NON-VALUE ADDED ACTIVITIES REDUCTION IN NA AUTOMOBILE FACTORY IN BRAZIL

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Abstract: Activities that add or not add value are identified in the most varied productive activities. The identification and reduction, or even elimination, of activities that do not add value result in increased productivity and reduced production costs. This identification is not by direct observation, because the information needed to perform the separation of activities that add value to the product is often subjective. In this way, this article explores a case study of identification of activities that do not add value in an assembly line of an automobile factory located in Brazil. The chronoanalysis tool was used in 7 stations of an assembly line and for the reduction were carried out the tasks of automation, reengagement of activities and changes in the layout of the stations. As a result, 41 tasks were identified as non-value in a total of 295 centiminutes of non-productive activities per product. With changes in layout, reengagement and automation, these activities that did not add value were reduced on average by 5.28% per station.

Keywords: Productivity, Value added activicties, Valeu Stream Mapping, Chronoanalysis, Line Balancing .

1. INTRODUCTION

Analysis of value aggregation is not always a direct observation activity because activities that do not add value go unnoticed without a correct assessment of the value stream and the production chain. According to Womack and Jones (1992) the starting point for lean thinking is value. Value can only be defined by the customer in terms of specific product, ie a good or a service or both simultaneously that meet the needs of the customer at a specific price and time; thus, waste is any activity that adds no value to the product defined by the customer. Each product or service has a value chain and its analysis must show three types of existing actions, according to Zhu and Lin (2017): activities with Added Value (AV), activities that Not Adding Value, but are Necessary (NNAV) and activities that Not Adding Value (NAV). Thinking the productive system focused on the aggregation of value for the final customer is one of the philosophies related to Lean Production, according to Tortorella et al. (2017).

After the identification of the NVA activities, it was able to rebalance the line. To Kumar and Mahto (2013), line balancing is leveling the workload across all processes in a cell or value stream to remove bottlenecks and excess capacity. Also, M. E. Salveson (1995) in his paper, assembly line balancing problem (ALBP) consists of assigning tasks to an ordered sequence of stations such that the precedence relations among the tasks are satisfied and some performance measure is optimized. Kumar and Mahto (2013) defines bottleneck as a delay in transmission that slow down the production rate. So an unbalanced line creates waiting and bottlenecks which decrease productivity and increase the cost. Line balance can reduce or eliminate bottlenecks thus incresing produtivity and decreasing costs.

2. METHODOLOGY

The methodolody is given below:
- Pilot study of the stations

- Identifiyng and reduction of NVA activities
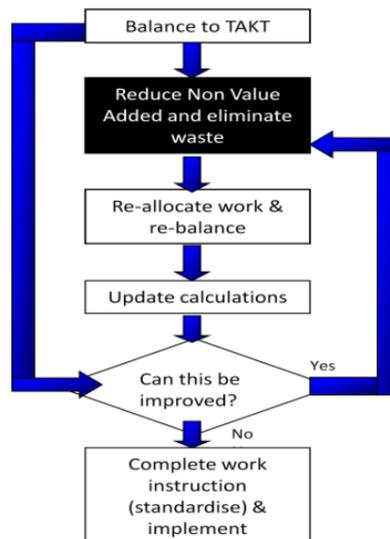- Line balancing and optimization

Figure 1. Methodology to line balancing according to Amardeep et al. (2013).

Value added is defined as the difference between the costs of purchases and the revenue from sales of goods and services produced using those services, Koskela (2000). To Womack and Jones (1996), non-value added activities are activities that absorbs resources but create no value. Convey (1991) says that a value-added activity is one which contributes to the customer's perceived value of the product or service. A non-value added activity is one which, if eliminated, would not detract from the customer's perceived value of the product or service.

Using Womack and Jones and Convey definitions to classify NVA and VA activities, activities that consumes time or resources and do not modify the product were classified as non-value added activities and the activities that consumes resources or time and modifies the product were classified as a value-added activity.

2.1 Pilot Study

A walk-through the assembly line to understand the process (machine and manual), cycle time and sequence of activities of each workstation. A detailed chronoanalysis was carried in each station. The cycle time was recorded for three times. The takt time was given by the company. The main objective was the elimination of non-value added (wastes) activities and line balancing.

The table 1 shows the cycle time and activities of the workstation 1 and its VA/NVA classification. The names of the activities were reduced to protect the company. Similar calculations were made for the others six stations.

The table 2 shows the cycle time of all workstations divided in VA and NVA (NNVA was computed as NVA). Takt time for the present time is also shown in the table. The table also shows the 7 wastes, abbreviated as i.e TIMWOOD (Transportation, Inventory, Motion, Waiting, Overproduction, Over processing and Defect) observed in each station. Figure 2 shows the cycle time and takt time.

Table 1. Cycle Time Study of workstation 1.

Op. Seq.	Operation	Avg. (Cmin)	VA/NVA
1.1	Walk	4	NVA
1.2	Open	2	NVA
1.3	Place	12	VA
1.4	Walk	4	NVA
1.5	Take	3	VA

1.6	Walk	4	NVA
1.7	Place	3	VA
1.8	Close	2	NVA
1.9	Walk	4	NVA
1.10	Rotate product	5	NVA
1.11	Unscrew	25	NVA
1.12	Remove	20	NVA
1.13	Read	5	NVA
1.14	Mount	25	VA
1.15	Lubricate	7	NVA
1.16	Place	9	NVA
	Average time:	134	

Table 2. Study of workstations.

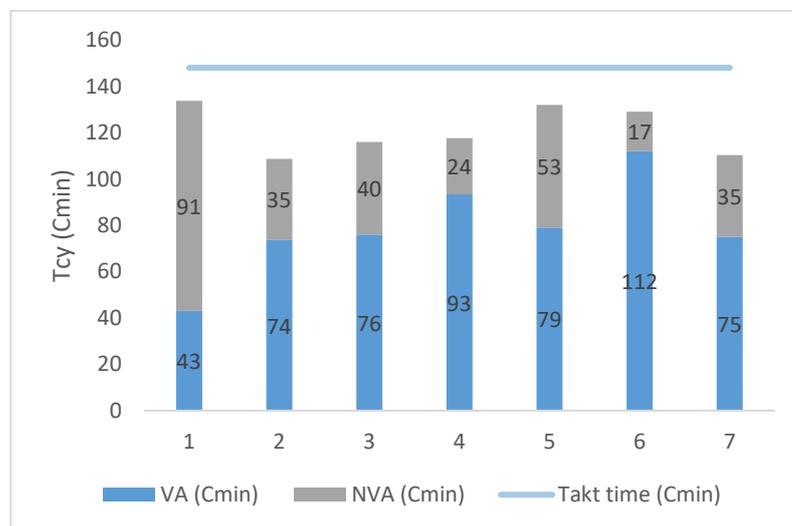| WS	VA (Cmin)	NVA (Cmin)	Cycle Time (Cmin)	Wastes (MUDAs)						
				T	I	M	W	O	O	D
1	43	91	134	x		x			x	
2	74	35	109			x			x	x
3	76	40	116						x	x
4	93	24	117			x			x	
5	79	53	132			x			x	x
6	112	17	129	x		x				
7	75	35	110			x				
	Average:		121							
	Takt time:		148							

Figure 2. VA and NVA Cycle Times with Takt Time.

2.2 Line Balancing and NVA reduction

There is no bottleneck workstation but work content can be added and the no of workstations can be reduced. Figure 3 shows the cycle time of each workstation before and after combining the work content and automatization. Figure 4 shows the VA and NVA of each workstation before and after combining the work content and automatization. Table 3 shows the changes in each station.
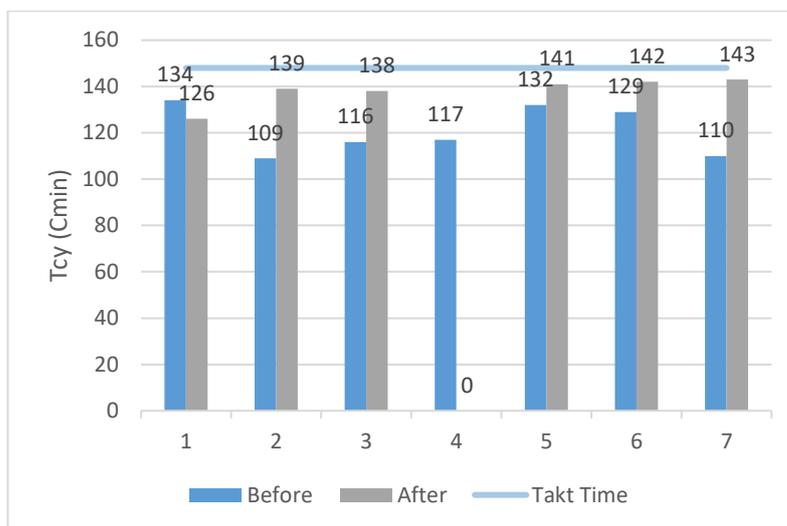
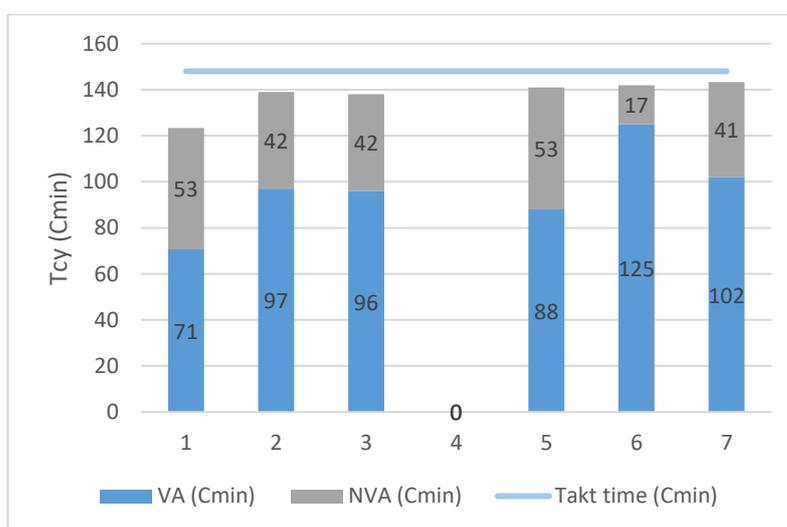**Figure 3. Stations before and after improvements.**

Figure 4. VA and NVA of the stations after improvements.

Table 3. After Line Balancing, automatization and some NVA reductions.

WS	VA	NVA	Cycle Time	Action Taken	Wastes reduced
1+2	71	53	123	Automation, reengagement, Station layout changes	O, M
2+3	97	42	139	Reengagement, Station layout changes	W, M
3+4	96	42	138	Reengagement, Station layout changes	-
4	0	0	0	Station removed	-
5+4	88	53	141	Reengagement	-
6+4	125	17	142	Reengagement	-
7+4	102	41	143	Reengagement	-

According to workstations work content it was able to divide and reengage the operations of the workstation 4 and eliminating this workstation. Operations of workstation 2 were reengaged to workstation 1, operations of workstation 2 reengaged with workstation 3, and similar to workstations 3 & 4, 5 & 4, 6 & 4 and 7 & 4. The layout changes were made in order to allow the stations to realize the activities that were reengaged and to reduce operator movements. This changes were such as mobile and tools reallocations.

3. RESULTS

Table 4. Before and after VA/NVA cycle time.

WS	Before VA (Cmin)	After VA (Cmin)	Before NVA (Cmin)	After NVA (Cmin)
1	43	71	91	53
2	74	97	35	42
3	76	96	40	42
4	93	0	24	0
5	79	88	53	53
6	112	125	17	17
7	75	102	35	41

Table 5. Before and after stations cycle time.

WS	Before Tcy (Cmin)	After Tcy (Cmin)
1	134	126
2	109	139
3	116	138
4	117	0
5	132	141
6	129	142
7	110	143

A simple automation of a screw activity on station "1", it was possible to reduce its NAV by 25%. From this, it was possible to reengage the actions of the following operators to rebalance the line.

In stations "2" and "3" there were changes of the station layout, rebalancing and reengagement, which resulted in a reduction of 2% and 4%, respectively, in NAV and its cycle times were closer to takt time of the line, thus reducing its inactivity due waiting and motion.

Stations "8", "10", and "15" suffered only reengagement, which resulted in a NAV reduction of 2%, 1% and 3%, respectively, and their cycle times approached the line takt time.

With these actions, it was also possible to reduce manforce from 7 to 6 by eliminating station "4", which represents a reduction of annual expenditure, according to data from the company, of 90 thousand euros per year assuming that the factory operates the whole year in 3 shifts. These changes represented a reduction of NVA on average by 5.28% per station.

4. CONCLUSION

It is clear that production lines needs deeper investigations on the entire line in order to get improvements that are more significant. However, line balancing and NVA activities reduction are essential and fast tools that can be used to little improvements. The improvements made on this study were subtle but stills supplements and improves the productivity and reduced costs.

5. ACKNOWLEDGMENTS

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