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Application of System Dynamics Model in Management of Highly Qualified Human Resources

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Abstract: - In the world economy the role of knowledge-based enterprises is rapidly increasing. Knowledge is becoming the main business resource and the basis for competitiveness of an enterprise. These facts are particularly evident in enterprises whose basic activity is providing intellectual services. Knowledge holders and creators in these kinds of enterprises are highly qualified employees. This is why we can say that the competitive ability of such enterprise will depend on the quality of management of highly qualified workforce. This paper describes system dynamics model whose purpose is to make strategic decisions in management of highly qualified workforce in enterprises providing intellectual services on the growing market.

Key-Words: - Knowledge-based Economy, System Dynamics, Human Resource Management, HRM

1 Introduction

Most authors of contemporary business literature agree that knowledge is becoming the main business resource and the basis for maintaining the competitive edge of an enterprise [2], [6], [8]. In developed economies, enterprises based on knowledge are leaders in their branches. Knowledge is built in every product, service and/or business process.

The role of enterprises providing intellectual services is very important in the world economy, and their importance will continue to increase in the future [3]. Since those enterprises are based on knowledge, efficient management of human resources is crucial for their development. Even more so, their competitive edge depends directly on the quality of managing highly qualified workforce. This is why it is necessary to investigate how efficient management of human resources in such enterprises contributes to their growth.

Every enterprise is a dynamic system with a feedback loop. Basic characteristics of such a system are [7]:

- parts of the system cannot be disassembled without losing its properties
- behavior of the system changes with time
- parts of the system are mutually interactive, the cause brings consequences with it and it is indirectly influenced by them
- the system interacts with the environment and its behavior will influence the behavior of the environment

System dynamics is a method that investigates the characteristics of complex dynamic systems with feedback loops, with the purpose of understanding the system behaviour. In doing so, qualitative and quantitative models are used and robust policies of managing the system are formed through simulation and optimization [4]; [1]. The method is suitable for forming various complex systems, so we can use it also in human resource management.

The purpose of this paper is to examine the policy of overburdening highly qualified workers influence the growth of an enterprise. In doing so, we will use the model of system dynamics of a smaller enterprise providing intellectual services. This paper aims to show that the development and usage of a simulation model can contribute to increasing the efficiency of growth management of such enterprises.

In order to design the model, research was conducted with the purpose of discovering an efficient policy of human resource management in knowledge-based enterprises. Various factors, which influence the growth of an enterprise providing intellectual services, were examined. A generic model of growth of an enterprise providing intellectual services was designed, and it will be used to identify efficient policies of human resource management.

2 Basis for Model Creation

Interviews with owners and employees of knowledge-based enterprises, as well as monitoring of their business data served as the main source of information used for the development of model. Both enterprises deal in the same type of services and have existed for several years. Because of the owners' wish to stay anonymous, in this paper we will refer to the enterprises as Zenith and Horizon.

Enterprise Zenith is a market leader. It was set up seven years ago, when it had only 10 employees and approximately 2.400.000 kunas of annual turnover (approx. 1 € = 7,4 kunas). The policy of the owner is to employ top, just graduated students. The salary is the same as the average salary of professionals of the same profile, but employees are attracted to the enterprise by an easy-going family atmosphere. The owner trusts the working habits of the employees and he controls them very little or not at all.

Enterprise Horizon was set up three years ago, with 6 employees and an annual turnover of approximately 2.000.000 kunas. Because of a smaller number of employees and nearly the same annual turnover, at first sight it would seem that Horizon had a better starting position than Zenith. However, so far Horizon has not been successful in taking an important role in the market. The policy of the owner is also to employ top, just graduated students, and their salary is also equal to the average salary of professionals of the same profile. The owner requires a lot of unpaid overtime work.

Both firms perform marketing and public opinion research services. However, Zenith offers many very specialized marketing research services (advertising and media, automotive, financial services, tourism and leisure, telecommunications, pharmaceutical, consumer goods), while Horizon offers only advertising and media research. Also, workers in Zenith are organized in cross-functional project teams, which mean that Zenith has matrix organizational structure. On the other hand, Horizon has divisional structure with workers organized by customer and products.

Owners of both firms are questioning their policy of human resource management. The owners of Zenith are wondering if their profitability and turnover would increase if they paid their existing employees 50% more, with the increase in their productivity. In this case working condition would be more stressful than so far.

On the other hand, the owner of Horizon is worried about the stagnation of its enterprise. He blames the employees, and thinks that their work is not on a good level.

Among other things, during interviews we noted several important facts for setting up a model:

- Although expressing their will to employ more professionals, the owners of the enterprises nevertheless are not easily persuaded to do so. They do it most frequently once their employees have been under too much stress through a longer period of time.
- Newly employed professionals have to go through a period of education in order to adjust to the new working environment and acquire specific knowledge necessary for doing the work.
- Professionals with a heavy workload do not succeed in doing all their contracted work on a good level. As a consequence, customers are not satisfied and loss of market share occurs.
- Both the employees and owners of the enterprises agree that employee satisfaction depends on their workload and the salary.
- Employees are willing to work part of the time more for a higher salary.

3 Description of System Dynamics Model

Based on the results of the conducted research and interviews, a system dynamics model has been set up, and it consists of 5 segments: (1) Employee lifecycle, (2) Employee satisfaction, (3) Quality of Service, (4) Demand and (5) Business Success.

The program tool used in the formation of the computer model of system dynamics is VENSIM. It was chosen because of its simplicity of use, an understandable layout of the results and additional functions, which make work easier. We started the development of the model of human resource management by developing every individual segment as a separate model.

Every segment was tested by conducting an extreme conditions text, a sensitivity analysis and a test of dimensional consistency [5]. The corrected segments were linked into a model, and the model itself was also tested by using the already mentioned tests. After a series of iterations of testing and modeling, we decided that the model was suitable for the simulation of the scenario of human resource management in knowledge-based companies. Now, we are going to describe segments of the model.

3.1 Segment 1: Employee Lifecycle

The work in the enterprise is done exclusively by expert professionals, and if there are not enough experts the company employs trainees. Knowledge necessary for the work is so specific that the only possibility is to employ a new worker as a trainee and educate him. New professional are employed on the basis of the imbalance between the necessary and the current number of employees. Experts are involved in educating trainees so that the total number of necessary experts depends on the workload and the number of employed trainees. However, the necessary number of experts does not depend only on workload, but also on the number of projects for which the owner thinks one expert should handle on a monthly basis. For example, if the owner thinks that an expert should complete 15 projects per month, he will employ fewer experts than an owner who thinks that an expert should complete 10 projects per month.

The number of experts is decreased depending on the ratio of current and necessary number of experts. If there are more experts than necessary, they are laid off – which is modelled through a shorter length of employment. However, experts also deliberately leave the enterprise if they have been dissatisfied for a longer period – this is also modelled through a shorter length of employment. The policy of firing experts is shown by a table function of effects of experts on length of employment.

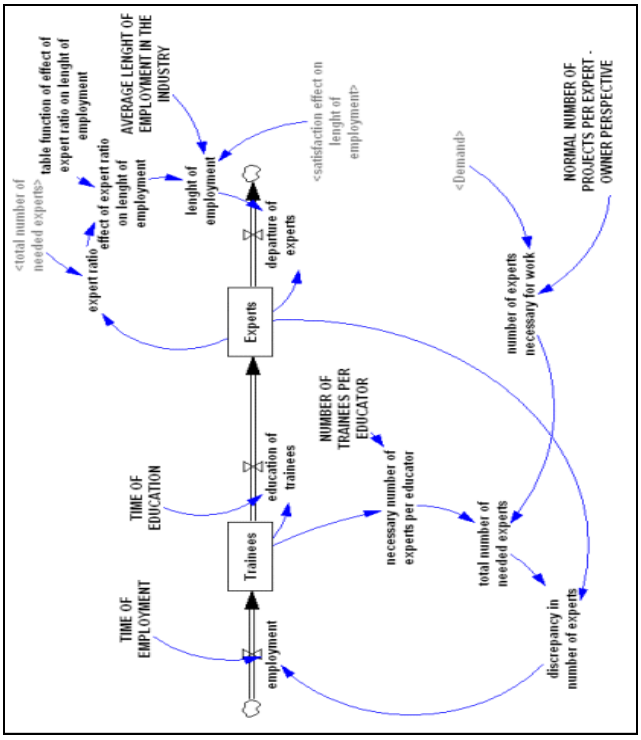

Figure 1. Flow chart of employment

The average length of employment of employees in the enterprise depends on the normal length of employment and on the effect of experts on length of employment. The effect of experts on length of employment depends on the ratio of the current number of experts and the necessary number of experts. If the current number of experts is lower or equal to the necessary one (ratio is less than or equal to 1), the average length of employment of experts is equal to the normal length of employment. If there are more experts than necessary, the redundant experts are fired, so the length of employment is shorter than normal. The structure of the Segment 1 is shown in Figure 1.

3.2 Segment 2: Employee Satisfaction

Employee satisfaction depends on the workload and on the salary. In order to determine employee satisfaction, we calculated the number of projects per expert on the basis of demand and the number of experts (Figure 2).

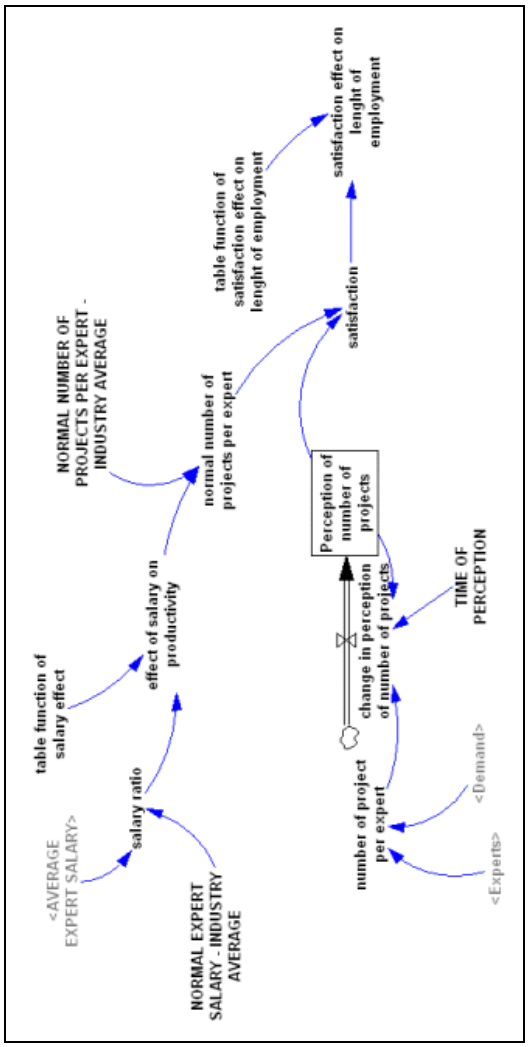

Figure 2. Flow chart of employee satisfaction

Experts are willing to work harder for a short period of time, so their satisfaction actually depends on the perceived and not real number of projects. Experts are willing to tolerate an increased workload for a maximum of one year.

When employees estimate their satisfaction, they compare the number of projects on which they work monthly with the number of projects that are handled by their acquaintances in other enterprises, i.e. with the number of projects per expert normal for their profession. However, if the salary of the expert is higher than average, they are willing to work more than average in their profession.

3.3 Segment 3: Quality of Service

The quality of services in knowledge-based enterprises is crucial for the satisfaction of their clients. Quality depends on the satisfaction of experts, because the more dissatisfied the experts are, the lower the quality of their work and by extension the quality of projects.

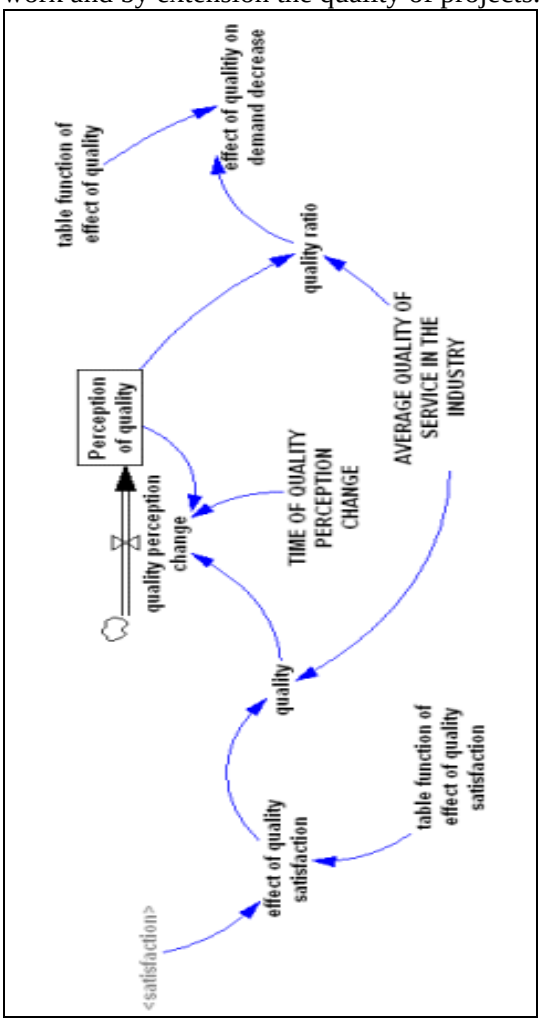

Figure 3. Flow chart of quality

However, clients do not react instantly to the decrease in quality – which is shown by the variable "Perception of Quality" (Figure 3). Clients need about 6 months to perceive the change in the level of quality. Lower quality than the normal one in the industry causes a decrease in demand for services.

3.4 Segment 4: Demand

For the purposes of this research, the demand sector was modelled in a very simple way (Figure 4). Both enterprises were set up when the markets in which they did business started to expand. Demand increases according to the average rate of growth in an activity. But, if the quality is lower than the average quality in the profession, dissatisfied clients will go over to the competition and the enterprise will stagnate or lose market share.

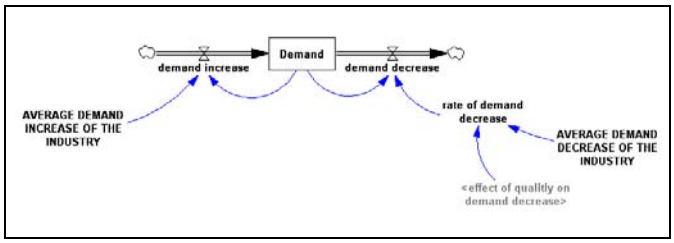

Figure 4 Flow chart of demand

It is necessary to stress out that the size of the market was not taken into consideration while creating the model, but in the long run this will become a limiting factor of growth of both enterprises. Thus it is to be taken into consideration while expanding the model.

3.5 Segment 5: Business Success

The success of the enterprises was measured in two ways: by profit and profit margin. Profit is calculated as the difference of total turnover and total cost. Total turnover is a product of the number of projects and the average price of a project, and the complete cost consists of the cost of workers and variable costs.

For the sake of simplicity, we ignored the fixed costs, and we defined variable costs as a product of the number of employees and variable costs per employee.

Profit margin was calculated as a ratio of profit and sales turnover. For illustration, here are some relations given in computer model:

*variable costs = (Trainees+Experts)*VARIABLE COSTS PER WORKER*

*employee cost = Trainees*AVERAGE TRAINEE SALARY + Experts*AVERAGE EXPERT SALARY*

total cost = employee cost+variable costs

4 Application of the Model for Evaluating Different Scenarios of Human Resource Management

Model of system dynamics described in the previous chapter was used for simulating three different scenarios: (1) normal working conditions, (3) stressful working conditions and (3) stressful working conditions with a high salary.

In the scenario "Normal working conditions", the number of projects that is acceptable to the owner and to the employees is equal to the industry average (10 projects per month). The expert salary is also equal to the average salary in the profession (8540,00 kunas). In the scenario "Stressful working conditions", the number of projects that is acceptable to the owner is higher than the profession average (15 projects per month), and the expert salary is equal to the profession average. In the scenario "Stressful working conditions with a high salary", the number of projects that is acceptable to the owner is higher than the profession average (15 projects per month). Because of a higher salary (1000,00 kunas), experts are willing to work more than the profession average, but not as much as the owner expects them to. They are willing to work on 12,5 projects per month. The behaviour of the enterprise according to 3 scenarios was simulated through 10 years (120 months).

The simulation showed that experts are most satisfied in normal working conditions. Furthermore, length of employment of an expert in an enterprise is the highest in normal working conditions, as well as the quality of provided services. This keeps the clients' perception of quality of service on a starting level, and thus there is no significant decrease in demand – which happens in other two scenarios.

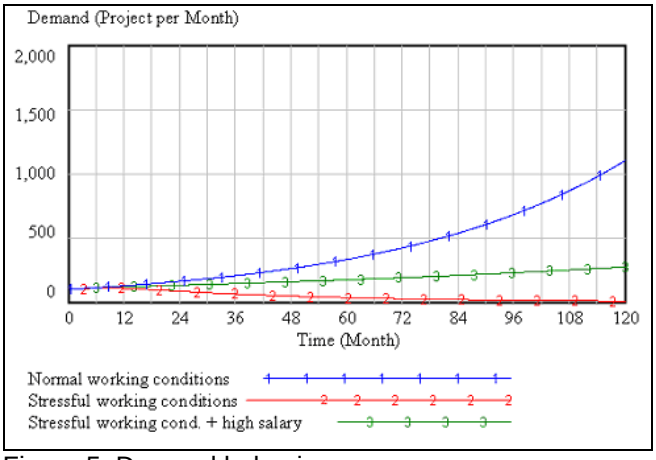

Figure 5. Demand behaviour

An enterprise with normal working conditions grows the fastest. An enterprise which has stressful working conditions with a higher salary grows, but much slower, while an enterprise with stressful working conditions stagnates. See figure 5.

When we look at the criteria for successful business (profit and profit margin), we will notice that the success of a particular scenario changes over time (120 months). At the beginning of the simulation, the enterprise that has stressful working conditions has the highest profit in absolute amount (Figure 6).

The reason for this is that all three enterprises started their business with equal turnover, but the enterprise with stressful working conditions had fewer workers, so at the beginning of the simulation their business was the most profitable one. Furthermore, experts are willing to work under stress for a period of time, but after that the quality of their work decreases significantly, which reflects on the decrease in quality of service. Clients then start perceiving the enterprise as a low-quality company and they turn to the competition. Let us remind ourselves that experts are willing to tolerate an increased workload throughout a year, and that clients need 6 months to perceive a decrease in quality. Figure 7 shows that the profit of the enterprises with stressful working conditions starts to stagnate exactly after 18 months, and the enterprise which does business in normal working conditions soon takes the lead.

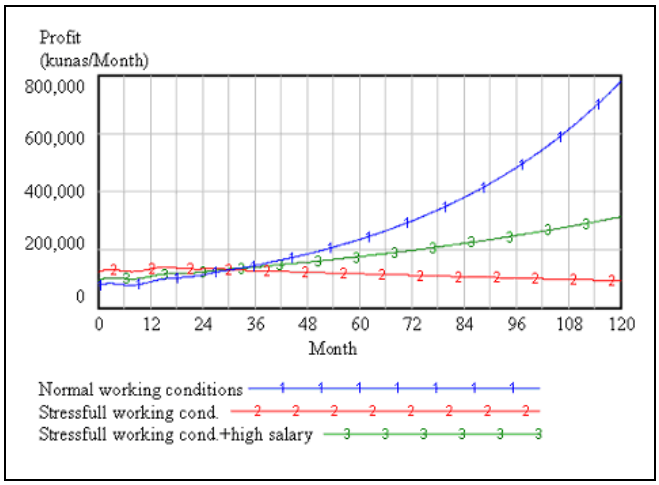

Figure 6. Profit behaviour

At the end of the simulation (after 120 months), an enterprise with normal working conditions becomes a market leader because of rapid market growth, and makes the highest profit in absolute amount. The middle enterprise is the one with stressful working conditions and high salaries. At the end of the simulation, the highest profit margin is achieved in the enterprise where experts work in stressful conditions with an average

salary, but as the demand in that enterprise stagnates so does the profit in the absolute amount.

The results of the simulations were presented to the owners of Zenith and Horizon enterprises. The owner of Zenith has so far nurtured normal working conditions, but he has started to wonder how the employees would react to increased demands with increased salary. Also, he has wondered how this would affect the quality of service that his enterprise provides, and how his clients would react. The conclusion stemming from the research has showed that the intuitive policy of human resource management of Zenith owner is the best one and that nothing needs to be changed, at least not in conditions of growing market.

On the contrary, the owner of Horizon was not pleasantly surprised with the results. Since he discovered that employee dissatisfaction actually leads to the stagnation of the enterprise. Therefore, he decided to increase the salary of experts, but he kept the workload on the same level. However, the question arises if he can still catch up with the competition.

4 Conclusion

In a knowledge-based economy quality is the key to success. The quality of service depends on the quality of employed experts. However, quality of service also depends on the workload of experts, since even the best experts cannot meet the quality level if they are overburdened. The level of workload of experts depends on the owner of the enterprise. A higher salary can be a compensation for the increased workload, but the question remains – to what point? How much should the experts be paid and how much should they work? These are precisely the questions, which we tried to answer on the basis of system dynamics modelling and simulation of different working conditions.

Conducted research, designed model and carried out simulations showed that an enterprise can achieve rapid growth only if it employs enough experts quickly enough, and those experts which would meet the standard of quality (without being overburdened) and earn a salary which is the industrial average. An enterprise with stressful working conditions, i.e. which expects an increased productivity and where workers are paid above average, will grow but not as fast as an enterprise with normal working conditions. An enterprise with stressful working conditions with an average salary will stagnate.

Unfortunately, owners of some enterprises (especially in developing countries) expect that their employees will work above average with average or below average salaries. They do not understand that with such practice the enterprise cannot achieve growth.

In a short period these enterprises make a big profit, but in the long run they stagnate or go bust since employee satisfaction is the key determinant of quality of provided services. Considering that, workers are either dissatisfied or underpaid and they follow the principle: “My salary cannot be low enough. I can always work less.” This leads to the vicious circle of stagnation and bust of the enterprise.

As the model showed, in a knowledge-based economy such enterprises are wiped out by those enterprises that employ enough workers and where employee satisfaction is high enough. The results of this research can be indicative of other activities as well. It needs to be stressed that this paper refers only to the growing market of intellectual services. For recommendations in other conditions (for example saturated market) and other industries (such as banking, trade and processing industry) we plan to conduct further research and adjust or expand the model.

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