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Method Yamazumi and its application

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Abstract: The main objective of the contribution is to improve the selected production process in an electrical engineering company. In order to achieve the main objective, it was necessary to gradually develop the specified partial objectives. The *Yamazumi method,* which is subsequently used to balance the *V*03 line or explain the bottleneck in the production process, which in the case of the analysed line is a hydraulic tester. After balancing the line and distributing the workstations among the workers, it was possible to plan and carry out a test of adding a worker to the line.

Keywords: *yamazumi*, process improvement, industrial engineering.

INTRODUCTION

Lean manufacturing is a production control technique to eliminate waste from the manufacturing process. Lean manufacturing also focuses on reducing costs by eliminating unnecessary activities by applying a management philosophy that focused on identifying and eliminating waste from every step in the production chain. The benefits of lean manufacturing include reduced inventory, less process waste, less rework, reduced lead times, financial savings, and improved process understanding. In order to achieve maximum production, a company must manage its production line using systematic techniques or approaches. One of the techniques is the line balancing technique. It has been shown that the use of line balancing technique can increase a company's productivity.

An assembly line is a cycle of workstations where tasks related to the assembly of a product are performed. The common objective of assembly line balancing is to minimize the number of workstations for a given cycle time and to minimize the cycle time for a given number of workstations.

1 METHOD YAMAZUMI

Yamazumi is a visual tool that originated in Japan and helps to streamline work cycles, identify losses, and properly balance a work line between multiple operators. Individual work operations in the production flow are divided into colour scales (Fig. 1), thanks to which it is easier to detect hidden waste.

The main task of this method is to help balance the individual steps of the production operations that are necessary to carry out the production cycle. The visualization of the individual steps of the production process is displayed using a cumulative bar graph, while the individual steps of the production process are color-coded into individual categories:

- *green colour* indicates work with added value, changes the properties, form and value of the product. Work can be manual or automated and represents any assembly operation that adds value to the product (screwing, pressing, loading pins, etc.),
- *orange colour* indicates necessary work that is without added value, but is necessary to change the properties, form or value of the product (grabbing, releasing a part). These steps must be performed so that the steps that add value can be carried out,
- *red colour* indicates work that does not add value, does not change the form or properties of the product (worker walking, searching for material, etc.). This work should be included in the method as little as possible and the company should eliminate it,
- *yellow colour* indicates work that is not performed on every product but depends on the specifications. This work is applicable to products of different designs and types,
- *blue colour* indicates variable work. It is performed on every product, its duration and scope depend on the specifics of individual product variants [14].

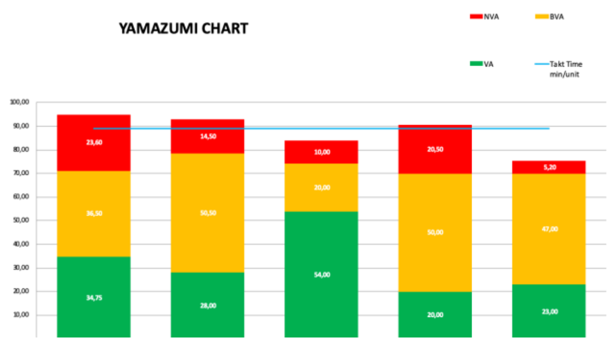

Fig. 1. *Yamazumi* chart - formed before any changes have been made

After you have the *Yamazumi* chart formed you can see the whole process, involving each and every step individually and you can rearrange it as you want. (technically approved) This too can lead to reducing a lot of waste, especially useless movement. Removing *Mura*, *Muri*, and *Muda*, gives you a better organized process with less wasted time and increases productivity.

Time data for creating a *Yamazumi* diagram can be obtained using a snapshot of the work operation or by determining predefined times using one of the methods.

Yamazumi is an ideal method for increasing labour productivity and balancing the production line. Changes in the production process can bring several benefits:

- eliminating a bottleneck on the assembly line,
- balancing activities with respect to the bottleneck of the line,
- improving employee performance,
- increasing the content of activities that add value,
- reducing production time,
- time alignment of work steps.

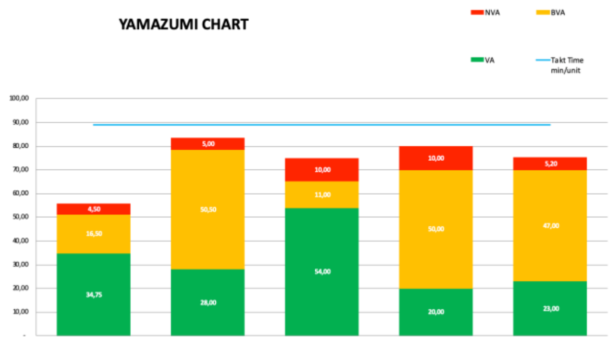

Fig. 2. *Yamazumi* chart after eliminating waste

The *Japanese Yamazumi method* is used in the *Toyota* car factory. The success of this method is also confirmed by other companies that adopt it and apply it to their production processes. It is a tool for reducing labour and eliminating costs. The purpose of this method is to analyse the process in the smallest details and find the best solution that will simplify the process and increase production. *Yamazumi* uses its colour marking standard to define the type of work and points out the possible elimination or need for balancing cycle times.

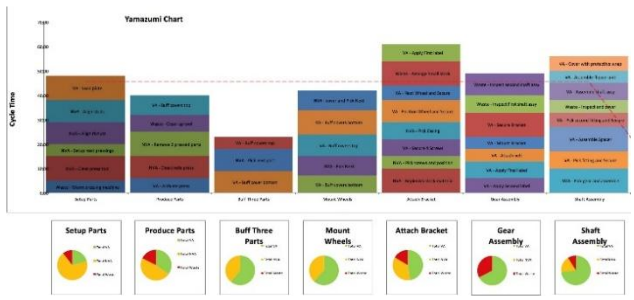

Fig. 3. *Yamazumi* chart - an example

The *Yamazumi* chart's capacity to offer a visual picture of how work is distributed among various process phases or operators is one of its main advantages.

2 THE USE THE YAMAZUMI CHART IN LEAN MANUFACTURING

The *Yamazumi* chart can work amazingly well for any process-based company. By implementing this easiest of tools, it allows the company to better understand where time is being potentially wasted in each process, which alone provides a number of advantages.

However, to better illustrate this point, we can look at just three reasons as to why a *Yamazumi* chart should be used in Lean manufacturing. By studying these reasons, it should then make it easier for the reader to understand how and why they can use this chart within their own business or process-driven application.

Wasted time is wasted money, and no organization wants to go ahead and waste money if it can be avoided. Thus, any method that can reduce this possibility should be embraced with open arms, and a *Yamazumi* chart is a free and simple approach that generates results.

By being able to look at each process individually and the time that each step takes, it is easier to see it in a visual format to then know where time is being wasted.

Imagine that a particular part of the manufacturing process has a number of steps. The *Yamazumi* chart would have one bar for that process, with additional bars for each individual aspect, but within the one bar would be a block for each individual aspect. Think of it as being *Process* 1 followed by *Process* 1:1, then 1:2 and so on.

When you then look at the chart, you can see how long it takes for part 1:2 compared to other sections and determine if too much time is being spent on that part of the process. As a result, changes can be made in the process to reduce that time, leading to a faster end result and a better outcome overall.

The *Yamazumi* chart can allow you to determine which option is better by looking at each individual component of each part of the manufacturing process. Then you can try to work out if the order should be changed. It's all about optimization from a time-based perspective, and it simply presents the information in a way that is easier to follow and to compare across the board. In fact, when companies such as *Toyota* use this approach to streamline the manufacturing side of their business and change the order on production lines, that gives us strong evidence that this method can be used on a large scale too.

By gaining insight into the time spent on each process, as well as coming to terms with the best order, it can mean that the target process will then become far more balanced thanks to employing one of these charts. By becoming aware of the potential wastage at various stages, it ultimately delivers something that is more efficient and still achieves that end result that the manufacturing process requires.

If the process is unbalanced, then it can ultimately lead to issues, making up for lost time or not enough energy being exerted into various key areas due to too much time being spent elsewhere. A balanced approach to business strategies and production will always lead to a better outcome overall.

2.1 The comparison of time balancing

The *Yamazumi method* visually showed how long the activities take, at which workstation, and how they can be divided among the workers. To make it logical, the worker will operate the workstations that follow each other. The first worker will perform activities at workstations *AP* 50 and *AP* 60 (79.4 seconds) and the second worker will be at the remaining four workstations (47.4 seconds).

The comparison of time balancing can be seen in Fig. 4. where the manual times of both workers and the automatic testing time are graphically shown and compared. It can be seen that the worker who will operate the first two workstations will perform the tasks 32 seconds longer than the second worker, but it is not possible to divide the work so that it is balanced evenly. Since I will be present when performing this test of two workers, it is possible to adjust this distribution during or notice how it suits the workers best.

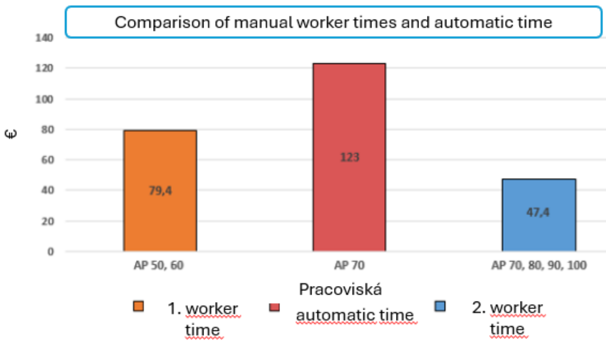

Fig. 4. *Yamazumi* chart - an example

After balancing the line and distributing the workstations among the workers, it was possible to plan and carry out a test of adding a worker to the line.

CONCLUSIONS

Balancing the line based on the *Yamazumi method* suited the workers, and in the event that the second worker with a smaller number of operations was waiting for the first worker, he attached a label to the cube and thus performed part of the operations at the *AP* 60 workplace. The high difference between the calculated number of pieces produced and the actual number is caused by the fact that the workers not only adhered to the specified norm per worker so that the current norm would not increase, but also by the fact that the workers produced more slowly towards the end of the shift because the company did not want to keep a large number of pieces in stock.

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REFERENCES

[1] ANTONIUK, I. - SVITEK, R. - KRAJČOVIČ, M. - FURMANNOVA, B. (2021): *Methodology of design and optimization of internal logistics in the concept of Industry 4.0*. In: Transportation Research Procedia, *55*, 503-509.

[2] BUCKOVA, M. - GASO, M. - PEKARCIKOVA, M. (2020): *Reverse logistic*. In: InvEnt 2020: Industrial engineering - Invention for enterprise - proceedings. Bielsko-Biała: Wydawnictwo Akademii Techniczno-Humnistycznej.

[3] BURGANOVA, N. - GRZNAR, P. - MOZOL, S. (2020): *Design of logistics system in production*. In: Technologie, procesy i systemy produkcyjne. Bielsko-Biala: Wydawnictwo naukowe Akademii techniczno-humanistycznej w Bielsku-Białej, p. 11-18, ISBN 978-83-66249-56-1.

[4] VAVRIK, V. - FUSKO, M. - BUČKOVÁ, M. - GASO, M. FURMANNOVÁ, N. - STAFFENOVA, K. (2022): *Designing of machine backups in reconfigurable manufacturing systems*. In: Applied Sciences, 12(5), pp. 1-27, ISSN 2076-3417.

[5] FILIPOVA, I. - DULINA, L. - BIGOSOVA, E. - PLINTA, D. (2021): *Modern Possibilities of Patient Transport Aids*. In: Transcom 2021. Virtual conference 26 May – 28 May, Slovakia. Transportation Research Procedia, 55, pp. 510-517.

[6] SUKALOVA, V. - STOFKOVA, Z. - STOFKOVA, J. (2022): *Human Resource Management in Sustainable Development*. In: *Sustainability*, 14(21), 142.

[7] BEREŽNÝ, Š. - KRAVECOVÁ, D. (2012): *Lineárne programovanie*. [cit. 2019-12-20]. Dostupné na internete.

[8] GANTTOV DIAGRAM (2016): [cit. 2019-11-15]. Dostupné na internete: https://managementmania.com/sk/ganttov-diagram-gantt-chart

[9] LINEÁRNE PROGRAMOVANIE 1 (2019): [online], [cit. 2019-11-21]. Dostupné na internete: http://www.fbi.uniza.sk/ktvi/leitner/2_predmety/OA/Semester/P03_LP_modely,%20graficke%20riesenie.pdf.

[10] TOMA, V. (2008): Základy lineárneho programovania. [online], [cit. 2019-11-22].

[11] SLAMKOVÁ, E. - CAJCHANOVÁ, O. - CHROMJAKOVÁ, F. (1998): *Operačná a systémová analýza*. 1. vyd. Žilina: Žilinská univerzita v Žiline, 181 s. ISBN 80-7100-467-

[12] MÁCA, J. - LEITNER, B. (1999): *Operačná analýza. I.* diel. 1. vyd. Žilina: Žilinská univerzita v Žiline, 181 s, ISBN 80-88829-39-9.

[13] SLAMKOVÁ, E. (1990): *Operačná a systémová analýza: Návody na cvičenia*. Bratislava: Alfa, vydavateľstvo technickej a ekonomickej literatúry, 177 s. ISBN 80-0500-2017.

[14] SEJMON, V. - EVIN, E. (2022): *Zvyšovanie produktivity montážnej linky vybalansovaním montážnych staníc pomocou metódy Yamazumi* [online], [cit. 2022-12-22]. Dostupné z: Microsoft Word - 073-077.doc (tuke.sk).