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LEAN MANUFACTURING ANALYSIS IN THE PRODUCTION PROCESS OF MAKING PAVING BLOCKS AT PT XYZ

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ABSTRACT

Manufacturing is an integral part of the production or material innovation process to increase the efficiency and effectiveness of company productivity. PT. XYZ is a company that utilizes plastic waste to be processed into paving block products. The problem is that the company does not reach the production target. PT. XYZ can improve performance in meeting market targets. The purpose of this research is to use the concept of lean manufacturing to identify activities that cause waste. The methods used are Value Stream Mapping (VSM) and Value Stream Analysis Tool (VALSAT). One of the analysis tools used is Process Activity Mapping (PAM) with a total weight of 139.9. In addition, this research identifies activities that can be categorized as value-added (VA), non-value-added (NVA), and non-value-added required (NNVA). The results obtained from this research can reduce cycle time from 517.53 minutes to 457.53 minutes. Evaluation of improvements using the 5W1H method describes the details of what problems occur in the production process starting from humans, machines, materials, methods, and the environment. Later the cause of the production process is described in 5W1H then by taking action for improvement.

Keywords: Process Activity Mapping, valsat, waste, 5W1H

INTRODUCTION

The rapid growth of the industry has resulted in many industrial sectors using plastic packaging, the high use of packaging products will certainly cause waste (Mandataris et al., 2023). The concepts that are well known to the public include the 3Rs (reduce, reuse, recycle) which aim to minimize the use of plastic materials, recycle plastics as new materials, and recycle plastic materials (Latipah & Khosi'in, 2023). Waste recycling is the process of converting or utilizing materials that are no longer suitable for use or waste into new materials that can be processed and reused (Sudarno, 2021). Creativity and hard work can turn waste into valuable goods. One innovation from the utilization of plastic waste is paving blocks made from plastic waste. Given that paving is widely used in the field of construction and is one of the alternative flooring options. Easy installation, relatively cheap maintenance, and more preferred. The utilization of waste plastic waste processed into paving blocks has benefits and economic value (B. Siregar et al., 2022). Manufacturing companies facing competitive competition must implement a continuous improvement strategy (Musfita & Mahbubah, 2021). Manufacturing is an inseparable part of innovation that aims to make materials or materials used efficiently and effectively increase productivity in a company (Jefri & Ibrohim, 2021).

High productivity is achieved by minimizing waste that occurs during the production process (Burhanuddin et al., 2020). The company faces various challenges and obstacles that need to be overcome. One of the main obstacles that disrupt the production process is the presence of waste with

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a large amount in each production stage. Waste refers to activities in the work process that cannot provide value added to the product. It is important to reduce waste to create an optimal value stream in the production process (Pattiapon et al., 2020). Lean manufacturing is a concept designed to improve the efficiency, speed, and effectiveness of manufacturing processes (Hasanah et al., 2020). PT. XYZ is a company engaged in the utilization of plastic waste which is processed into paving blocks. Later paving blocks produced with manual tools will go through several processes. In the paving block production process, there are 15 employees with 3 shifts with working time from 08.00 to 21.00, with a target of 400 to 650 production units. But in reality it is still not optimal and there is still a lot of waste in the production process. This can be seen in the fluctuations in the amount of production in Figure 1. The following production histogram.

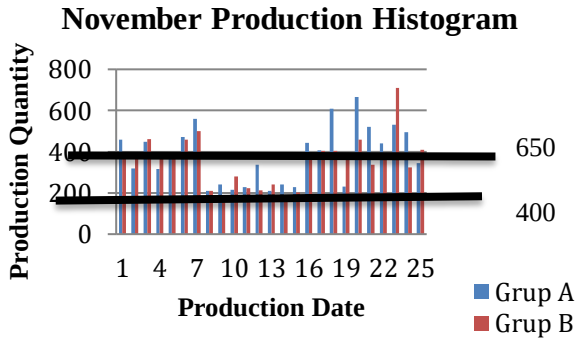

Figure 1. Histogram of total production

Based on the data in Figure 1. the production process in November often does not meet the target set by the company of 400 to 650 production units, this is certainly a problem, therefore the company must find a solution to the problem. Based on observations at PT. XYZ, production that does not meet the target is caused by the process of cutting time, cleaning materials, setting up machines, and tidying up the paving block unit. The number of activities affecting waste has a significant impact. Therefore, there is a need for further waste-related observations on paving block production activities.

RESEARCH METHOD

This study uses secondary data and primary data, where secondary data in the form of data on the amount of production in the last 3 months, data on the number of employees, and the division of worker shifts obtained from the company. Then primary data is obtained from the results of interviews by filling out questionnaires and making direct observations to record each production activity and measure the cycle time of each activity as many as 30 samples. Researchers used the Value Stream Analysis Tool (VALSAT) analysis method to determine the highest priority based on summary data regarding seven types of waste in paving block production. Data were collected through questionnaires to workers at PT. XYZ. The data is tested using a validation test and reliability test which is processed using SPSS 29 software.

The data is declared valid with a value of 0.01 or less than 0.05 and reliable with a Crombach'Alpha value of 0.773 because it is more than 0.6 (Armyanto et al., 2020a) then the data is averaged to find a value which is then multiplied by the weights listed in the Value Stream Analysis Tool (VALSAT) table in this study. Researchers also applied weights in process activity mapping (PAM) to identify (VA) activities, (NVA) activities, and (NNVA) activities. The data collected by researchers is represented in the Process Activity Mapping table (Kasanah & Suryadhini, 2021). Then making Value Stream Mapping (VSM) to describe the flow of information and materials at PT. XYZ, and facilitate the identification of the types of waste that exist so that researchers can identify what

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processes need to be improved (Febrian, 2023). Then to identify and develop improvement proposals, 5W1H (what, why, where, when, who, and how) identification is carried out based on the problems previously identified in the 5W1H framework (Ahmad, 2019) which are summarized in the fishbone diagram (M. T. Siregar & Puar, 2018).

RESULTS AND DISCUSSIONS

A. Value Stream Analysis and Mapping Tools

The process of selecting VALSAT tools (Value Stream Analysis and Mapping Tools), is done by multiplying the VALSAT matrix with the weight results obtained from the average results of each waste questionnaire (Armyanto et al., 2020b). The results of the weighting multiplication can be known tools that are selected in the highest rank in the following calculation results are the results of the calculation of valsat tools in Figure 2. Histogram of valsat weighting results.

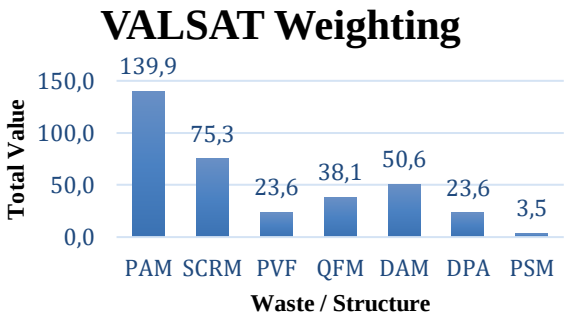

Figure 2. VALSAT weighting

To find out the results of the calculation and ranking of the VALSAT tool, Process Activity Mapping (PAM) was chosen as the tool to be used. PAM is to describe the production process in detail based on the steps taken. The goal is to identify value-added activities, non-value-added activities, and non-value-added activities that are still needed (mandatory but not value-added activities) (Komariah, 2022).

B. Process Activity Mapping

Classification of production activities, namely activities that add value, activities that do not add value, and activities that are necessary but do not add value. Production process activities that add value are considered value-added activities. Non-value-added activities are activities that do not add value, such as waiting for the process or delays. then grouped in Table 1. As follows.

Table 1. Recap of process activity mapping and cycle time

Activity Type	Total	Percentage	Time (M)
Operation	20	57.14%	225.09
Transportation	4	11.43%	35.83
Inspection	1	2.86%	3.97
Storage	6	17.14%	98.94
Delay	4	11.43%	153.7
Total	**35**	**100.00%**	**517.53**
Activity Type	**Total**	**Percentage**	**Time (M)**
Value Added	23	65.71%	343.83

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Necessary Non Value Added	8	22.86%	103.5
Non-Value Added	4	11.43%	70.2
Total	**35**	**100%**	**517.53**
Cycle Time			517.53

Based on the results of the Process Activity Mapping calculation, it shows that operation is the activity with the highest percentage reaching 54.29%. This is because the production process is part of the overall operation, or operations include all activities carried out in it. These results certainly have an influence on the efficiency and effectiveness of the production process. The indicator between operation and waiting shows a correlation because waiting can occur at various stages in an operation, such as waiting for raw materials, queuing at workstations, or waiting for machines or equipment that are being used. For example, the activity of highlighting paving blocks is part of the operation, but this affects waste waiting because it affects the effectiveness of production.

C. Value Stream Mapping

Value stream mapping is performed using VSM symbols, and data such as the number of operators, cycle time, and available time are entered. Next, a timeline is created to show value-added and non-value-added, which is used to calculate the total cycle time Figure 4.2 shows that the value stream mapping is as follows.

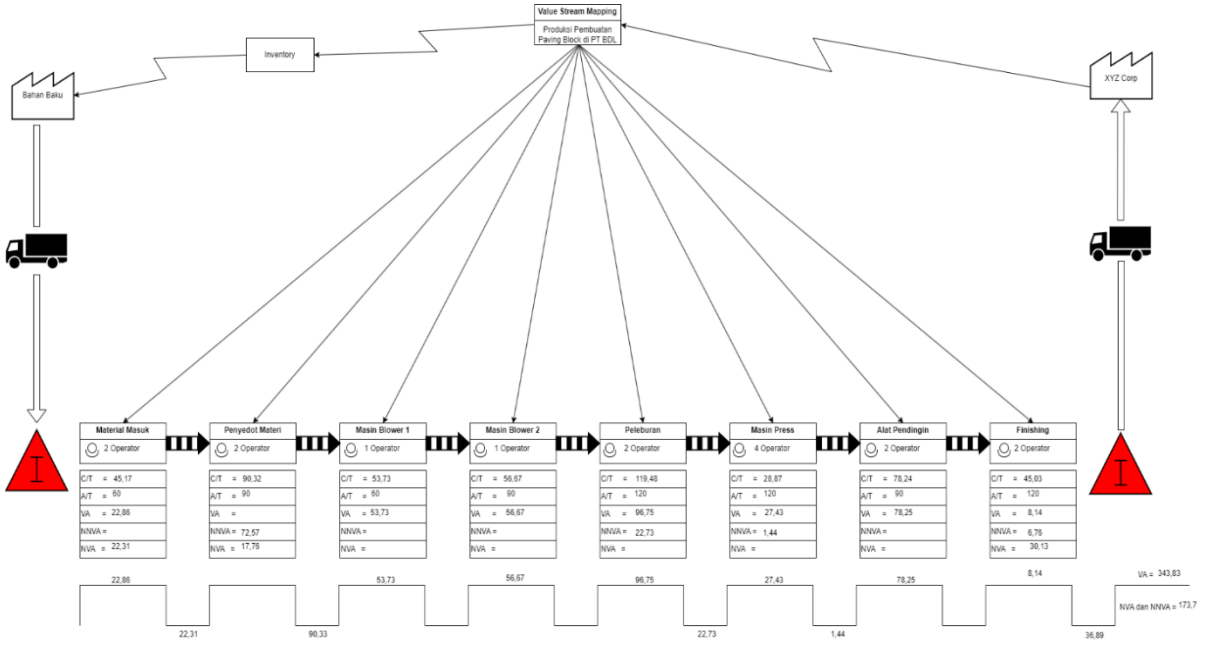

Figure 3. Value stream mapping

Based on the value stream mapping image in the production process at PT. XYZ there are 8 processes that are carried out, for Value Added with a total of 343.83 seconds, then the Necessary Non-Value Added and Non-Value Added activity processes total 173.7 seconds. Then for the available time (AT) each process is different. In the (AT) section, the number of working hours available at PT PT. XYZ in the production section in the incoming material process is 60 minutes with 2 operators, material suction is 60 minutes with 2 operators, blower machine 1 is 60 minutes with 1 operator, then on blower machine 2 is 90 minutes with 1 operator, then in the smelting process with AT of 120 minutes with 2 operators, press machine of 120 minutes with 4 operators, cooling equipment of 90 minutes with a total of 2 operators, and finishing process with a total of 120 minutes for 2 operators.

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D. Fishbone Diagram

The cause-and-effect diagram is a tool used to identify the root causes of problems from the existence of waste in the production process at PT. XYZ. With the type of waste discussed, waiting occurs due to the length of time the operator is in the process of heating the machine and cleaning on the blower 1 and blower 2 machines, causing residual cleaning or residual materials that interfere with production. Fishbone diagram.

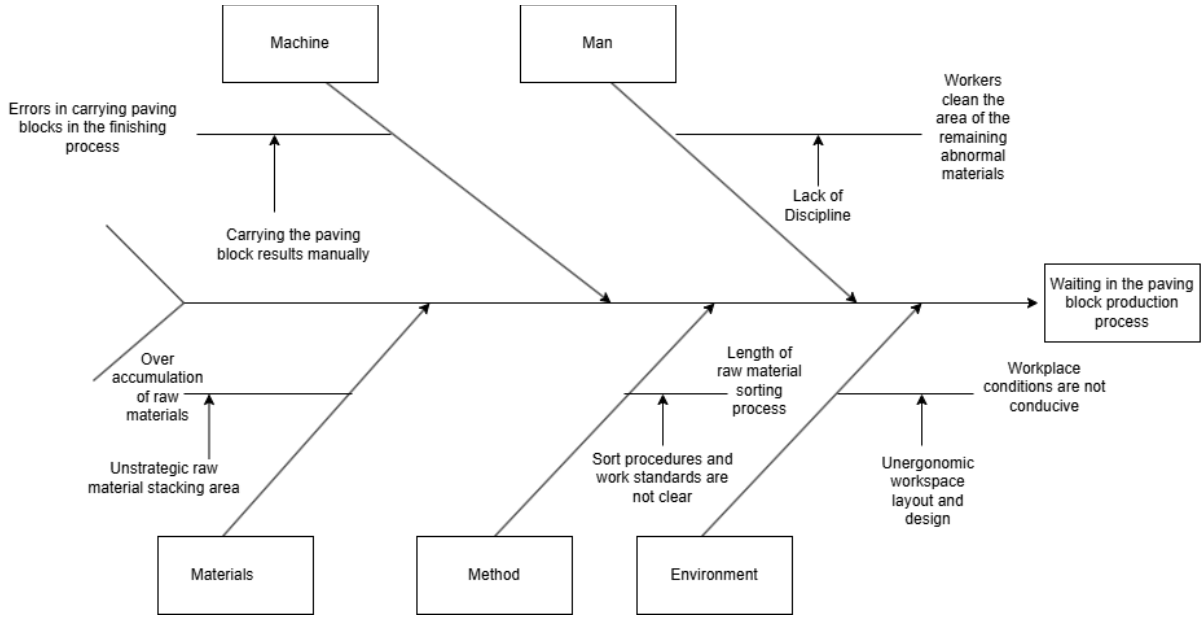

Figure 4. Fishbone diagram

Based on Figure 4. above the type of waiting that affects the occurrence of waste to the production process. This fishbone diagram is used to see the type of waiting that affects the production process, the waiting is caused by several factors in the fishbone diagram, factors including machine factors, human factors, material factors, method factors, and environmental factors.

E. Evaluation 5W+1H Suggestions for Improvement

The 5W1H method is used to describe the details of what problems occur in the production process, starting from humans, machines, materials, methods and the environment. Later, the causes of the start of the production process are described in 5W1H then by taking evaluation actions.

Table 2. 5W+1H recap and evaluation

Problems	5W+1H	Action
Human Factors Suboptimal cleaning of residual materials	What	Optimize the cleaning process
	Why	Reduce waiting time along the production process
	Where	PT. XYZ
	When	The start of the production cycle.
	Who	Workers

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Problems	5W+1H	Action
	How	Segregate materials based on their type to facilitate the handling process.
Machine Factors Errors in paving block products to the finishing process section	What	Reduce excessive buildup of paving blocks before entering the finishing process.
	Why	To reduce waiting time along the production process
	Where	*Production line*
	When	Start of production cycle
	Who	The machine operator is responsible for the setup and operation of the machine.
	How	The most effective and efficient transportation to carry materials with conveyor belts.
Factor Material over accumulation of raw materials	What	Optimization of raw material entry layout
	Why	Optimization of raw material input layout
	Where	Raw material procurement
	When	Performed immediately after receipt of raw materials
	Who	Workers
Method Factor Length of material sorting process	What	Reduce queuing in the material sorting process
	Why	To reduce waiting time along the production process.
	Where	PT. XYZ
	When	Implementation of work method improvements is carried out immediately after the design process.
	Who	Operators and Workers
	What	Design and implement scheduling after the end of working hours to reduce the accumulation of materials on the next working day.
Environmental Factors Workplace conditions that are not conducive	What	Less conducive production site environment
	Why	Creating a work environment conducive to productivity
	Where	PT. XYZ
	When	Analyze and design improvements to the layout and work environment regularly.
	Who	Production Manager
	What	Improve lighting, air circulation, cleanliness, and safety conditions in the work area.

The 5W1H method is used in this research to describe the details of what problems occur in the production process starting from humans, machines, materials, methods and the environment. Later, the causes of the start of the production process are described in 5W1H then by taking evaluation actions. Suggestions for improvements to the cleaning of residual materials that are not optimal, namely the need to separate materials based on their type to facilitate the handling process, the process is carried out optimally to reduce the accumulation of residual materials with the aim of reducing waiting time throughout the production process. Errors in paving block products to the finishing process result in excessive buildup, resulting in waiting time along the production process. Improvements that need to be made are the most effective and efficient transportation to carry materials with conveyor belts. Suggested improvements to the material factor are storage areas that are directly integrated with the material separation process. This will increase the efficiency and effectiveness of the overall process. The problem with the method factor is the length of the material sorting process which results in queues in the material sorting process. Suggested improvements include designing and implementing scheduling after working hours to reduce the buildup of materials on the next working day. Suggested improvements to material factors are improving lighting conditions, air circulation, cleanliness, and safety in the work area to create a work environment conducive to productivity.

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F. Future Process Activity Mapping (PAM)

Future process activity mapping methods on work methods are carried out through simplifying procedures and standardizing processes, researchers provide improvement proposals based on process activity mapping (PAM) analysis that has been made. This aims to reduce activities in the production process that are categorized as non-value-added (NVA) and non-value-added but required (NNVA) activities. There are 5 activities that have improved in the NVA and NNVA categories. Proposed corrective actions on PAM certainly affect the time on these activities based on the classification of (VA), (NVA), and (NNVA) can be seen in Table 3. As follows.

Table 1. Future cycle time

Activity Type	**Amount**	**Percentage**	**Time (M)**
Operation	20	57.14%	208.09
Transportation	4	11.43%	28.83
Inspection	1	2.86%	3.97
Storage	6	17.14%	62.94
Delay	4	11.43%	153.7
Amount	**35**	**100.00%**	**457.53**
Activity Type	**Amount**	**Presentage**	**Time (M)**
Value Added	23	65.71%	343.83
Necessary Non-Value Added	8	22.86%	86.5
Non-Value Added	4	11.43%	27.2
Amount	**35**	**100%**	**457.53**
Cycle Time			457.53

Based on Table 3. the results of the proposed improvements above, it can be seen that the total time required for all activities is 457.53 minutes. The total number of activities is 35, which consists of 20 operations, 4 transportation, 1 inspection, 6 storage, and 4 delays. Value Added is 343.83 minutes, Necessary Non-Value Added is 86.5 minutes and Non-Value Added is 27.2 minutes.

G. Future Value Stream Mapping

Future value stream mapping after the proposed improvements to describe the improvement criteria more clearly in Figure 5. as follows

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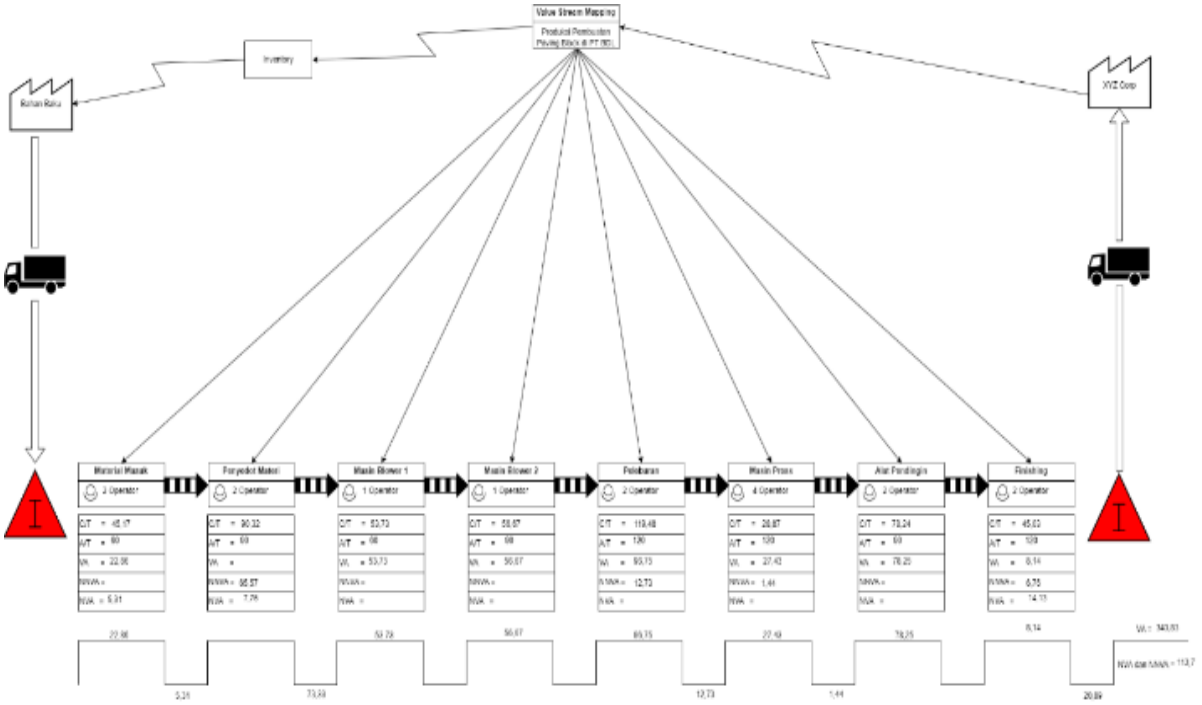

Figure 5. Future stream mapping

CONCLUSIONS

Based on observations made at PT. XYZ in the production of paving blocks. Based on Based on the results of the seven waste analyses from the questionnaire data, the highest weight is on the waiting process because it does not provide added value, such as the length of the operator in the cleaning process on the blower 1 and blower 2 machines, causing residual cleaning or residual materials that interfere with production. Based on the analysis of Value Stream Analysis and Mapping Tools process activity mapping, Process Activity Mapping was selected as a tool that will be used to identify activities that are classified as operation, inspection, transportation, delay, and storage. Based on the W51H Method, an evaluation of improvements that need to be made to reduce waste in the production process of making paving blocks at PT. XYZ was obtained. Human factors, machines, materials, methods, and the environment as an evaluation of improvements. Human factors optimize cleaning improvements to reduce the accumulation of material waste. Machine factors need the most effective and efficient transportation to carry materials with conveyor belts. Material factors optimize the layout of raw material entry. Method factor design and implement scheduling after working hours to reduce material accumulation on weekdays. Environmental factors Improve lighting conditions, air circulation, cleanliness, and safety in the work area.

Future research is recommended to deepen the analysis of the types and sources of waste generated by the company, as well as examine their impact on the environment and production efficiency. In addition, a more accurate calculation of production activities will provide a solid basis for identifying opportunities for process improvement and optimization. The results of this research are expected to be implemented directly into the production process to improve efficiency, reduce waste, and ultimately make a positive contribution to the sustainability of the company.

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