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Scheduling The Production Process Using Genetic Algorithm Method In Optimization Improvement PT. Kemasan Ciptatama Sempurna

Ahmad Fikri Ardianto [1] , Tedjo Sukmono [2]
[1,2] Universitas Muhammadiyah Sidoarjo
Email : ahmadfikriardianto@gmail.com

***Abstract*— PT. Kemasan Ciptatama Sempurna is a company engaged in manufacturing styrofoam. In the company concerned, the order system is still manual, where the order process only depends on the order. This results in a less efficient scheduling system as evidenced by the ineffectiveness of the scheduling system when some orders from various consumers place orders simultaneously. The method used in this study uses a Genetic Algorithm approach, by choosing this method in this study can improve problems in the company so that the scheduling system can run according to the wishes of consumers both in terms of scheduling time that has been agreed with consumers. The results of the research using the Genetic Algorithm method in production using genetic algorithms, the best time in scheduling production capacity is 2699 seconds, this is an increase in the efficiency of the production process as evidenced by the previous production activity process of 3600 seconds (corner production process), thus saving time by 901 seconds as well as the total time of the production process using a job shop. can be reduced by selecting an alternative in the production job shop using a genetic algorithm with a value of 0.023 seconds on the 11th chromosome.**

***Keywords*: Styrofoam, First Come First Served, Genetic Algorithm, Makespan.**

I. INTRODUCTION

The production scheduling system of PT. Ciptatama Perfect Packaging in its implementation uses the rules of first-in, first-out, *First Come First Serve* (FCFS) *orders*. Regarding FCFS rules, there are short and long processing times. The first order will be produced first. In a job especially in order need to run through a queue. Seen in the production scheduling process, the resulting product is not by the proven schedule of 5 products the production process time on the corner type product takes 2 hours with an hourly production target of 78 pcs, elbows take 3.1 hours with an hourly production target of 63 pcs, buoy takes 1 hour with an hourly production target of 34 pcs, sheet takes 0.8 hours with an hourly production target of 112 pcs, the box takes 2.3 hours with an hourly production target of 121 pcs. While the production target from supplier needs per day for angles is 1320 pcs, production targets from supplier needs per day for elbows are 440 pcs, production targets from supplier needs per day for floats are 548 pcs, production targets from supplier needs per day for sheet 2400 pcs, target production from supplier needs per day for 900 pcs boxes. So, for the corners it requires an additional product of 0.47% per month, for elbows it requires an additional amount of product of 0.72% per month, for floats it requires an additional number of products of 0.99% per month, for sheets it requires an additional number of products of 0,93% per month, for the box requires an additional number of products of 0,96% per month.

From the problems that have been researched in getting problems in production scheduling. To solve this problem, the genetic algorithm method is used to make scheduling effective and efficient, especially for PT. Ciptatama Perfect Packaging has many types of products so it requires a more scheduling process effective in determining alternative solutions in the scheduling process for each type of product. Based on this, efforts are needed to anticipate production scheduling. To find out efforts to increase production scheduling, several methods can be used, including the genetic algorithm method.

According to (Ilhamsah et al, 2017) (Kenneth, 2009) scheduling is the process of allocating machine resources to select tasks within a certain period of time (in Widodo, 2014). The allocation of machine resources is

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adjusted to the work included in the production process, so as to minimize delays. According to (Alfandianto et al, 2017) in (Suriadi, 2011) and (Kurniawan, 2014) the genetic algorithm approach aims to optimize the occurrence of delays, production flow time and production time, production flow time and production time. It is hoped that with the use of effective scheduling, all orders can be completed on time with efficient resources. The scheduling of the genetic algorithm method aims to determine the smallest completion time with the largest *fitness value* (Triswara et al, 2019).

After identification and development with the above method, the company is expected to know the factors that influence production schedules to get an efficient time and analyze each of the most dominant factors on the level of sequencing of production scheduling. And it is hoped that after this activity, the company can implement Production scheduling planning using the analysis that has been done so that the production process time becomes more efficient.

II. LITERATURE REVIEW

A. Styrofoam

Products are defined as several characters marketed to obtain organizational goals and complement the needs and expectations of product users, product innovation is an interest and creates change to carry out activities and achieve planned results (Pratiwi, 2017). Product attributes include packaging, brand, label, presentation, and product quality guarantee. *Styrofoam* is generally pure white. The shape is simple and light. *Styrofoam* made from styrene copolymer is often used as food wrappers because it can prevent leakage and can to maintain its shape when held. According to Wirahadi (2017), the characteristics of *Styrofoam* are usually solid and can melt at higher temperatures. The basic material needed in the manufacture of *styrofoam* is EPS (*expanded polystyrene*).

B. Production scheduling

Referring to the research of Nasution (1999), Scheduling is a good measure of aggregation planning. Actual orders in this phase are assigned to specific resources (plant, workers, equipment) for the first time. The workflow is then executed in each machining center to make the best use of the available capacity(K. Z. Gao et al., 2020). Production scheduling is the determination of the arrangement of the amount of work to be carried out. Scheduling is a stage of production control that implements work in sequences according to its priorities and then completes the implementation of the plan at the right time and in the right order (Sutji, 2000). Scheduling production is a strategic part of creating a manufacturing plan and manipulating how in which painting collections and resource allocations are managed. Scheduling is a way of organizing, deciding, and finding out the available time and resources to deliver the expected results (Heri, 2017). Production is the process of converting raw materials into finished goods or adding value to a product (goods and services) to meet the needs of the community. The perpetrators of this production activity are called producers (both individuals and organizations), while the goods produced are called products (goods or services).

C. Priority *Dispatching Rules*

The priority *of dispatching rules* better known as dispatching rules with *scheduling in advance is* a scheduling technique that uses the *First Come First Serve* (FCFS) principle. Using this rule, the existing jobs are carried out according to the order in which they arrive (Amin and El-Bouri (2018). The measurement of working time can be done with two events, direct and indirect (Wignojosoebroto in Roidelindho). (2017). An example of measuring working time directly is with a sampling technique or what is known as *work sampling* and the stopwatch method (stopwatch *time study)* (Asrawati, 2021).

Sari and Darmawan (2020) define standard time as the time required for someone who has an average completion ability to complete work which is usually used as a standard for completing work. a job. Standard time can be used by the company to find out the optimal number of workers needed in a production process (Beauty, 2018). The steps needed to find the standard time are as follows: Measurement Introduction, Uniformity Test Data with steps Calculating the average of the sub-average prices group, Calculates the actual standard deviation of time settlement(Meng et al., 2019), Calculating the standard deviation of the sub mean price distribution group, Calculating the degree of accuracy of each

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operator, Calculate the confidence level, Determine the upper control limit (BKA) and the lower control limit (BKB), Sufficiency Test Data, Timing Standard with steps, Counting cycle time average, Calculate normal time, and Calculate standard time. Production scheduling with the integration of genetic algorithm methods can be classified based on several criteria (Nahmias, 2000):

a. Forward *scheduling* the scheduling operation starts from the date the order is received in advance. Consequently, there is an inventory of raw materials until they are in turn processed.
b. Backward *scheduling the scheduling* technique starts from the time of completion of the last operation. The advantage is to reduce the inventory of semi-finished goods (work *in process).*

Planning Production aims to minimize the amount of production and distribution scheduling costs, and the second objective function tries to minimize the amount of initial weight and delivery delays(Gahm et al., 2016). To validate the practical application of our framework, a case study of a furniture manufacturing company producing specialty items was considered(Fang et al., 2016), and experimental data were derived. (Mohammadi, et al. 2019). Based on real data, the model is first optimally solved by the constraint method, and then the *Hybrid Particle Swarm Optimization* (HPSO) algorithm is developed to solve the model for medium and large-sized problems in a reasonable time. We discuss the benefits of integration by comparing the results of the proposed model with separate approaches. The results show that companies can establish the right rational balance between costs and customer concerns, and they can use integration policies as leverage to increase customer satisfaction without the system experiencing a significant increase in total operating costs. Production planning can also be defined as a process to produce goods in a certain period according to what is predicted or scheduled through organizing resources such as labor, raw materials, machinery, and other equipment(Deng & Wang, 2017). Thus, forecasting is an integral part of production planning (Buffa & Sarin, 1996).

III. METHOD

1. Genetic Algorithm Method

algorithm (GA) is a solving procedure in finding and finding a *value* that has a basis in biological development g genetics capable for complete happening timetable which clash (Josie, 2017). *Step by step* will be applied GA based on procedure standard choice individual from process natural based on rule genetics, whereas in natural by ongoing To do election use defense personnel which has ability *survive* tall as well as eliminate individuals who have a weak *survival ability*(K. Gao et al., 2019). with the process of interbreeding between related individuals will result in changes ingene(K. Z. Gao et al., 2020). This gene change does not only occur in crossbreeding but can also occur because of gene mutations and adaptation processes. at a certain time (often known as the word generation), the population will more many loads individuals which is good (Christian et al., 2021).

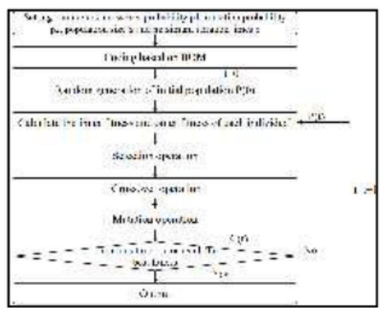

Figure 1: Organism Process Flow

Population initialization is a step that will change a *problem* into individual forms that are substituted for up to 1 to more chromosomes with a special code (Yuan et al., 2019). The size of a population is related to the problems to be solved and the types of genetic operators to be applied. After getting the population size, the chromosomes in the populationjust had to can conduct initialization for to *next step* (Laksono, *et.al,* 2016). *Fitness Value* (Score *fitness)*, is the score origin something function special which is used individual evaluation. For Individuals in the population who have high *fitness* the possibility to be maintaining is greater (Suwirmayanti, *et.al,* 2016). Function*fitness is* capable of direct use of function destination or

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can also be a little modification of function destination. (Santosa and Ai, 2017). A Genetic algorithm is a method to find the optimal solution by simulating the natural evolution process(Zhang et al., 2017). Selection, crossing, and mutation of chromosomes in the process of biological evolution leads to the evolution and evolution of organisms that are arranged in a flow process (Putra, 2018).

2. *Flowshop* Scheduling

Flowshop Scheduling is scheduling the production process of each *job* that has a production process sequence and goes through the machine that same (Baker 1974). Scheduling *Flowshop is* usually characterized by existence something one-way process flow and machines arranged in series. Every *job* that will be solved must pass all machines with the order machine which came in the process(Lu et al., 2017). Description of the Flowshop scheduling model according to Hejazi and Saghafian (2005):

A set of machines, = {1,2, . . .,} (1)

Jobs, = {1,2, . . .,}. (2)

Each machine can only process one job at the same time and each job is only processed once at each stage.

3. Chromosomes M

Chromosome M are individuals present in one population; chromosomes are also a combination of genes – genes that make up a certain value. The coding representation used in the genetic algorithm is a representation of random keys. This representation encodes a gene by generating a random number between (0,1). The random value in position *i* determines the order in which the city arrives in the VRP path. An example of a VRP path can be seen in the following figure:

4. Fitness

The *fitness function* is used for the chromosome evaluation process to obtain the desired chromosome. This function distinguishes the quality of the chromosomes to find out how well the chromosomes are produced.

1. The *fitness value* is a measure of whether a solution is expressed as an individual, or in other words, the *fitness* value states the value of the objective function.
2. The genetic algorithm has the aim of maximizing the *fitness value* or finding the maximum *fitness value*.

The criteria used in this selection process is that this criterion is a *fitness function criterion*. each path in the initial population has been calculated as the distance, fitness value, *fitness probability* and cumulative *fitness probability*. The stages of calculating its *fitness* are as follows:

1. Distance traveled per lane (*Zi*) (3)
2. Total distance of the entire line($\sum_{i=1}^{N} Z$) (4)
3. The *fitness value* of each path($\sum_{i=1}^{n} f$) (5)
4. Looking for total *fitness*($\sum_{i=1}^{N} f$) (6)
5. The probability of each path *pi*= $\frac{f}{\sum_{i=1}^{N} f}$ (7)
6. Cumulative probability of each path (*qi*) (8)

Furthermore, the selection of a path that produces the next population is done by taking N random numbers r with 0 < r < 1 and comparing the random numbers with the cumulative probability of fitness of each path. Settlement steps are carried out by P (generation) is a population of one generation, then simply GA consists of steps starting with the activity [start] Generation = 0, followed by Initialization of the initial population, randomly, then [Fitness] Perform a search for fitness and probability values on each chromosome, [Replace] Repeat the process as many chromosomes in the population, [Selection] Compare all probability values until the smallest value is obtained and [Test] If the final condition is met then stop and display the solution from the population.

IV. RESULTS AND DISCUSSION

1. Production Capacity

The company data used in the completion of this final project are data related to the styrofoam production process starting from production process data, production capacity data, production results in data, and company demand data in the production process for the June - August period in 2021.

Table 1. Production Capacity

Types of products	Production capacity	Production result	Number of Requests
Corner	108.000	93,600	99,000
Elbow	132,000	75,600	86,000
Lifebuoy	50,400	40,800	51,000
Sheet	141,600	134,400	180,000
Box	153,600	145,200	167,500

After determining the related

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variables, it is necessary to determine the limits that affect the problem. Constraints are made to limit the fitness function and as a stopping criterion used in the iteration process. The limitations used in the final project include the total number of goods produced must be equal to the number of requests for each destination.

2. Operation Process Data

To be able to solve this production process scheduling problem, takes some data that will be used to obtain optimal production process scheduling solutions and to carry out a comparative analysis. The data needed include data on machines and production processes.

The explanation from the table is that in the pillaring process, the first process goes through the first machine, the second process goes through the second machine, the third process is carried out by the third machine, the fourth process, and the last process is carried out by the fifth machine.

Table 2: Machine Code

Machine	Code
Expander	1
Box dryer	2
Compression	3
Pierre Block	4
CNC	5

From the description of the table above, it can be seen that the production process is carried out according to the machine sequence, the machine sequence is based on the code set starting from code 1 which is the initial process to code 5.
is the last process. Furthermore, the determination of the time of the production process.

Table 3: Operation Process

No.	*Job Production*	Number of machines(units)				
		1	2	3	4	5
1	Corner	1	2	3	4	5
2	Elbow	1	2	3	4	5
3	Lifebuoy	1	2	3	4	-
4	Sheet	1	2	3	4	-
5	Elbow	1	2	3	4	-

Table 4: Production Job Process Time

Job	Processing Time				
	1	2	3	4	5
Corner	285	240	262	236	177
Elbow	277	214	231	241	237
Lifebuoy	216	289	198	247	-
Shett	271	199	243	267	-
Box	261	263	239	237	-

3. Initialization of Initial Population

In determining this initialization, we can see the value of everyone or genes and the *fitness value* of each individual or gene.

Table 5. Chromosomal Probability Results

Chromosome	Binary	X	*Fitness*
V1	1 0 1 0 0 0 0 1 1 0 1 0 1 1 0 1 0 0 0 0 0 0 1 0	2.066	0.8147
V2	1 0 0 1 0 0 0 1 1 1 0 0 1 0 0 1 0 0 1 0 0 1 1 0	6,067	0.9058
V3	1 0 0 0 0 0 0 1 1 0 1 0 1 1 0 1 1 0 1 1 0 0 0 1	4,670	0.1270
V4	1 1 0 0 1 0 1 0 0 0 1 1 1 1 1 1 0 0 0 1 1 0 1 0	0.422	0.9134
V5	1 1 1 1 0 1 0 1 1 1 0 0 0 1 0 0 0 0 0 0 0 1 1 1	1,213	0.6324
V6	0 1 0 1 1 1 0 0 1 1 1 1 0 1 0 0 1 0 0 1 1 0 1 1	2,840	0.0975
V7	1 0 1 1 1 1 1 1 0 0 0 0 1 1 0 1 0 1 0 1 0 0 1 1	2,568	0.2785
V8	0 1 0 0 1 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 1 1 1 0	7.222	0.5469
V9	1 1 1 1 0 1 0 1 1 0 1 0 0 0 0 0 1 0 1 1 0 1 1 0	6.013	0.9575
V10	0 0 0 0 0 1 0 0 1 0 1 1 0 1 0 1 0 1 1 0 1 0 1 1	6.786	0.9649
V11	0 0 0 0 0 0 0 0 1 1 1 1 1 0 1 1 1 1 0 1 0 1 0 1	5,355	0.1576
V12	0 0 0 0 1 1 0 1 1 0 0 1 1 0 1 1 1 0 1 0 0 0 0 1	11,667	0.9706
V13	0 1 1 0 0 0 1 1 0 1 0 1 1 0 0 0 1 0 1 0 0 1 0 0	5.062	0.9572
V14	1 0 0 1 1 0 1 0 0 1 1 0 0 0 1 0 0 0 1 0 1 1 0 0	0.257	0.4854
V15	1 1 0 0 1 0 1 1 0 0 1 1 0 1 0 0 1 1 1 0 1 0 0 1	7,113	0.8003
V16	0 0 1 1 1 0 0 1 0 0 0 0 1 1 0 1 0 1 1 1 1 1 0 0	5.162	0.1419

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V17	11100000 10000010 10000100	6,870	0.4218
V18	00110000 00110011 11111111	6,311	0.9157
V19	01100010 00011101 11001110	5,369	0.7922
V20	01011000 01100010 01101010	6,714	0.9595
V21	11110101 00111100 11101011	3,501	0.6557
V22	11111101 00111110 00011010	4,732	0.0357
	Total		11.6847

The total *fitness* is 13325, so *fitness relative* (PK) of each chromosome up to chromosome 22 in the same way the results of 22 relative fitness values produce:
0.072, 0.077, 0.010, 0.078, 0.541, 0.008, 0.023, 0.046, 0.081, 0.082, 0.013, 0.083, 0.081, 0.041, 0.068, 0.012, 0.036, 0.078, 0.067, 0.082, 0.056, 0.003. Then proceed by randomizing the chromosomes so that the values are 0.617, 0.499, 0.708, 1.145, 0.898, 0.464, 0.430, 0.596, 0.345, 0.560, 0.682, 0.357, 0.467, 0.627, 0.629, 0.624, 0.733, 0.231, 0.288, 0.451, 0.453, 0.409. The crossover value generated in the probability value is 0.25 with a total time of 2699 seconds, 0.45 with a value of 4589, followed by a crossover probability value of 0.6 with a total time of 6478 seconds and a crossover probability value of 0.9 with a value of 9718 seconds. The results of determining random values on chromosomes produce the 4 smallest fitness values in the table below:

Table 6: Selected Crossover Probability

Chromosome	Binary	X	*Fitness*
V3	10000001 10101101 10110001	2,801	0.028
V7	10111111 00001101 01010011	2,134	0.032
V11	00000000 11111011 11010101	1,799	0.023
V22	11111101 00111110 00011010	8,317	0.024

4. List Programming

List programming as input using software Matlab (*.m) which is used in the solution that will use the Genetic Algorithm tools already contained in the Matlab software.

A. Determine the number of populations in the genetic algorithm.

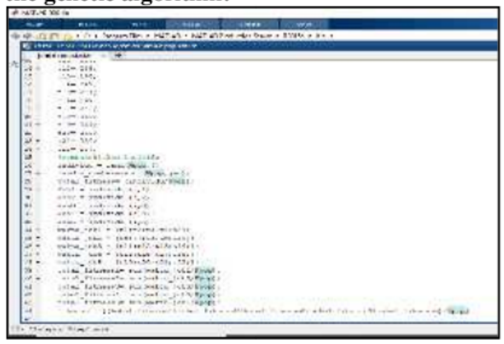

Figure 2: Awakening the individual

After carrying out the process of inputting the number of populations in generating individuals, the limits for determining the value limit in chromosomes are 22 chromosomes, which are produced in the following figure:

Figure 3. Determination of chromosome values

After the process of determining the value of the chromosome, the next step is to determine the crossover of the genetic algorithm as a process of choosing a random position by exchanging the characters in the string with the function of producing child chromosomes from the combination of the gene materials of the two parent chromosomes and the crossover probability is determined to control the crossover frequency.

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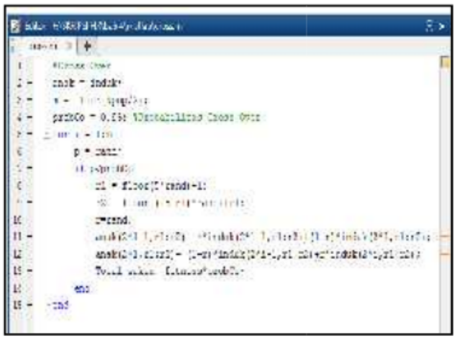

Figure 4. The results of determining the crossover

The next step is to generate random numbers using LCM as follows to connect and produce the latest chromosomes that are better and can be used with optimal chromosome values and followed by a reshuffle in determining the better chromosome values

.

Figure 5: LCM

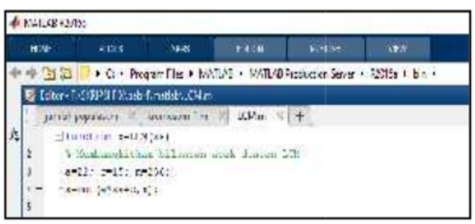

Figure 6: Reshuffle chromosome probability values

The last activity is a chromosomal mutation which is selected from 4 alternative values of the most optimal chromosome that can be used as an alternative solution in determining the scheduling of the production process.

Figure 7. Mutation of the production schedule

V. CONCLUSION

The production process using genetic algorithms obtained the best time in scheduling production capacity of 2699 seconds, this was an increase in the efficiency of the production process as evidenced by the previous production process of 3600 seconds (corner production process), thus saving time 901 seconds by determining the chromosome value. Of the 22 production processes produced, each product produces the best fitness value in the angle production process with a fitness value of 0.1270 seconds on a compression machine, so that the optimal use of the production process can be done using a compression machine to reduce production *lead time*. Thus, the total production time can be reduced due to the selection of alternatives in the production job shop using a genetic algorithm with a value of 0.023 seconds on the 11th chromosome.

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