parts, the first part contain four holes, injection head and four runners.

The second part contains four locators pressed into the holes to give flange the required shape.

● After studying the mould dimensions and the flange dimensions team planned the future state of the flange production as follows:

Keep the external dimensions of the mould and change some internal parts of the mould in order to produce finished flanges without using the machine center which will minimize the cycle time, number of workers, amount of used material and the scrap.

The new design of the mould was necessary to combine the two production steps of the flange to one step.

Fig (4): Value stream mapping represents flange production future state.
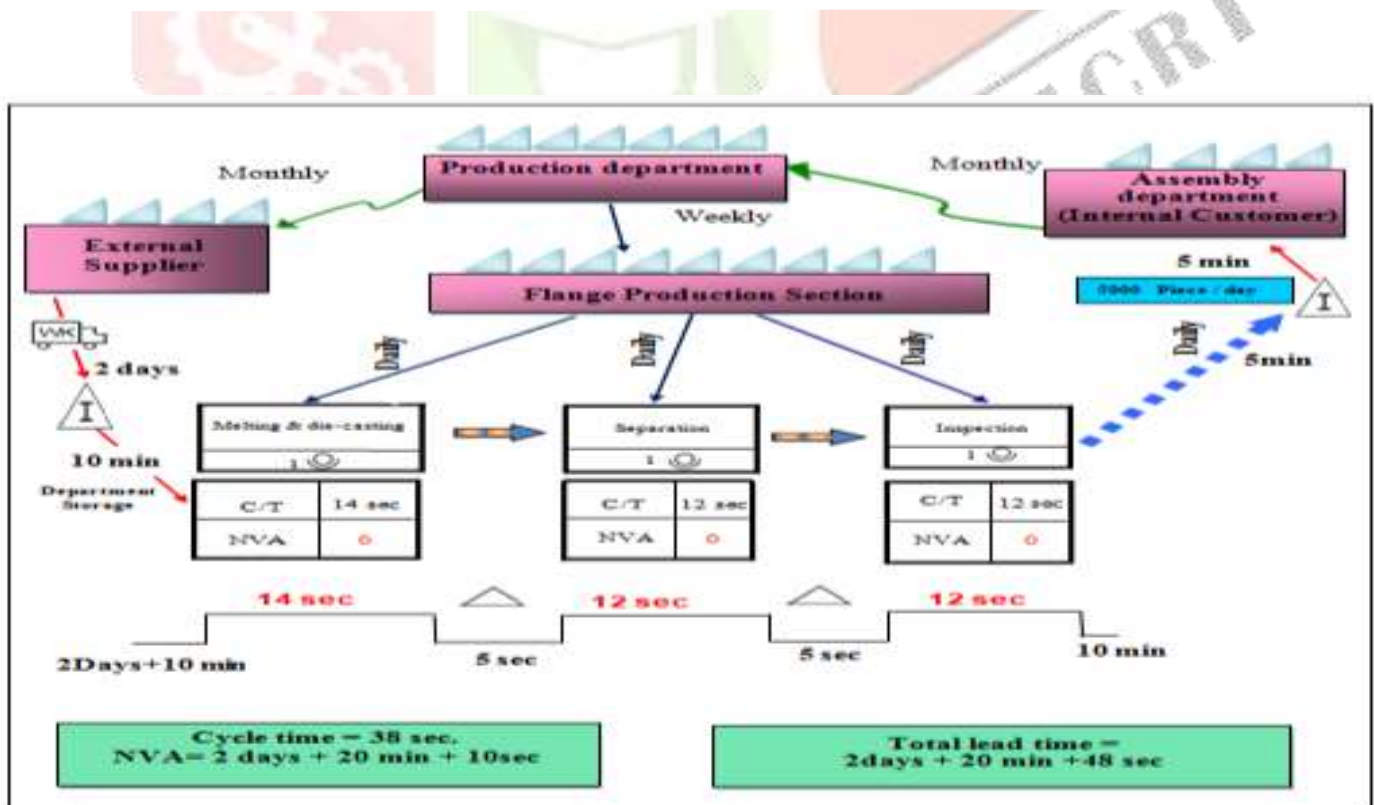
Analysis of the flange production VSM in the future state.

● After applying the new method for producing the flange in a single step through casting the cycle time was decreased from 67 seconds to 38 seconds, the number of operator needed to perform this production step was only 3 steps.

● Number of machines is one instead of two, all of this improvement reflected on the types of wastes which the team designated earlier where the waiting time was eliminated to zero also scrap was reduced by 10% where only small percentage of scrap where resulted after casting.

● finally the excess motion was eliminated because the transportation of the finished flanges after casting will be directly to the next assembly step.

Evaluation of flange production present and future state.

The comparison between the Value Stream Mapping in the present state and in the future state flange production steps are given in table (1).

The magnitude of improvement calculated in the last column.

Points of comparison	Present State	Future State	Percentage of decrease
Cycle time	67 sec/ piece	38 sec/ piece	43.4%
Manpower	5 workers/ shift	3 workers/ shift	40%
Number of machines	2 machines	1 machine	50%
Used material	14 grams/ piece	12 grams/ piece	14.3%
Steps of flange production	5 steps	3 steps	40%
Scrap due to machining	10%	0%	10%

Table (1): Comparison between the Present and Future State for the Flange.
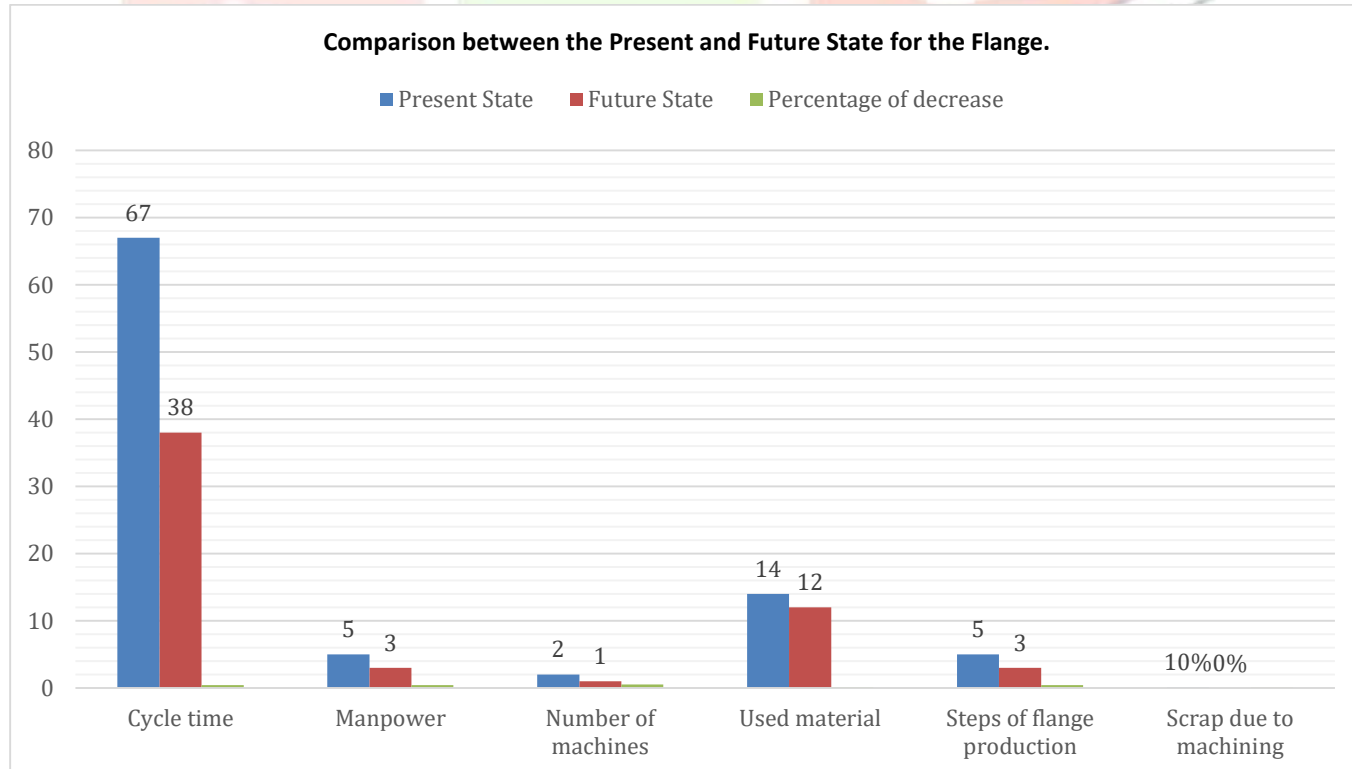

Fig (5): Comparison between the Present and Future State for the Flange.

●Cycle time was decreased by twenty nine seconds due to the usage of the new mould which eliminate the two steps of machining and the visual inspection. The percentage of decrease is 43.4%.

● the number of workers was decreased by two workers due to the removal of machine operator and the inspector of the flange after machining. The percentage of decrease is 40%.

● the number of machines will be one instead of two machines after using the new die with the final dimension which will produce the flange in the final shape instead of the semi-finished one. The percentage of decrease is 50%.

● the amount of used material per piece was decreased by 2 grams / piece which affect the annual production as follows:

2 grams/piece * 1,200,000 piece/year = 2400 kg/year.

The percentage of decrease is 14.3%.

● The number of steps was decreased from five to three steps after using the new mould where the machining step and visual inspection step where decreased after using the new final dimension die which give the flange after mould casting in the final dimension instead of the semi finished flange which produced from the conventional mould. The percentage of decrease is 40%.

Calculation of cost reduction in flange production process.

• Time needed to produce one finished flange will be as follow:

• Casting cycle time is 14 seconds to produce four finished flanges.

• Cycle time for one finished flange will be 4.5 seconds.

• Daily customer demand = Customer demand (year) / working days = 1,200,000 / 240 = 5000 pieces.

• The direct cost and indirect cost for the machining step is 20.89 Pt/ Piece.

Numbers of parts produced in one year 1,200,000•

The total saving cost in one year is 1,200,000x20.89 = 250,680 LE/Year.

• The cost of the new mould is 20,000 Le.

• The period for the mould price retrieve

=Price of new mould/saving cost
= 20,000*12/250,680 = 1 month.

This means that the cost of the new mould will be covered in one month.

The new mould can work effectively for 6 years.•

Amount of saving in 6 years = 6 x 250, 680 = 1,504,080 LE.

Time Reduction

The period for the mould price retrieve	Casting cycle	Cycle time for one finished flange
1	14	4.5

Cost Reduction

1600000	
1400000	
1200000	
1000000	
800000	
600000	
400000	
200000	
0	direct cost and indirect · Numbers of parts · The total saving cost in one year · The cost of the new mould · Total amount of cost saving in 6 years · Daily customer demand
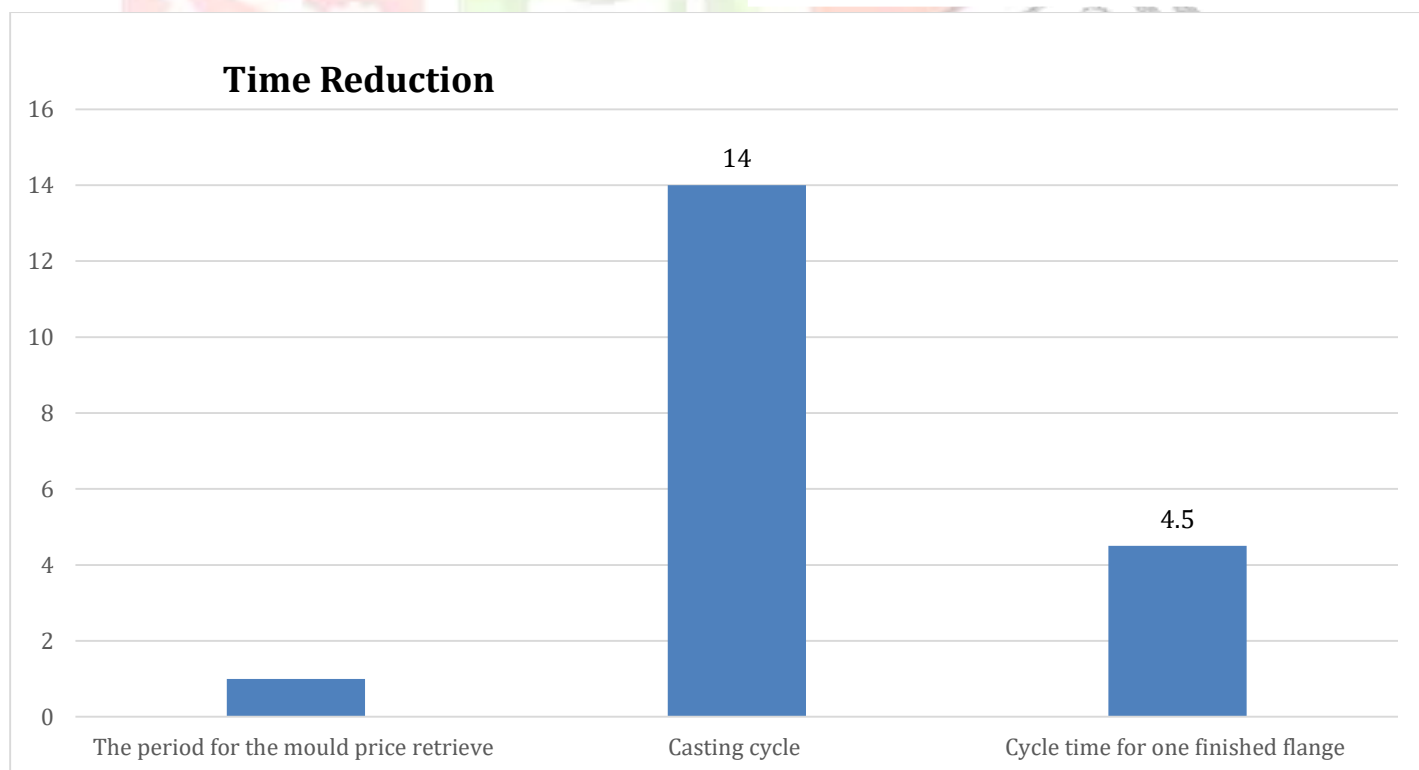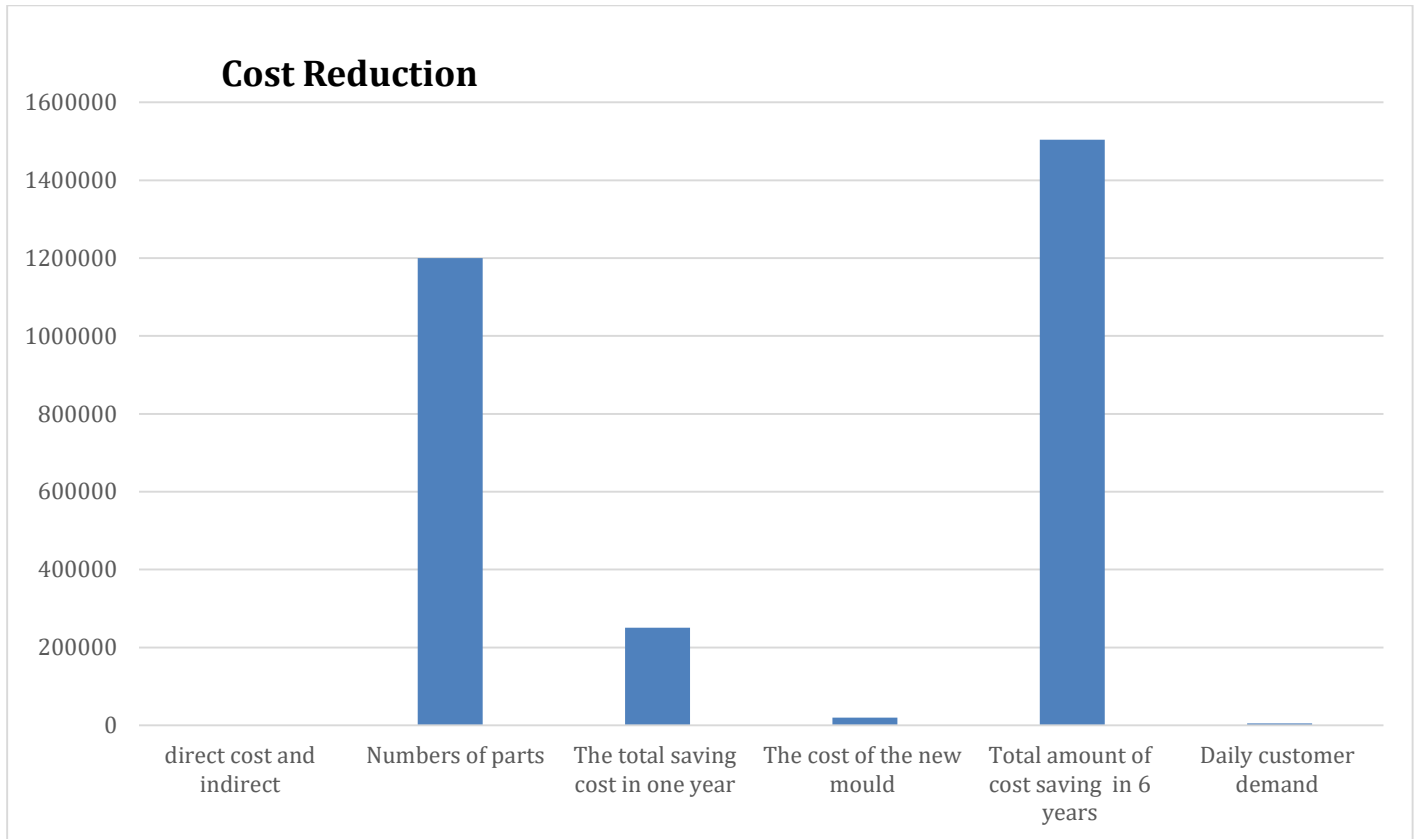
References:

[1]　The Toyota Way: 14 Management Principles from the World's Greatest Manufacturer by Jeffrey Liker.

[2]　The Machine that Changed the World by James P. Womack and Daniel.

[3]　Hutchins, David C. (September 2008). Hoshin Kanri: the strategic approach to continuous improvement. Burlington, Vermont: Gower.

[4] Imai, Masaaki (1986). Kaizen: The Key to Japan's Competitive Success. New York: Random House.

[5]　Imai, Masaaki (1997). Gemba Kaizen: A Commonsense, Low-Cost Approach to Management (1st Ed.). McGraw-Hill.

[6] James,L.B 1991, Quality Function Deployment, ASQC Quality press ,Milwaukee,USA.

[7] Juran, JM 1986,' The quality Trilogy ', proceeding of the fourteenth annually ASQC, quality congress in Anahiem , California .

[8] Juran, Joseph M. (1992). Juran on quality by design: the new steps for planning quality into goods and services. New York: Free Press.

[9]　Upadhye, N., Deshmukh, S. G. and Garg, S., 2010. Lean Manufacturing in Biscuit Manufacturing Plant: A Case. International Journal of Advanced Operations Management, 2 (1/2): 108–139.

[10]　Velarde, G. J., Pirraglia, A., van Dyk, H. and D. E. Saloni, D. E., 2011. Lean manufacturing in the US South Atlantic Region: an overview of the current state of implementation in the secondary wood industry. International Wood Products Journal, 2(1), pp. 30-37.

[11]　White, R. E., and Prybutok, V., 2001. The Relationship between JIT Practices and Type of Production System. Omega - The International Journal of Management Science, 29 (2), pp. 113–124.

[12]　Womack, J. P., Jones, D. T., Roos, D., 1990. The Machine That Changed the World. New York: Harper Perennial.

[13]　Womack, J, P. and Jones, D, T. 2003. Lean Thinking: Banish Wastes and Create Wealth in your Corporation. London: Simon & Schuster.