An Heuristic Approach N×3 Flow Shop Scheduling Problem In Which Processing Time Are Associated With Probabilities Including With Transportation Time And Job- Block Criteria

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Abstract- This paper is an attempt to study the nx3 flow shop scheduling problem, where processing time are associated with their respective probabilities including the job-block criteria and transportation time. The objective of the study is to get an algorithm to minimize the total elapsed time. The method is clarified with the help of numerical illustration.

Key Words- Flow shop scheduling, Processing time, Transportation time, Optimal sequence, Job-block.

I. Introduction

Flow shop scheduling problem concerned with the sequencing of jobs through a series of machine in exactly the same order with aim to optimized the objective. The research into flow shop problem has drawn a great attention in the decades with the aim to increase the effectiveness of industrial production. A vast amount of research about scheduling has been conducted during the past several decades by the academic community. Optimization algorithm for 2&3 machine flow shop problem in order to minimize the makespan, has been developed by Johnson(1954), Ignall and Schrage(1965), Combell(1970), Maggu and Das(1977), Yoshida and Hitomi(1979), Nawaz(1983), Bansal(1986), Sing T.P(1995), Narain and bagga(1998), Rajendran(2010), Gupta Deepak and Sharma Sameer(2011,2012).

Recently, Gupta Deepak and singla payal(2012) made to attempt to study constrained n-job, 3-machine flow shop scheduling problem with transportation time to minimize the total elapsed time under some special structure condition. The present paper is further an extension of the study made by Gupta Deepak and single payal (2012) in the sense here that it is now associated the probability with the processing time and further these concept of job block criteria has been included considered. Thus the study make here the concept of equivalent job for a job-block is meaning full when the situation of giving priority of one job over another aries, may be for the purpose of improving productivity of by virtue of some technology constrains. The problem is discussed here is wider and more applicable to practical situation.

II. Practical Situation

We consider and example of a book which we has to pass through three machine of composing, binding and printing. Here we suppose that these three machines are located at different situations to execute. Now we shall introduced respective probabilities and transportation time in the problem.

III. Notations

S :Sequences of jobs 1,2,3,…..,n

A_i :Processing time of job ith on machine A

B_i : Processing time of job ith on machine B

C_i : Processing time of job ith on machine C

P_i :probability associated to the processing time Ai of ith job on machine A

q_i :probability associated to the processing time Bi of ith job on machine B

r_i :probability associated to the processing time Ci of ith job on machine C

t_i :Transportation time of ith job from machine A to to machine B

g_i : Transportation time of ith job from machine B to C

β : Equivalent job for job block

IV. Problem Formulation

Let n jobs are to be processed on three machines A, B and C. Let A_i B_i and Ci (i=1,2,3,…….,n) be the processing time of each job on machine A,B and C respectively. Let ti and gi (i=1,2,3,….,n) be the job-block with transportation time of job i from machine A to machine B and machine C respectively. The mathematical model of the given problem in matix can be stated as:

Table 1

Jobs	Machine A			Machine B			Machine C	
i	a_i	p_i	t_i	b_i	q_i	g_i	c_i	r_i
1	a_1	p_1	t_1	b_1	q_1	g_1	c_1	r_1
2	a_2	p_2	t_2	b_2	q_2	g_2	c_2	r_2
3	a_3	p_3	t_3	b_3	q_3	g_3	c_3	r_3
4	a_4	p_4	t_4	b_4	q_4	g_4	c_4	r_4
5	a_5	p_5	t_5	b_5	q_5	g_5	c_5	r_5
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.	.	.	.	.	.	.	.	.
n	a_n	p_n	t_n	b_n	q_n	g_n	c_n	r_n

V. Algorithm

STEP 1: Define expected processing time A_i, B_i and C_i on machine on machine A, B and C respectively as follows:-

$A_i = a_i*p_i$

$B_i = b_i*q_i$

$C_i = c_i*r_i$

Step 2: Compute, the processing time by creating two fictitious machine G & H with their processing time G_i & H_i respectively as follows:-

$G_i = |A_i+B_i+t_i+g_i|$ and $Hi= |C_i+B_i+t_i+g_i|$

Either

$\min(A_i+t_i) \geq \max(B_i+t_i)$

if or

$\min(C_i+g_i) \geq \max(B_i+g_i)$

or

both

STEP 3: Take equivalent job β=(k,m) define processing time as follows.

(i) $G_\beta = G_k+G_m-\min(G_m,H_k)$

(ii) $H_\beta = H_k+H_m-\min(G_m,H_k)$

STEP 4: Define a new reduced problem with processing time A,B as defined in step1 & job(k,m) are replaced by single equivalent job β with processing time G_β & H_β as defined in step 3 above.

STEP 5: Apply johnson's(1954) technique and find an optimal schedule of given jobs.

STEP 6: Compute the in out table for the sequence in step 5.

VI. Numerical illustration

Let 5 jobs be processed on three machines A,B and C with processing time associated with their respective probabilities including transportation time .

Table 2

Jobs	Machine A			Machine B			Machine C	
	a_i	p_i	t_i	b_i	q_i	g_i	ci	ri
1	12	0.2	4	3	0.3	5	11	0.3
2	14	0.3	3	7	0.2	6	13	0.3
3	11	0.1	4	5	0.1	4	14	0.1
4	13	0.1	4	3	0.2	3	10	0.1
5	16	0.3	1	2	0.2	7	12	0.2

Our objective is to obtain a sequence of job which minimize the total elapsed time.

Solution:

Step 1: define expected processing time A_i,B_i&C_i on machine A,B andC respectively in table 3.

Table 3

Jobs	A_i	B_i	C_i
1	2.4	0.9	3.3
2	4.2	1.4	3.9
3	1.1	0.5	1.4
4	1.3	0.6	1.0
5	4.8	0.4	2.4

Step 2: Here $\min(A_i+t_i) > \max(B_i+t_i)$ is satisfies therefore. Let us create two fictitious machine G and H with their processing time Gi&Hi using $Gi=|A_i+B_i+t_i+g_i|$ and

$Hi=|C_i+B_I+t_i+g_i|$ as follows

Table 4

Jobs	Gi	Hi
1	12.3	13.2
2	14.6	14.3
3	9.6	9.9
4	8.6	8.6
5	13.2	10.8

Step 3: The corresponding processing time for β=(2,5) on machine Gi & H_i follows:

$G_\beta= G_k+G_m-\min(G_m,H_k)$

$=14.6+13.2-\min(13.2, 14.3)$

$=14.6+13.2-13.2$

$=14.6$

$H_\beta=H_k+H_m-\min(G_m,H_k)$

$=14.3+10.8-\min(13.2, 14.3)$

=14.3+10.8-13.2

=11.9

Step 4: Represent new reduced problem in table 4 with processing time as per step 2 & 3

Table 5

Job	G_i	H_i
1	12.3	13.2
ß	14.6	11.9
3	9.6	9.9
4	8.9	8.6

Step 5: on applying jhonson (1954) , technique the optimal schedule (3 ,1 , ß ,4)

i.e. 3,1,2,5,4.

Step 6: The optimal sequence (3, 1, 2, 5, 4) is the optimal schedule for the original problem.

Table 6

Jobs	Machine A	Machine B	Machine C
i	In-out	In-out	In-out
3	0-1.1	5.1-5.6	9.6-11.0
1	1.1-3.5	7.5-8.4	13.4-16.7
2	3.5-7.7	10.7-12.1	18.1-22.0
5	7.7-12.5	13.5-13.9	22.0-24.4
4	12.5-13.8	17.8-18.4	24.4-25.4

Total elapsed time=25.4.

VII. Conclusion

The study may further be extended by introducing different parameters such as setup time separated from their processing time,break down interval etc.

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