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SYSTEM DYNAMIC MODEL OF MARKETING IN HOTEL COMPANY

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Abstract

The subject of this paper is qualitative as well as quantitative system dynamics modeling of the marketing department in a hotel company. It is known that there is an increasing number of tourists in Croatia and also that in some regions hotel capacities are insufficient so hotel management has a major challenge to make decisions about increasing hotel capacities. The dynamic model, in this study, is oriented towards building new hotel capacities according to the increased demand. The paper describes a dynamic model of the marketing department of the hotel company that allows simulation of its dynamic behavior. The dynamics of events and the complexity of the process in the hotel company and the marketing department are shown with mathematical model, mental-verbal model and flow charts. The graphic of the system dynamic structural model of marketing department illustrates the important factors influencing the discrepancy between the desired and actual hotel capacity and between supply and demand for hotel capacities. The mathematical model enables practical insight into the dynamic behavior of the observed system, i.e. the analysis of the marketing department of hotel company and observation of mutual correlation between input, output and internal variables of processes occurring in the observed system.

Keyword: system dynamic model, hotel company, marketing

1. INTRODUCTION

The subject of this paper is qualitative as well as quantitative system dynamics modeling of the influence of marketing on building new capacities in a hotel company. It is known that there is an increasing number of tourists in Croatia and also that in some regions hotel capacities are insufficient so hotel management has a major challenge to make decisions about increasing hotel capacities."Decisions, which include wide financial, technical, logistic and environmental resources, demand the decisions simulation before they go into action in a form of policy realization" (Kljajić, 2000, p.294). The system dynamics modelling methodology, relatively rarely used in economy problems research so far, is applied in this paper. „It integrates existing knowledge and contributes to a better understanding of newly created relationships between complex natural and economic systems. The methodology can also be applied to assess a wide range of scenarios and create better strategies ."(Forrester, 1975, p.37).

The creation of the system dynamics model required:

- the analysis of hotel enterprises and marketing,
- creatingcausal loop diagram of marketing influence on hotel capacities,
- creating a mental-verbal model of the marketing influence on building new hotel's capacities,
- creating a mathematical model,
- analyzing the marketing influence on the hotel capacity.

2. MARKETING

Hotel companies are complex organizational systems functioning differently from other manufacturing and service companies. The complexity, stems from the fact that if the hotel wants to provide a quality service it must integrate products and services with many industries and connect natural, cultural, energy, material, transport and human resources with all the specifics in its product. The management of materials and information has far-reaching consequences in the hotel business.

The hotel industry, as a significant area of tourism, in its business concept brings into sharp focus, the needs of the consumer. Accordingly, the marketing concept has a dominant role in the entire hotel business.

In the hotel industry, the success of any hotel often depends on good reputation. Since all aspects of the business depend on successful marketing, it is difficult to highlight all the roles which marketing plays in a company. Kotler, one of the leading authorities in the field of marketing defines marketing as: "the science and art of exploring, creating, and delivering value to satisfy the needs of a target market at a profit. Marketing identifies unfulfilled needs and desires. It defines, measures and quantifies the size of the identified market and the profit potential. It pinpoints which segments the company is capable of serving best and it designs and promotes the appropriate products and services."(Kotler, 2001, p. 102)

The definition given by the American Marketing Association will also help

to clear some of the misconceptions on marketing and give a deeper understanding to it. According to them "Marketing is the activity, set of institutions, and processes for creating, communicating, delivering and exchanging offerings that have value for customers, clients, partners and society at large"(AMA 2013).

The hotel industry is one of the most important sectors in the tourism and hospitality industry. The World Tourism Organization (UNWTO) stated that the global number of hotel rooms has grown from 14 million to 17 million between 1997 to 2005 and the figure is expected to increase astronomically by the end of 2020. (Talabi, 2015, p.3). The growth in the hotel industry has been identified as one of the major facilitators in the development of tourism and hospitality industry as a whole. No wonder the governments of some countries give incentives to hotel developers and owners in order to further enhance their country's tourism sector (Page, 2009, p.259).

It is known that there is an increasing number of tourists in Croatia and also that in some regions hotel capacities are insufficient so hotel management has a major challenge to make decisions about increasing hotel capacities. Also, the fact that the hotel industry is an industry with perishable products, in other words, if a room is not occupied during a particular period, the income that is supposed to be realized on that particular room is lost forever and it cannot be regained, makes decision even harder.

3. SYSTEM DYNAMICS STRUCTURAL AND MENTAL-VERBAL MODEL OF MARKETING INFLUENCE ON HOTEL CAPACITY

System dynamics is a type of research system that analyses behavior of the system in time, depending on the structure of elements ofthe system and their mutual influence, including causal interrelations, feedbacks, and delayed reaction on influence.System Dynamics (SD) is basically built upon traditional management of social system, cybernetics and computer simulation (Sushil, 1993, p.35).System Dynamic Symulating Modeling is one of the most appropriate and successful scientific dynamics modeling methods of the complex, non-linear, natural, technical and organizational systems. The methodology of this method, together with use of digital computer, showed its efficiency in practice as very suitable means for solving the problems of management, of behavior, of sensibility, of flexibility of behavior dynamics of very complex systems. All this is made by computer simulating, i.e. „in laboratory", which mean without any danger for observed realities.(Forester, 1973, p.17)

SD is based on the philosophy that the behaviour of a system is principally caused by its structure based on policies and traditions; and the structure of an organization can be best represented in terms of underlying flows of various resources cutting across the functional departments tracing across various feedback loops, delays and amplifications in the system. Hence, a SD model typically consists of 'causal loop' and 'flow diagram'. The causal loop depicts causal hypothesis during model development, so as to make the presentation of the structure in an aggregate form, whereas, flow diagrams represent the detailed flow structure of the system in terms of

the fine policy structures so as to facilitate the development of the mathematical model for simulation (Coyle, 1977. p).

Qualitative modelling is a starting point in the modelling process. A structured and integrated casual loop diagram follows a mental presentation of the observed system (Munitić and Ristov, 2009, p.53).

The structural model, shown in Ficture 1., is designed on the basis of the analysis of parameters influencing decision about building new hotel capacities. The basic parameters of the model are: difference between actual and desired hotel capacities (RZISHK), actual state of hotel capacity (SSHK), speed of building new hotel capacity (BINK), physical cancellation of hotel capacities (FOHK), the demand for hotel capacities (PTRHK) , the supply of hotel capacities (PONUDA) the exponential average of demand for hotel capacities (EPTHK), the desired hotel capacities (ZHK)

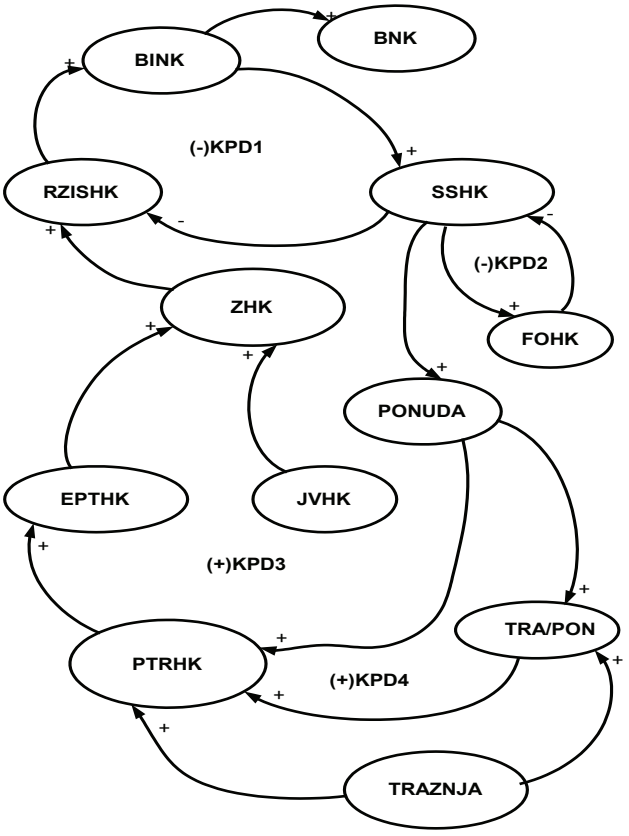

Figure 1. System dynamic structural model for marketing department influence on hotel capacity

Source: Author's own

The causal loop diagram shown in Figure1. consists of four feedback loops, two with negative and two with positive feedback effects.

In the feedback loop KPD1 there are three internal feedbacks. The feedback loop KPD1 comprises links among the difference between actual and desired hotel capacities (RZISHK), the speed of building new hotel capacity (BINK) and the actual state of hotel capacity (SSHK). If the difference between actual and desired hotel capacities(RZISHK) increases, the quicker is the speed of building new hotel capacity (BINK) (+). The quicker the speed of building new hotel capacity (BINK) means the higheractual state of hotel capacity (SSHK) (+). If (SSHK) increases, (RZISHK) decreases (-).From the above it can be seen that two internal feedbacks are of a positive dynamic character and one negative, which means that feedback loop KPD1 has a globally negative character.

The link between physical cancellation of hotel capacities (FOHK) andthe actual state of hotel capacity (SSHK) is describe by feedback loop KPD2. The higher state of hotel capacity (SSHK) means the higher state of physical cancellation of hotel capacities (FOHK) (+). Increasing the physical cancellation of hotel capacities (FOHK), the actual state of hotel capacity (SSHK) is decreasing (-). One positive and one negative dynamic character give a negative sign to the feedback loop KPD2.

In the feedback loop KPD3 there are seven internal links. If demand for hotel capacities (PTRHK) is larger the exponential average of demand for hotel capacities (EPTHK) is growing;(+). If EPTHK grows, the desired hotel capacities (ZHK) grow; (+). If ZHK increases, the difference between actual and desired hotel capacities RZISHK increases; (+). If RZISHK is growing, the speed of building new BINK capacities increases; (+). With quicker BINK the actual state of hotel capacities increase SSHK(+). If SSHK is growing, there is an increase in supply (PONUDA); means a positive sign of an internal feedback. If the supply (PONUDA) is larger PTRHK grows; means a positive sign of an internal feedback. Since KPD3 consists of seven positive internal links, this circle has a positive global dynamic sign.

The feedback loop KPD4 includes link between the ratio between demand and supply (TRA/PON) and demand for hotel capacities (PTRHK) which is positive. In KPD3 are described links between ZHK, RZISHK, BINHK, SSHK i PONUDA, all of them are also in KPD4 and the dynamic characters of the mentioned internal links are positive so the feedback loop KPD4 has a positive dynamic character.

4. MATHEMATICAL MODEL

After defining the problem, i.e., the first system dynamics modelling stage, the second stage - the system conceptualization takes place. It includes the mathematical model development based on the created cause-effect diagrams as well as the structural system model. The mathematical model development stage

is crucial in the system dynamics modelling process. The dynamic mathematical model is created theoretically applying the basic laws of the system's behavior.

The mathematical model, in this study, is oriented towards building new hotel capacities according to increased demand. The speed of new hotel capacity building (BINHK) is based on the difference between the requested and available hotel capacities (RZISHK).

Demand for hotel capacities is modeled as a level that depends on increasing and decreasing demand. Demand depends on seasonality, investment in marketing, the effect of experts and the effect of demand policy. Demand for hotel capacities (TRAZNJA) is given in table for 60-months.

Following the demand for hotel capacities over a given time interval, it is necessary to assess the economic viability of building new hotel capacities.

$$BK = \int_0^t BINHK dt \tag{1}$$

$$BINHK = \frac{1}{T}\begin{cases} 0, \ za \ \ RZISK \langle 450 \\ RZISK, \ za \ \ RZISK \geq 450 \end{cases} \tag{2}$$

$$RZISK = ZHK - SSHK \tag{3}$$

$$SSHK = SSHK_0 + \int_0^t (BINHK - FONK) dt \tag{4}$$

$$FONK1 = (1/T^2) * 4.5 * BINHK * t^2 * e^{-\frac{3t}{T}} \tag{5}$$

$$FONK = \begin{cases} FONK1 \ , \ \ za \ \ FONK1 \geq 1 \\ 0 \end{cases} \tag{6}$$

$$EPTHK = EPTHK_0 + \frac{DT}{VUIT}\left(PTRHU - EPTHK_0\right) \tag{7}$$

$$ZHK = EPTHK * JVHK \tag{8}$$

BK in the equation (1) represents number of newly built hotel capaticies and it is calculated as the change of speed of building new hotel capacities BINHK integral in the preceding time interval.

BINHK stands for speed of building new hotel capacities and it is calculated as discrepancy between desired and actual hotel capacities devided by timein the equation (2).

RZISK in the equation (3) is discrepancy between desired ZHK and actual SSHK hotel capacities.

Real hotel capacities SSHK inthe equation (4) represents the number of the hotel capacities at a specific time interval and it is calculated by adding up the preceding number of the hotel capacities e and the integral of the change in discrepancy between BINHK and FONK in the preceding time interval.

FONK in equation (6) is the average time of physical write-off of hotel capacities and is calculated by FONK1 which is auxiliary function, exponential delay function of 3rd order in equation (5).

EPTHK stands foran exponential average demand for hotel capacities in equation (7) and it is it is obtained by adding up previous average demand value and first derivation of diference between PTRHU increased average demand and EPTHK, devided by the average time of exponential delay VUIT.

The desired hotel capacities ZHK in equation (8) is first order function of the exponential average of the demand EPTHK and unit value of the hotel capacity JVHK.

5. SYSTEM DYNAMIC SIMULATION MODEL OF THE MARKETING INFLUENCE ON HOTEL CAPACITY

The above facts were necessary to create a basis for developing computer simulation model of marketing influence on hotel capacity. These are the basic settings for the understanding of the functioning of the system dynamic modeling.

Based on the mathematical and structural model of the marketing service, a dynamic computer simulation model of marketing service was developed, which can simulate and optimize this service.

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R BINHK.KL=CLIP(0,RZISK.K,450,RZISK.K)
L BK.K=BK.J+DT*BINHK.JK
N BK=0
L SSHK.K=SSHK.J+DT*(BINHK.JK-FONK.JK)
N SSHK=1400
R FONK.KL=DELAY3(BINHK.KL,PVFO)
C PVFO=120
A RZISK.K=ZHK.K-SSHK.K
A ZHK.K=EPTHK.K*JVHK
C JVHK=600
A EPTHK.K=SMOOTH(PTRHU.K,VUIT)
C VUIT=6
A PTRHU.K=FPT*TABHL(PTRHUT,TRAPON.K,0,2,1)
T PTRHUT=0,2,4
C FPT=1
A TRAPON.K=TRAZNJA.K/PONUDA.K
A PONUDA.K=SSHK.K
A TRAZNJA.K=TABHL(TRAZNJT,TIME.K,0,60,4)
T ZNJT=100,400,2000,600,400,2500,600,800,3000,800,900,4000,1000,1000,5
500,900
SAVE  BINHK,SSHK,FONK,RZISK,ZHK,EPTHK,PTRHU,TRAPON,PONU
DA, TRAZNJA, BK
SPEC DT=0.1,LENGTH=60,SAVPER=1
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6. SIMULATION AND VERIFICATION OF THE SYSTEM DYNAMIC MODEL

Dynamic model of marketing service, which is described in mathematical equations and shown in the structural diagram is verified by comparing the results of the simulation with the actual results of hotel company. The simulation was conducted according to the following scenario:

- Maximumhotel capacity is 100%
- The hotel starts work in March and ends in November,
- Full availability is anticipated in July and August.

Real (STPOP) and simulated(SPOP) occupancy of the hotel capacities are shown in Table 1.

Table 1

Real and simulated occupancy of the hotel capacities

Time	STPOP	SPOP
0	0,00	0,00
1	0,00	0,00
2	0,00	0,00
3	36,30	40,00
4	41,00	45,00
5	57,40	60,00
6	81,10	85,00
7	99,23	100,00
8	104,94	100,00
9	81,15	90,00
10	61,18	70,00
11	38,44	30,00
12	0,00	0,00

Source: Author's calculation

Table 1.shows that the dynamic behavior of the model of the marketing influence on the hotel availability is in compliance with relevant information obtained from a real model. The results of the simulation have given the expected results.

The influence of marketing on building new hotel capacities can be analyzed by simulating impact of individual parameters on hotel capacities as shown in scenario 1.

Scenario 1. The change of deman for hotel capacities is given in Table 2.

Table2

Demand for hotel capacities

Time	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12	13.	14.	15.
Demand(000)	11	0,44	2,2	0,66	0,44	2,75	0,66	0,88	3,3	0,88	0,99	4,4	1,1	1,1	6,06

Source: Author's calculation

An exponential average diagram of demand for hotel capacities is shown on Figure 2. The decision to build new hotel capacities is based on the forecast of the future value of demand, using previous information of the value of that size. In the order to reduce the effect of a random fluctation of demand, smoothing of information was made and also the delay of information was taken into account.

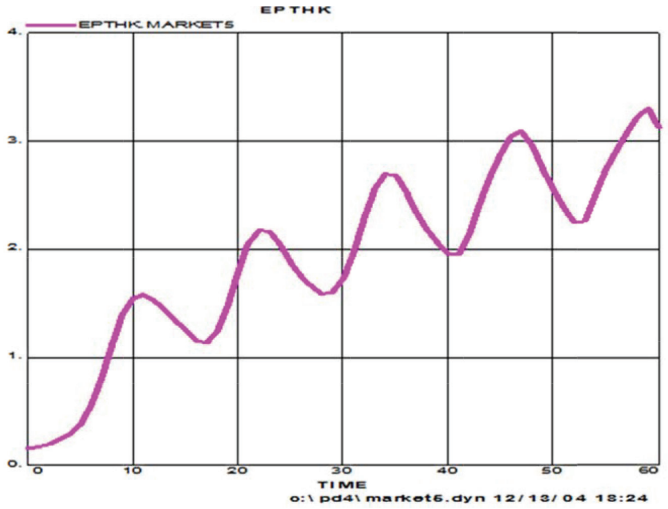

Figure 2 The exponential average demand of hotel capacities

Source: Author's own

Decisions are often made based on the forecast of a future value of some size - in this case demand for hotel capacities, using previous information on the value of that magnitude.

The forecast based on one value usually does not meet the fluctuation of size in time, so a larger number of previous values is regularly taken and based on the estimation of the predicted value. Most commonly used are statistical methods based on the so-called. smoothing information, which in different ways takes the average of the previous changes in size of importance (Munitić, 1989, p.107)

Smoothing information leads to a reduction in the effect of a random fluctuation, and it also introduces a delay, which in this case is expressed by the SMOOTH function.

According to the exponential average demand of hotel capacities, the desired hotel capacities are determined. If the difference between desired and actual hotel capacity exceedes 450 beds, it is encouraged to build new capacities. The average time of physical cancellation of hotel capacities is 120 months which is shown in Figure 3.

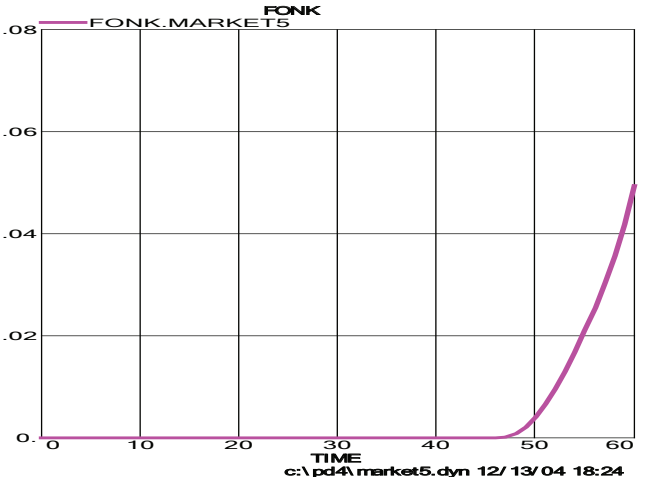

Figure 3 The physical cancellation of hotel capacities

Source: Author's own

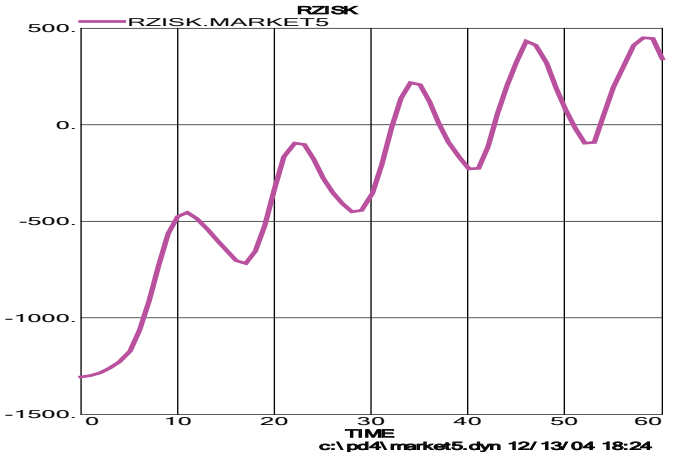

Figure 4. The diagram of the difference between real and desired hotel capacities

Source: Author's own

7. CONCLUSION

Both the qualitative and quantitative system dynamics modelling of the marketing influence on building new hotel capacities have been presented in this paper.

Decisions, which include wide financial, technical, logistic and environmental resources, demand the decisions' simulation before they go into action in a form of policy realization. System Dynamic Symulating Modeling showed its efficiency in practice as very suitable means for solving the problems of management, of behavior, of sensibility, of flexibility of behavior dynamics of very complex systems such as hotel company.

Both the structural dynamic model and the development diagram have been created on the basis of the mental-verbal model.The above mentioned models have been used to create a mathematical and simulation model. .

The obtained results confirm the validity of such synthetic models, which suggests the possibility of multiple use, especially in university education processes, education processes in hotel companies, design of new hotel companies, and diagnosis of possible disturbances in the work of individual hotel companies.

As the hotel is a complex organizational system in which a whole range of hotel services and departments play an important role in successful business, a systematic approach of performance analysis is required. The analysis should include the impact of each service and department on the overall performance of the hotel.

Since only the influence of marketing on building new hotel capacities is analyzed in this paper, in further research it is necessary to include the influences of all departments: technical, human resources, sales, marketing, maintenance, procurement ect. on making decision about new capacities. Given the complexity of hotel business operations as well as their individual services, it can be concluded that this work is only one "step" on the way to solving this very complex task.

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