International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 07 Issue: 12 | Dec 2020 www.irjet.net p-ISSN: 2395-0072

Waste Material Movement and Lead Time as Reduced using Spaghetti Diagram in Low-Pressure Gate, Globe, Check, (LPGGC) Valves Manufacturing Industry

Hariprasath M[1], Pari Erriayarasan P[2], Suriya S[3], Nirmalkumar T[4], Harikrishnan R[5]

[1]*Hariprasath M, Department of Mechanical Engineering, Coimbatore, SKCT, (Tamil nadu), INDIA*
[2]*Pari Erriayarasan P, Department of Mechanical Engineering, SKCT, Coimbatore, (Tamil nadu), INDIA*
[3]*Suriya S, Department of Mechanical Engineering, SKCT, Coimbatore, (Tamil nadu), INDIA*
[4]*Nirmalkumar T, Department of Mechanical Engineering, SKCT, Coimbatore, (Tamil nadu), INDIA*
[5]*Harikrishnan R, Associate Professor, Department of Mechanical Engineering, Coimbatore, (Tamil nadu), INDIA*

Abstract – *Lean manufacturing is the methodology used in the manufacturing process to reduce waste, and also helps to improve productivity. [2] This project deals with the problems of bottleneck in assembly and valve painting. low-pressure gate globe check valve (LPGGC) are the valves produced in this industry. Spaghetti diagram is a visual representation of a process using a continuous flow line tracing the path of an item or activity. Spaghetti diagram is used to track the material's movement and the process time is also calculated by the total lead time, measured from inspection section to section SCN. Once the information is collected, the material is expressed in step-by-step process and the total distance from one operation to another is calculated. [7] Since the lead time is more in the current assembly some improvements are made in the process layout, line balancing and in the overall process. [16] The future state of proposed layout and improvement ideas was also suggested, which helps to reduce the total lead time and increase the overall productivity.*

Keywords: *Lean manufacturing, gate globe check valve (LPGGC), process layout, line balancing.*

1. INTRODUCTION

Lean manufacturing involves the process of increasing production in manufacturing sectors by identifying and eliminating wastes. There are seven basic wastes in an industry they are Transport, Inventory, Motion, waiting time, Overproduction, over-processing, Defects by eliminating these wastes in industry production get increased. [2] There are several lean tools to identify the wastes in an industry they are Process mapping, Time observation, lead time, cycle time, Spaghetti diagram, Communication circle, Waste walk, Voice of the customer, Root cause analysis and some of the tools to eliminate wastes in an industry they are 5S, Poke yoke, Kanban, Kaizen, Single minute exchange of die, Single piece flow, Total quality management, Total preventive maintenance, and FMEA, etc… In this project, we are identifying the waste in the LPGGC line in production by using the Spaghetti diagram and Time observation for different machining and other processes. LPGGC line involves the production of the low-pressure gate, globe, check valve. Gate and Globe valves have the same working process. But the disc placements are different. In gate valve discs are placed vertically to arrest the flow of fluids and in the globe valve discs are placed horizontally to arrest the flow of fluids. And these valves are working manually but the check valve works automatically by regulating the pressure of fluids. Spaghetti diagram involves the process of gathering information from the employees about the material movement. [7] Once the information is gathered, material movement is to be represented in the form of step by step marking. By using the above information total lead time and the distance is to be calculated. [1] By combining and reducing the process flow total lead time and distance are reduced, which helps in improving the production rate. Spaghetti diagram is drawn for valve movement in the low-pressure gate, globe and check valve (LPGGC) line. By drawing the spaghetti, the waste movement of the valve can be identified. By changing the layout these waste can be reduced. [2] Time observation involves the process of observing time study on different machining processes from loading of the job to unloading of job and it provides the length of time to complete the process. By observing the time study on different machining processes certain waste can be identified. [16] These wastes are eliminated by providing suitable improvement ideas. Provided ideas are to eliminate the waste time and thereby to reduce the operator work. By Appling lean tools and techniques, the total lead time is calculated in the manufacturing process. To reduce the total lead time, the improvement ideas, suggestions and it helps to increases the production rate.

2. PROJECT METHODLOGY

1. Process study for Gate, Globe, Check (LPGGC) Valve production.
2. Layout prepare for the current state of LPGGC line
3. Spaghetti diagram drawn for material movement in LPGGC line.
4. Time study for each step by step process in LPGGC line.

5. Waste movement of material and total lead time is reduced by changing the layout using spaghetti.

6. Improvement ideas as suggested for reduced lead time using lean tool and techniques.

7. By this, the resulting total lead time and increase the production rate.

3. IMPLEMENTATION OF LEAN TOOL IN VALVE MANUFACTURING PROCESS

3.1 Process flow in LPGGC line:

Valve from the vendor is moved to the receiving area in the LPGGC line. After quality is checked, it is moving on to the storage area in the LPGGC line. When the material receipt from the shop floor is provided to the store, they provide the required material to the valve assembly. After MR is provided, the storage body of the valve is moved to the welding area. In this area, the seat ring is welded by using metal inert gas welding. Once welding of seat ring is completed it is moved on to the manual grinding area. In this area, extra material that is coated over the seat ring is removed by the pneumatically operated abrasive tool which is operated by manual. And the valve body is moved on to a dye penetration test where the outer surface area is checked for any discontinuous in welding and manually ground area. After that valve body is moved on to the lapping area, where the seat ring surface is lapped to achieve the required surface finish.

Once it is completed based on the customer demand valve body, bonnet and disc are moved to stress relief and hot phosphating in case of WCB material, for CF8M, CF3M acid picking is carried out. After phosphating or acid picking again it is moved on to the LPGGC line, where disc suiting and disc grinding are carried out for gate valve, for check valve disc grinding is carried and for globe valve machining is carried out. In case of the smaller valve from 2 inches to 6 inches, it is moved to assembly area after assembly, and testing serration is carried out and for larger valve from 8 inches to 12 inches serration is done before assembly. Before assembly of the valve, the bonnet is assembled in bonnet sub-assembly. It is moved on to the assembly area where the body and disc have already existed when the valve is assembled it is moved to the testing area.

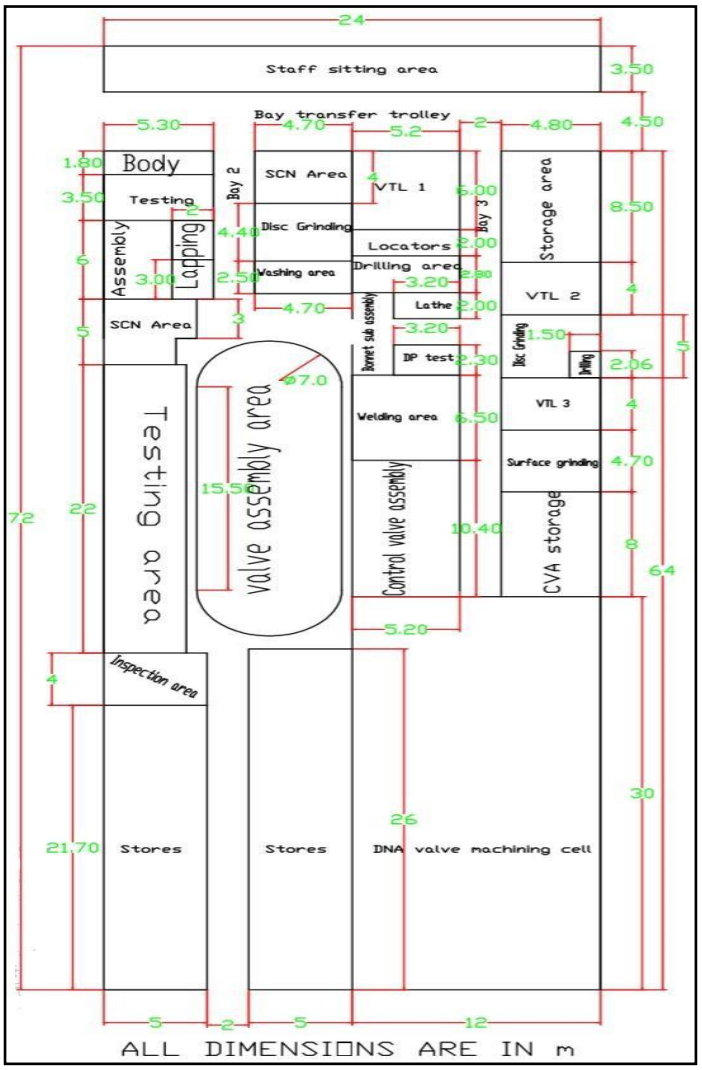

Fig.1. Current state layout of LPGGC line

In the testing area valve is tested based on two bases, one is an air leakage test and the other one is the hydro test. Once the test gets completed and meets the customer demand valve is moved on to the sales credit note area. In this area, the finishing of the valve is carried out. After that valves are moved to the painting block.

3.2 Spaghetti diagram:

Spaghetti diagram involves the process of gathering information from the employees about the material movement. [2]

PRESENT SPAGHETTI DIAGRAM FOR BODY

S.NO	Indications
1)	Receiving body to store
2)	Movement of body to welding area from store
3)	Movement of body to manual grinding from welding
4)	Movement of body to DP area from manual grinding
5)	Movement of body to SR from DP area(Outside line)
6)	Movement of body to SRFL or Lapping from SR

7) Movement of body to suiting from SRFL or Lapping
8) Movement of body to Serration from suiting
9) Movement of body to assembly from serration
10) Movement of body to testing from assembly
11) Movement of body to SCN from testing
12) Movement of body to painting and packing from SCN area

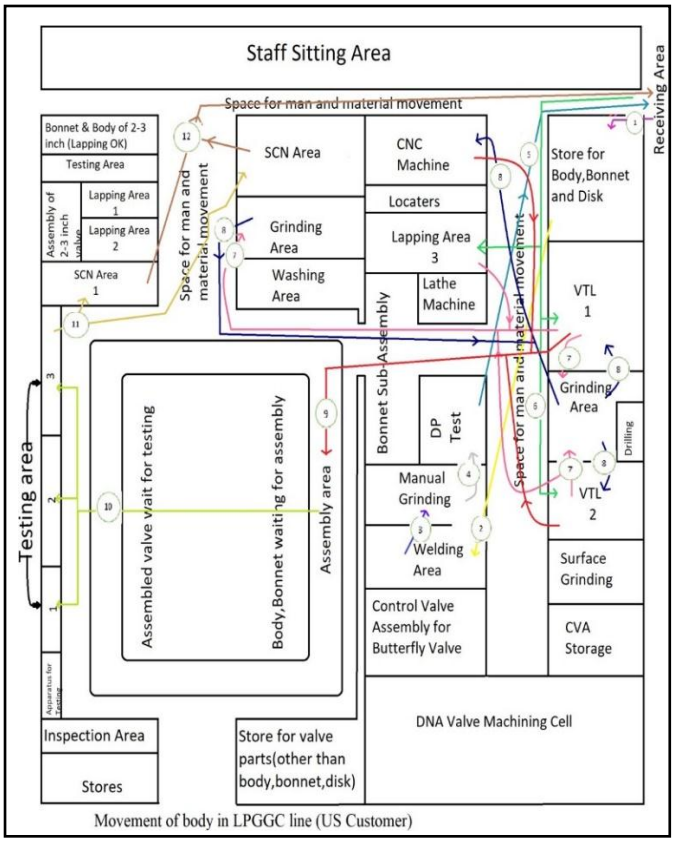

Fig.2. Material movement for body

By using the spaghetti diagram, body movement is tracked and the total distance traveled by the body is 199.3 meters and the total material movement time is 128min.

PRESENT SPAGHETTI DIAGRAM FOR BONNET

S.NO	Indications
1	Receiving bonnet to store
2	Movement of bonnet to phosphating from store(MR)
3	Movement of bonnet to bonnet sub assembly from phosphating area
4	Movement of bonnet to assembly from sub assembly
5	Movement of bonnet to testing from assembly area
6	Movement of bonnet to SCN area from testing
7	Movement of bonnet to painting and packing from testing

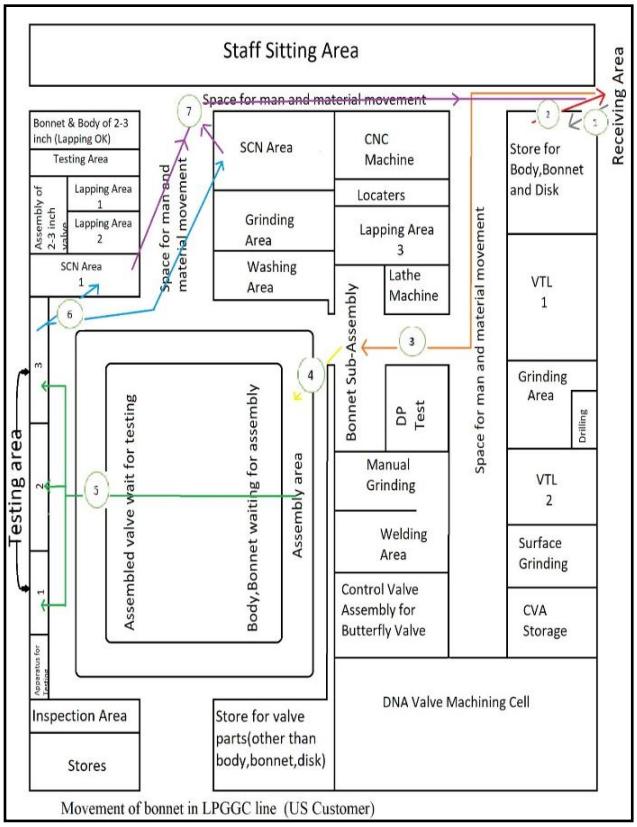

Fig.3. Material movement for bonnet

By using the spaghetti diagram, the bonnet movement is tracked and the total distance traveled by bonnet is 147.2 meters and the total material movement time is 72min.

PRESENT SPAGHETTI DIAGRAM FOR DISC

S.NO	Indications
1)	Receiving disc to store
2)	Movement of disc to phosphating from store(MR)
3)	Movement of disc to machining(globe), grinding(check) and suiting(disk) from phosphating area
4)	Movement of disc to assembly area
5)	Movement of disc to testing from assembly area
6)	Movement of disc to SCN area from testing
7)	Movement of disc to painting and packing from testing

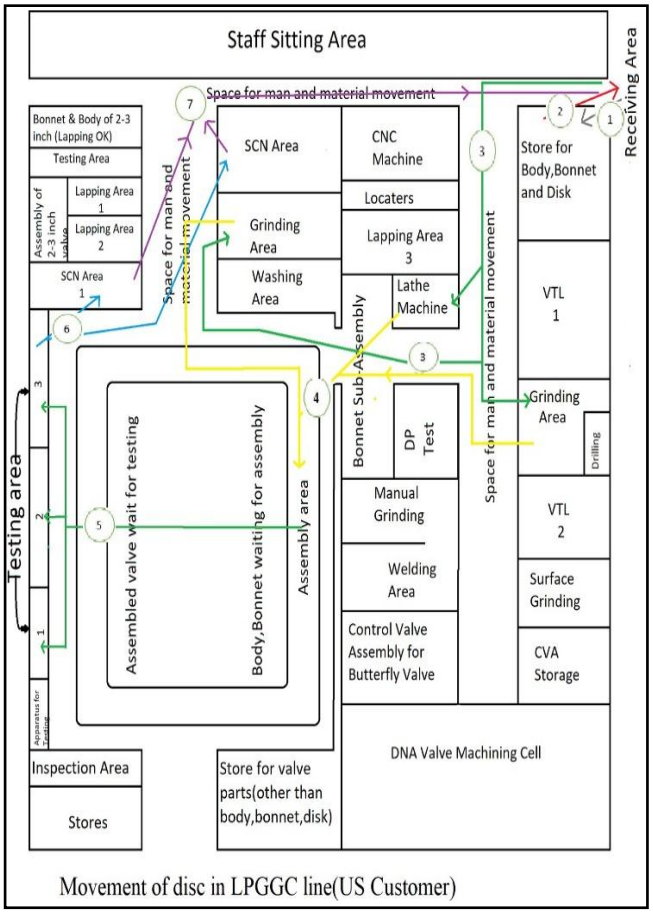

Fig.5. Material movement for disc

By using the spaghetti diagram, disc movement is tracked and the total distance traveled by the disc is 139.8 meters and the total material movement time is 77min. Overall cycle time and material movement time is 907 min/valve. Total lead time is 3628 min (2 days 12 hours).

4. RESULT AND DISCUSSION

A. *Improvement in LPGGC line.*

The current state Process that is carried out in the LPGGC line is Welding, Manual grinding, DP test, Stress relief & phosphating, SRFL/Lapping, Disc suiting/Grinding/Machining, Serration, Assembly, Testing, SCN. [16] The total cycle time is 630 min and material movement is 277 min. To reduce the lead time, the improvement idea suggested, and it as shown in the tabulation. Overall cycle time and material movement time is ***907 min/valve.*** Total lead time is 3628 min (2 days 12 hours)

S.NO	Process or Activity done	Cycle time (min)	Suggestion
1	Welding	75	Jack for seat ring setting
2	Manual grinding	50	
3	DP test	32	
4	Stress relief & phosphating	175	
5	SRFL/Lapping	88	Tool bar 4.75 degree inclined
6	Disc suiting	58	
7	Serration	72	SRFL and Serration is combined
8	Assembly	40	Lapping tool, small extrusion to nail
9	Testing	40	
	Total Cycle time	***630 min***	

Table 1: Improvement idea suggestion for LPGGC.

The improvement ideas suggested will reduce to cycle time for each operation. The proposed layout is created to reduce material movement and the distance travel for each processed form the receiving area to the SCN process for the LPGGC Line. The proposed layout of the LPGGC Line and spaghetti diagram for each process as shown below.

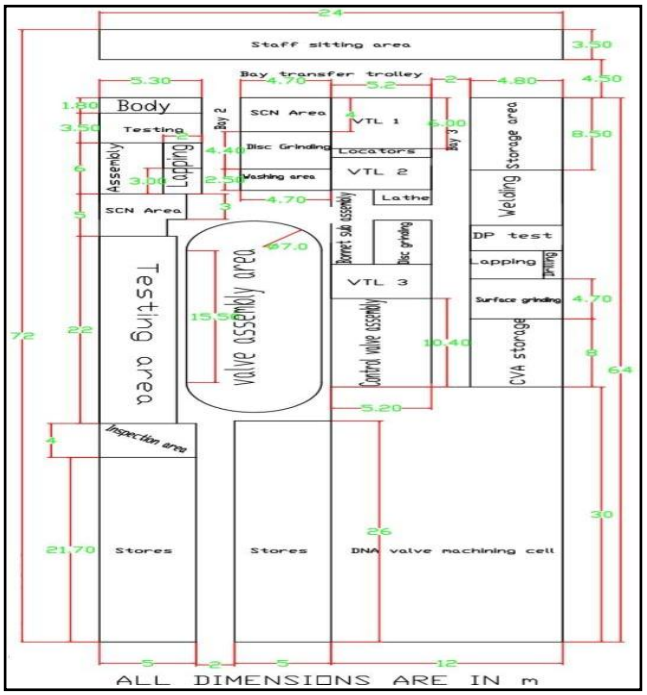

Fig.6. Future state layout of LPGGC line

PROPOSED SPAGHETTI DIAGRAM FOR BODY

S.NO	Indications
1)	Receiving body to store
2)	Movement of body to welding area from store
3)	Movement of body to manual grinding from welding
4)	Movement of body to DP area from manual grinding
5)	Movement of body to SR from DP area(Outside line)
6)	Movement of body to SRFL or Lapping from SR
7)	Movement of body to suiting from SRFL or Lapping
8)	Movement of body to Serration from suiting
9)	Movement of body to assembly from serration
10)	Movement of body to testing from assembly
11)	Movement of body to SCN from testing
12)	Movement of body to painting and packing from SCN area

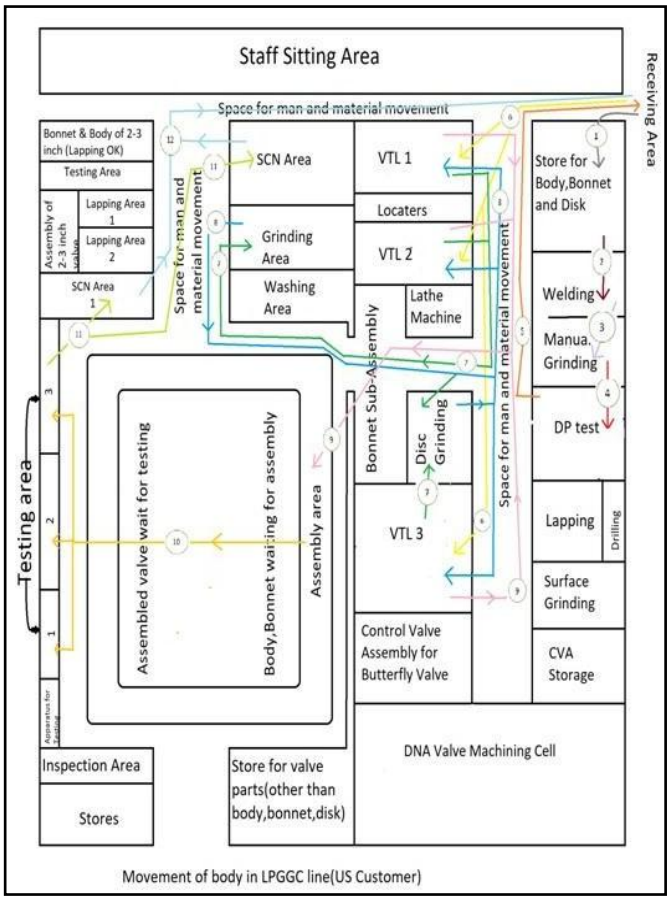

Fig.7. Material movement for body

By changing the layout, Spaghetti is drawn and the total material movement is 164.5meters and the total material movement time is 105min.

PROPOSED SPAGHETTI DIAGRAM FOR BONNET

S.NO	Indications
1)	Receiving bonnet to store
2)	Movement of bonnet to phosphating from store(MR)
3)	Movement of bonnet to bonnet sub assembly from phosphating area
4)	Movement of bonnet to assembly from sub assembly
5)	Movement of bonnet to testing from assembly area
6)	Movement of bonnet to SCN area from testing
7)	Movement of bonnet to painting and packing from testing

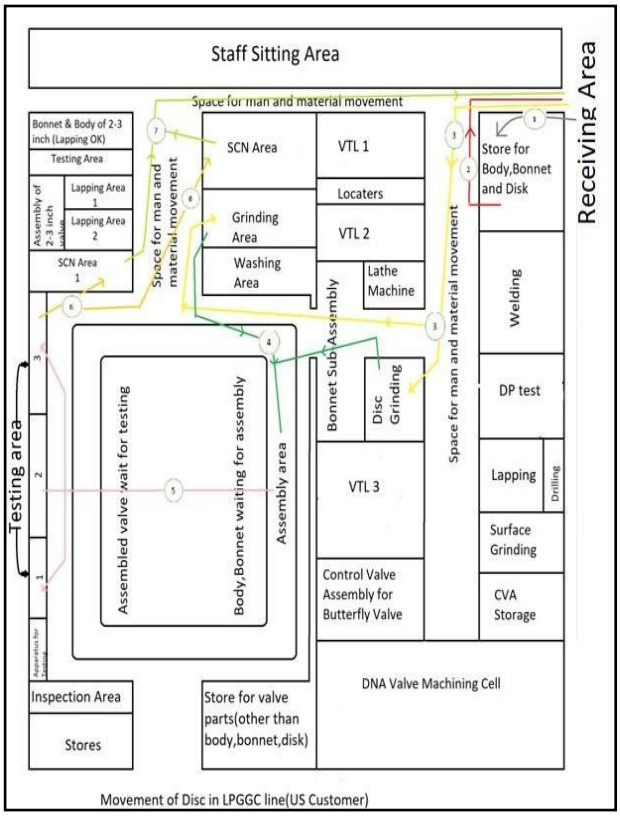

Fig.8. Material movement for bonnet

By changing the layout, Spaghetti is drawn and the total material movement is 135.2 meters and total lead time is 72min.

PROPOSED SPAGHETTI DIAGRAM FOR DISC

S.NO	INDICATIONS
1)	Receiving disc to store
2)	Movement of disc to phosphating from store(MR)

3) Movement of disc to machining(globe), grinding(check) and suiting(disk) from phosphating area

4) Movement of disc to assembly area

5) Movement of disc to testing from assembly area

6) Movement of disc to SCN area from testing

7) Movement of disc to painting and packing from testing

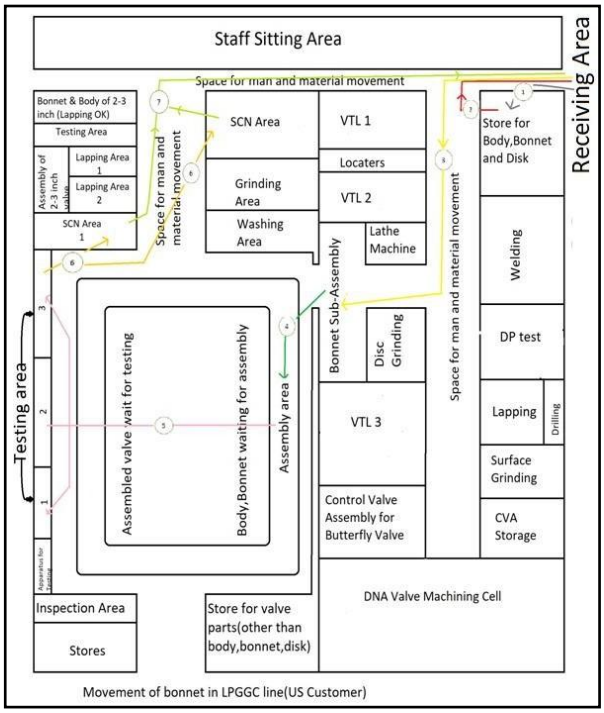

Fig.9. Material movement for Disc

By changing the layout, Spaghetti is drawn and the total material movement is 128.2 meters and the total lead time is 75min.

Table 2: Result in future state.

S.NO	Process or Activity done	Cycle time(min)	Reduced cycle time(min)
1	Welding	75	70
2	Manual grinding	50	50
3	DP test	32	32
4	Stress relief & phosphating	175	175
5	SRFL/Lapping	88	68
6	Disc suiting	58	58
7	Serration	72	32
8	Assembly	40	35
9	Testing	40	40
	Total Cycle time	***630 min***	***590min(40min)***

After the suggestion, overall cycle time and material movement time is 842 min/valve. Total lead time is 3368 min (2 days 8 hours). The percentage reduced in the assembly area after the suggestion is 6.45percentage (40min).

5. CONCLUSION

From the above results, it is observed that the total lead time is reduced in the production of low-pressure gate globecheck valve (LPGGC) by applying lean techniques. [1] The data from inspection section to SCN section is calculated by using a spaghetti diagram to visualize process flow. Also, this method is used to track the routing through factories and the distance is measured in the current state. [9] The processing time and movement of the material is reduced by implementing some improvements in changing the assembly layout and in line balancing. These improvements are made in future state of value stream mapping and by implementing the future state the total lead time is reduced. [16] As the total lead time is reduced assembly and painting of valves, the overall productivity increases.

ACKNOWLEDGEMENTS

The humble thankful to the valve manufacturing industry employee and organization for collecting the current state data and gives us full cooperation for improvement as modified in future state.

REFERENCES

1. Purushothaman Mahesh babu1, Seadon Jeff1, Moore Dave1 (2020) Waste reduction using Lean tools in a multicultural environment.
2. Katarína SENDERSKÁ1, Spaghetti diagram application for workers movement analysis -2017
3. Cristiano Politowski*a*, Foutse Khomh*b* "A Large Scale Empirical Study of the Impact of Spaghetti Code and Blob Anti-patterns on Program Comprehension" 2019
4. Budak' (2), I . Lazoglu', B.U. Guzel' Improving Cycle Time in Sculptured Surface Machining Through Force Modeling
5. F. Hnaien _ H.M. Afsar Integration of additional purchase cost to reduce the lead time uncertainty for one level assembly system 2013
6. P. Kuhlang *, T. Edtmayr, Methodical approach to increase productivity and reduce lead time in assembly and production-logistic processes.
7. Vijaya Ramnath, B., etal., 2009. Impact of lean manufacturing on improving productivity of auto components manufacturing industry. Manufacturing Technology Today, Vol.8, pp.20-26.

8. Orhan Engin a , Ahmet C¸ elik a , I˙hsan Kaya b, 2008. A fuzzy approach to define sample size for attributes control chart in multistage processes: An application Murthy, Y. Rambabu, Design and application of economical process control charts, Des. Sci. J. 47 (1) (1997) 45–53.
9. Dhruv Shah, Productivity Improvement by Implementing Lean Manufacturing Tools In Manufacturing Industry, IRJET March 2018, pp. 3794–3798.
10. M. Middlesworth, A Step-by-Step Guide to the RULA Assessment Tool [Blog post]. Retrieved from http://ergo-plus.com/rula-assessmenttool-guide/(2016)
11. P. Nowotarski, J. Pasławski, J. Matyja, Improving Construction Processes Using Lean Management Methodologies–Cost Case Study. Procedia Engineering, 161 (845), (2016), 1037–1042.
12. . Ohno, Toyota Production System: Beyond Large-Scale Production, Productivity Press, New York, 1988.
13. Avinash Panwar, Rakesh Jain, A.P.S. Rathore (2015). Lean implantation in Indian process industries-some empirical evidence.
14. H. M. Fazi, N. M. Z. N. Mohamed, M. F. F. Ab Rashid, A. N. M. Rose. Ergonomics study for workers at food production industry. MATEC Web of Conferences. 90, (2017), (01003).
15. P. Basavarajgowda, Material management in cement industry with special reference to associated cement company in Gulbarga district. (2012).
16. I. L. Nunes, (2015). Integration of Ergonomics and Lean Six Sigma. A model proposal. Procedia manufacturing, 3, 890–897.
17. P.Arunagiri, A. Gnanavelbabu, Identification of High Impact Lean Production Tools in Automobile Industries using Weighted Average Method. Procedia Engineering, 97(450), (2014), 2072–2080.
18. P. Guariente, I. Antoniolli, L. P. Ferreira, T. Pereira, F. J. G. Silva, "Implementing autonumous maintenance in na automotive componentes manufacturer", Procedia Manufacturing 13 (2017) 1128-1134.
19. C. Rosa, F. J. G. Silva, P. Ferreira, "Improving the Quality and Productivity of Steel Wire-rope Assembly Lines for the Automotive Industry", Procedia Manufacturing 11 (2017) 1035-1042.
20. L.R.F. Ferreira Static strength improvement of tubular aluminium adhesive joints by the outer chamfering technique 2019.
21. R. B. Detty and J. C. Yingling, "Quantifying benefits of conversion to lean manufacturing with discrete event simulation: A case study. International Journal of Production Research [Online], (2010) 38(2), 429-445.
22. R. Shah and P. T. Ward "Lean manufacturing: context, practice bundles and performance", Journal of Operations Management [Online]. 21 (2002) 129-149.
23. L. Bamber and B. G. Dale, "Lean production: a study of application in a traditional manufacturing environment", Production Planning & Control 11 (2010) 291-298.
24. R. V. Narang, "Some Issues to Consider in Lean Production" in 2008 First International Conference on Emerging Trends in Engineering and Technology, India, Nagpur, (2008) 749-753.
25. Costa MJR, Gouveia RM, Silva FJG, Campilho RDSG. How to solve quality problems by advanced fully-automated manufacturing systems. The International Journal of Advanced Manufacturing Technology 2018. In press. DOI 10.1007/s00170-017-0158-8.