International Journal of Science, Engineering and Technology Research (IJSETR)
Volume 6, Issue 11, November 2017, ISSN: 2278 -7798

NEW METHOD FOR SOLVING SINGLE MACHINE SCHEDULING PROBLEM WITH FUZZY PROCESSING TIME AND DISTINCT DUE DATE

Abdelaziz Hamad, Ismail Abaker

Abstract: This paper was focused on the development of a new method base on moving average to solve single machine scheduling problem with fuzzy processing time and distinct due date. The concept of single machine with fuzzy processing time has been presented and a new method base on moving average to sequence the jobs on the single machine, so that the total penalty cost to be minimum has been proposed. This cost is composed of the total earliness and the total tardiness cost. The performance of the proposed the new method has been measured on numerical examples. This is the first time a moving average was use to resolve the problem and the results are very encouraging for further investigation.

Key Words: Single Machine, Fuzzy processing, Earliness and Tardiness, Distinct Due Date, Moving Average

I. INTRODUCTION

The study of earliness and tardiness penalty in scheduling is a relatively recent area of inquiry. For many years scheduling research focused on single performance measures .most of the literature deals with regular measure such as mean flow time, mean lateness percentage of jobs tardy mean tardiness and in deterministic time. But the environment in modern society is neither fixed nor probabilistic .So here we are considering fuzzy environment i.e. .the processing time of each job is in un deterministic environment. The time considered here is in three situations (a, b ,c)where a-in favorable (high)condition ,b-normal (medium)condition and c-worse (bad)conditions . Baker and Scudder (1990) Studied sequences with earliness and tardiness penalties in a JIT scheduling environment, jobs that complete early must be held in finished in good inventory until their due date. while jobs that complete after their due date may cause a customer to shut down operation .therefore an optimal schedule ,is one in which all jobs finish on their assigned due dates . This can be translated to scheduling objective in several ways .The most obvious objective is to minimize the deviation of job completion time around these due dates in non-deterministic time.

The concept of penalizing both earliness and tardiness has spawned anew and rapidly developing line of research in the scheduling field. Because the use of both earliness and tardiness penalties give rise to a non-regular performance measure, it has led to new methodological issues in the design of solution procedure.

In this paper we present special case of Early / Tardy (E/T) single machine schedule problem in a fuzzy environment and having distinct due dates and the earliness and tardiness are penalized at the rate fixed by demand maker for the jobs. In the next Section we introduce the concepts of single machine and the fuzzy processing time of the jobs. .The moving average method and the scheduling of some small systems are determined in Section after. An algorithm based on these arguments is developed and it is justified by a numerical examples.

II. SINGLE MACHINE

Now a day, in competitive and flexible market installing of machines is very expensive, as the technology changes very frequently and the out dated machines can not satisfy the demands of the modern market. Installing of more than one machines of the same type can speed up the work but needs more maintenance and supervision Also installation of machines demands for more space to install, which also increases the idle cost of the project. So reduce the expenditure, contractor wishes to process the work on a single machine using an intelligent scheduling system and for the small systems single machine maximizes the profit of whole the project. **I**

III. FUZZY PROCESSING TIME

The processing time of a job can vary in many ways, may be due to environmental factor or due to the different work places .We find that when a contractor takes the work from a department, he calculates total expenditure at the time of allotment. But due to many factors like non-available of labor ,weather not favorable ,or sometimes abnormal condition cost may vary .Hence due to these reasons work can be completed late and creates due date problem i.e. order cannot be delivered on time , on the other hand if the work completes before the due date time it arises the inventory problem. So to overcome these factors, the processing time of a job considered here is in three situations favorable (high), Normal (Medium) and worse (Bad) conditions. In this paper, a new concept of different processing time of each job is considered which helps the contractor to estimate the cost of the work at the time of allotment. Here also different due dates for each of the job be considered which meets the demand maker with more satisfaction level.

IV. ASSUMPTION AND NOTATION

The machine scheduling problem studied in this paper requires n independent jobs, j_i (i= 1, 2 , 3 , …….,n) to be processed on a single machine with the following assumptions:

(i) All jobs are available for processing at time zero

***Abdelaziz Hamad Elawad**,*
Department of Mathematics Faculty of Science, University Of Albaha.,Albaha , Suadi Arabia

Ismail Abaker,
PhD Student Department of Mathematic, Faculty of Applied and industrial Sciences, University of Bahri, Bahri , Sudan.

(ii) The single machine can process at most one job at a time
(iii) No pre-emption is allowed
Let S Schedule for the n jobs

< a, b , c > Processing time of job i on the machine in fuzzy environment.
M_i Moving average of the processing time
(a ,b , c) = {a+2b+c}/4
d_i Due date for the job i
c_i Completion time of job i
T_i Max.$(0 \ ,c_i - d_i)$
E_i Max $(0 \ , \ d_i - c_i)$
Sl_i Slack time of job i
α_i Penalty per unit tim for the earliness of job i
β_i Penalty per unit time for the tardiness of job i

An important special case in the family of earliness and tardiness problems involves minimizing the sum of absolute deviation of job completion time from a distinct due date having processing time in fuzzy environment. In particular, the objective function can be written as follows:

$$f(s) = \sum \alpha_i E_i + \beta_i T_i$$

When we write the objective function in the above form, it is clear that the earliness and tardiness are penalized at the rate α_i and β_i for all jobs. In this paper, processing time of the jobs considered are in triangular fuzzy that means at < a, b, c >

V. MOVING AVERAGE ALGORITHM

Step1: *Find Moving Average (MA) of the fuzzy processing time (a, b, c) of all The jobs.*
$M_i = |a + 2b + c|/4$

Step2: *Find the slack time of all the jobs*
$Sl_i = |M_i - d_i|$

Step3: *Arrange the jobs in increasing order of their slack time.*
If two jobs have the same Slack time then considers the jobs of the lowest processing time at the earlier position.

Step4:
Using the sequence obtained in step 3 find the total penalty of all the jobs using earliness α_i and β_i penalty cost .

VI. NUMERICAL EXAMPLES

EXAMPLE. 1

Table (1) shows a 5-jobs having fuzzy processing time, single machine and distinct due dates. Penalty cost α_i for earliness and β_i tardiness is also given. This example already solved by S. Gupta and M. Rambha (2011). They used average high ranking method and found that the sequence of schedule is 4-2-1-5-3 with total cost equal 237.67

In this example we use the same data and solve it by our algorithm so as to compare between two schedule solutions.

Table (1)

Job $_i$	P_i	<MA>	d_i	Sl_i	α_i	β_i
1	5 ,7 ,8	6.75	9	2.25	2	3
2	3 ,5 ,7	5	7	2	2	3
3	11,15,17	14.5	18	3.5	2	3
4	6 ,8 ,11	8.25	10	1.75	2	3
5	7 ,8 ,10	8.25	10	1.75	2	3

The Five jobs of Table .1, having fuzzy processing time (a, b, c) are converted first to moving average by using <MA> = $M_i = |a + 2b + c|/4$. After that we use the algorithm of **Section (V)**. Finally we found that sequence of the jobs are 4 - 5 - 2 - 1 – 3, with total cost equal 198.5 units, which is better than their cost. **Table .2** shows the sequence schedule of the jobs, the total flow time of the system and the total optimized penalty cost due to earliness/tardiness of the jobs.

Table .2

Seq.	p_i	c_i	d_i	c_i-d_i	α_i	β_i	cost
4	8.25	8.25	10	1.75	2	3	1.75*2=3.5
5	8.25	16.5	10	6.5	2	3	6.5*3=19.5
2	5	21.5	7	14.5	2	3	14.5*3=43.5
1	6.75	28.25	9	19.5	2	3	19.*3=58.5
3	14.5	42.75	18	24.5	2	3	24.5*3=73.5

EXAMPLE .2

Table .3 below shows a 10 jobs having fuzzy processing time, single machine, distinct due date and the Penalty cost α_i for earliness and β_i tardiness is also given. This example was already solved by E. Janaki and R. Vigithra (2015). By Average High Ranking (AHR) and they found that the total cost is equal 1219.66, with jobs sequence 1, 9, 4,3, 2, 10, 6, 8, 5, 7. We need to solve the same example by our algorithm so as to compare between two Schedule solutions.

Table. 3

Job_i	P_i	<MA>	d_i	Sl_i	α_i	β_i
1	3,4,5	4	5	1	2	3
2	8,10,12	10	7	3	2	3
3	5,6,8	6.25	10	3.6	2	3
4	8,9,11	9.25	12	2.6	2	3
5	11,12,15	12.5	8	4.5	2	3
6	7,9,11	9	15	6	2	3
7	5,7,9	7	17	10	2	3
8	12,14,15	13.75	10	3.6	2	3
9	5,7,8	6.75	6	0.6	2	3
10	6,8,10	8	14	6	2	3

The10 jobs having fuzzy processing time (a , b , c) are converted into moving average method by using, $M_i = |a + 2b + c|/4$, and as per algorithm mentioned in Section V we found that the optimal sequence is 9-1-4-2-3-8-5-10-6-

Table 4.

Seq.	p_i	C_i	d_i	$\lvert c_i - d_i \rvert$	α_i	β_i	cost
9	6.25	6.75	6	0.75	2	3	2.25
1	4	10.75	5	5.75	2	3	17.25
4	9.25	20	12	8	2	3	24
2	10	30	7	23	2	3	69
3	6.25	36.25	10	26.25	2	3	78.75
8	13.75	50	10	40	2	3	120
5	12.5	62.5	8	54.5	2	3	163.5
10	8	70.5	14	56.5	2	3	169.5
6	9	79.5	15	64.5	2	3	193.5
7	7	86.5	17	69.5	2	3	208.25

Table 4 shows the total flow time of the system and the total optimized penalty cost of the jobs, which equal **1046.25**. This is better than their cost

VII. CONCLUSION

The single machine with fuzzy processing time and distinct due dates has been studied. The objective was to find an optimal scheduling that minimizes a total cost function containing earliness and tardiness costs with penalties. We developed a moving average algorithm to solve this problem. It was found that our method of moving average gives an optimal solution. Further investigation can be carried out for multi machine system

REFERENCES

[1] Baker, k. s and G.D. Scudder (1990) "Sequencing with earliness and tardiness penalties A review- operation research, 38.22-36.

[2] Dueness, A. and, Petrivic (1995)," A New Approach to Multi-Objective Single Machine Scheduling problem under fuzziness ", CTAC School of math. and Information Sciences, Conventry U.K

[3] H. Ishii and M.Tada (1995), " Single Machine Scheduling with Fuzzy precedence relation". European Journal of operation Research,87,284-288.

[4] XIE Yuan et al. (2005), "Single Machine Scheduling with Fuzzy due dates and Fuzzy precedence" . Journal of Shanghai University (English Edition). Volume 9. Issue 5.

[5] J. K .Sharama 2007) ,Operations Research Theory and Applications. Macmillan India Ltd Third Edition

[6] Sunita Gupta M. M. G .I .Rambha (Kamal) (2011)," single machine scheduling with distinct due dates under fuzzy environment". International Journal of Enterprise computing and Business system. Volume 1, Issue 2.

[7] Vikas S.Jadhav and V.H.Bajaj (2012), single machine scheduling problem under fuzzy processing time and fuzzy due dates .International Journal of Computer Engineering Science, volumse2, Issue 5,12-19.

[8] Vikas S.Jadhav[1] and V.H.Bajaj[2] (2013)" Fuzzy Average High Ranking Method for Solving Single Machine Scheduling Problem. International Journal of Statistika and Mathematika. .Vol. 227-279

[9] E. Janaki and R.Vigithra (2015)" One –Machine Scheduling Problem with No Common Due Dates Under Fuzzy Environment". IOSR Journal of mathematics. Volume 11, Issue4 ver.111, 61-64

Abdelaziz Hamad Elawad
Associate Prof. of Mathematics,
Department of Mathematics Faculty of Science, University Of Albaha. Albaha , Saudi Arabia, PhD (2002) UTM, Malaysia, In scheduling and neural Networks. My Research Areas Neural Networks, Scheduling with due date and with Fuzzy and also area of Fluid Mechanics Forced KdV equations and any Equation produces Solitons Solutions.

Ismail Abaker,
PhD Student Department of Math. Faculty of Applied and industrial Science University of Bahri , Bahri ,Sudan.
This PhD research in scheduling with Fuzzy

.