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SCHEDULING OF UNCERTAINTY UNDER VARIOUS PARAMETERS INCLUDING WEIGHTAGE OF JOBS

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ABSTRACT

The objective of this paper pertains to determine an optimal or near optimal sequence for n-jobs flow shop problem which associates 'weight' with a job in the sense of relative importance in the process and includes job block, transportation time and break-down machine time to minimize the total weighted mean flow time. The processing time of jobs are considered in fuzzy environment.

Key word: *Job block; weightage of job; break down; transportation time; optimal sequence.*

1. INTRODUCTION

Flow shop scheduling deals with determination of optimal sequence of jobs which is to be processed on some machines in a fixed order so that it satisfies certain scheduling criteria. Scheduling is an important tool in production management. It is useful in increasing the rate of production, improving the quality of products, fulfilling the demands of the market in time and to minimize the flow time or cost etc. Various researchers [2, 5, 4] (Johnson, Jackson, Miyazaki, Maggu & Dass,) studied various scheduling models under different permutations, combinations and arguments. Various concepts as transportation time, relative importance of a job over another jobs; break down in machine times and job block criteria in scheduling, making the problem wider & significant. Many applications namely avionic, traffic control, automatic factories and the military system require scheduling. Nonetheless, scheduling is more significant both in fuzzy and non fuzzy environment. In non fuzzy situation, jobs have to be performed correctly and in a timely fashion as well. Jobs are classified as periodic and non periodic. The execution request of a non fuzzy environment scheduling repeatedly occur at regular interval. On the contrary, the execution request of jobs in fuzzy environment is unpredictable. Zadeh L.A. [6] in 1975 studied fuzzy logic and approximate reasoning.

Problem discussed here is wider and practically more applicable and has significant use of theoretical results in process industries or in situations where weightage in jobs become significant due to quality maintains. The concept of job block has many applications in production situation where the priority of one job over the other is taken in to account as it may raise an additional cost for providing this facility. It is also useful when service is done in batches in industry or in a service system. This paper gives a general case considering for n stage flow shop scheduling. Various constraints along with weightage of jobs have been considered under fuzzy environment making the problem wider and general. The algorithm has been mentioned for m stage scheduling and a numerical illustration has been demonstrated.

2. ALGORITHM

Step1. Find <AHR> of the fuzzy processing time of each job.

Step2. Modify the problem in two fictitious machines G_i and H_i as

$$G_i = A_i + t_i + B_i + g_i + C_i + h_i \qquad H_i = t_i + B_i + g_i + C_i + h_i + D_i$$

Step3. Find min (G_i, H_i)

(a) If min (G_i, H_i) = G_i then define
$G_i' = G_i - w_i$ and $H_i' = H_i$

(b) If min (G_i, H_i) = H_i then define
$G_i' = G_i$ and $H_i' = H_i + w_{ij}$

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Step4. Define a new reduced problem as $G''_i = \frac{G'_i}{w_i}$ and $H''i = \frac{H'_i}{w_i}$

Take equivalent job block β (l, m) and calculate the processing time of β (l, m) on G & H using equivalent job block theorem given by Maggu and Dass (1977) as

$G''_\beta = G''_{il} + G''_{im} - \min (H''_{il}, G''_{im})$

$H''_\beta = H''_{il} + H''_{im} - \min (H''_{l,i} G''_{im})$.

Step5. Determine the optimal sequence by using Johnson's algorithm for the new reduced problem obtained and see the effect of break down interval (a, b) on all the jobs.

Step6. Taking the optimal sequence formulate the new problem with the processing time A', B' and C'

where
A' = A + (b-a) B' = B + (b-a) & C' = C + (b-a), if (a, b) has effect on the job

Otherwise A' = A B' = B & C' = C if (a, b) has no effect on the job.

Step7. Calculate the weighted mean flow time and the make span of the jobs.

3. NUMERICAL PROBLEM

Consider 5 jobs and 4 machines flow shop scheduling problem whose processing time is given in fuzzy environment. β = (2,4) is job block, 30-50 is the break down interval, t_i g_i and h_i represent the transportation time and w_i represent the weight age of the jobs as in table 3.1. Our aim is to optimize the make span and to find the mean flow time of the machines.

Job	M_1	t_i	M_2	g_i	M_3	h_i	M_4	w_i
1	(10,11,15)	1	(5,7,9)	3	(3,4,6)	4	(2,4,6)	2
2	(12,14,16)	2	(4,6,7)	2	(5,6,8)	5	(1,2,4)	4
3	(8,9,12)	3	(2,3,4)	2	(4,5,7)	3	(1,3,7)	1
4	(5,6,8)	4	(4,6,7)	1	(3,5,6)	1	(3,5,6)	5
5	(8,9,11)	4	(2,4,7)	5	(5,7,9)	2	(5,7,8)	3

Table 3.1

Solution: As per step1of algorithm finding < A H R> of processing time of all the jobs

Job	A_i	t_i	B_i	g_i	C_i	h_i	D_i	w_i
1	$\frac{38}{3}$	1	$\frac{25}{3}$	3	$\frac{15}{3}$	4	$\frac{16}{3}$	2
2	$\frac{46}{3}$	2	$\frac{21}{3}$	2	$\frac{21}{3}$	5	$\frac{9}{3}$	4
3	$\frac{31}{3}$	3	$\frac{11}{3}$	2	$\frac{18}{3}$	3	$\frac{15}{3}$	1
4	$\frac{21}{3}$	4	$\frac{21}{3}$	1	$\frac{18}{3}$	1	$\frac{18}{3}$	5
5	$\frac{30}{3}$	4	$\frac{17}{3}$	5	$\frac{25}{3}$	2	$\frac{24}{3}$	3

Table: 3.2

As per step 2, 3 & 4, we have

Job	G_i''	H_i''
1	17	14.3
2	9.6	7.5
3	27	22.7
4	5.2	6
5	11.7	11.7

Table: 3.3

Job	G_i''	H_i''
1	17	14.3
β	9.6	8.3
3	27	22.7
5	11.7	11.7

Table: 3.4

Using Johnson rule we have 5, 3, 1, β i.e. 5, 3,1,2,4 is an optimal sequence.

Taking this optimal sequence the flow time of jobs on machines is as in table 3.5

Job	A	B	C	D	w_i
5	$0-\frac{30}{3}$	$\frac{42}{3}-\frac{59}{3}$	$\frac{74}{3}-\frac{99}{3}$	$\frac{105}{3}-\frac{129}{3}$	3
3	$\frac{30}{3}-\frac{61}{3}$	$\frac{70}{3}-\frac{81}{3}$	$\frac{99}{3}-\frac{117}{3}$	$\frac{129}{3}-\frac{144}{3}$	1
1	$\frac{61}{3}-\frac{99}{3}$	$\frac{102}{3}-\frac{127}{3}$	$\frac{136}{3}-\frac{151}{3}$	$\frac{163}{3}-\frac{179}{3}$	2
2	$\frac{99}{3}-\frac{145}{3}$	$\frac{151}{3}-\frac{172}{3}$	$\frac{178}{3}-\frac{199}{3}$	$\frac{214}{3}-\frac{223}{3}$	4
4	$\frac{145}{3}-\frac{166}{3}$	$\frac{178}{3}-\frac{199}{3}$	$\frac{202}{3}-\frac{220}{3}$	$\frac{223}{3}-\frac{241}{3}$	5

Table: 3.5

Due to the effect of break down interval 30-50, problem will reduce in table 3.5

Job	A_i	t_i	B_i	g_i	C_i	h_i	D_i	w_i
1	$\frac{98}{3}$	1	$\frac{85}{3}$	3	$\frac{75}{3}$	4	$\frac{16}{3}$	2
2	$\frac{106}{3}$	2	$\frac{21}{3}$	2	$\frac{21}{3}$	5	$\frac{9}{3}$	4
3	$\frac{31}{3}$	3	$\frac{11}{3}$	2	$\frac{78}{3}$	3	$\frac{75}{3}$	1
4	$\frac{81}{3}$	4	$\frac{21}{3}$	1	$\frac{18}{3}$	1	$\frac{18}{3}$	5
5	$\frac{30}{3}$	4	$\frac{17}{3}$	5	$\frac{85}{3}$	2	$\frac{84}{3}$	3

Table: 3.5

According to the step 7 of the algorithm the processing schedule of the jobs to calculate the make span and the weighted mean flow time are given as

Job	A	B	C	D	w_i
5	$0-\frac{30}{3}$	$\frac{42}{3}-\frac{59}{3}$	$\frac{74}{3}-\frac{159}{3}$	$\frac{165}{3}-\frac{249}{3}$	3

3	$\frac{30}{3}-\frac{61}{3}$	$\frac{70}{3}-\frac{81}{3}$	$\frac{159}{3}-\frac{237}{3}$	$\frac{249}{3}-\frac{324}{3}$	1
1	$\frac{61}{3}-\frac{159}{3}$	$\frac{162}{3}-\frac{247}{3}$	$\frac{256}{3}-\frac{331}{3}$	$\frac{343}{3}-\frac{359}{3}$	2
2	$\frac{159}{3}-\frac{265}{3}$	$\frac{271}{3}-\frac{292}{3}$	$\frac{331}{3}-\frac{352}{3}$	$\frac{367}{3}-\frac{376}{3}$	4
4	$\frac{265}{3}-\frac{346}{3}$	$\frac{358}{3}-\frac{379}{3}$	$\frac{382}{3}-\frac{400}{3}$	$\frac{403}{3}-\frac{421}{3}$	5

Table: 3.6

$$\text{Weighted Mean flow time} = \frac{\frac{249}{3}\times 3+\frac{294}{3}\times 1+\frac{298}{3}\times 2+\frac{217}{3}\times 4+\frac{156}{3}\times 5}{1+2+4+5+3} = 73$$

Total elapsed time = 140.3

CONCLUSIONS

This paper employs fuzzy numbers to describe uncertain processing times in n- machines flow shop problems. It is assumed that in the cases where there exist various sources and different types of uncertainty in a flow shop, which cause imprecise job processing times. Fuzzy mathematics is an appropriate tool to find an optimal job sequence. A new algorithm for determining optimal job sequence in the presence of uncertainty based on the well known Johnson algorithm is a modification of Average high ranking approach.

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