DECISION MAKING IN ECONOMY AND MANAGEMENT BY MEANS OF FUZZY LOGIC WITH THE SUPPORT OF CLASSICAL METHODS

Abstract: *The article deals with the decision making in the field of economy and management. The tool for decision making is the fuzzy logic theory together with classical method represented by two dimensional partial differential equations of second order. The solution is focused on the judgmental forecasting of competitive environment in the branch of hotels. At first the theory is mentioned, then the way of building up a model and finally the case study of competitive environment of hotels in specified territory is mentioned.*

Keywords: *judgmental forecasting, hotel sector, simulation model, decision making, competitive environment, fuzzy logic*

1. INTRODUCTION

The article deals with the build up of a model for judgmental forecasting in hotel sector. It presents the model, explains the used variables and their interpretation in the competitive environment. The case study presents the application of the build up model. The results are discussed. The two dimensional partial differential equation of second order is used for the simulation and the build up fuzzy model for the set up of simulation parameters.

2. BUILD OF THE MODEL

The meaning of used variables in competitive environment model in hotels sector is as follows: The values of "cells" represents the hotel utilization $D_{t,i,j}$ with index of time t and coordinates i, j. The hotel utilization is in the range from *+100%* to *0%*, where *+100%* means the maximum hotel utilization and *0%* means the zero utilization of hotel. The various conditions of hotels create the competitive environment. The value K is a simulation constant. The simulation parameters $Kx_{i,j}$ and $Ky_{i,j}$ present the rate of "influence" of competition environment in the direction of coordinates x, y of each cell. Each cell $O_{i,j}$ is coded in the following manner:

a) any influence (except initial condition), b) solid obstacle,
c) positive and constant influence, d) positive and variable influence,
e) negative and constant influence, f) negative and variable influence.

The program was designed for the simulation of the competitive environment. The input values are constants K , $Kx_{i,j}$*(n* x *m)*, $Ky_{i,j}$ *(n* x *m)*, matrix $D_{0,i,j}$*(1* x *n* x *m)* (initial conditions of hotel utilization in time $T_0 = 0$), matrix *O(n* x *m)* (code of each cell). The last item is the time T_{end}, the end time of calculation of competitive environment. The differential equation was used for the simulation in the form

$$D_{t+1,i,j} = D_{t,i,j} + K\left[Kx_{ij}\left(D_{t,i,j-1} - 2D_{t,i,j} + D_{t,i,j+1}\right) + Ky_{ij}\left(D_{t,i+1,j} - 2D_{t,i,j} + D_{t,i-1,j}\right)\right]. \qquad (1)$$

The details of the program were described in [Dostál 2008] and the applications in other branches in [Dostál at al. 2009] and [Dostál at al. 2010]. The parameters for simulation Kx_{ij} and Ky_{ij} are set up by means of fuzzy logic.

3. REAL CASE

The real case presents the placement of important hotels in town Brno (see fig.1).

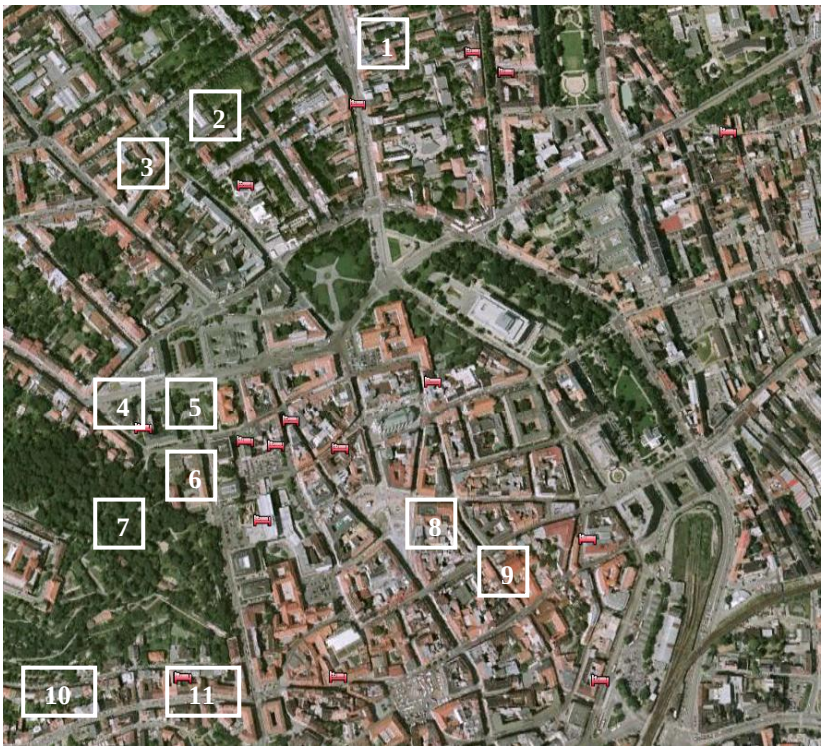

Fig.1 The placements of hotels

The parameters for simulation Kx_{ij} and Ky_{ij} is suitable to set up by means of fuzzy logic. The inputs are represented by evaluation of variables such as placement, staff quality, used technology, productivity, service quality, brand image, operation costs and pricing. The fuzzy model was build up for the set up of parameters. The fuzzy model has the eight inputs characterised by *Placement*, *Staff quality*, *Technology*, *Productivity*, *Service quality*, *Brand image*, *Costs* and *Pricing*. The output is the value of parameter with attributes such as *Very Low*, *Low*, *Medium*, *High* and *Very High*. See fig.2 and fig.3.

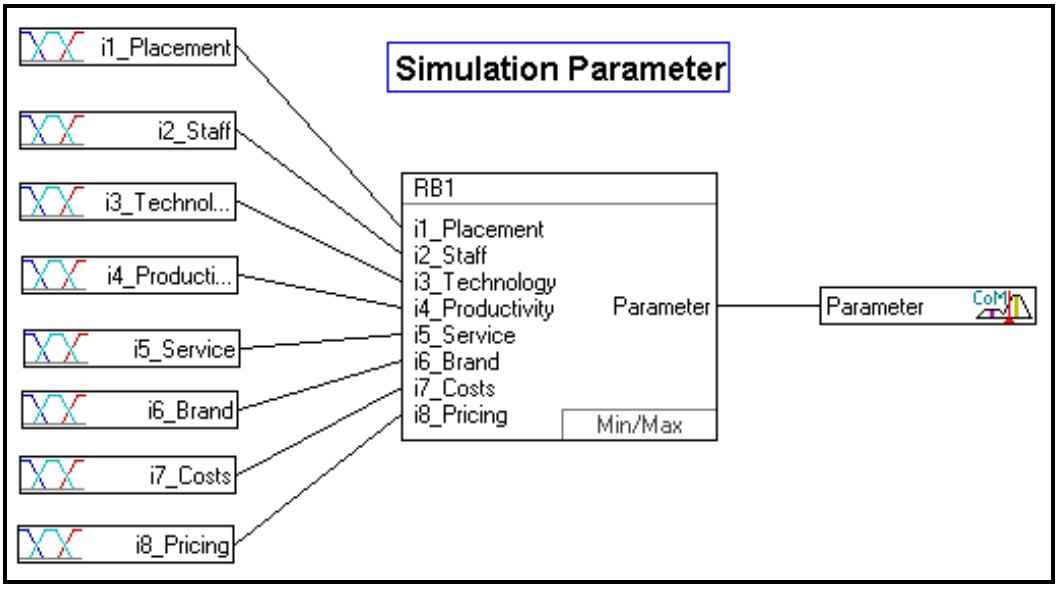

Fig.2 Fuzzy model

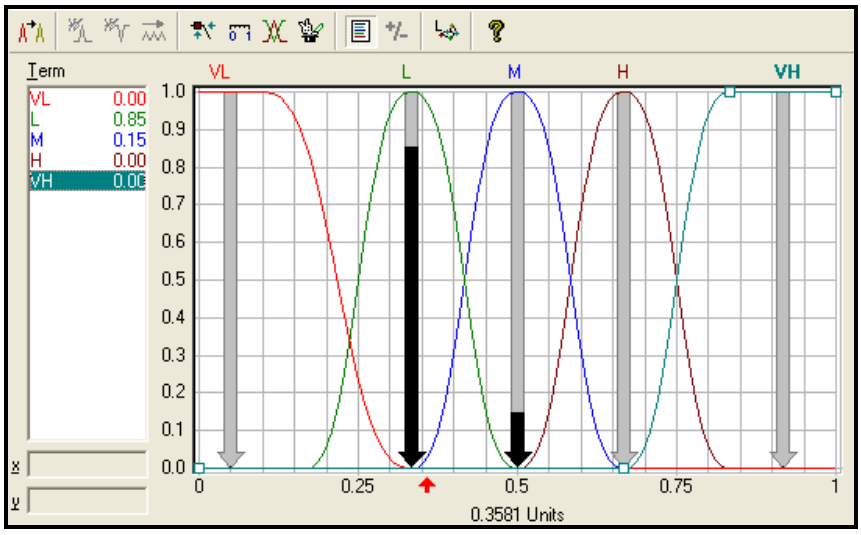

Fig.3 Set up of parameter for simulation

The important hotels for judgmental forecasting are marked by number 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11 and are presented in initial state graphically at fig.4 and numerically at fig.5.

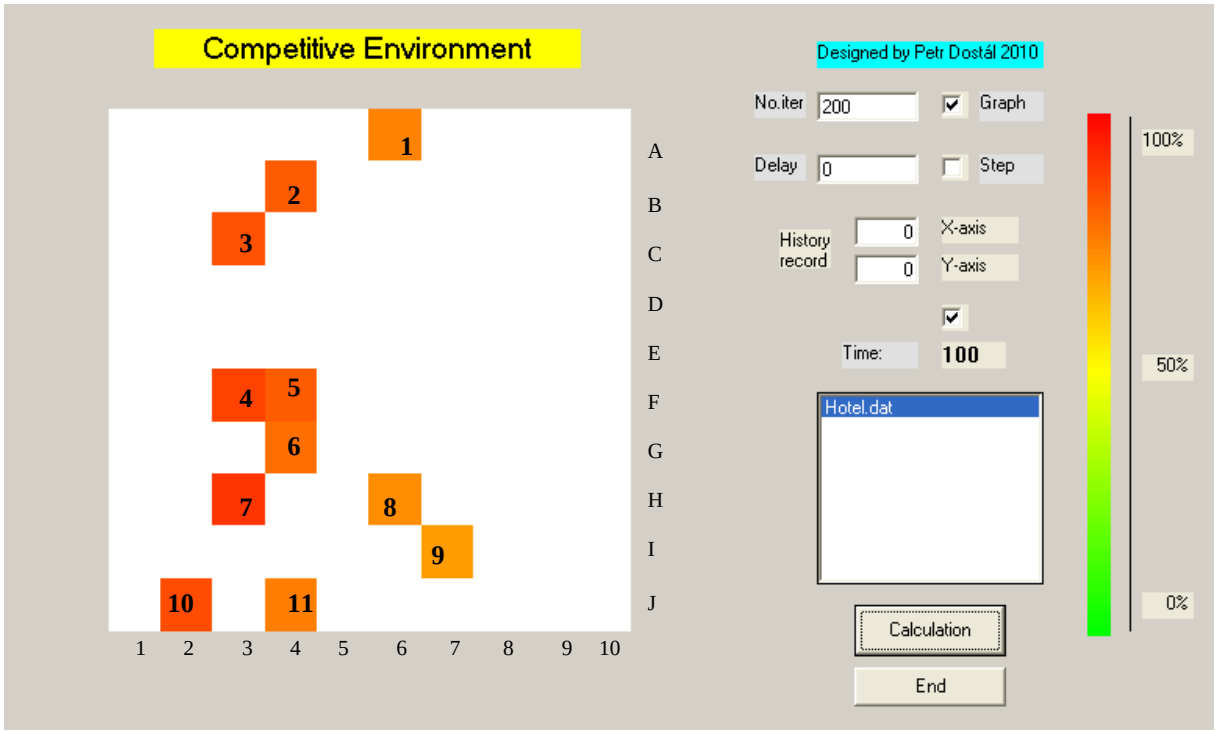

Fig.4 The initial situation of hotels

1	2	3	4	5	6	7	8	9	10	
000	000	000	000	000	084	000	000	000	000	A
000	000	000	092	000	000	000	000	000	000	B
000	000	094	000	000	000	000	000	000	000	C
000	000	000	000	000	000	000	000	000	000	D
000	000	000	000	000	000	000	000	000	000	E
000	000	097	092	000	000	000	000	000	000	F
000	000	000	088	000	000	000	000	000	000	G
000	000	080	000	000	082	000	000	000	000	H
000	000	000	000	000	000	079	000	000	000	I
000	095	000	085	000	000	000	000	000	000	J

Fig.5 The initial situation of hotels

The hotel No.7 has a problem with its utilization therefore the new management starts new strategy to attract the tourists, to increase the number of accommodated people by attracting the new ones and to "cannibalize" others from other hotels. It is done by aggressive home and foreign campaign, by the joining to chain of hotels etc. The simulation model was built up.

1	2	3	4	5	6	7	8	9	10	
000	000	000	000	000	076	000	000	000	000	A
000	000	000	084	000	000	000	000	000	000	B
000	000	082	000	000	000	000	000	000	000	C
000	000	000	000	000	000	000	000	000	000	D
000	000	000	000	000	000	000	000	000	000	E
000	000	086	084	000	000	000	000	000	000	F
000	000	000	077	000	000	000	000	000	000	G
003	000	091	000	000	074	000	000	000	000	H
000	000	000	000	000	000	071	000	000	000	I
000	085	000	075	000	000	000	000	000	000	J

Fig.6 The situation after 100 days of simulation

The fig.6 presents the situation after 100 days numerically. The utilization of hotel No.7 increased from 80% to 91%. The utilization of other hotels is nearly constant or decreasing. It is possible to compare the fig.5 and fig.6. It means that the decision of managers of the hotel is correct.

The results of calculations is possible to present by a spider graph, where the hotels with number 1, 3, 5, 7, 9, 11 were drawn in time T_0 (full line), T_{50} (dashed line) and T_{100} (dotted line). See fig.7 and prog.1. The graph enables the search of dynamic change of utilization of hotels given by influx and reflux of clients. The increase of usage of hotel No.7 confirms the correct decision making of management.

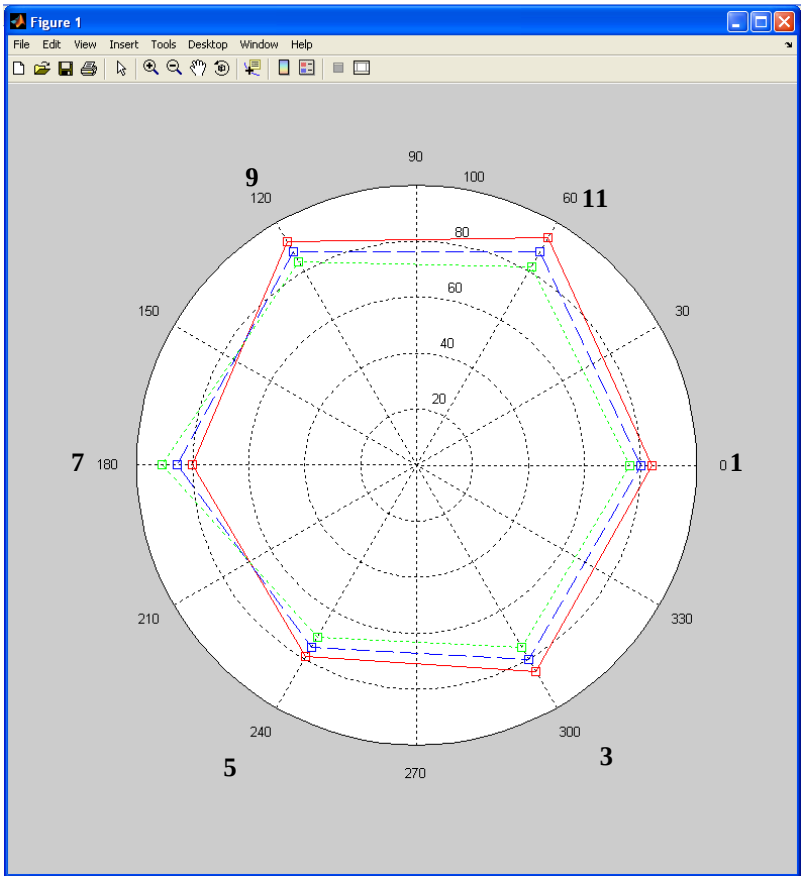

Fig.7 Utilization of hotels

```
clear all;
P=(xlsread('Data','Polar'))';
n=P(1,1);
t = 0:pi/3:2*pi;
polar(t, P(n+1:2*n),'-rs')
hold on
polar(t, P(2*n+1:3*n),'--bs')
polar(t, P(3*n+1:4*n),':gs')
```

Prog.1 Program for drawing the polar graph

4. CONCLUSION

The result of simulation and decision making process is clear. The increase of usage of hotel No.7 confirms the correct way of management. The mentioned designed model is focused on the field of competition among hotels. The described method of the build up of a model and its realization by suggested program enabled the search for strategy of hotels that are very important for the decision making processes. The calculation can increase the quality of decision making process. The designed method can be used not only for hotel competitive environment by also for example for hospitals, banks, markets, firms, suppliers or customers relations etc.