SIMULATION

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MODELIAVIMAS

Use of Simulation and Gaming to Enhance Entrepreneurship

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Introduction

Study "Entrepreneurship education in Mykolas Romeris University, Kaunas University of Technology and Vilnius Gediminas Technical University in the areas of social and engineering sciences" has shown the insufficient entrepreneurship education in the Lithuanian educational system [1].

As research in various countries show, business games (BG) are useful to improve entrepreneurship of students. The popularity of computer BG arises constantly. Many computer BG and simulation systems exist, but only a part of them has been prepared for study.

Most of BG offer the user to improve skills in a specific area of business (for example, marketing), some other games are dedicated to show an overview of business decisions without any deep analysis [2]. Most of BG have a rather limited set of student-controlled variables. Furthermore, most of the games are organised by the teacher and the students just have to fill out the decision forms, sometimes even without understanding the subject matter. It has been found that it is harder for the players to understand the games made in countries with different culture [3]. Some scientific works investigate the influence of national and cultural traditions for learning business and management [4]. Analysis of BG used in Lithuania has shown that educational institutions generally use foreign games (sometimes translated to Lithuanian) and the financial statements used in those games slightly differ from the ones used in Lithuania. That creates a secondary problem: as Lithuania has no BG design traditions, both designing new games and studying their use in education is important.

The objective of this work is to analyze the possible methods of business process simulation and to create a tool of simulation of economic processes that would encourage the willingness of the students to understand relationships between economic processes and increase the motivation. For that it is important to adapt the architecture of the game to help its integration to engineering study programs.

Our experience has shown the importance of giving sufficient attention to bankruptcy. Although educational reasons (need to give all students an opportunity to participate in the whole game) prevent us from fully implementing it, we decided to integrate bankruptcy prediction to the game.

The method of modeling of economical processes

Business game is one of the main concepts used in this work. Since the field of BG is relatively new, the educational aspect in simulation of economical processes encouraged by the spread of the IT is comparably new.

It is important to evaluate economical factors and to select those that satisfactory reflect reality and are suitable in respect of education. The complexity of business game depends on number of evaluated economical factors.

The simplest description of the market is given by P. Kotler: marketing index M_i is calculated according to the formula. In this work x_i has been modified – credit to customers added.

$$M_i = \frac{x_i}{\sum_{j=1}^{m} x_j}, \qquad (1)$$

$$x_i = p_i^{-\alpha} a_i^{\beta} d_i^{\gamma} \left(k_i^{\delta} + \delta_1 \right), \qquad (2)$$

here p_i – price; a_i – advertisement expenses; d_i – distribution expenses; k_i – customer credit; α, β, γ and δ – corresponding elasticities; δ_1 – constant that decreases the influence of credit for customers.

Our BG "Kietas riešutas" ("Hard Nut") simulates processes of electronic engineering enterprise which produces receivers. BG suggests students to simulate producing two types of receivers TC-202 and TC-402.

Team of students needs to make managerial decisions which allow getting the best profit.

Architectural solutions of economical processes modeling and management in an educational environment

This section describes the enterprise activity model that makes the basis of the web-based computer business game. Architecture of the business game is given; advantages of open access database structure are

explained. The main advantage is related to the possibility of using the same game in the learning process to illustrate the structure of the enterprise information system and its possibilities. Fig. 1 shows common functional schema of business game.
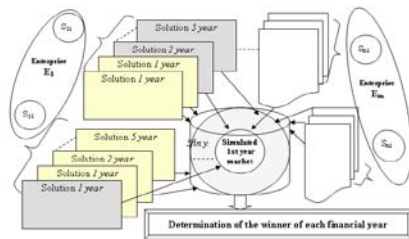

Fig. 1. Common functional schema of business game

The proposed algorithm of the business game enables students to make both team and individual decisions. They can be stored in the same database. Analysis of the demand for the universal modeling tool has led towards the selection of the groups of controlled variables and the relationships between them (Fig. 2).
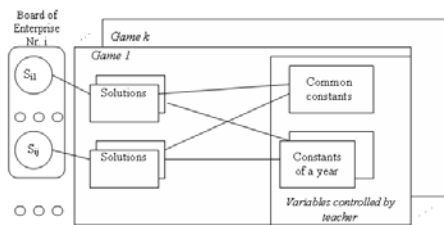

Fig. 2. Relation between the business game solutions and the initial state of an enterprise

In the game 51 variable can be changes by the teacher and 29 – by the student. It is important to know the relations between different decisions and respective economic factors (Fig. 2) when developing the activity model of an enterprise. The initial state of an enterprise should also take into account each component of its environment (bank, clients, main enterprise, suppliers etc.). Each economic factor is related to the appropriate calculations, i.e. in order to evaluate each group of factors distinct algorithms have to be developed.

BG also describes relationships between economic factors and common decisions, personnel decisions and selling-related decisions. Analysis of study process requirements has lead to the creation of the computerized BG environment integrating the simulation of economical processes of industrial enterprise. This simulation includes formal market model. Computer BG control environment is adapted to stationary and Internet-based computer games. The architecture of computer BG "Kietas riešutas" has been proposed. It has the advantages of open database structure. The created software gets universality and dynamism because of possibility to model activity scenarios of various types of firms. Our BG differs from the other business games by using a single database for both individual and group work. That enables the students to analyze the decisions and results in various aspects.

The new classification of the database queries by the managerial aspect is proposed. Students use it in the decision-making. This makes an opportunity to practical

use of various decision support methods (linear programming, inventory task, decision making in uncertain conditions, financial business evaluation, time series forecasting, loan management, bankruptcy forecasting and data mining). The possibility of implementation of the specialized packets for the rational decision making illustrates the flexibility of this model.

Additional Tool of Business Game for Forecasting Bankruptcy

A bankruptcy case is supposed to be started in case the delayed obligations of the company are larger than a half of the value of the capital incorporated into its balance. For this purpose the coefficient of the total debt (S_1) can be estimated:

$$S_1 = \frac{L}{TA}, \qquad (3)$$

here L – total liabilities; TA – total assets.

So, those companies are nearly brought to the point of bankruptcy. Actually the companies, which find themselves at the point of bankruptcy, couldn't get a credit and bankruptcy cases against those companies, which got in debt heavily, would be started. During the game the work of the recent five years is imitated, so the game takes place independently, despite the financial situation in the company, i.e. the coefficient of the total debt. Production, marketing and financial reports are provided at the end of every year, although detailed analysis is done at the end of the game.

An additional analysis of financial situation could be possibly done at the end of every year when the game was played. That would permit the students (company's executives) not only to estimate the present situation in the company but also to show a possible risk of being brought to the point of bankruptcy next year even for the company, which finished the year at a profit. It is completely possible because the participants are provided with all reports of their company, such as profit (loss), money flow, distribution of profit, balance sheet of the company etc.

The coefficient of the total debt is claimed not to be a reliable index for bankruptcy of the company forecasting. E. Altman model (*Z' Score Bankruptcy Model*) [5, 6] is used for companies' bankruptcy forecasting in business practice. One of the suggested versions i.e. E. Altman model was tried to use when the stocks of the companies are not quoted in the market (according to the case of the game "Kietas riešutas"):

$$Z = 0.717X_1 + 0.847X_2 + 3.107X_3 + 0.420X_4 + 0.995X_5, \quad (4)$$

$$X_1 = \frac{WC}{TA}, \qquad (5)$$

$$X_2 = \frac{S}{TA}, \qquad (6)$$

$$X_3 = \frac{ET}{TA}, \qquad (7)$$

$$X_4 = \frac{E}{L}, \qquad (8)$$

$$X_5 = \frac{RE}{TA}, \qquad (9)$$

here *WC* – working capital, *TA* – total assets, *S* – sales, *ET* – earnings before interest and taxes, *E* – book value of equity, *L* – total liabilities, *RE* – retained earnings.

The amount of working capital is calculated according to the principle of the balance rate: the steady investment must reimburse the value of the non-current asset and the rest part of it is used to sustain the circulation of finances. Then the amount of revolving fund is calculated according to the following formula:

$$WC = (E + NCL) - NCA, \qquad (10)$$

here *NCL* – non-current liability, *NCA* – non-current asset. Probability of bankruptcy is very high if the figure Z is less than 1.23 (*distress zone*). If the figure Z varies between 1.23 and 2.90, bankruptcy is possible (*grey zone*), and if the figure is more then 2.90 the probability of bankruptcy is very little (*safe zone*). An example of bankruptcy forecast results for enterprises R1 and R2 are shown in Table 1.

Table 1. The coefficients of the Altman model for the companies R1, R2 the meanings of the figure Z and probability of bankruptcy

Indicator	Simulated financial year					
	1		2		3	
	R1	R2	R1	R2	R1	R2
X_1	0,02	0,24	0,40	0,21	0,66	0,17
X_2	0,21	0,44	1,32	0,22	0,85	0,16
X_3	0,01	0,28	0,44	0,00	0,33	0,05
X_4	0,05	0,32	0,79	0,28	2,31	0,21
X_5	0,01	0,21	0,35	0,17	0,55	0,13
Z	0,27	1,75	3,44	0,61	3,75	0,65
S_1	0,95	0,76	0,56	0,78	0,3	0,83

As it is shown in the table 1, probability of bankruptcy in the company R1 after the first financial year was very high. Having assessed that the company's administration made appropriate decisions on production and marketing for the second and third years and improved the situation. The sales had increased, the profit had risen significantly also the company's debts to banks had been constantly decreasing. The coefficient of the total debt for the first and the second years was more than 0.5 that might show probability of bankruptcy although it is correct only for the first year and incorrect for the second. Administration of the company R2 like taking a risk and do not tend to make too many accounts and analyze as well. With the reference to the information presented in the reports of BG (as balance sheet) it is possible to calculate the meaning of variables and perform the analysis of the probability of bankruptcy. As it is shown in the table 1 the probability of bankruptcy in the company R2 was very high during all the years. The coefficient of the total debt S1 confirms that. The company R2 did not have any cash during all the years and its debt to the bank constantly increased.

Summarizing the 5646 game records of the BG "Kietas riešutas" from the bankruptcy forecasting point of view, the figure 3 shows that only 30 % of the companies,

which participated in the game during the whole period of research, were out of risk of being brought to the point of bankruptcy. The rest went bankrupt or they were very close to the point of bankruptcy, but right administrative decisions helped to avoid bankruptcy.
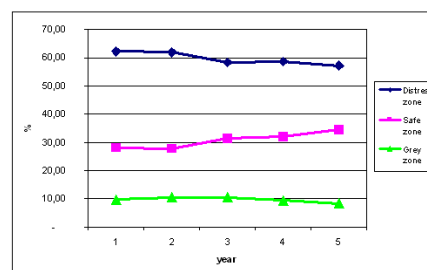

Fig. 3. Distribution percent of number of enterprises according to the segment of probability of bankruptcy

In the university level it is preferable to have the student create the required queries, although pre-created queries can be used if learning information systems is not intended. So, Altman model can be used successfully for probability of bankruptcy forecasting while playing the game. Such an extension also further adapts the business game to multidisciplinary studies [7, 8]. Extended version of BG is used in Kaunas University of Technology.

Business game integration in educational environment

The section describes the model of organization of studies using the business game for interdisciplinary integration. Examples of modules that may be used in the BG with additional modifications or different analysis of results are provided. The aspects of informal studies using BG as a main educational tool are also described. Examples of the BG implementation scenarios are given. Fig. 4 shows the usage of BG „Kietas riešutas" in university module "Simulation of business processes". Optimization methods are used for rational decision-making.
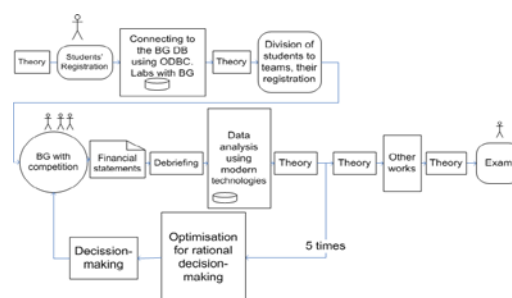
Fig. 4. Use of business game "Kietas riešutas" in university module "Simulation of business processes"

Scenarios for the use of the BG in the informal studies of different level have been proposed. The software has been designed to support them. For example, students can do lab assignments using the "Monopolistic market". The modern learner often has specific requirements for study process, for example, to make it possible to study at the chosen time, but keeping the common timetable. In such case distance studies are preferred. This paper also includes a methodology to prepare a distance leaning

course to use the BG. VIPS (Video lecture system by the Distance learning centre of Kaunas University of Technology) can be used for briefings and debriefings. For imagining business processes more deeply it is not enough to show simulation of basic part of BG, but it is advisable to simulate other parts enterprise activity in more detail. It means that could be useful students to integrate in BG simulation of operation management process. This paper shows possibility to use more complicated version of exploring BG in teaching engineers for introduction to business or enhance entrepreneurship.

BG that applies the model described in this work has been implemented by using PHP. The database was implemented by using Microsoft SQL Server and is accessible for students via ODBC for further analysis. The distance learning course is accessible via URL http://webct.liedm.lt or directly BG is accessible via http://info.smf.ktu.lt/eikwin2006/en.

Conclusions

Use of business game in the educational process has shown these main educational advantages: students understand the material better; open version of database of BG allow user to improve skills and attitudes not only in field of entrepreneurship but in the field of informatics engineering; it encourages students to seek knowledge, and to apply it in practice; extended version of BG allow learners and teachers to evaluate financial results and encourage them to improve decisions in the next year simulations. In the future BG can be extended by additional modules (inventory task, decision making in uncertain conditions and etc.).

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E. Bagdonas, I. Patašienė, M. Patašius, V. Skvernys. Use of Simulation and Gaming to Enhance Entrepreneurship // Electronics and Electrical Engineering. – Kaunas: Technologija, 2010. – No. 6(102). – P. 155–158.

Business Game (BG) "Kietas riesutas" ("Hard Nut") has already used for about ten years for teaching business basics. The study performed in 2007 has revealed insufficient attention given to entrepreneurship of engineering students. Thus it has been decided to propose the distance education module "Simulation of business processes" using BG. That could be expected to improve the module's appeal and to encourage the students not just to learn the business basics, but also to deepen their understanding of business processes. The architecture of the described BG enables the use of additional extensions and gives the student an opportunity to learn not just about business, but about informatics as well. The compatibility between BG and Altman model has been checked and improvements to BG suggested. Ill. 4, bibl. 9, tabl. 1 (in English; abstracts in English, Russian and Lithuanian).

Э. Багдонас, И. Паташиене, М. Паташюс, В. Свернис Использование игр и имитационного моделирования для совершенствования антренерских навыков // Электроника и электротехника. – Каунас: Технология, 2010. – № 6(102). – С. 155–158.

Деловая игра (ДИ) „Твердый орех" („Kietas riešutas") уже используется более 10 лет при обучении студентов основам предпринимательства. В 2007 г. произведены исследования показали, что недостаточно внимания уделяется при развитии предпринимательских способностей студентов инженерных специальностей. Для решения этой задачи был создан новый предмет „Моделирование процессов на предприятии", составной частью которого является ДИ. Структура ДИ позволяет не только принимать основные управленческие решения (по объемам производства, ценам, персоналу, маркетингу), но и произвести анализ финансового состояния предприятия, предвидеть вероятность банкрота. Для этой цели проведена проверка пригодности модели Е. Алтмана. Ил. 4, библ. 9, табл. 1 (на английском языке; рефераты на английском, русском и литовском яз.).

E. Bagdonas, I. Patašienė, M. Patašius, V. Skvernys. Modeliavimo ir žaidimų taikymas verslumui ugdyti // Elektronika ir elektrotechnika. – Kaunas: Technologija, 2010. – Nr. 6(102). – P. 155–158.

Verslo žaidimas (VŽ) „Kietas riešutas" jau 10 metų naudojamas verslo administravimą studijuojantiems studentams mokyti verslo pagrindų. 2007 metais atlikta studija parodė, kad nepakankamai dėmesio skiriama inžinerinių specialybių studentų verslumo ugdymui. Įvertinus tai, buvo nutarta sukurti nuotolinių studijų modulį „Verslo procesų modeliavimas", kuriame būtų integruotas VŽ. Jį taikant padidėtų modulio patrauklumas, studentai būtų skatinami ne tik įsisavinti verslo pagrindus, bet ir gilintis į verslo procesus. Aprašyto VŽ architektūra leidžia naudoti įvairias papildomas priemones racionaliems sprendimams priimti ir pagrįsti, suteikia galimybę studentui gilinti žinias ir įgūdžius ne tik verslo, bet ir informatikos inžinerijos srityse. Patikrintas Altmano modelio suderinamumas su VŽ, pasiūlytos VŽ tobulinimo kryptys. Il. 4, bibl. 9, lent. 1 (anglų kalba; santraukos anglų, rusų ir lietuvių k.).