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"COMPARATIVE STUDY OF ASSEMBLY LINE BALANCING USING PLANT SIMULATION SOFTWARE WITH RANKED POSITION WEIGHT METHOD"

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ABSTRACT

In this research work, the main object to reduce the number of stations or to find out optimum number of stations this is also called as TYPE-1 problem. A simulation software PLANT SIMULATION also used for visualize the whole procedure what changes takes place when different methods apply on that data. The simulation software used for find out optimum solution or checking purpose because all these methods gives the results in mathematical manner and this software result in practical manner. This software shows satisfactory result when run on given data by given the optimum solution to the present assembly line work station for the product there by reducing the human resources, work place require for existing set up.

KEYWORDS : *Assembly line balancing, methods, Ranked Positional Weight Method, Plant simulation software.*

I. INTRODUCTION

One of the topics which has attracted a lot attention from industrial and research centers from the beginning of the industrial production is, production or assembly lines balancing problem of the products. Failure to achieve a balanced production system means that you have not reached the full capacity the system. Due to the high cost of production systems, balancing these systems is the most important preoccupation of researchers and industrial engineers in research and industrial centre's. In this manner, one of the main reasons for non-use of the industrial centres capacities in Iran is that the production and assembly lines of the products are not balanced, So the main objective of this paper is to introduce scientific and appropriate methods for assembly line balancing in Electronic Industry. One of the fundamental characteristics of an assembly line balancing is the movement of a task from one station to another. The main problem in the assembly line is that a required task in a station must be assigned with considering constraints of production system and the task priorities, which is called an assembly line balancing problem. If there is a single model applied to the assembly line balancing, and required tasks and its tasks processing times are known and constant, it is called simple assembly line balancing problem (SALBP) (Baybars, 1986). In order to balance this type of assembly line, the following information is required:

- Production rate.
- Tasks of a product and each task‟s standard processing time.
- Task orders and precedence relation among tasks.

- Constraints of production system and products.

II. LITERATURE REVIEW

Boysen et al.(2008) [1] in their work on assembly line balancing tried to make understand that which model to use when. This work structures the vast field of assembly line balancing according to characteristic practical settings and highlights relevant model extensions which were required to reflect real world problems and open research challenges were identified. An ant colony optimization algorithm for balancing two-sided assembly lines was presented by Simaria and Vilarinho (2009) [2]. Two-sided assembly lines are a special type of assembly lines in which workers perform assembly tasks in both sides of the line. The highlighted approach of this work is to address the two-sided mixed-model assembly line balancing problem. First, a mathematical programming model ,then, an ant colony optimization algorithm. Fan et al. (2010) [3] published their work unbalancing and simulating of assembly line with overlapped and stopped operation on the subject modeling and simulation of assembly line with overlapped and stopped operation, builds mathematical model for the assembly line both under certainty and uncertainty environment. Blum and Miralles (2011) [4] works on solving the assembly line worker assignment and balancing problem via beam search. In this work they deal with a specific assembly line balancing problem that was known as the assembly line worker assignment and balancing problem (ALWABP). This problem arises in setting where tasks must be assigned to workers, and workers to work stations. In this work an algorithm based on beam search was introduced for solving the ALWABP with the objective of minimizing the cycle time when given a fixed number of work stations ,respectively, workers. Cheshmehgaz 2012) [5] worked on accumulated risk of body postures in assembly line balancing problem and modeling through a multi-criteria fuzzy-genetic algorithm. A novel model of assembly line balancing problem was presented that incorporates assembly worker postures into the balancing. Also anew criterion of posture diversity was defined and contributes to enhance the model. The proposed model suggests configurations of assembly lines via the balancing and the assigned workers gets the opportunities of changing their body postures, regularly. A work on two-sided assembly lines balancing with assignment restrictions was presented by Purnomoet al. (2013) [6]. Two-sided assembly line is a set of sequential workstations where task operations can be performed in two sides of the line. In this work amathematical model was proposed for two-sided assembly line type II. The aim of the model was minimizing the cycle time for a given number of mated work stations and balancing the workstation simultaneously.

III. PROBLEMS IN ASSEMBLY LINE BALANCING

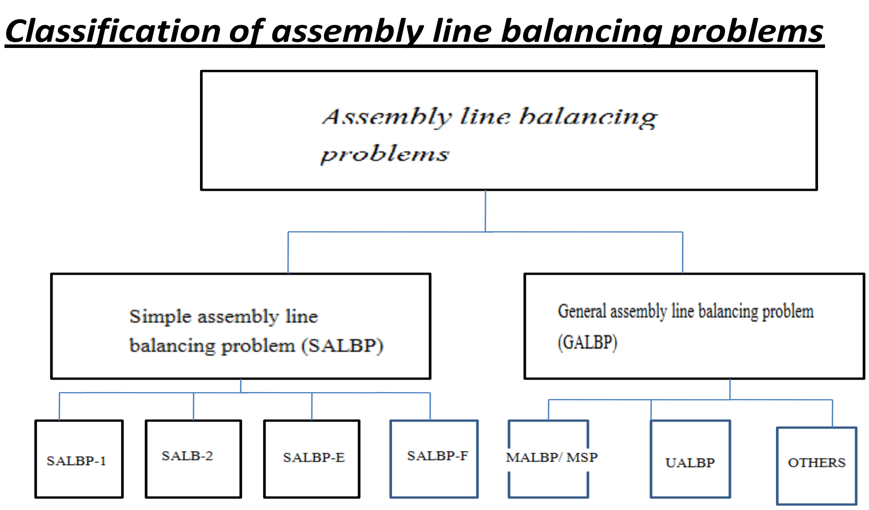

Fig.3.1

SALBP : The simple assembly line balancing problem is relevant for straight single product assembly lines where only precedence constraints between tasks are considered (for a survey see Scholl and Becker, 2006)

3.1.1 Type 1(SALB-1) of this problem consists of assigning tasks to work stations such that the number of stations *(m)* is minimized for a given production rate (fixed cycle time, *c*).

3.1.2 Type 2 (SALBP-2) is to minimize cycle time (maximize the production rate) for a given number of stations *(m).*

3.1.3 Type E (SALBP-E) is the most general problem version maximizing the line efficiency *(E)* thereby simultaneously minimizing *c* and *m* considering their interrelationship.

3.1.4 Type F (SALBP-F) is a feasibility problem which is to establish whether or not a feasible line balance exists for a given combination of *m* and *c*.

3.1 GALBP : In the literature, all problem types which generalize or remove some assumptions of SALBP are called generalized assembly line balancing problems (GALBP). This class of problems (including UALBP and MALBP) is very large and contains all problem extensions that might be relevant in practice including equipment selection, processing alternatives, assignment restrictions etc. (for a survey see Becker and Scholl, 2006).

3.2.1MALBP and MSP : Mixed model assembly lines produce several models of a basic product in an intermixed sequence. Besides the mixed model assembly line balancing problem (MALBP), which has to assign tasks to stations considering the different task times for the different models and find a number of stations and a cycle time as well as a line balance such that a capacity- or even cost-oriented objective is optimized (cf. Scholl, 1999, chapter 3.2.2). However, the problem is more difficult than in the single-model case, because the station times of the different models have to be smoothed for each station (*horizontal balancing*; cf. Merengo et al., 1999). The better this horizontal balancing works, the better solutions are possible in the connected short-term *mixed model sequencing problem* (MSP). MSP has to find a sequence of all model units to be produced such that inefficiencies (work overload, line stoppage, off-line repair etc.) are minimized. (e.g. Bard et al., 1992 and Scholl et al., 1998)

3.2.2 UALBP : The U-line balancing problem (UALBP) considers the case of U-shaped (single product) assembly lines, where stations are arranged within a narrow U. As a consequence, worker are allowed to work on either side of the U, i.e. on early and late tasks in the production process simultaneously. Therefore, modified precedence constraints have to be observed. By analogy with SALBP, different problem types can be distinguished. (cf. Miltenburg and Wijngaard, 1994; Urban , 1998; Scholl and Klein,1999; Erel et al., 2001)

IV. METHODOLOGY

In this case data is taking from a research paper

Table No.:4.1 Data from given data in reference paper

Work station	**Task time** (T_E)	**Efficiency %**	$(T_C - T_E)$	$(T_C - T_E)2$
1	82	50	80	6400
2	34	20	128	16384
3	8	4	154	23716

4	11	6	151	22801
5	22	13	140	19600
6	11	6	151	22801
7	9	5	153	23409
8	30	18	132	17424
9	13	8	149	22201
10	38	23	124	15376
11	24	14.8	138	19044
12	24	14.8	138	19044
13	20	12.3	142	20164
14	10	6	152	23104
15	18	11.1	144	20736
16	10	6	152	23104
17	16	9.8	146	21315
18	37	22.8	125	15625
19	34	20.9	128	16384
20	23	14.1	145	21025
21	32	19.7	130	16900
22	16	9.8	146	21316
23	29	17.9	133	17689
24	47	29	115	13225
25	7	4	155	24025
26	9	5	153	23409
27	36	22	126	15876
28	10	6	152	23104
29	17	10.4	145	21025
30	22	13.5	140	19600

31	9	5	153	23409
32	38	23.4	124	15376
33	8	4	154	23716
34	11	6.7	151	22801
35	18	11.1	144	20736
36	31	19.1	131	17161
37	10	6	152	23104
38	10	6	152	23104
39	15	9.2	147	21609
40	29	17.9	133	17689
41	34	20.9	128	16384
42	26	16	136	18496
43	16	9.8	146	21316
44	12	7.4	150	22500
45	13	8	149	22201
46	10	6	152	23104
47	19	11.1	143	20449
48	10	6	152	23104
49	51	31	111	12321
50	9	5	153	23409
51	69	42.5	93	8649
52	53	32.7	109	11881
53	6	3.7	156	24336
54	25	15.4	137	18769
55	15	9.2	147	21609
56	15	9.2	147	21609
57	26	16	136	18496

58	25	15.4	137	18769
59	10	6	152	23104
60	20	12.3	142	23164
61	6	3.7	146	24336
62	14	8.6	148	21904
63	14	8.6	148	21904
64	28	45	134	17956
65	38	23.4	124	15376
66	24	14.8	138	19044
67	15	9.2	147	21609
68	18	11.1	144	20736
69	156	96	6	36
70	162	100	0	0

V. RESULTS

5.1 Result from current method:

Table No.5.1 Result from given data

S. No.	Description	Current method
1	Cycle time	162 Sec
2	Efficiency	15.9%
3	No. of work station	70
4	No. of operation	70
5	Smoothness index	19.3
6	Delay period	84%

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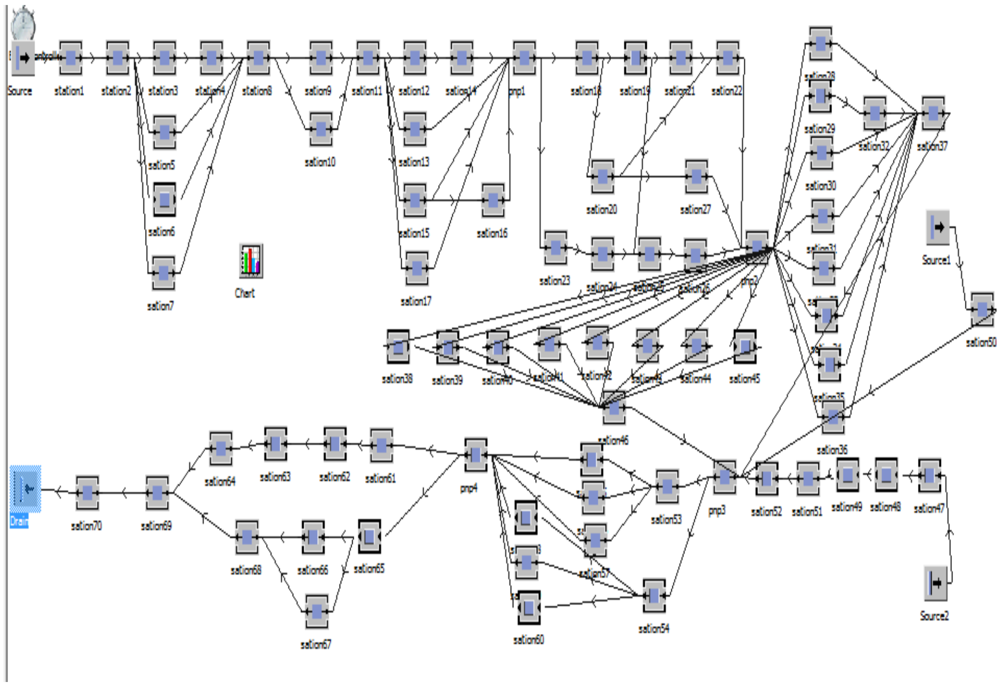
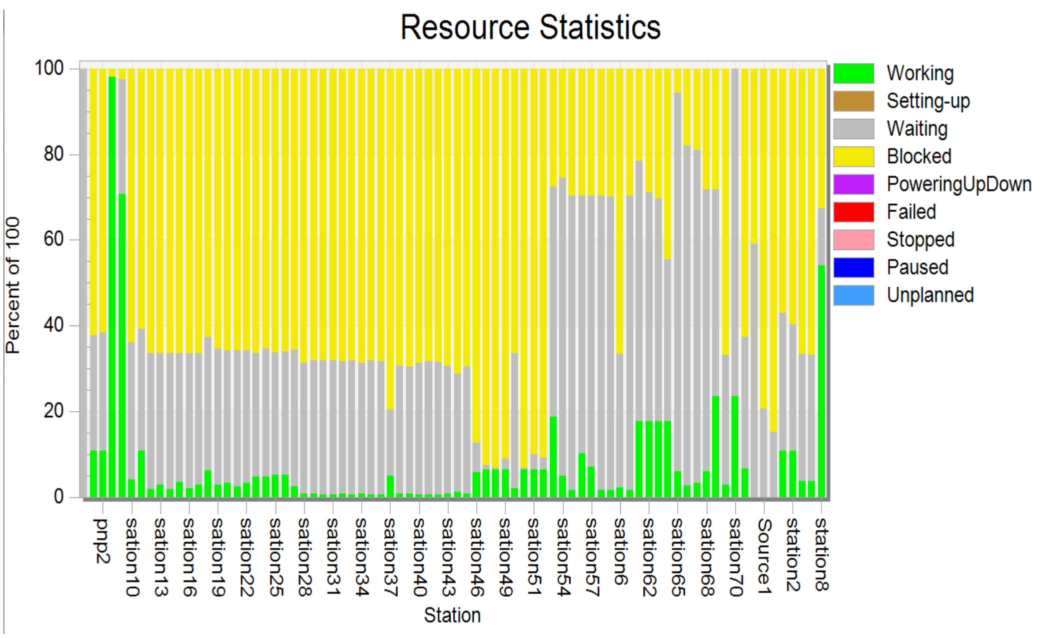
5.1.1 Simulation results for current method





Mean Exit Time	Throughput per Hour	Throughput per Day
3:14.4000	14.269536	342.46886

Fig.5.1

5.2 Solution:

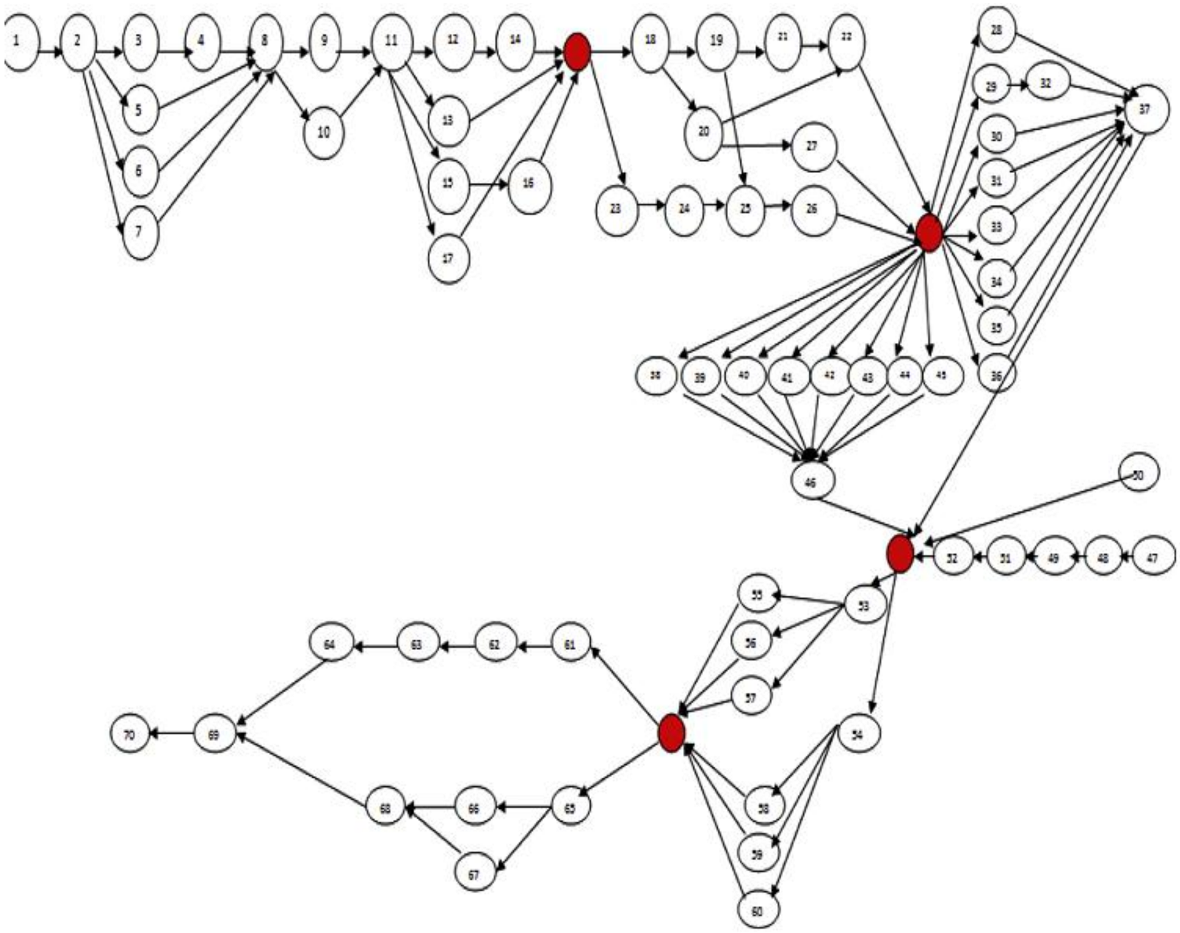


Fig.5.2 Precedence diagram for RPW Method

5.2.1 Ranked Positional Weight Method (RPW):

Step 1. Calculate the RPWfor each element by summing the elements Te together with the Te values for allthe elements that follow it in the arrow chain of the precedence diagram.

Step 2 List the elements in the order of their RPW, largest RPW at the top of the list. For convenience,include the Te value and immediate predecessors for each element.

Step 3. Assign elements to stations according to RPW, avoiding precedence constraint and time cycle violations.

Table No.5.2 for given data by RPW Method
(Cycle time 162 Sec)

Work station	Cycle time	Efficiency %	$(T_C - T_E)$	$(T_C - T_E)2$
1	157	96	5	25
2	159	98	3	9
3	64	39	98	9604
4	162	100	0	0
5	108	66	54	2916
6	88	54	74	5476
7	77	47	85	7225
8	77	47	85	7225
9	97	59	65	4225
10	149	91	13	169
11	53	32	111	12321
12	9	5	153	23409
13	142	87	20	400
14	147	87	17	289
15	156	96	6	36
16	162	100	0	0

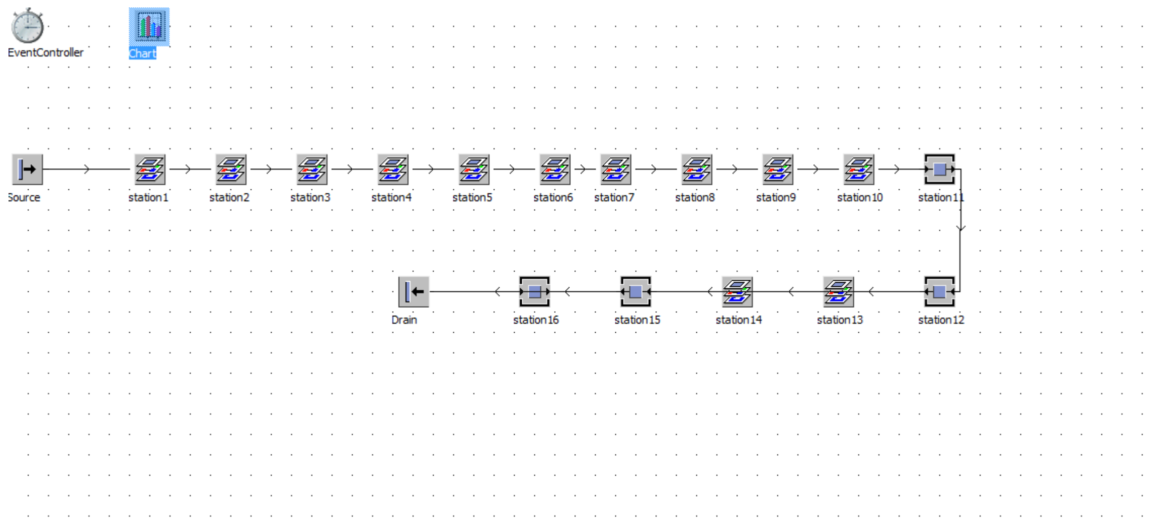
.2.2 Results from RPW Method

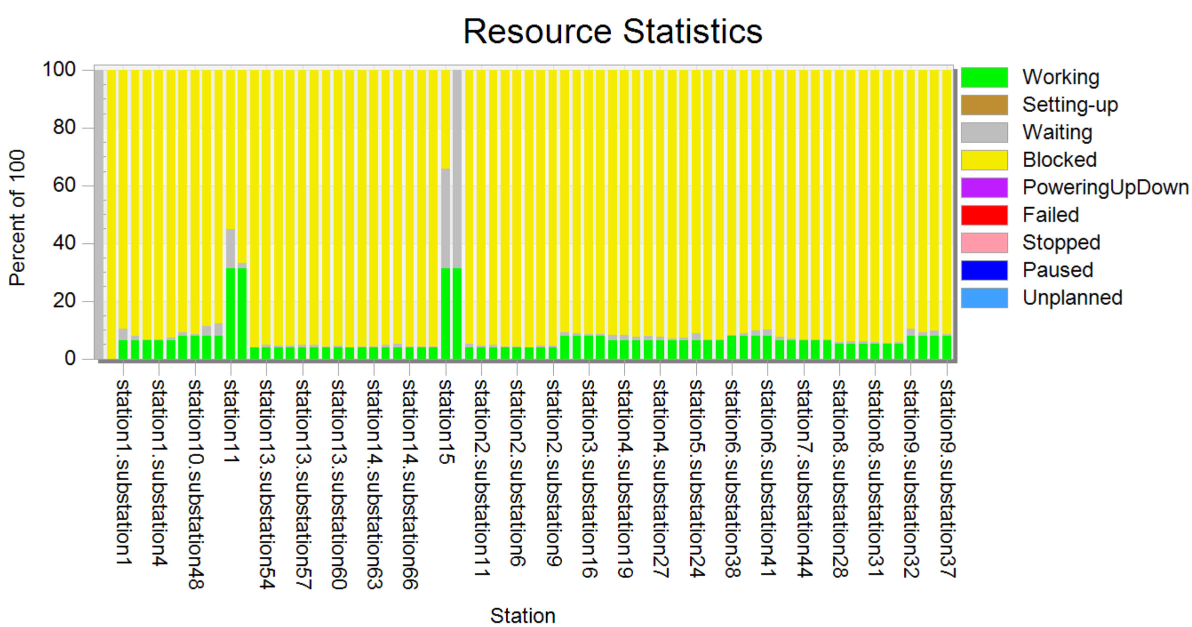
Table No.5.3 Result from RPW Method

S. No.	Description	RPW method
1	Cycle time	162 Sec
2	Efficiency	69%
3	No. of work station	16
4	No. of operation	70

5	Smoothness index	4.5
6	Delay period	31%

5.2.3 Simulation results for RPW Method:





Mean Exit Time	Throughput per Hour	Throughput per Day
3:11.4545	18.803281	451.27874

Fig. 5.3

5.3 Comparison of results between given data from reference paper and RPW Method

Table No.5.4 Comparison between present method and RPW Method

S No.	Description	Present Method	RPW Method
1	Cycle time	162	162
2	Line efficiency	15.9	69
3	No. of work station	70	16
4	No. of operation	70	70
5	Delay period	84%	31
6	Smoothness index	19.3	4.5

VI. CONCLUSION

- This research work totally based on TYPE-1 problem in which cycle time will constant and workstation may vary.
- All the calculations made on both data's and results took in the form of EFFICIENCY,DELAY PERIOD and SMOOTHNESS INDEX.
- A simulation software named "PLANT SIMULATION" is also used to visualize whole process of Assembly Line in practical manner which cross check mathematical calculation too.
- In this case data have taken from research paper and RPW method apply on that data for comparison
- In last results come out is that RPW method is more efficient than all of other methods.

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