

# SIMULATION MODEL FOR DECISION MAKING: BUILD UP A NEW WAREHOUSE

## Abstract

The article deals with the decision making in the field of economy and management. The tool for decision making is 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 warehouses. At first the theory is mentioned, then the way of building up a model and finally the case study of competitive environment of placement of a new warehouse is mentioned.

## 1. Introduction

The article deals with the build up of a model for judgmental forecasting in warehouse sector. It presents the model, explains the used variables and their interpretation in the competitive environment. The case study presents the application of decision making – build up or not a new warehouse. The two dimensional partial differential equation of second order is used for the simulation as a support of decision making process.

## 2. Theory

The meaning of used variables in competitive environment model in warehouses sector is as follows: The values of “cells” represents the utilization of warehouse  $D_{t,i,j}$  with index of time  $t$  and coordinates  $i, j$ . The utilization is in the range from  $+100\%$  to  $0\%$ , where  $+100\%$  means the maximum warehouse utilization and  $0\%$  means the zero utilization of warehouse. The value  $K$  is a simulation constant. The constants  $Kx_{i,j}$  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  $K$ ,  $Kx_{i,j}$  ( $n \times m$ ),  $Ky_{i,j}$  ( $n \times m$ ), matrix  $D_{0,i,j}$  ( $1 \times n \times m$ ) (initial conditions of warehouse utilization in time  $T_0 = 0$ ), matrix  $O$  ( $n \times m$ ) (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

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

The details of the program were described in [Dostál 2008] and applications in other branches in [Dostál at al. 2009] and [Dostál at al. 2010].

## 3. Case study

The case study presents the situation of 13 existing warehouses on the territory of Czech Republic and the simulation done for the support of decision making process to build up a new one. The

warehouses for judgmental forecasting are marked by number from 1 to 14. See fig.1. The initial state is represented graphically at fig.2 and numerically at fig.3.



Fig.1 The placements of warehouses

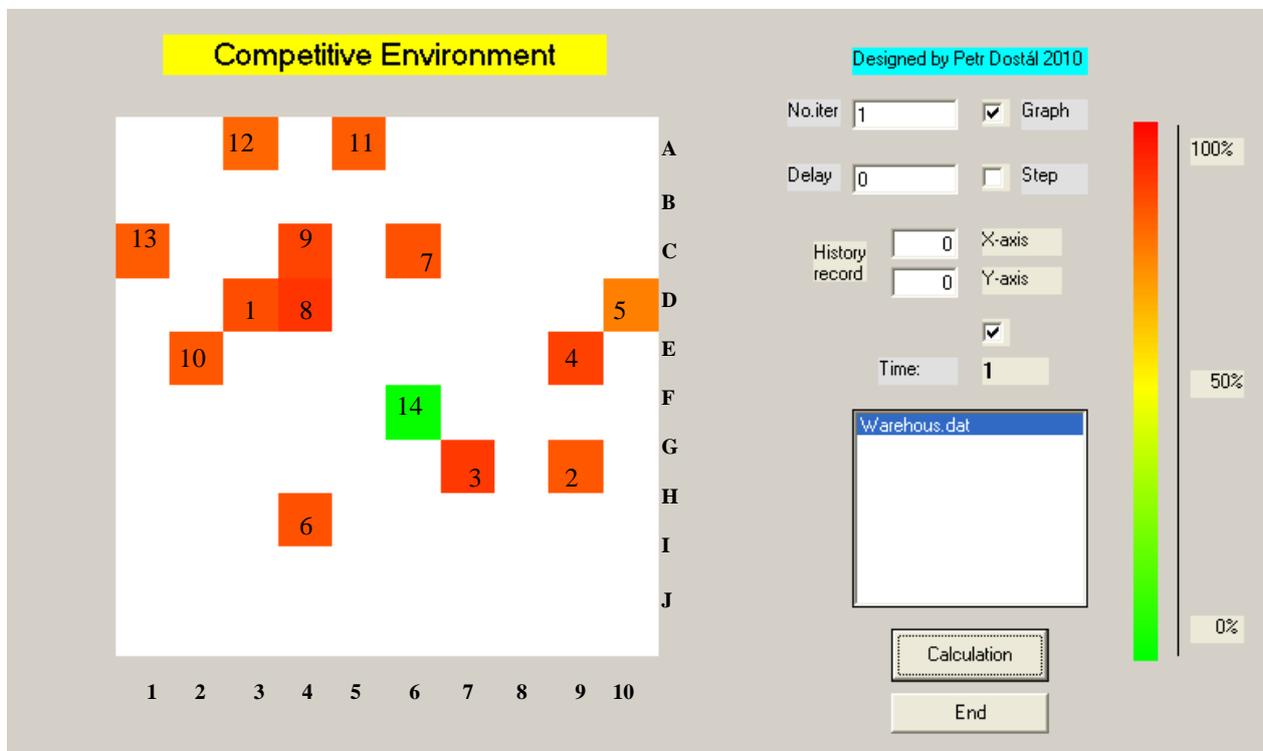


Fig.2 The initial situation of warehouses

1	2	3	4	5	6	7	8	9	10	
000	000	080	000	082	000	000	000	000	000	A
000	000	000	000	000	000	000	000	000	000	B
082	000	000	087	000	084	000	000	000	000	C
000	000	085	090	000	000	000	000	000	075	D
000	083	000	000	000	000	000	000	087	000	E
000	000	000	000	000	000	000	000	000	000	F
000	000	000	000	000	000	089	000	083	000	G
000	000	000	084	000	000	000	000	000	000	H
000	000	000	000	000	000	000	000	000	000	I
000	000	000	000	000	000	000	000	000	000	J

**Fig.3** The initial situation of warehouses

The decision making process uses simulation whether to build up (or not) a new warehouse No.14 in F6 section. Therefore the value of utilization of warehouse is zero at the start of simulation. The simulation model includes the influence of surroundings, the availability, population density etc. The warehouses are of one company therefore there is a positive and negative influence on competitive environment. The positive influence means influx of new customers from competition; the negative influence means reflux of customers from neighbouring warehouse of the same company. The most important fact of judgmental forecast is the future utilization of warehouse No.14 in case of its build up. The process of simulation was done and the results are presented on fig.4.

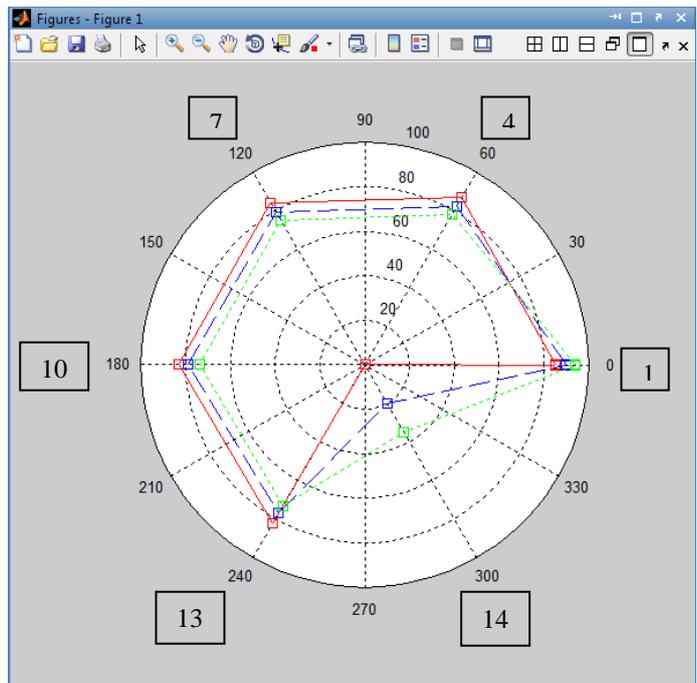
1	2	3	4	5	6	7	8	9	10	
000	000	071	000	073	000	000	000	000	000	A
000	000	000	000	000	000	000	000	000	000	B
073	000	000	096	000	075	000	000	000	000	C
000	000	094	099	000	000	000	000	000	066	D
000	074	000	000	000	000	000	000	078	000	E
000	000	000	000	000	035	000	000	000	000	F
000	000	000	000	000	000	098	000	074	000	G
000	000	000	075	000	000	000	000	000	000	H
000	000	000	000	000	000	000	000	000	000	I
000	000	000	000	000	000	000	000	000	000	J

**Fig.4** The situation after 300 days of simulation

## 4. Discussion

The simulation after 300 days gives the following results. The utilization of warehouse No.14 increased only from 0% to 35%. The values of utilization of cooperating warehouses were slightly decreasing, not only by fact of economic crisis. Only the utilizations of warehouses No.1, 8, 9 in Prague and warehouse No.3 in Brno represent small increase. The result for the support of decision making is: not to build a new one warehouse No.14 placed at F6 sector.

The results of calculations is possible to present by a spider graph, where the warehouses number 1, 4, 7, 10, 13 and 14 were drawn in time  $T_0$  (full line),  $T_{150}$  (dashed line) and  $T_{300}$  (dotted line). See fig.5. The graph enables the search of dynamic changes of utilization of warehouses given by influx and reflux of customers. The low increase of utilization of warehouse No.14 supports the solution not to build up a new warehouse.



**Fig.5** The utilization of warehouses

## **5. Conclusion**

The result of simulation and decision making process is clear. The increase of utilization of warehouse No.14 suggests not building a new one. The mentioned designed model is focused on the field of environment among warehouses. The described method of the build up of a model and its realization by suggested program enabled the search for strategy of warehouses that are very important for the decision making processes. The calculation can leads to right decision with the aim to decrease costs and save money of companies and firms. The designed method can be used not only for warehouse environment by also for example for hospitals, banks, companies, firms, suppliers or customer relations etc.