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A Study Review of Completion Multi Job on Job Shop Scheduling Technique To Minimize Make Span

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Abstract

In this paper, the development of flexibility job shop scheduling problem was many discussed before globally. The concept job shop scheduling had discussion like minimize total make span, throughput approaching, lot streaming, no-wait job shop, and many more. Also, into job shop scheduling always consider deadline or due date for job load into machine available with target at the end how to optimize machine capacity and minimum make span.

Keywords : Scheduling problem, job shop, setup time, process time, make span, flow time.

1. Introduction

Production scheduling is one of critical point on production management. Many cases job-shop scheduling already known as NP problem type (Mohan et al, 2019). Most of previous cases discussed about job-shop scheduling problem is happen when all machine is real on job shop layout like similar machine installed into same location/area with variance product, machine and not uniform for setup and running time when load on different machine for different product. From others point of view also discuss about un schedule break down machine, absenteeism of workers, etc. A lot of constraint can be discussion was affects into how to solve job shop scheduling problem. Because of that job shop scheduling problem become one of critical point for production schedule topic for research.

At present research, since technology and timeline that is two components was influence to industry performance to meet their target, to speed up problem solving some researcher was implement-

ed simulation with computer base to find optimize solution for job shop scheduling problem. (Alli & Ph, 1989) talked about algorithm scheduling on N job / M machine with heuristic technique. Fuzzy flexible job shop scheduling problem with a hybrid multi-verse optimize by (J. Lin, Zhu, & Wang, 2019). By increasing demand that made industry have to do flexibility and consider many constraints facing without fail minimize total flow time (*ASchauer2018.pdf*, n.d.), (Deng, Zhang, Jiang, & Zhang, 2019).
(Benttaleb, Hnaien, & Yalaoui, 2018), was consider a two-machine on job-shop scheduling problem were one machine is assumed unavailable during production run. In (Deng et al., 2019), tried to solve job-shop scheduling problem through no-wait job to minimize total flow time.

2. Description of Job shop Production

Comparison volume and variance within industrial, production systems can be classified as job shop, batch, mass and continuous production systems.

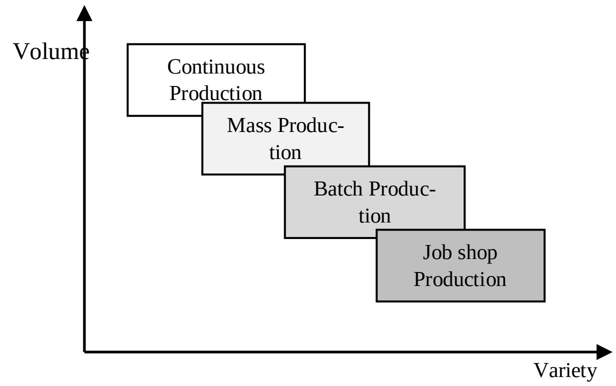

Fig. 1. Production Systems Classification

Job shop production are characterized by manufacturing of one or few quantities of products designed and produced as per the specification of customers within prefixed time and cost. The distinguishing feature of this is low volume and high variety of products. A job shop comprises of general-purpose machines arranged into different departments. Each job demands unique technological requirements, demands processing on machines in a certain sequence.

The Job-shop production system is followed when there is:

a. High variety of products and low volume.
b. Use of general-purpose machines and facilities.

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c. Highly skilled operators who can take up each job as a challenge because of uniqueness.
d. Large inventory of materials, tools, parts.
e. Detailed planning is essential for sequencing the requirements of each product, capacities for each work center and order priorities.

3. Minimize Flow Time

Large product varieties, awareness to improve product quality and need for shorter production time is necessitate an integrated procuring, production and delivery system as a whole. To maintain and improve the market share, manufacturing/service systems must respond by delivery required products at right points in time, while early completion of jobs is not desirable in delivery when jobs have to be despatched together (Kumar & Iyer, 2006). This research talked about minimizing total absolute differences of completion times (TADC) of jobs and mean flowtime studied. In that studied discuss previous job shop problem was highlighted by Lawrence (1984) about schedule a 20-jobs on five machines.

Table 1. Lawrence problem – 20 jobs, 5 machines

Jobs	Machine sequence Operations					Processing time Operations				
	1	2	3	4	5	1	2	3	4	5
1	2	1	0	3	4	34	21	53	55	95
2	0	3	1	4	2	21	52	71	16	26
3	0	1	2	4	3	12	42	31	98	39
4	2	3	4	0	1	66	77	79	55	77
5	0	4	3	1	2	83	37	34	19	64
6	4	2	0	3	1	79	43	92	62	54
7	0	4	2	1	3	93	77	87	87	69
8	4	3	1	2	0	83	24	41	38	60
9	4	1	0	2	3	25	49	44	98	17
10	0	1	2	4	3	96	75	43	77	79
11	0	3	1	4	2	95	76	7	28	35
12	4	2	0	1	3	10	95	61	9	35
13	1	2	4	0	3	91	59	59	46	16
14	2	1	4	0	3	27	52	43	28	50
15	4	0	3	2	1	9	87	41	39	45
16	1	0	4	3	2	54	20	43	14	71
17	4	1	3	0	2	33	28	26	78	37
18	1	0	2	3	4	89	33	8	66	42
19	4	0	2	1	3	84	69	94	74	27
20	4	2	1	3	0	81	45	78	69	96

The result research can be shown as below:

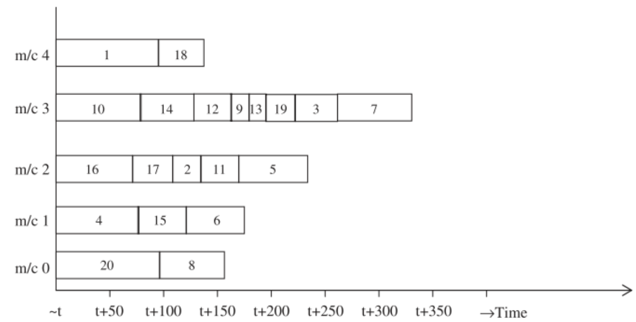

Fig. 1. Schedule representative the sequences of jobs on each machine for the minimum TADC

Then by the calculation mean completion time $\overline{M}$ for various machines as follow:

$\overline{M_0}$ = (2t + 96 + 156) / 2 = t + 126

$\overline{M_1}$ = (3t + 77 + 122 + 176) / 3 = t + 125

$\overline{M_2}$ = (5t + 71 + 108 + 134 + 169 + 233) / 5
= t + 143

$\overline{M_3}$ = (8t + 79 + 129 + 164 + 181 + 197 + 224 +

263 + 332) / 8 = t + 196.125

$\overline{M_4}$ = (2t + 95 + 137) / 2 = t + 116

From that observed that machine #3 has the largest value of mean completion time. The purpose of calculation for minimum value of TADC is obtained by scheduling the last operations of all jobs on other machines (Machine #0, #1, #2 and #4) as close as possible to the mean completion time of jobs on machine #3. This is required by shifting the jobs on machine #0, #1, #2 and #4 to the right, as per fig. 2.

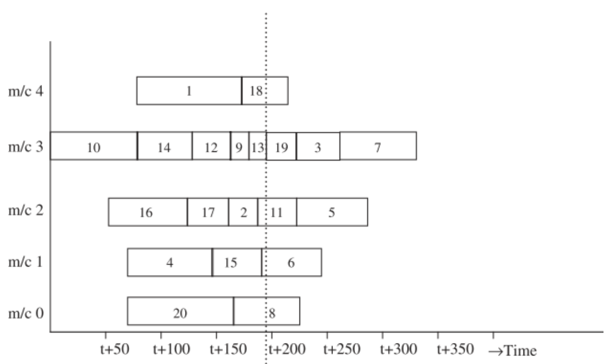

Fig. 2. Schedule for calculation of minimum TADC

The problem of minimizing mean flow-time subject to minimum TADC also did backward scheduling approaching using simulate annealing algorithm, but again this method only talked how to minimum gap completion all job since customers wants those job will deliver together not discuss how to shorter make span for delivery is self.

In (Lee, 2014) also mentioned when a company produces make-to-order products, delivering orders on time is regarded as an essential capability that the company must possess. However, on time delivery is difficult to achieve in today's dynamic business environment. Also, (Kumar & Iyer, 2006) in theirs research said the completion time variance problem is proved to be NP hard problem even in single machine.

Considering setup times separate from processing times of the jobs forms another important class of scheduling problem. This is particularly important when the ration of the setup time to the processing time is non-negligible. When setup times are considered separate from processing times, the completion time of a job may be reduced since the setup time of the jobs on a sub-sequent machine may be performed while it is idle. This reduction in completion time will not be realized when setup times are considered as part of processing times (Aldowaisan & Allahverdi, 1998),

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(Wang & Cheng, 2005). Formulation for no-wait two-machine flow shop, the completion time can be defined as follow:

$$C_{[1]} = \max\{s_{[1],1} + t_{[1],1}, s_{[1],2}\} + t_{[1],2}, \quad (1)$$

$$C_{[2]} = \max\{C_{[1]} + s_{[2],2}, + C_{[1]} - t_{[1],2} + s_{[2],1} + t_{[2],1}\} + t_{[2],2}, \quad (2)$$

$$C_{[3]} = \max\{C_{[2]} + s_{[3],2}, + C_{[2]} - t_{[2],2} + s_{[3],1} + t_{[3],1}\} + t_{[3],2}, \quad (3)$$

In general

$$\boldsymbol{C_{[j]} = \max\{C_{[j-1]} + s_{[j],2}, + C_{[j-1]} - t_{[j-1],2} + s_{[j],1} + t_{[j],1}\} + t_{[j],2}}, \quad (4)$$

Where $C_{[0]} = t_{[0],2} = 0$

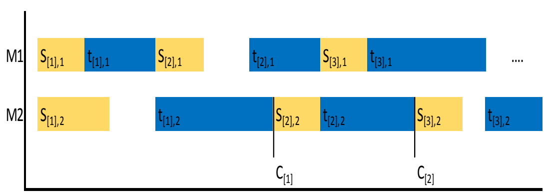

Fig. 2 Graphical Illustration of Completion Times for two-machine

No-wait flow shop production has been widely applied in manufacturing where no waiting time is allowed between intermediate operation. Make span or maximum completion time is defined as the completion of the last job on the last machine which reflect the utilization of the facility. Minimization of make span, min (C_{max}) is one of the most meaningful objectives for no-wait flow shop production (Ye, Li, & Abedini, 2017).

(C. Lin & Liao, 2004), consider a scheduling problem that assign *n* available and independent jobs to *m* identical parallel machine. They experiment consider three factors there is *m*, *n* and *p*. The number of machine *m* is 3, 4, 5 and 6. The number of jobs *n* is 10, 15, 20, 25, 30, 40, 50, 100, 500 and 1000. The processing time *p* are randomly generated from a uniform distribution over [1,*b*], *b* = 25, 50, 100. Optimal solution come from large-job sized that is *n* = 100, 500, 1000.

The objective of scheduling to the minimize total flowtime is a significant objective in many real-life situations, especially with respect to the minimization of inventory or holding costs and is more important objective than that of minimizing makespan. Likewise, the objective of scheduling to minimize total tardiness of jobs, because tardiness may result in the contractual penalty of be late the delivery and loss of customer goodwill then need respect to real-life and consider (Rajendran & Ziegler, 1999). Another researcher was raised to minimize total flowtime through combine the two areas of "scheduling a maintenance activity" and "batch scheduling". The objective is consider maintenance activity will improves of machine performance and then the processing time of the jobs schedule after the maintenance are reduced (Mor & Mosheiov, 2014).

(Wang & Cheng, 2005), discuss about minimize flowtime at single machine which delivery date fixed and set before the job processed. A job delivery is delivered on the earliest fixed delivery date but not earlier than completion time. Minimization of makespan and minimization of flowtime are two fundamental criteria in flow shop scheduling, because many other performance measures are derived out from them, such as improving utilization of production lines, meeting due date, reducing lateness or earliness, reducing work-in-process inventories, smoothing material flows in supply chain, etc (Pontevedra, Santana, Afonso, Zanin, & Wernke, 2018).

In a complex job shop system, batch size can be a crucial role and have significant impact on the throughput (Golmohammadi, 2015).

4. Optimization Methods

To get optimal solution by transforming the production scheduling problem many research has taken for optimization models of target function. The approximate methods for optimization are *rule of priority assignment, expert system, simulation method, neural network, tabu search algorithm, genetic algorithm, simulated annealing algorithm, ant colony optimization algorithm, particle warm optimization, immune algorithm, multi-agent method, fuzzy logic* and *hybrid optimization scheduling method* (*Jatoth2019.pdf*, n.d.)

5. Conclusion

A major research has mentioned mostly scheduling problem are already proved NP problem. More in dynamics job shop environments and various real time events, production scheduling become importance for the successful implementation of real problem in manufacturing system. To help and get faster result for model has builds with many constraint and consideration for affect into scheduling problem then optimization need to be taken following model. Which model approach to the problem can be apply based on situation.

6. References

Aldowaisan, T., & Allahverdi, A. (1998). *TOTAL FLOWTIME IN NO-WAIT FLOWSHOPS WITH SEPARATED SETUP TIMES*. *25*(9).

Alli, A. M., & Ph, D. (1989). *Computers ind. Engng*. *17*, 359–365.

ASchauer2018.pdf. (n.d.).

Benttaleb, M., Hnaien, F., & Yalaoui, F. (2018). Two-machine job shop problem under availability constraints on one machine: Makespan minimization. *Computers and Industrial Engineering*, *117*, 138–151. https://doi.org/10.1016/j.cie.2018.01.028

Deng, G., Zhang, Z., Jiang, T., & Zhang, S. (2019). Total flow time minimization in no-wait job shop using a hybrid discrete group search optimizer. *Applied Soft Computing Journal*, *81*, 105480. https://doi.org/10.1016/j.asoc.2019.05.007

Golmohammadi, D. (2015). A study of scheduling under the theory of constraints. *International Journal of Production Economics*, *165*, 38–50. https://doi.org/10.1016/j.ijpe.2015.03.015

Jatoth2019.pdf. (n.d.).

Kumar, V., & Iyer, A. (2006). *Scheduling in static jobshops for minimizing mean flowtime subject to minimum total deviation of job completion times*. *103*, 633–647. https://doi.org/10.1016/j.ijpe.2005.12.004

Lee, G. (2014). Real-time order flowtime estimation methods for two-stage hybrid flowshops. *Omega*, *42*(1), 1–8. https://doi.org/10.1016/j.omega.2013.02.004

Lin, C., & Liao, C. (2004). *Makespan minimization subject to owtime optimality on identical parallel machines*. *31*, 1655–1666. https://doi.org/10.1016/S0305-0548(03)00113-8

Lin, J., Zhu, L., & Wang, Z. J. (2019). A hybrid multi-verse optimization for the fuzzy flexible job-shop scheduling problem. *Computers and Industrial Engineering*, *127*(November), 1089–1100. https://doi.org/10.1016/j.cie.2018.11.046

Mor, B., & Mosheiov, G. (2014). Int . J . Production Economics Batch scheduling with a rate-modifying maintenance activity to minimize total fl owtime. *Intern. Journal of Production Economics*, *153*, 238–242. https://doi.org/10.1016/j.ijpe.2014.03.004

Pontevedra, V., Santana, A., Afonso, P., Zanin, A., & Wernke, R. (2018). ScienceDirect ScienceDirect ScienceDirect ScienceDirect An efficient constructive heuristic to balance trade-offs between An efficient constructive heuristic to balance trade-offs between makespan and flowtime in permutation flow shop scheduling makespan . *Procedia Manufacturing*, *26*, 40–48. https://doi.org/10.1016/j.promfg.2018.07.005

Rajendran, C., & Ziegler, H. (1999). *Heuristics for scheduling in ¯owshops and ¯owline-based manufacturing cells to minimize the sum of weighted ¯owtime and weighted tardiness of jobs*. *37*, 671–690.

Sun, C. H. (2017). Timing of entry and product location in a linear barbell model: Application to flexible manufacturing systems. *International Review of Economics and Finance*, *52*(June), 29–38. https://doi.org/10.1016/j.iref.2017.09.004

Wang, X., & Cheng, T. C. E. (2005). *Two-machine owshop scheduling with job class setups to minimize total owtime*. *32*, 2751–2770. https://doi.org/10.1016/j.cor.2004.04.002

Ye, H., Li, W., & Abedini, A. (2017). An improved heuristic for no-wait flow shop to minimize makespan. *Journal of Manufacturing Systems*, *44*, 273–279. https://doi.org/10.1016/j.jmsy.2017.04.007