APPLICATION OF LINE BALANCING TECHNIQUE TO IMPROVE PRODUCTION EFFICIENCY AT THANH THANG LIMITED COMPANY

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Abstract

Waste in the production process causes waste of resources and resources while not creating real value, which is a major threat, reducing the competitiveness of enterprises. One of the measures that can both improve productivity and reduce costs effectively for enterprises is line balancing. Line balancing effectively maximizes idle time at stations, minimizes the number of workstations as well as uses fewer workers and equipment while still ensuring the company's production output and significantly increases production efficiency. The article focuses on the production line of Vancover Dining chair backrest clusters at Thanh Thang Limited Company. The actual production line still has some problems such as many stages of semi-finished products and too much idle time at some other stages. Therefore, the study proposes a method of rearranging the line in a U-shape to balance the production line to optimize the production process, but also from eliminating non-value-added activities. By reducing waste, enterprises not only save costs but also achieve increased output and shortened production time.

Keywords: Cost, Line balancing , U-shape, waste

1. Introduction

In the context of fierce competition and instability from macro factors, reducing waste, optimizing costs, and using resources creatively is an inevitable strategy for survival and development. Calculating to balance the production line, specifically to solve the problem of no part being overloaded while other parts are idle, is a very important problem in manufacturing plants. Many information systems installed with techniques and algorithms to calculate for balancing the line have been applied in many developed countries and large enterprises. However, for small and medium enterprises in Vietnam, the field of balancing the production line is still mainly based on the experience of the line operator to transfer workers from one department to another when there is a congestion or idle situation somewhere in the production line. Therefore, the labor efficiency of workers as well as the production output have not achieved optimal results. At the Vancover Dining chair backrest cluster production line of Thanh Thang Limited

Company , due to the nature of manual work that depends largely on the skills of workers, labor efficiency is still low. Measuring production time, identifying bottlenecks, calculating the overall efficiency of the line, through this result, it is possible to propose adjustment measures to improve overall productivity. Therefore, the U-shaped line design is used to balance the Vancover Dining chair backrest assembly product line, the main product of Thanh Thang Limited Company, helping the company identify and solve current waste problems, thereby optimizing the production process and improving overall efficiency.

2. Scientific research and research establishments

Balancing the production flow allocates the tasks to the employees, creating stations so that the production time of the stations is the sum of the work cycles of the station, not exceeding the production cycle of the production line. Balancing the production flow determines the actual number of employees for the production line.

Balancing the production flow analyzes the current situation with the tool of the balance chart. Steps to build the chart:

• Determine the tasks, time.

• Draw the diagram

• Determine the number of employees.

• Balancing the tasks.

After balancing the line, the production time of the production line includes the production time of the stations and the inventory time between the stations (Phan, 2015).

According to Nguyen (2012), Time study is an analytical method applied to divide work into elements (units) and use time as a scale to evaluate the work. The objectives of time study:

• Quantitatively understand the work time. Create a model for the work. From there, draw out the necessary improvements.

• Examine all the facts. Clarify and analyze the current work structure to prevent improving production time by eliminating steps in the process.

• Detect waste and be the first step to improve. The first step is to find waste and improve the work process.

Basic steps in time study:

• Break down the work: Break down the work into units. Then consider which jobs will not be repeated. Repeated jobs will refer to previous observations.

• Observation: Measure the time of each work unit using the stopwatch method to measure time. If the work is repetitive, we can take an average of 10-15 continuous measurements.

• Observational study: Rearrange the observational data and model the work steps and time values.

• Improvement idea study: To analyze the current work, a questioning attitude is needed. There should be no prejudice when collecting ideas for improving the process. There can be many perspectives and ways of thinking that coexist.

Standardizing the process means that the procedures and instructions for performing the steps in the process are clearly and specifically communicated to avoid inconsistencies and false assumptions about how a job is done. Standardizing the process aims to ensure that activities are always performed consistently, except in cases where the process is intentionally adjusted. Standardizing the process in Lean Manufacturing includes several main components:

Standard work sequence: This is the sequence a worker must follow when performing a job, including the operations and steps to perform the job. Standard Time: Cycle time is the rate at which a product is produced. Cycle time is used to clearly describe and track the speed at which a process should be maintained at different stages. For Lean manufacturers, the cycle time of each production process is actively coordinated and monitored to maintain a constant flow of production (Nguyen, 2015) .

3. Research methods

To identify waste, the author used a number of methods such as: collects necessary data of the production line such as the number of stages, the time taken to perform each stage, the sequence of stages, the working time per day, and the productivity. The purpose of collecting data is to understand the current situation of the entire line.

Identified wastes :

Currently, Thanh Thang Limited Company operates 4 production workshops, the Vancover Dining chair assembly stage, the work steps are mainly done by hand, it is inevitable that there is a waiting time between stages, causing a decrease in workers' productivity. Through careful observation, the author found that waiting waste appears significantly on the production line in all 4 workshops. The production process consists of 5 stations with different execution times. Details are presented in Picture 1 and Table 1.

Picture 1. Production process flow diagram

The author observed and measured the time taken to perform work operations at 5 stations. The average results after 20 measurements are shown in the following table.

*TABLE 1.*Vancover dining chair backrest assembly job description:

Station	Number of people	Jobs	Operations	Time
1	2	Assemble the chair's shoulder, back and armrest into one assembly.	**Worker 1**	**19,0 s**
			Apply glue to the grooves of the chair's shoulder and armrest.	11,0 s
			After that moving the details to worker 2	4,0 s
			Non value adding time	4,0 s
			Worker 2	**21,7 s**
			Assemble the backrest of the chair onto the chair's shoulder and the armrest.	12,7 s
			Move the details to station2	4,0 s
			Non value adding time	5,0 s

2	2	Assemble the assembly at station 1 onto the two rear chair legs.	**Worker 1**	**19,3 s**
			Apply AB glue to the grooves on both sides of the chair legs.	12,3 s
			Move the details to worker 2	3,0 s
			Non value adding time	4,0 s
			Worker 2	**29,7s**
			Apply white glue to the bottom groove	4,0 s
			Assemble the assembly into the two chair legs.	18,3 s
			Move the details to station 3	4,0 s
			Non value adding time	3,4 s
3	1	Press the backrest assembly and shoot nails to fix it	**Worker 1**	**19,2 s**
			Use high frequency wood press to press the product detail assembly at station 2 and then shoot nails to fix it	13,2 s
			Move the details to station 4	4,0 s
			Non value adding time	2,0 s
4	1	Check and adjust	**Worker 1**	**18,3 s**
			Use the horizontal bar to go between the two chair legs to check if the distance is suitable. If not, he must screw the horizontal bar to the two chair legs	11,8 s
			Move the details to station 5	4,5 s
			Non value adding time	2,0 s
5	1	Glue remover	**Worker 1 (QC)**	**5,6 s**
			Conduct inspection	2,1 s
			Wipe off excess glue joint position	1,0 s
			Non value adding time	2,5 s

TABLE 2. Mean, standard deviation and sample size of time taken at stations

Station	Mean	standard deviation	sample size
1	21,7	3,4	10
2	29,7	6,1	10
3	19,2	1,5	10
4	18,3	2,3	10
5	5,6	1,1	10

Table 2 clearly shows the variation in lead time of each production station over different measurements. The average time to complete each production station is as follows: station 1: 21,7 seconds, station 3: 19,2 seconds, station 4: 18,3 seconds and station 5: 5,6 seconds. Station 2 has the highest Lead Time (29,7 hours), causing waiting for the following stages. Stations 1 and 2 have the greatest variation in completion times, while stations 3 and 5 are more stable.

Waiting time also varies from station to station, and it can be seen that station 5 has the highest waiting time with 24,1 seconds. This can cause waste and affect the overall efficiency of the production line. To optimize the production process, minimizing waiting time and understanding the causes of lead time variation will be important factors to consider. From the above data, the author reviewed and analyzed the average working time of each person in the production stations, especially production station 2, to find out the cause of waiting waste.

Production capacity: 121 products/hour

Production efficiency: 70,18%. shows that this line is unbalanced and can be improved to be better.

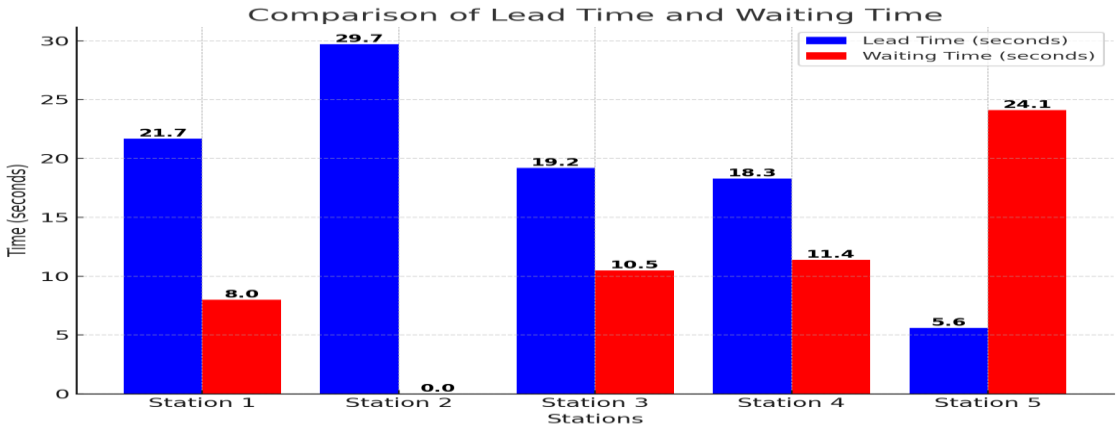


Chart 1. Compare lead time and waiting time at stations

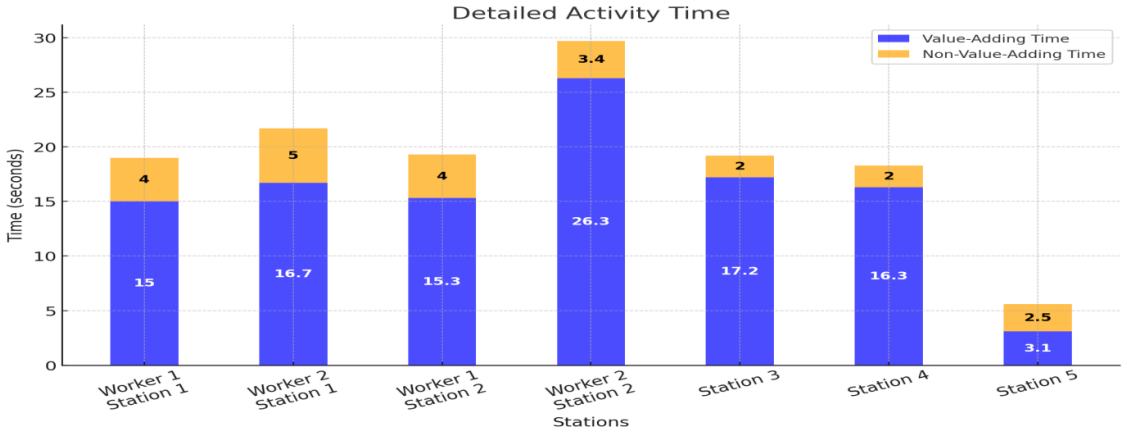


Chart 2. Value adding time and non value adding time

Through observation, the author found the following problems:

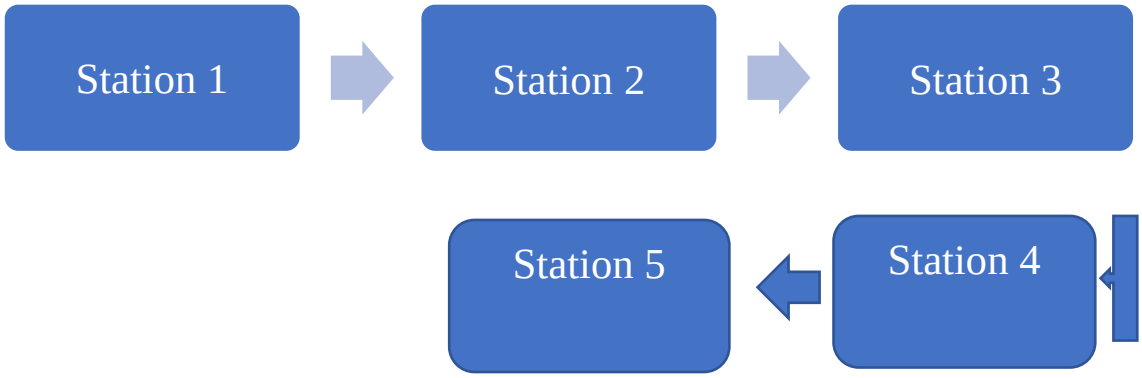
1. Work productivity at stations is interdependent and determines product quality

2. Defect correction time and waiting time at stations do not create value and affect the productivity of the entire production process. Workers receive wages and bonuses based on productivity, so they perform operations very carefully and want to reduce non-value-added time so they can make more products.

3. The second person's job at station 2 takes the longest and has the most products to repair.. The reason is that this person had to undertake 3 operations in the same stage: gluing, assembling and moving the part.

4. The worker at station 5 is a QC who checks the production quality. If there is a product defect, he will return the defect to the corresponding station for correction. After listening to the author's suggestion on balancing the lines at the stations to improve overall productivity, he completely agrees and is ready to support station 2. With the U-shaped production model, the travel distance from station 5 to the stations is the shortest. The increase in production productivity will result in additional bonuses for the workers at station 5 from the company.

The author proposes a solution to reduce unnecessary travel time for workers. Instead of continuing to arrange in a straight line, adjusting to a U-shape will create better coordination between workstations, shortening the distance between station 5 and other stations.



Picture 2. U -shaped production process flow diagram

Workers have agreed on the new line layout. Workers at station 5 can easily access other stations without having to travel far and can support work at station 2. This reduces waiting times for all stations while improving line balance and increasing productivity for the entire production process. The reorganization also creates a more conducive work environment, making it easier for workers to communicate and collaborate with each other. Flexibility in the production line layout will facilitate adaptation to specific production requirements and minimize delays in the workflow.

4. Results and discussions:

TABLE 3. Improved Vancover dining chair backrest assembly job description:

Station	Number of people	Jobs	Operations	Time
1	2	Assemble the chair's shoulder, back and armrest into one assembly.	**Worker 1**	**17,0 s**
			Apply glue to the grooves of the chair's shoulder and armrest.	11,0 s
			After that moving the details to worker 2	4,0 s
			Non value adding time	2,0 s
			Worker 2	**18,0 s**
			Assemble the backrest of the chair onto the chair's shoulder and the armrest.	13,0 s
			Move the details to station2	4,0 s
			Non value adding time	1,0 s
2	2	Assemble the assembly at station 1 onto the two rear chair legs.	**Worker1**	**18,5 s**
			Apply AB glue to the grooves on both sides of the chair legs.	12,5 s
			Move the details to worker 2	4,5 s
			Non value adding time	1,5 s
			Worker 2	**19,1s**
			Assemble the assembly into the two chair legs.	18 s
			Non value adding time	1,1 s
3	1	Press the backrest	**Worker1**	**19,2 s**

		assembly and shoot nails to fix it	Use high frequency wood press to press the product detail assembly at station 2 and then shoot nails to fix it	13,2 s
			Move the details to station 4	4,0 s
			Non value adding time	2,0 s
4	1	Check and adjust	**Worker1**	**18,5 s**
			Use the horizontal bar to go between the two chair legs to check if the distance is suitable. If not, he must screw the horizontal bar to the two chair legs	12,0 s
			Move the details to station 5	4,5 s
			Non value adding time	2,0 s
5	1	Glue remover	**Worker1 (QC)**	**19,0 s**
			Go to station 2	4,0s
			Apply white glue to the bottom groove	3,0 s
			Move the details to station 3	4,0 s
			Comeback to station 5	5,0
			Conduct inspection	2,0 s
			Wipe off excess glue joint position	0 s
			Non value adding time	1,0 s

TABLE 4. Mean, standard deviation and sample size of time taken at stations after

Station	Mean	standard deviation	sample size
1	18,0	1,8	10
2	19,1	2,1	10
3	19,2	1,5	10
4	18,5	2,4	10
5	19,0	1,1	10

Table 4 shows that the execution time of the improved stations is more stable and the waiting time between stations is no longer much different.The working time at Station 2 is significantly improved by 10.6 seconds compared to the original because the two tasks of moving and applying glue will be eliminated. Worker 2 at Station 2 will only focus on product assembly work, so the products made at this stage have fewer errors. The total production time of the process is shortened due to the reduction of waiting time for the stages. Specifically, the time at Station 1 is reduced from 21.7 seconds to 18.0 seconds. Although the total execution time at Station 5 increases from 5.6 seconds to 19.0 seconds, it does not affect the efficiency of the whole process.

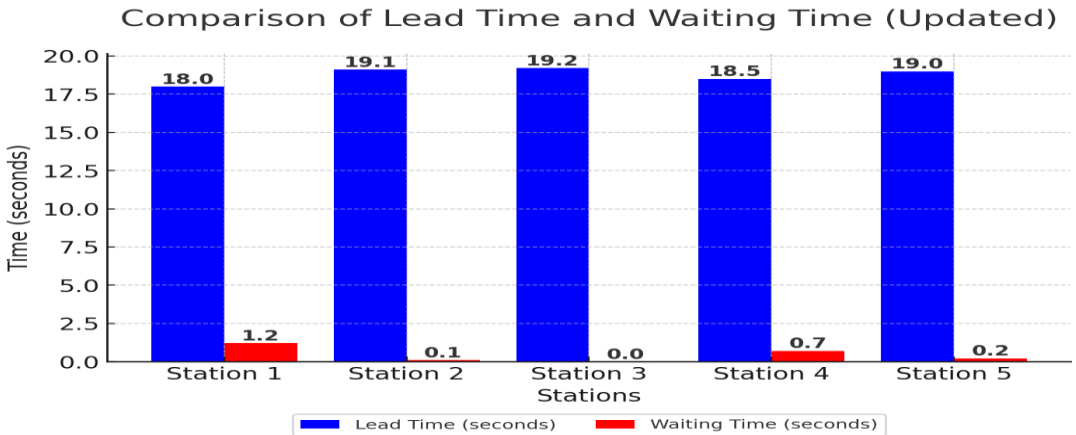


Chart 3. Compare lead time and waiting time at stations after

TABLE 5. Production efficiency

	Before	After
Production capacity	121 products/hour	187 products/hour
Production efficiency	70,18%	97,40%

The results after improvement have proven the feasibility of the solution. The time of the longest stage has been significantly shortened, leading to a reduction in waiting time and non-value-added time between production stages. Productivity and work efficiency have increased significantly, reaching 97.40%, showing that the production line is more optimized and balanced, bringing high efficiency to the company's production activities. The solution also helps motivate workers because their monthly salary has also increased.

4. Conclusion and Future research

Production efficiency depends not only on the skills of workers but also on the reasonable arrangement of resources. From the collected data, data analysis determined the bottlenecks at station 2 of the current production line. The author proposed a suitable line balancing solution, using the U-shaped line balancing method to rearrange the station to solve the bottleneck and increase the line efficiency from 70,18% to 97,40%. This article proposed and analyzed the implementation of the line balancing method in actual production at small and medium-sized companies to maximize efficiency in the workplace. This study still has limitations in that it has not mentioned the costs of the enterprise when applying this method in the production line and planning a specific line balancing roadmap. However, with the result of reducing production time of the line, increasing the efficiency of resource use and certainly being able to increase output, production line efficiency is significantly improved and the simple application, businesses can easily apply the model to reduce waste, optimize production costs and increase profits.

References

F. E. Meyers, J. R. Stewart (2002). *Motion and Time Study for Lean Production System*. John Wileysons INC.

Nguyen (2013). *Production Management*. Ho Chi Minh City National University Publishing House.

Nguyen (2016). *Lean Manufacturing*. Ho Chi Minh City National University Publishing House.

Phan (2005). *Lean Manufacturing Management - Some world experiences*. Hanoi National University Publishing House.

Ta (2010). *Quality Management*. University of Economic Ho Chi Minh City. Statistics Publishing House.

W. M. Feld (2000). *Lean Manufacturing: Tool-Techniques and How To Use Them*. CRC Press Series On Resources Management.

R. G. Askin, J. B. Goldberg (2002). *Design and Analysis of Lean Production System*. Wiley & Sons, Inc.