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Training Balance Analysis Of 3 Kg Lpg Tube Retester Repair Using Ranked Positional Weight Method In Pt. Earth Trans Energy Wajo Regency South Sulawesi Province

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ABSTRACT

PT. Bumi Trans Energi is one of the companies engaged in 3 Kg LPG cylinder retested repair, this company repairs 3 Kg LPG cylinders that have been damaged for 5 years, damage to the *handguard*,and *footring*, and welded joints on the tube. In the repair process, there are 5 stations and 21 work processes, PT. Bumi Trans Energi encountered a problem in the repair line at station 1, and a *bottleneck occurred*. This *bottleneck* occurs because the production flow is not smooth from one station to the next, this problem causes each *work station* in the repair path to have a different speed level, which causes material accumulation between *work stations*, and waiting times between *work stations*. For this reason, this study aims to determine the number of workstations needed to get maximum efficiency and balance the repair process line when *bottlenecks occur*. Observations were made in data collection 30 times, each work element was observed and calculated in the data uniformity test and data adequacy test to obtain standard time. The results of this study were the application of 3 work stations from 5 initial work stations, there was a reduction in idle time to 425,74 seconds (7minutes) following the increase in track efficiency to 84,17 % the balance delay decreased to 15,83 %, and *the Smoothness Index* was 212,63. The actual idle time was 1004,97 seconds (17 minutes) whilethe proposed trajectory idle time used the *Ranked Positional Weight method of* 425,74 seconds (7 minutes). The difference between actual and proposed idle time is 10 minutes, and the placement of work elements at work station 1 (one) consists of 9 work operations, while work stations 2 (two)consist of 1 work process, and work stations 3 (three) consist of 8 work processes.

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1. INTRODUCTION

PT. Bumi Trans Energi is a company engaged in 3 Kg LPG cylinder retested repair, this company repairs 3 Kg LPG cylinders that have been damaged for 5 years, damage to the handguard and footring, and welded joints on the tube. In the repair process[1]. there are 5 stations and 21 work processes, at station 1 (there are 8 work processes, namely removing the remaining gas in the tube using a purging gas machine, seeing tube leaks using the initial leak test machine, opening the valve using the open valve 1 engine[2]. opening the valve using the engine open valve 2, test valve using a test valve machine, repairing the handguard and footring using a handguard and footring press machine[3]. repairing the handguard and footring using a handguard and footring press machine, weighing tubes using a digital scale), station 2 (there are 2 work processes namely looking at the amount of volume development in the tube using a hydrostatic test machine[4], [5]. giving the month and year on the right side of the tube handguard using a stamping machine), station 3 (there are 2 work processes, namely welding on the tube that is damaged by the handguard and footring using a welding machine, inserting the tube in the tube)[6], [7].

in annealing using an annealing machine), station 4 (there are 3 work processes, namely cleaning the rest of the paint, rust, and dust using a sandblasting machine, cleaning the remaining paint on the tube manually using a brass wire brush, checking the inside of the tube manually using an inspection camera), and station 5 (there are 6 work processes, namely painting the tube using a paint machine, installing markings and logos manually). manual, installing the valve on the tube using the valve fitting machine 1, installing the valve on the tube using the valve fitting machine 2, pressing the tube that has been repaired using the final leak test machine, the tube is weighed which has been repaired using a digital scale)[8], [9].

It is indicated that there is an imbalance in the path so it requires performance improvements in the line assembly to reduce the occurrence of bottlenecks that have a cycle time that is longer than the predetermined production cycle time. Therefore, it is necessary to identify bottlenecks and efforts to reduce cycle times at the bottleneck stations to increase production capacity so that demand targets and improvement targets can be achieved[10]. The cause to be identified is the bottleneck in the line assembly section. A bottleneck is a condition in which an operation or facility limits or hinders the output for one line of improvement. The reason for selecting a bottleneck to identify is because a bottleneck has a direct impact on the decline in the company's improvement results[11].

Bottlenecks in the production line result in reduced repair results achieved because there are semi-finished products that are idle in the production line or called work in process and using the Ranked Positional Weight method because this method is different from the method that has been used previously for track balance in manufacturing companies[12]. as well as service companies on the production line. This method will improve the trajectory balance of the 3 Kg LPG cylinder retested repair[13].

To carry out the product functions properly, a series of activities are needed that will form a production system. The production system is a collection of sub-systems that interact with each other to transform production inputs into production outputs. These production inputs can be in the form of raw materials, machinery, labor, capital, and information[14]. Meanwhile, production output is the product produced and its by-products, such as waste, information, and so on[15]. The production line is the placement of work areas where these areas have various sequential operations according to the rules and the continuous movement of materials through balanced operations[16].

Based on the problems above, this study aims to analyze the balance of the 3 Kg LPG cylinder retested repair trajectory using the Ranked Positional Weight method[17].

2. RESEARCH METHODS

2.1 Time and Place of Research.

The time of study was carried out for one month (March) and was carried out at PT. Bumi Trans Energi on Jl. The Sengkang-Palopo Axis, Lamata, Gilireng, Wajo Regency, South Sulawesi Province.

2.2 Data Collection.

2.2.1. Field observation

Direct observation of the working environment conditions at PT. Bumi Trans Energi was then recorded to obtain the data needed for research.

2.2.2. Interview

Direct questions and answers to certain parties in the production department at PT. Earth Trans Energy is associated with objects researched problem.

2.2.3. Documentation

documents and company records related to the object under study.

2.2.4. Measurements

Measurement of time with a stopwatch for each work element on the 3 kg LPG cylinder retested production line.

2.3 Data Processing

The data processing used in this study uses the Ranked Positional Weight (RPW) method, this method is a combination of the great candidate rule method with the region approach method[18]. The RPW value is a calculation between the work elements and the position of each work element in the priority diagram[19], [20]: (1) Working Time Measurement; (2) Creating Priority Diagrams; (3) Calculation of the Positional Weight Rating Design Method; (4) Calculation of Efficiency, Balance Delay, and Idle Time

3. RESULTS AND DISCUSSION

This study initially collected data on repairs per day for 3 Kg LPG cylinders, data on work stations, work sequences, and operators, and took the working time of each work element using a stopwatch. Next, make an actual repair path to find out bottlenecks and idle time. And create a proposed path using the Ranked Positional Weight (RPW) method to reduce bottlenecks and idle time.

Table 1. Repairs Per Day and Total Working Time

Date	Broken Tube	Repair amount	Working Time
1 March	-	-	
2 March	1.500	1.250	
3 March	1.500	1.250	
4 March	750	750	
5 March	750	750	
6 March	-	-	
7 March	750	750	
8 March	750	750	
9 March	2.500	1.250	
10 March	1.250	1.250	
11 March	2.500	750	
12 March	-	-	
13 March	-	-	8 Hour/ Day
14 March	1.500	1.250	
15 March	1.500	1.250	
16 March	1.500	1.250	
17 March	2.500	1.250	
18 March	2.500	1.250	
19 March	2.500	1.250	
20 March	-	-	
21 March	2.500	1.250	
22 March	750	750	
23 March	1.500	750	
24 March	1.500	1.250	
25 March	1.500	1.250	

Source : (PT. Bumi Trans Energi, 2022)

Table 2. Work Stations, Work Sequences, and Operators

Station	Activity	Operator
	Remove the remaining gas on the cylinder (gas purging engine)	1
	See tube leak (early leak test engine)	1
	Opening valve (Machine 1 open valve)	1
	Opening valve (Engine 2 open valve)	1
1	Test valve (Test valve machine)	1
	Fixing hand guard and tube footring (Press machine The hand guard and footing 1)	1
	Repairing tube hand guard and footring (Handguard and footing 2 press machine)	1
	The tube is weighed (digital scale)	1
	Seeing the size of the tube volume expansion (Hydrostatic test machine)	1
2	Give the month and year on the right-hand guard tube (stamping machine)	1
	Welding on tubes that are damaged by hand guard and footring (Welding machine)	1
3	Insert the tube into the welded annealing (Annealing Machine)	1
	Remove paint residue, rust, and dust (sandblasting machine)	3

	Clean the remaining paint on the tube manually (Brush brass wire)	1
4	Perform inspection of the inside of the tube (Inspection camera)	1
	Installation of markings and logos	6
	Installation of the valve on the tube (Machine 1 valve fitting)	1
5	Installation of the valve on the tube (Machine 2 valve fittings)	1
	Checking the repaired tube (Leak test engine end)	1
	The weighing tube that has been repaired (digital scale)	1

Table 3. Processing time of each work element

No	Purgingas (Second)	Leeks early (Second)	Open valve 1 (Second)	Open valve 2 (Second)	Test valve (Second)	Pres hand guard and foot ring 1 (Second)	Pres hand guard and foot ring 2 (Second)	Digital Scales (Second)
1	67,86	3,37	9,77	3,97	4,67	11,57	7,52	4,25
2	67,26	3,12	9,53	3,96	3,84	10,23	7,92	3,97
3	67,00	3,89	9,73	4,48	3,88	10,38	7,19	4,04
4	67,81	3,21	9,68	5,19	3,92	11,06	8,19	3,38
5	67,41	3,10	8,16	4,93	3,76	11,43	8,57	3,08
6	67,13	3,01	7,89	5,85	4,34	10,76	7,06	4,33
7	61,81	2,44	7,77	3,70	3,17	11,74	6,05	4,89
8	68,32	3,45	9,83	3,34	4,22	11,14	7,63	3,48
9	68,71	3,06	7,76	4,31	3,45	10,23	8,31	3,67
10	67,42	3,45	7,15	3,74	3,57	11,61	7,06	3,66
11	62,4	3,71	9,98	4,21	4,43	10,01	8,42	4,96
12	77,00	3,62	7,88	4,55	3,86	10,89	5,37	3,33
13	62,32	3,08	8,85	4,94	3,01	12,12	7,75	3,57
14	63,42	3,96	7,53	4,53	4,56	11,02	7,55	4,21
15	64,20	3,50	9,11	4,84	3,22	11,05	8,41	3,95
16	62,46	3,88	7,23	3,53	3,61	12,3	7,41	3,21
17	67,63	3,29	9,96	4,08	3,17	9,78	7,05	3,48
18	62,45	3,31	7,76	4,72	3,48	9,35	7,22	3,15
19	66,00	3,17	8,39	4,84	4,55	13,83	6,55	4,04
20	60,00	3,29	8,51	4,71	3,13	10,77	8,31	4,66
21	61,20	3,50	8,26	3,83	3,20	12,09	7,09	3,80
22	61,43	3,63	8,03	4,26	3,39	11,22	7,76	3,64
23	61,22	3,18	9,01	4,78	3,59	10,07	8,58	3,37
24	67,91	3,46	7,46	3,41	3,90	10,99	6,84	3,71
25	63,4	3,73	7,19	4,84	3,88	11,93	8,65	4,25
26	68,72	4,21	7,50	4,67	2,84	11,54	7,12	3,10
27	75,00	4,28	9,19	4,87	3,58	10,11	8,93	3,44
28	70,12	3,03	7,76	4,93	3,95	11,53	7,93	3,7
29	70,45	3,65	8,02	3,88	4,23	11,22	7,53	3,33
30	71,40	3,54	7,05	5,36	3,11	10,21	8,48	4,42

No	Hydro test (Second)	Press stamping (Second)	Las (Second)	Annealing (Second)	Sandblastingg (Second)	Brass wire brush (Second)	Inspection camera (Second)	Paint Machine (Second)
1	245,60	6,83	21,80	384,6	146,4	126,6	3,99	4,89
2	240,60	6,28	22,25	386,4	176,6	120,6	3,45	4,80
3	247,80	6,55	23,92	375,6	171,6	127,8	2,76	5,21
4	252,51	5,30	21,92	387	145,01	124,2	3,70	4,55
5	230,91	6,10	23,68	387,6	146,3	121,8	3,34	5,28
6	210,32	5,59	22,00	385,2	140,6	132,6	3,37	4,60
7	260,60	5,40	22,01	388,2	142,6	135,6	3,55	4,28
8	261,20	5,22	26,41	388,8	145,6	125,4	2,95	3,96
9	249,40	6,62	22,44	384	174,2	123	3,51	4,18
10	255,60	6,19	21,01	379,2	145,2	124,2	2,88	3,95
11	267,20	5,19	21,94	380,4	143,1	128,4	3,73	4,72
12	299,40	5,55	22,20	390	173,2	129,6	3,62	3,99
13	321,45	6,81	22,40	390,6	132,01	130,2	3,08	4,11
14	265,20	6,13	21,45	391,2	170,21	131,4	3,84	3,76
15	367,80	6,52	22,33	378,6	171,8	132,6	3,14	3,88
16	261,80	5,07	22,33	385,8	175,6	138,6	3,77	5,43

17	273,20	6,14	22,21	393,6	176,2	133,2	3,43	5,21
18	263,60	6,40	23,10	382,2	143,6	130,2	3,79	4,74
19	262,40	5,31	21,56	388,8	145,8	124,2	2,29	4,20
20	260,60	6,30	22,04	378	131,2	127,2	3,55	3,63
21	264,80	6,81	22,20	378,6	145,4	121,8	3,61	4,35
22	265,40	5,77	21,22	385,8	146,03	128,4	2,59	3,97
23	272,60	6,91	22,65	385,2	172,6	138	3,32	3,91
24	378,60	6,85	20,42	388,2	176,2	137,4	3,68	4,18
25	269,60	6,11	26,59	388,8	138,6	120	3,08	3,84
26	261,80	6,27	21,58	391,2	149,02	144,6	3,91	3,43
27	264,20	5,67	21,36	391,8	140,2	146,4	3,94	4,02
28	261,20	5,40	26,66	379,2	147,4	147	3,50	3,74
29	279,80	5,57	22,83	381	175,6	142,2	3,64	4,19
30	285,20	5,69	21,55	384,6	177,01	136,2	3,56	3,28

No	Installation of markings and logos (Second)	Fitting valve 1 (Second)	Fitting valve 2 (Second)	Leeks and (Second)	Digital Scales (Second)
1	9,85	3,08	4,30	2,36	4,11
2	11,30	4,86	3,34	3,03	4,45
3	10,52	3,54	3,40	2,67	3,42
4	9,89	3,45	3,81	3,29	4,11
5	11,82	3,69	3,84	2,14	4,00
6	11,32	4,00	3,33	3,06	4,21
7	10,09	3,62	3,91	2,20	4,33
8	14,34	3,42	3,60	3,25	3,01
9	11,14	3,76	3,21	2,15	4,22
10	9,91	3,29	3,16	2,00	4,12
11	9,74	4,71	4,63	2,03	3,05
12	10,23	3,03	3,56	2,05	4,16
13	10,26	4,43	3,30	2,33	4,00
14	8,70	4,10	3,75	2,87	3,25
15	9,65	3,72	3,82	2,34	4,17
16	8,60	4,36	3,29	2,10	4,50
17	8,95	3,93	3,89	2,63	3,62
18	8,51	3,70	3,21	2,06	4,00
19	9,65	3,09	4,33	2,35	4,62
20	9,25	4,14	4,20	2,40	3,72
21	9,00	4,09	2,79	2,31	4,08
22	8,78	3,55	2,81	2,18	4,50
23	8,96	3,06	3,11	2,14	3,66
24	8,52	4,04	3,28	2,26	4,10
25	8,77	4,44	3,96	2,43	3,82
26	8,30	3,12	3,71	2,30	3,99
27	8,61	3,64	3,52	2,07	3,04
28	8,41	4,14	3,84	2,15	4,01
29	8,55	3,79	3,43	2,27	3,37
30	9,01	3,02	3,29	2,25	3,70

Source : (PT. Bumi Trans Energi, 2022)

3.1 Working Time Measurement

1. Data Sufficiency Test

A data adequacy test is carried out to know whether the data taken has beemeetinget the amount that should be or not yet. In this study, the level of 95% confidence and 5% accuracy level. If 95% confidence level and accuracy level 5% is used then used the variable multiplier of the $N = \left(\frac{\frac{k}{s}\sqrt{N\sum Xi^2 (\sum Xi^2)}}{\sum Xi}\right)^2$

$$N = \left(\frac{\frac{2}{0{,}05}\sqrt{30\ (132426{,}3138) - (1989{,}46)^2}}{1989{,}46}\right)^2$$

$$N = \left(\frac{40\ x\ 121{,}82}{1989{,}46}\right)^2$$

$$N = 6{,}00$$

Conclusion: N'< N, it means that the data is sufficient. Results test data adequacy on all data has been declared sufficient. Recapitulation calculation of data adequacy test for all work elements are shown in table 4.

Table 4. Data Sufficiency Test Recapitulation

Work Element	Σxi	∑(xi2)	N	N'	Information
1	1989,46	132426,3138	30	6,00	Enough
2	103,12	358,8152	30	19,62	Enough
3	252,14	2146,174	30	20,34	Enough
4	133,25	602,4911	30	28,73	Enough
5	112,51	428,5047	30	24,80	Enough
6	332,18	3702,256	30	10,56	Enough
7	228,45	1758,926	30	17,72	Enough
8	114,07	441,4599	30	28,51	Enough
9	8100,39	2221082,533	30	24,80	Enough
10	180,55	1096,2339	30	14,14	Enough
11	676,06	15303,881	30	7,18	Enough
12	11560,2	4455268,2	30	0,24	Enough
13	4664,89	732863,5857	30	16,48	Enough
14	3929,4	516375,72	30	5,29	Enough
15	102,57	355,636	30	22,56	Enough
16	128,28	557,525	30	26,21	Enough
17	292,63	2901,736	30	26,52	Enough
18	112,81	431,727	30	28,30	Enough
19	107,62	391,68	30	23,23	Enough
20	67,67	153,8229	30	12,39	Enough
21	67,67	153,8229	30	19,98	Enough

Source: (Data Processed, 2022)

2. Data Uniformity Test

Data uniformity test needs to be done first before using the data in order to it is known whether the data is in a state uniform toset the standard time. Example of data uniformity test calculation on the work element one can be seen as the following :

$$\bar{X} = \frac{1989{,}49}{30} = 66{,}32$$

$$\sigma = \sqrt{\frac{\sum(xi - \bar{x})}{N-1}}$$

$$\sigma = \sqrt{\frac{(67{,}86 - 66{,}32)^2 + (61{,}81 - 66{,}32)^2 + (67{,}91 - 66{,}32)^2 + (71{,}40 - 66{,}32)^2}{30 - 1}}$$

$$\sigma = \sqrt{\frac{17321{,}20}{29}} = 24{,}44$$

$$BKA = \bar{x} + K\sigma = 66{,}32 + 2(24{,}44) = 115{,}20$$

$$BKB = \bar{x} + K\sigma = 66{,}32 - 2(24{,}44) = 17{,}44$$

Table 5. Recapitulation of Data Uniformity Test

Work Element	Average	Deviation	BKA	BKB	Information
1	66,32	24,44	115,20	17,44	Uniform
2	3,44	1,42	6,28	0,60	Uniform
3	8,40	0,95	10,30	6,50	Uniform
4	4,44	0,60	5,64	3,24	Uniform
5	3,75	0,47	5,82	1,72	Uniform
6	11,07	0,91	12,89	9,25	Uniform
7	7,61	0,81	9,23	5,99	Uniform
8	3,80	0,52	4,84	2,76	Uniform
9	270,01	34,17	338,35	201,67	Uniform
10	6,02	0,58	7,18	4,86	Uniform
11	22,53	1,54	25,61	19,45	Uniform
12	385,34	4,77	394,88	375,80	Uniform
13	155,50	16,07	187,64	123,36	Uniform
14	130,98	7,66	146,30	115,66	Uniform
15	3,42	0,41	4,24	2,59	Uniform
16	4,28	0,56	5,40	3,16	Uniform
17	9,75	3,11	15,92	3,53	Uniform
18	3,76	0,51	4,78	2,74	Uniform
19	3,59	0,44	4,47	2,71	Uniform
20	2,26	0,20	2,66	1,86	Uniform
21	3,91	0,44	4,79	3,03	Uniform

3. Westinghouse, Cycle Time, Normal, Standard

Cycle time is the sum of each job element, normal time is the time for completion of work completed by workers in reasonable conditions and with average work ability, and standard time, which is the time required by normal workers to work normally. complete the work carried out in the best work system of the time. The recapitulation of the calculation of the normal time value for all work elements can be seen in Table 6.

Table 6. Cycle Time, Normal, Standard for Repair of 3 Kg . LPG Cycle Retester

Work Element	Cycle Time (Second)	Normal Time (Second)	Standard Time (Second)
1	66,32	126,01	153,73
2	3,44	6,54	7,98
3	8,40	15,96	19,47
4	4,44	8,44	10,30
5	3,75	7,12	8,62
6	11,07	12,29	14,99
7	7,61	8,,44	10,30
8	3,80	4,22	5,14
9	270,01	299,71	365,65
10	6,02	6,68	8,15
11	22,53	25,01	30,51
12	385,34	427,73	521,83
13	155,50	172,60	210,57
14	130,98	145,39	193,37
15	3,42	3,80	5,09
16	4,28	4,75	5,80
17	9,75	10,82	14,39
18	3,76	4,17	5,09
19	3,58	3,97	4,84
20	2,26	2,51	3,06
21	3,91	4,34	5,30

3.2 Precedence Diagram Initial

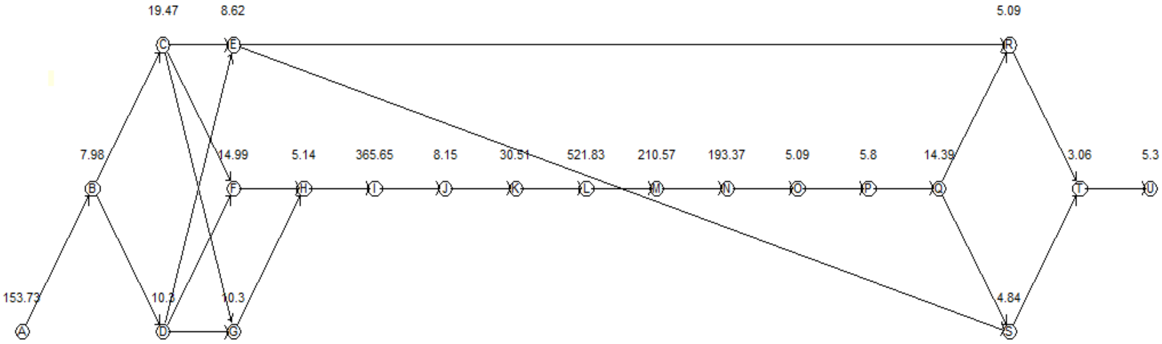
The data from the research that has been done on the 3 Kg LPG cylinder retester table PT. Bumi Trans Energi by calculating the working time of each repair process or resetter can be seen in the table below. The time taken is the standard time for each work element.

Table 7. Early Predecessor Operations

Station	Order Operation	Work Order Name	Time Raw (Second)	Preceding Operation
1	A	Removing the remaining gas in the cylinder (Machine purgin gas)	153,73	
	B	Seeing tube leaks (early leaktest engine)	7,98	A
	C	Open valve (Machine 1 open valve)	19,47	B
	D	Open valve (Machine 2 open valve)	10,30	B
	E	Test valve (Machine test valve)	8,62	C,D
	F	Repairing tube hand guard and footring (Handguard and footring press machine 1)	14,99	C,D
	G	Repairing tube hand guard and footring (Handguard and footring press machine 2)	10,30	C,D
	H	The tube is weighed (digital scale)	5,14	F,G
2	I	Seeing the magnitude of the volume expansion tube (hydrostatic test machine)	365,65	H
	J	Gives month and year on the right side hand guard tube (stamping machine)	8,15	I
3	K	Welding on tubes subjected to damage to hand guard and footring (Welding machine)	30,51	J
	L	Inserting the tube in the annealing already welded (annealing machine)	521,83	K
4	M	Removes residual paint, rust and dust (sandblasting machine)	210,57	L
	N	Clean the remaining paint on the tube with manual (brass wire brush)	193,37	M
	O	Checking the inside of the tube (Inspection camera)	5,09	N
5	P	Carrying out painting on the tube (Machine paint)	5,80	O
	Q	Installation of markings and logos	14,39	P
	R	Valve installation on the tube (Machine 1 valve fitting	5,09	E,Q
	S	Installation of the valve on the tube (Machine 2 fittings valves)	4,84	E,Q
	T	Pressing the repaired tube (final least engine)	3,06	R,S
	U	The tube is weighed which has been repaired (Digital scales)	5,30	T
		Total	**1604,18**	

ction Line Condition

Initial production line conditions to identify whether it needs to be repaired or not, so that the production line can be better. The initial production trajectory can be seen below:



Source: (Processed Data, 2022)

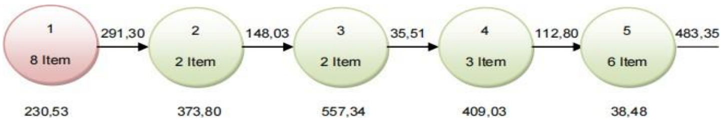


Figure 1. Precedance Diagram Initial

From the results of the initial precedence diagram above, there are 5 stations, (at station 1 there are 8 work elements, removing the remaining gas with a time of 153.73 seconds, seeing tube leaks with a time of 7.98 seconds, opening the valve with a time of 19.47 seconds, opening valve with a time of 10.30 seconds, test valve with a time of 8.62 seconds, repairing the tube handguard and footring with a time of 14.99 seconds, repairing the tube handguard and footring with a time of 10.30 seconds, the tube being weighed with a time of 5.14 seconds) the total working time is 230.53 seconds and the waiting time for station 1 to station 2 is 291.30 seconds, at station 1 to station 2 a bottleneck occurs, (at station 2 there are 2 work elements, see the size of the tube volume expansion with a time of 365.65 seconds , gives the month and year on the right side of the tube handguard with a time of 8.15 seconds) the total working time is 373.80 seconds and the waiting time for station 2 to station 3 is 148.03 seconds, (at station 3 there are 2 work elements, welding on the tube that get damaged n handguard and footring with a time of 30.51 seconds, inserting the tube in the annealing that has been welded with a time of 521.83 seconds) the total working time is 557.34 seconds and the waiting time for station 3 to station 4 is 35.51 seconds, (at station 4 there are 3 working elements, cleaning the remaining paint, rust, and dust with a time of 210.57 seconds, cleaning the remaining paint on the tube using a brass wire brush with a time of 193.37 seconds, checking the inside of the tube with a time of 5 ,09 seconds) the total working time is 409.03 seconds and the waiting time for station 4 to station 5 is 112.80 seconds, (at station 5 there are 6 work elements, painting the tube with a time of 5.80 seconds, installing markings and logos with a time of 5.80 seconds). 14.39 seconds, installing the valve on the tube with a time of 5.09 seconds, installing the valve on the tube with a time of 4.84 seconds, pressing the repaired tube with a time of 3.06 seconds, weighing the tube that has been repaired with a time of 5 .30 seconds) the total working time is 38.48 seconds and the waiting time for station 5 to finish is 483.35 seconds. Idle time 1004.97 seconds, balance delay 38.52%, smoothness index 595.30, and track efficiency 61.48%.

3.3 Solving Using the Ranked Positional Weight (RPW) Method

After knowing the results of the actual path for repairing 3 Kg LPG cylinders, the next step is to calculate the proposed path using the Ranked Positional Weight (RPW) method.

Table 8. Proposed Preceding Operations

Station	Order Operation	Work Order Name	Time Raw (Second)	Preceding Operation
1	A	Remove the remaining gas in the tube (gas purgin engine)	153,73	
	B	Seeing tube leaks (Machine initial leak test)	7,98	A
	C	Open valve (Machine open valve)	19,47	B
	D	Test valve (Machine test valve)	8,62	C
	E	Repairing tube hand guard and footring (Hand guard and footring press machine	14,99	C
	F	The tube is weighed (digital scale)	5,14	E
	G	Seeing the large expansion of the volume of the tube (Hydrostatic Machine test)	365,65	F
	H	Give the month and year on the right side of the tube hand guard (stamping machine)	8,15	G
	I	Welding on tubes that are damaged by hand guard and footring (Welding machine)	30,51	H
2	J	Insert the tube in the annealing that has been welded (Annealing Machine)	521,83	I
3	K	Cleans residual paint, rust, and dust (Sandblasting machine)	210,57	J
	L	Clean the remaining paint on the tube manually (Wire brush brass)	193,37	K
	M	Doing part inspection in the tube (Inspection camera)	5,09	L
	N	Doing painting on tube (paint machine)	5,80	M
	O	Installation of markings and logos	14,39	N
	P	Valve installation on the tube (valve fitting machine)	5,09	D,O
	Q	Printing the repaired tube (End leaktest engine)	3,06	P
	R	The tube is weighed that has been fix (digital scale)	5,30	Q
		Total	**1578,74**	

From the table of the predecessor operation of the above proposal number of operations 18 working elements, station 1 there are 9 work elements, station 2 has 1 work elements, and station 3 there are 8 elements work. Determination of cycle time (cycle time), namely maximum amount of time required each work station to work on each product items so that the production target will be set is reached. Determine cycle time by using the formula :

ti_{maks} =The largest operating time in the track
= 521,83 Second

P = Effective working hours per day
= Hours worked x number of workers
= 8 hours x 29 person
= 28.800 second x 29 person
= 835.200 second

Q = number of repairs per day
= 1.250 Product

CT = Sycle time

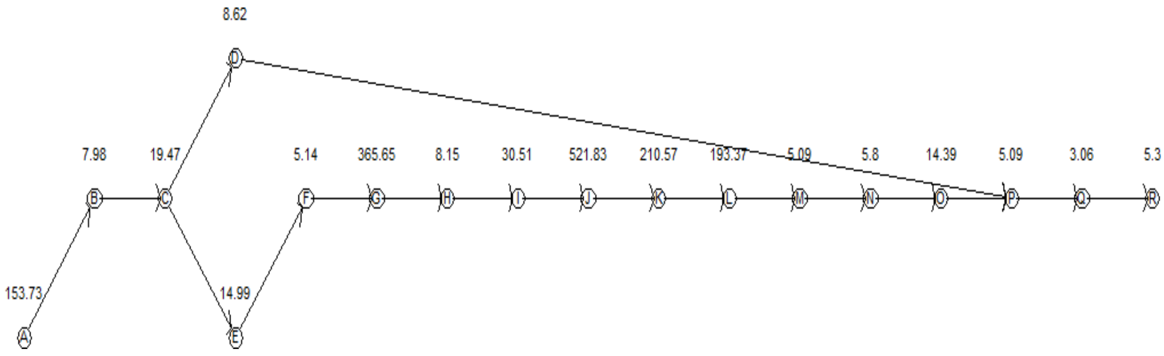
$$= ti_{maks} \leq CT \geq \frac{P}{Q}$$

$$= ti_{maks} \leq CT \geq \frac{835.200}{1.250}$$

$$= 521{,}83 \leq CT \geq 668{,}16$$

From the above calculations it is known that cycle time is at 521.83 seconds to 668.16 seconds. To find out the minimum required work station. Station Minimum work can be determined by divide the total task time by the time cycle, as for the data needed in the calculate the minimum station requirement is as follows :

$$= K \frac{\sum t}{\sum CT} = \frac{1578{,}74}{668{,}16} = 3\ station$$



Source: (Processed Data, 2022)

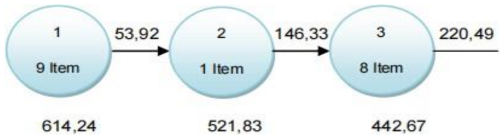


Figure 2. Precedance Diagram of the Proposed Positional Weight (RPW) Method

In the precedence diagram of the proposed ranked positional weight (RPW) method above, there are 3 stations, (at station 1 there are 9 work elements, removing the remaining gas with a time of 153.73 seconds, seeing tube leaks with a time of 7.98 seconds, opening the valve with a time of 7.98 seconds). 19.47 seconds, test valve with a time of 8.62 seconds, repairing the handguard and footring of the tube with a time of 14.99 seconds, weighing the tube with a time of 5.14 seconds, seeing the magnitude of the expansion of the volume of the tube with a time of 365.65 seconds, giving the month and the year on the right side of the tube handguard with a time of 8.15 seconds, welding on the tube with handguard and footring damage with a time of 30.51 seconds) the total working time is 614.24 seconds and the waiting time for station 1 to station 2 is 53.92 seconds, (at station 2 there is 1 working element, inserting the tube in the annealing that has been welded with a time of 521.83 seconds) the total working time is 521.83 seconds and the waiting time for station 2 to station 3 is 146.33 seconds, (at station 3 there are 8 working elements, cleaning the rest of the paint, rust, and dust with a time of 210.57 seconds, cleaning the remaining paint on the tube using a brass wire brush with a time of 193.37 seconds, checking the inside of the tube with a time of 5.09 seconds, doing painting on the tube with a time of 5.80 seconds, installing markings and logos with a time of 14.39 seconds, installing a valve on the tube with a time of 5.09 seconds, painting a tube that has been repaired with a time of 3.06 seconds, the tube is weighed has been fixed with a time of 5.30 seconds) the total working time is 442.67 seconds and the waiting time for station 3 to finish is 220.49 seconds. Idle time 425,74 seconds, balance delay 21.24%, smoothness index 270.07, and 78.76% track efficiency.

4. CONCLUSIONS AND SUGGESTIONS

4.1 Conclusion

1. Implementation of 3 (three) work stations using the Ranked Positional Weight (RPW) method, there was a reduction in idle time to 425.74 seconds (7 minutes) followed by an increase in track efficiency to 84.17% balance delay decreased to 15.83%, and the Smothness Index is 212.63, and the actual idle time is 1004.97 seconds (17 minutes) while the idle time for the proposed trajectory uses the Ranked Positional Weight method of 425.74 seconds (7 minutes). The difference between actual and proposed idle time is 10 minutes.
2. Placement of work elements at work station 1 (one) consists of 9 work operations, while work station 2 (two) consists of 1 work process, and Workstation 3 (three) consists of 8 work processes.

4.2 Suggestions

Based on the research results that have been obtained, the authors provide suggestions to PT. Bumi Trans Energi, namely because the repair trajectory is very important so that the 3 Kg LPG cylinder retester repair process is better, there needs to be improvements so that the 3 Kg LPG cylinder retester repair process is balanced, it is hoped that the company will implement a trajectory balance system with the Ranked Positional Weight (RPW) method as an improvement the process of repairing the 3 Kg LPG cylinder retester in the future so that demand is achieved on time

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