RESEARCH ARTICLE OPEN ACCESS

Fuzzy Sequencing Problem on One Machine

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ABSTRACT
This paper is dealt with fuzzy sequencing problem on one machine where the processing time are represented by fuzzy technological values like triangular fuzzy numbers. The methodology involved was the fuzzy sequencing problem are defuzzified using ranking function by average method and hence solving the crisp sequencing problem by standard sequencing algorithm for obtaining the optimal sequence and minimum completion time in terms of fuzzy values. Finally, the illustrated examples with solutions are given.
Keywords: Fuzzy sequencing problem, Triangular fuzzy numbers, fuzzy arithmetic and ranking function.

Date Of Submission: 24-01-2019 Date Of Acceptance:08-02-2019

I. INTRODUCTION

Operations Research is a problem solving and decision making science. Modelling is the essence of operations research. Formulating a model help us to convert the complexities and uncertainties of decision making problem to a logical model which is open to formal analysis. It also involves the application of scientific tools for finding optimal solution to the problem involving the operations of the system.

A sequencing problem is to determine the optimal sequence in which 'n' jobs to be performed by 'm' machines and various optimality criteria like minimum elapsed time, minimum idle time, minimum inventory cost with the given conditions i) the order of the machine in which each job should be performed ii) the actual or expected time required by the jobs on each of the machine.

Sequencing have been most commonly encountered in production shops where different products are to be processed over various combinations of machines.

The complicated real life situations are defined in terms of impressions which was overcame by ZADEH with a powerful tool of fuzzy data. Thus fuzzy sequencing problem plays vital role in formulating the uncertainty in actual environment.

This paper is framed as follows Section 2: Basic definitions and preliminary results, Section 3: Applications of ranking functions to solve fuzzy sequencing problems (FSP), Section4: Numerical examples illustrated with solutions and section 5: Conclusion.

II. PRELIMINARIES

Basic notations and preliminary results are referred from [1,2,3].

Definition 2.1

A fuzzy set $A = \{ (x,\mu_{\tilde{A}}(x)) : x \in X \}$ is defined for $x \in X$ with respect to the membership function $\mu_{\tilde{A}}(x)$ where $\mu_{\tilde{A}}(x)$ is defined by $\mu_{\tilde{A}} : X \to [0,1]$

Definition 2.2

A fuzzy number $\tilde{A} = (a,b,c)$ is said to be triangular fuzzy number if its membership function is defined by

$$\mu_{\tilde{A}}(x) = \begin{cases} \frac{x-a}{b-a}, & a \le x \le b \\ \frac{x-c}{b-c}, & b \le x \le c \\ 0, & x > c \end{cases}$$

Definition 2.3

A ranking function is an efficient method for ordering the fuzzy number and is defined by $R(\tilde{A}) = \frac{a+2b+c}{4}$ where $\tilde{A} = (a,b,c)$

Definition 2.4

Let $\tilde{A} = (a,b,c)$ and $\tilde{B} = (e,f,g)$ then

i) $\tilde{A} \oplus \tilde{B} = (a + e, b + f , c + g)$

ii) $-\tilde{A} = (-c, -b, -a)$

iii) $\tilde{A} \ominus \tilde{B} = (a - g, b - f , c - e)$

iv) Let $\tilde{A} = (a_1 , a_2 , a_3)$ and $\tilde{B} = (b_1 , b_2 , b_3)$ then

i) $\tilde{A} \approx \tilde{B}$ iff $a_i = b_i$

ii) $\tilde{A} \le \tilde{B}$ iff $a_i \le b_i$

iii) $\tilde{A} \ge \tilde{B}$ iff $a_i \ge b_i$

iv) $\tilde{A} \ge 0$ iff $a_i \ge 0$, for i = 1,2,3

Definition 2.5

If (x_i , y_i , z_i) is a triangular fuzzy number then the relation $x_i \leq y_i \leq z_i$ for
i = 1,2,3....m is called bounded constraint.

3. Application of ranking function to solve fuzzy sequencing problem

3.1 Algorithm for solving fuzzy sequencing problem

Consider 'n' different jobs processing on a single machine where the processing time is given with the following objective:

1. Any new job that arrives doesnot disturb the processing of these 'n' jobs.
2. If new job arrives, it has to wait for being considered in the next batch of jobs after the processing of the current 'n' jobs is completed.

The optimal solution to the fuzzy sequencing problem is to determine the optimal sequence and the completion time to perform all the jobs.

This type of problem can be completely described as

1. Only one machine is involved.
2. The expected processing time is denoted by (x_i , y_i , z_i)

The procedure for the solution of the above problem is described as follows:

1. Using ranking function for the fuzzy sequencing problem is defuzzified into crisp sequencing algorithm.
2. The optimal sequence for crisp sequencing problem can be determined by the following rules:

i) Shortest processing time (SPT) rule:

By this rule, the jobs are sequenced such that the job with least processing time is processed first, followed by the one with next smallest processing time and so on.

ii) First come first serve (FCFS) rule:

By this rule, the sequence of jobs are determined on first come first serve basis.

iii) Slack time remaining (STR) rule:

Slack time for a job is determined by subtracting the processing time from due date of a job.

Slack time of a job = $d_i - t_i$ where d_i = due date of job i , t_i = processing time of job i.

The jobs are sequenced in such a way that the jobs with minimum slack time are processed first followed by the next leat slack time and so on.

iv) Earliest due date (EDD) rule:

In this rule, jobs are sequenced in the increasing order of due dates.

4.Numerical examples are illustrated with solutions:

The information regarding jobs to be scheduled through one machine is given below:

Job : A B C D E F G

Processing Time (days) : (3,4,5) (11,12,13) (1,2,3) (10,11,12) (9,10,11) (2,3,4) (5,6,7)

Due date (days) (19,20,21) (29,30,31) (14,15,16) (15,16,17) (17,18,19) (4,5,6) (8,9,10)

Find processing time using the following rules 1) FCFS rule 2) SPT rule 3) EDD schedule 4) STR schedule

Solution:)FCFS Schedule: A→ B→ C →D→E→F→G

The processing time will be as follows:

Job	machine	
	in	out
A	(0,0,0)	(3,4,5)
B	(3,4,5)	(14,16,18)
C	(14,16,18)	(15,18,21)
D	(15,18,21)	(25,29,33)
E	(25,29,33)	(34,39,44)
F	(34,39,44)	(36,42,48)
G	(36,42,48)	(41,48,55)

2) SPT Schedule : C→F→ A →G→F→D→E
The processing time will be as follows:

Job	machine	
	in	out
C	(0,0,0)	(1,2,3)
F	(1,2,3)	(3,5,7)
A	(3,5,7)	(6,9,12)
G	(6,9,12)	(11,15,19)
E	(11,15,19)	(20,25,30)
D	(20,25,30)	(30,36,42)
B	(30,36,42)	(41,48,55)

3) EDD Schedule :F→ G→ C → D →E→A→B
The processing time will be as follows:

Job	machine	
	in	out
F	(0,0,0)	(2,3,4)
G	(2,3,4)	(7,9,11)
C	(7,9,11)	(8,11,14)
D	(8,11,14)	(18,22,26)
E	(18,22,26)	(27,32,37)
A	(27,32,37)	(30,36,42)
B	(30,36,42)	(41,48,55)

4) STR Schedule : The STR table is obtained as follows

Job	Due Date (d_i)	Processing time (t_i)	Slack time ($d_i - t_i$)
A	(19,20,21)	(3,4,5)	(14,15,16)
B	(29,30,31)	(11,12,13)	(16,18,20)
C	(14,15,16)	(1,2,3)	(11,13,15)
D	(15,16,17)	(10,11,12)	(3,5,7)
E	(17,18,19)	(9,10,11)	(6,8,10)
F	(4,5,6)	(2,3,4)	(0,2,4)
G	(8,9,10)	(5,6,7)	(1,3,5)

The STR Schedule : F→ G→ D → E →C→A→B
The processing time will be as follows:

Job	machine	
	in	out
F	(0,0,0)	(2,3,4)
G	(2,3,4)	(7,9,11)
D	(7,9,11)	(17,20,23)
E	(17,20,23)	(26,30,34)
C	(26,30,34)	(27,32,37)
A	(27,32,37)	(30,36,42)
B	(30,36,42)	(41,48,55)

III. CONCLUSION:

Fuzzy sequencing problem is solved by classical approach after defuzzification, which is easy to understand, helps to formulate uncertainty in actual environment and also serves as application for the decision makers in real life situation.

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