Rules used in Decision Process based on Fuzzy Sets

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Abstract: The paper presents an application of Decision Process based Fuzzy Sets used in fabrication scheduling. The inputs in fuzzy procedure are the simple scheduling rules, changed in scheduling criteria. There are three criteria: Select the job with the Shortest Imminent Operation- SIO, Select the job with Smallest ratio obtained by Dividing the processing Time of the imminent operation by the total processing time for the part- SDT, Select the job with Smallest ratio obtained by Multiplying the processing Time of the imminent operation by the total processing time for the part- SMT.
These criteria are aggregated with Fuzzy Sets characteristic method. The output variable is the priority of fabrication for each job.

Key-Words: decision process, fuzzy sets, shortest imminent operation, smallest dividing time, smallest multiplying time

1 Introduction

Ordering process that use a fuzzy sets decisional process will be detailed for the case of fabrication of two types of pieces and three types of machines in a flexible fabrication system.
Priority rules that are contained in the decisional system are the following:
R1. Minimum manufacturing time (TP). The piece with the smallest execution (task) for the next operation is selected:
R2. Minimum ratio between manufacturing time and total manufacturing time (Select the job with Smallest ratio obtained by Dividing the processing Time of the imminent operation by the total processing time for the part- SDT)
R3. Minimum multiply between manufacturing time and total manufacturing time (Select the job with Smallest ratio obtained by Multiplying the processing Time of the imminent operation by the total processing time for the part- SMT).

2 Procedure description

II.1. Input data of the decisional process
Input informations of the decisional process are presented in Table 1. These are referring at manufacturing time for each machine and for each type of piece.

Table 1. Input informations of the decisional process

Manufacturing Time (TP)[min]	Machine-M1	Machine-M2	Machine-M3
Piece-P1	15	30	20
Piece-P2	25	20	22
Piece-P3	35	15	20

II.2. Values domains of criteria (rules) for ordering
For manufacturing time (TP) of a piece with one of the system machines the adopted values domain is : TP= [10; 40] [min];
For the ratio between execution time of the next operation and total manufacturing time (SDT) the adopted values domain is : SDT= [0,12; 0,6]
For the multiply between between execution time of the next operation and total manufacturing time (SMT) the adopted values domain is : SMT=[900; 2500]

II.3. Used linguistic variables
It will be adopted the following linguistic variables:

- Manufacturing time (TP);
- Ratio between execution time of the next operation and total manufacturing time (SDT);

- Multiply between execution of the next operation and total manufacturing time (SMT).

II.4. Linguistic degrees of the linguistic variables and functions.

For the linguistic variable *Manufacturing Time* (TP) linguistic degrees, values domain specific to each linguistic degree and type of membership functions are centralised in Table 2.

Table 2. Linguistic degrees and values of specific domain.

Linguistic variable **Manufacturing Time (TP)**			
Linguistic degrees	*Domain*	*Function type*	*Observations*
Very small- Fm	[10; 20]	Trapezoidal	
Small- m	[15; 25]	Triangular	
Medium- Md	[20; 30]	Triangular	
Large- M	[25; 35]	Triangular	
Very large- FM	[30; 40]	Trapezoidal	

For linguistic variable *Ratio between execution time of the next operation and total manufacturing time* (SDT) linguistic degrees, values domain specific to each linguistic degree and type of membership functions are centralised in Table 3.

Table 3. Ratio between execution time of the next operation and total manufacturing time.

Linguistic variable **Ratio between execution time of the next operation and total manufacturing time (SDT)**			
Linguistic degrees	*Domain*	*Membership function type*	*Observations*
Very Small- Fm	[0,12; 0,26]	Trapezoidal	
Small- m	[0,20; 0,36]	Triangular	
Medium- Md	[0,28; 0,44]	Triangular	
Large- M	[0,36; 0,52]	Triangular	
Very Large- FM	[0,44; 0,60]	Trapezoidal	

Linguistic degrees, domain and membership functions coresponding to linguistic variable *Multiply between execution of the next operation and total manufacturing time* (SMT) are presented in Table 4.

Table 4 Linguistic variable of multiply between execution of the next operation and total manufacturing time.

Linguistic degrees	*Domain*	*Membership function type*	*Observations*
Very Small- Fm	[900; 1400]	Trapezoidal	
Small- m	[1100; 1700]	Triangular	
Medium- Md	[1400; 2000]	Triangular	
Large- M	[1700; 2300]	Triangular	
Very Large- FM	[2000; 2500]	Trapezoidal	
Linguistic variable **Multiply between execution of the next operation and total manufacturing time(SMT)**			

Table 5 Linguistic degrees, values domain specific for variable Priority apreciation.

Linguistic variable *Priority apreciation* **(PRIORI)**			
Linguistic degrees	*Domain*	*Membership function type*	*Observations*
Very Large- PFM	[0; 0,25]	Triangular	
Large- PM	[0; 0,50]	Triangular	
Medium- PMd	[0,25; 0,75]	Triangular	

Small-m	[0,50; 1,00]	Triangular	
Very Small - Pm	[0,75; 1,00]	Triangular	

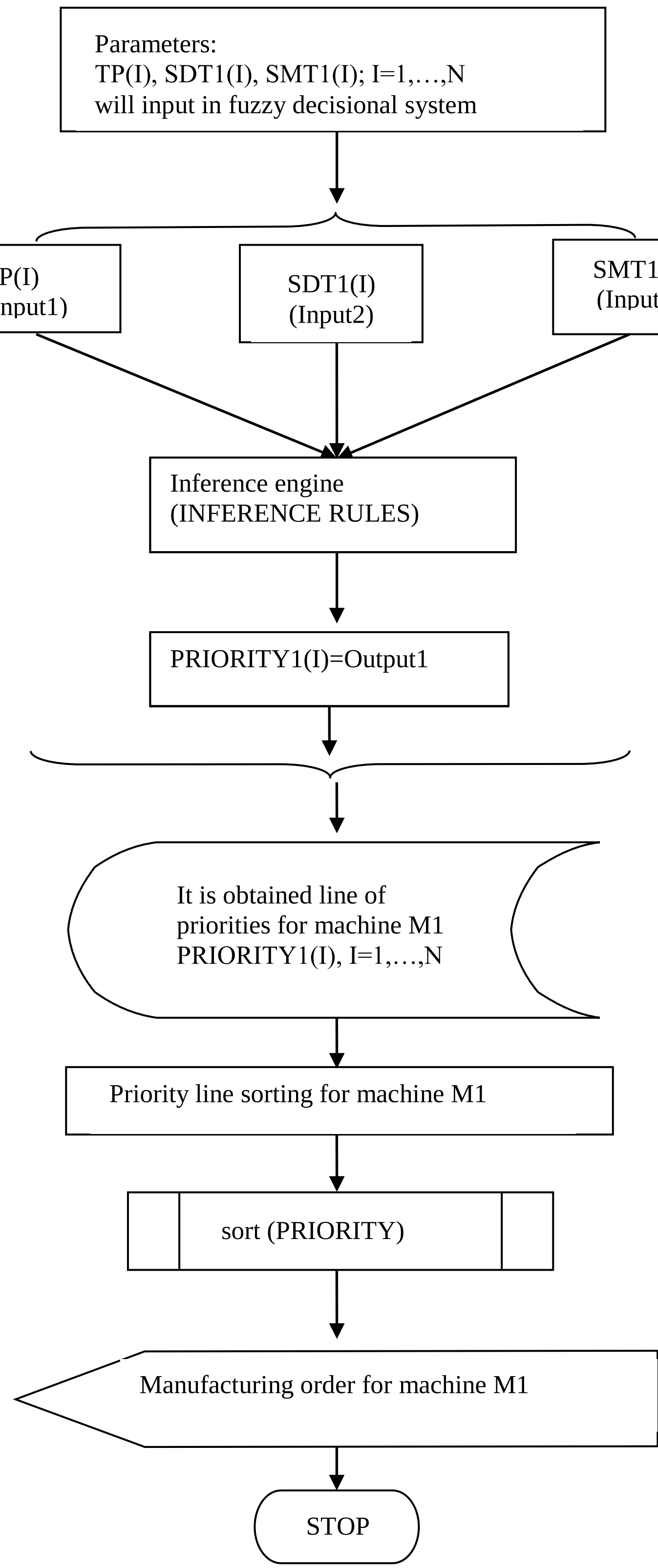

Fig.1 Developing of the proper decisional process.

II.5.Defining the output of the decisional process

The output of the decisional process will be *Priority apreciation*, denoted with PRIORI. Values domain of the output is : PRIORI = [0; 1]

II.6. Establishing the connecting method of the different values of the membership functions

Connecting method is MAX- MIN method. In general this method is defined as:

R2: Y x Z→ [0,1]; (2)

R3: Z x U→ [0,1]; (3)

Connecting (composing) fuzzy relations R1, R2 and R3 in the following :

R1 o R2 o R3 : X x Z x U→ [0,1] (4)

With evaluation product MAX- MIN as:

$\mu_{R1oR2\ oR3}$ (x,z,u) = MAX(MIN(μ_{R1} (x,y), μ_{R2} (y,z) μ_{R3} (z,u))), cu (x,z,u) $\in$ X x Y x U şi u $\in$ U (5)

II.7. Calculus procedure of the input parameters in decisional process

For linguistic variable *Priority* a*preciation* (PRIORI) linguistic degrees, values domain specific to each linguistic degree and membership function type are centralised in Table 5.

Let R1, R2 and R3 three fuzzy relations , where :

R1: X x Y→ [0,1]; (1)

Calculus stages are :

a)- *Total manufacturing time* calculus

b)- *SDT* and *SMT parameters* calculus

c)- *Developing of the proper decisional process* is schematic presented in Fig. 1.

II.8. Inference fuzzy system

All presented data were implemented in software medium Matlab® which is asociated with a Fuzzy Logic Toolbox (FLT).

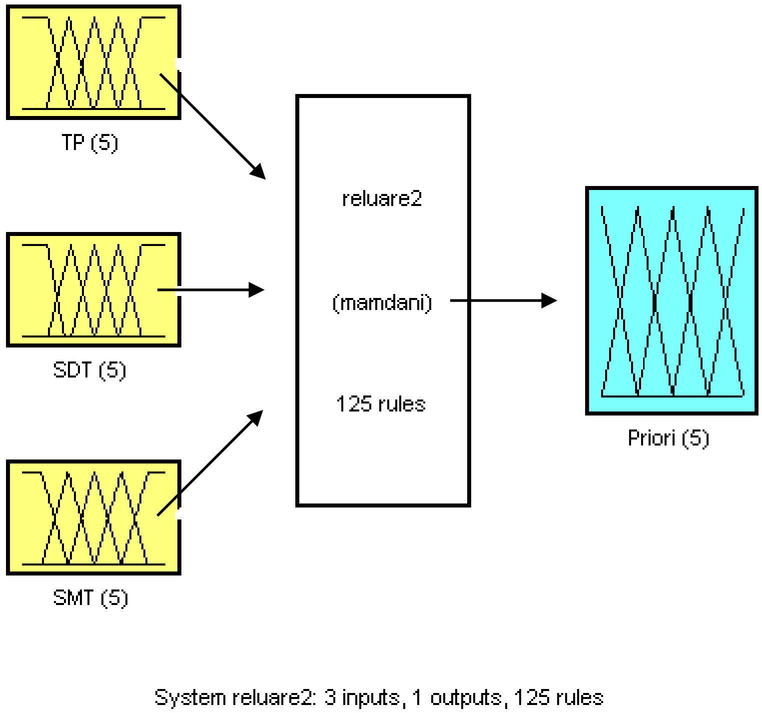

Fig.2 Inference fuzzy system with two inputs.

Inference fuzzy system is structured with two inputs the assemble of inference rules and an output is the one in Fig.2.

II..9. Data centralising

As a consequence of decisional procedure applying for each of the three machines in the case of the two types of pieces manufacturing the obtained data are centralised in Table 6.

Analysing the results of Tabel 6. the following are founded:

- For M1 machine the priorities order is: P1, P2, P3;
- For M2 machine the priorities order : P3, P2, P1;
- For M3 machine the priorities order : P1, P3, P2

Table 6 Decisional procedure applying for each of the three machines.

PIECE	PARAMETER	M1	M2	M3
P1	TP [min]	15	30	20
	SDT	0,2308	0,4615	0,3077
	STM	975	1950	1300
	PRIORI	0,0952	0,7500	0,2351
P2	TP [min]	25	20	22
	SDT	0,3731	0,2985	0,3284
	SMT	1675	1340	1474
	PRIORI	0,500	0,2441	0,3611
	TP [min]	35	15	20
	SDT	0,500	0,2143	0,2857
	SMT	2450	1050	1400

PIECE	PARAMETER	M1	M2	M3
P3	PRIORI	0,9153	0,0843	0,2500

3 Conclusion

The workpaper presents in detailed form the ordering procedure which is based on a multiatribute decisional system and fuzzy systems for a given case, for which three simple ordering rules are considered. Decision system offers, in the end, informations about manufacturing priorities of the pieces for each of the manufacturing machines of the system.

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