VIRTUAL STRATEGIC MANAGEMENT GAMES AS A TOOL FOR BUSINESS EDUCATION

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Abstract: *The constant evolution of internet and electronic communication which can be observed in the last two decades lead to implementation of various tools that support learning process regardless of its level. Simulation board games have always been an efficient method of teaching managers and it extension to virtual environment gives almost infinite learning possibilities. There are many virtual simulation games available on the market but most of them are limited to a specific scenario. This article is focused on presenting an alternative framework applicable for business education which, however in contrast to other products, gives the teacher the flexibility to set up a business case which suits the needs of his trainees.*

Keywords*: management, business, education, management games*

JEL Classification*: A20, C63, C73, C88.*

1. INTRODUCTION

This paper focuses on the design process of an education game used for courses in management education. Its goal is to demonstrate an approach to game development which would be both – playable and educating at the same time. After giving some background about computer games and simulations as teaching methods, the authors provide an overview of the design and implementation of the Virtual Strategic Management Game (SMG). The presented framework is the result of the project "Strategic Management Games – innovative teaching method for business education" financed by Leonardo da Vinci education-research program of the European Union. The first part of the paper describes problems related with the design of the game core. Then the framework model is being presented. At the end, the paper gives preliminary results and concludes with future directions of design.

2. BACKGROUND

The growing potential of Information and Communication Technologies (ICT) created vast possibilities for their usage in the education process in every thinkable area. The potential of ICT has been discovered in the late 1970s, when the introduction of the personal microcomputer brought a new impetus to computer-related learning. Programming languages had been taught as a learning tool for applied mathematics and algorithms [1]. Later on, when personal computers got more popular, ICT were used in many other aspects of education, enabling the usage of multimedia and simplifying the process of visual aids preparation. Simulations of simple and complex systems gained their place in classrooms as a dynamic way to introduce concepts in different areas. Economics and management where not an exception, and computer based simulations are nowadays commonly used in many classes especially in the form of decision games. Academia, industry, and governments have embraced games as useful tools for education, training, advertising, and a multitude of purposes outside of "pure" entertainment [2]. Serious Games began to receive attention [3].

After the strength of ICT-based teaching methods was observed, the market was flooded with many education tools, programs and applications which were supposed to aid tutors [4] [5] [6]. Theoretically educators nowadays have many possibilities to choose from. In practice most applications available on the market don't possess the requirements needed to be used as efficient learning tools. They are either too game driven – the playability is high because of good quality graphics, sound, story etc. – but they lack the educational potential, or they are extremely focused on simulating reality and at the same time, they are lacking the needed visual attractiveness to establish the necessary interest. The aim of the before mentioned project was the development of a simulation game which would posses both at the same time.

3. FRAMEWORK DESCRIPTION

SMG was designed to allow players to understand basic rules of company and market functioning. In everyday business, entrepreneurs and their employees are facing fierce competition and fight for the customer. The implemented model should not only push the user to fulfil customer needs by adjusting his own product and service parameters but also force him to coordinate all aspects of the enterprise. These principles were leading us through the design process of the strategic management game framework, which is a tool for teachers, enabling them to simulate how to effectively manage a company on the competitive market. A basic advantage of this method of business education is letting players (managers, regular employees, students, etc.) to experiment and make independent decisions regarding the operation of virtual enterprises. This is called the *learning by doing* principle which is considered to be very effective, especially in business education. On the other hand by designing the SMG we wanted to foster players knowledge towards seeing an enterprise as an interconnected vessel. When one *pours* money into one domain of the company she/he must consider not *pouring* it to another which may cause decrease of its economic indicators. Therefore all business and management decisions must consider the company as a whole, not as independent functions or departments.

The problem

A common problem in the design of business games, meant for classroom usage, is simplification. Real world market mechanisms are too complex to introduce them into one package for universal application. That's why authors of business games must always choose the most appropriate approach to parameterize their model. The most complex tasks involve quantifying the demand as a function and the evaluation of players performance. Demand is hard to quantify if a series of assumptions need to be met. In the proposed framework, the following assumptions had to be met:

- there is a limited number of customers on the market,
- customers buy products of all companies but a single customer makes only one purchase per turn,
- each customer is described by a set of preference parameters,
- each product is characterized by a set of corresponding parameters in a way that one product parameter can correspond to many preference parameters and vice versa.

Every simulation game has to tackle this problem. The approach implemented in SMG has been described below.

General game description

SMG is a simplified model of the market on which companies can sell products or product like services. This assumption means that in SMG, one can model only products and services that follow traditional business chains, for example it is possible to prepare a scenario simulating the behaviour of a fast food restaurant market, because it has a central or a regional place/s for ingredients for meal production(similar to a factory) and network of restaurants (service provision points). The required conditions that must be met for modeling market in SMG are:

- Business is embedded in real life. Each virtual company has its headquarters/production site and sales offices (at most one for each possible geographic area).
- The Product/service is described by four parameters. Default parameters are: price, quality, technology index, ecology index. The last two can be named freely with respect to the modelled commodity[1]. These parameters may vary for subsequent commodities.
- The manufacturing process requires supplies for final commodity production.
- Final commodity must be transferred from production site to sales offices.
- After-sales service cannot be crucial for business effectiveness and therefore cannot be modelled in SMG.

SMG is a turn-based game framework which simulates competition of independent companies. Each team (company) starts with the same level of resources (money, inventory levels, sales offices, workers, etc.) and is obliged to submit decisions divided into six areas:

- Marketing and Sales. All decisions made by the players in this area are connected with specific commodity-to-market relations, i.e.: opening/closing sales offices, commodity price setting, advertising channel selection.
- Operations. All operational decisions made by the players are due to manufacturing and supply chain needs, i.e.: set the volume of each commodity production, supplier selection, commodities transfer in supply chain (from headquarters to sales office/s, from sales office to other sales office/s).
- Research and development of commodities and production lines with respect to its parameters, i.e.: increase/decrease the production capacity of production line/s, increase/decrease technology index of commodity X.
- Human resources. Players make decisions related to various aspects of human resource management, i.e.: number of production and sales workers, the salary and pension levels for each group , number of holidays, extra benefits (health program, sport activities, etc.).
- Finance. Players decide how much they want to borrow from virtual bank to support their business. If a company has a debt players can also increase the automatically calculated instalment for specific turn.
- Strategic management. In this area mission, vision and goals of the company are defined. This data is qualitative , therefore it can be only evaluated be the trainer. Additionally virtual managers determine the market share forecast. If the forecast is achieved the company receives a financial bonus specified by scenario creator.

When all players (companies) submit their decisions. SMG runs a player performance evaluation algorithm to assess effectiveness of each virtual company. For detailed description of the algorithm please see *Players performance evaluation* section of this paper.

Customer demand generation

As in many other games, the main goal of each company is to sell as many products as possible. Therefore a demand generation algorithm is a crucial factor for the framework. Demand for commodities is generated independently for each market, i.e. when a company sells product X and Y on market A and B, demand for both products (treated as one product mix) is generated for market A and B separately. Detailed demand generation algorithm for an individual market is presented on Figure 1.

The customer-groups and commodities-selection looping in the demand generation algorithm is rather straightforward and doesn't need further explanation (see Figure 1). The parameter calculation is however more complex. As previously mentioned, in SMG, we distinguished four parameters describing each commodity. We can divide them into two groups: price-related (price) and commodity-related (quality, technology index, ecology index). For each group, we propose slightly different method of calculation.

[1] The term commodity refers, in this context, to a single product or a single service.

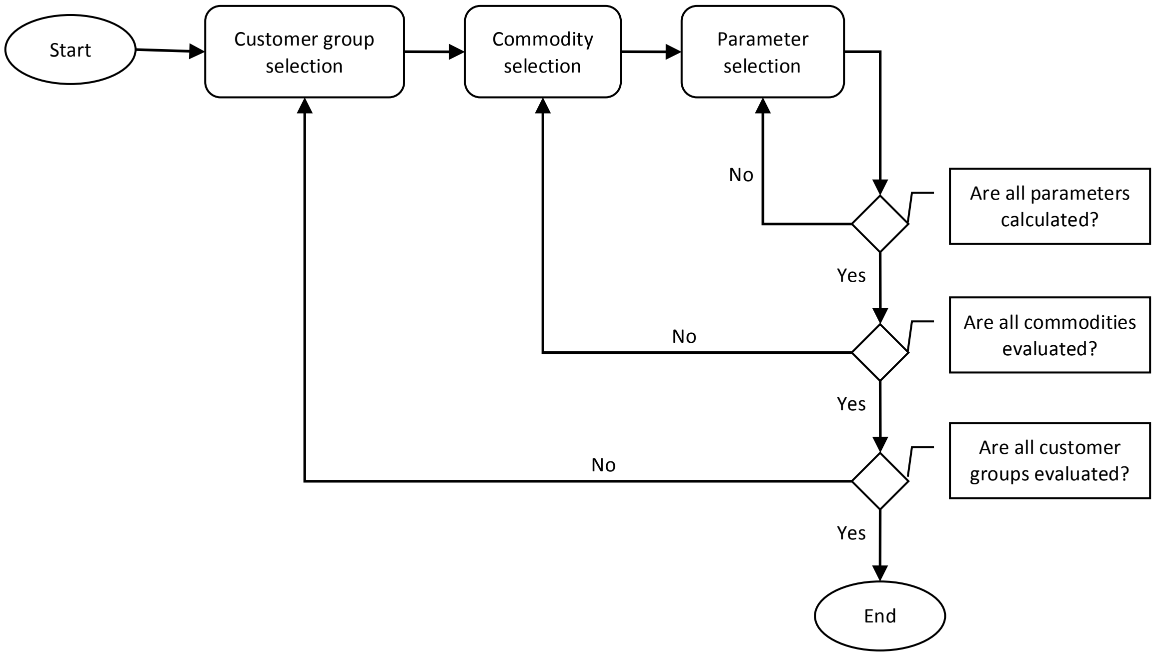

Figure 1 Demand generation algorithm for individual market

The price parameter is calculated using the formulae

$$P_p = \begin{cases} 0, & P_i > P_{max} \\ \frac{\max(P_i, P_{opt})}{\min(P_i, P_{opt})}, & P_i \geq 0 \text{ and } P_i \leq P_{opt} \\ \frac{\min(P_i, P_{opt})}{\max(P_i, P_{opt})}, & P_i > P_{opt} \text{ and } P_i \leq P_{max} \end{cases} \quad (1)$$

where P_i denotes price of the evaluated commodity, P_{opt} and P_{max} are the optimal and the maximal price that the customer from each group is willing to pay. Commodity-related parameters are calculated using the formulae

$$P_c = \begin{cases} 0, & P_i < P_{min} \\ \frac{\min(P_i, P_{opt})}{\max(P_i, P_{opt})}, & P_i \geq P_{min} \text{ and } P_i < P_{opt} \\ \frac{\max(P_i, P_{opt})}{\min(P_i, P_{opt})}, & P_i \geq P_{opt} \text{ and } P_i \leq P_{max} \end{cases} \quad (2)$$

where P_i denotes parameter value of the evaluated commodity, P_{opt}, P_{max}, P_{min} are the optimal, the maximal and the minimal parameter value related to the customer preferences (e.g. technology index preference).

The matrixes of market-customer group-commodity-parameter allow the SMG framework to prepare a list of preferential commodities for each market and each customer group on that market. Then the commodities are bought by customers according to these lists.

Players performance evaluation

For every area of activity of each company some evaluation criteria are defined. The weight is defined for every criterion, as well as for every area. Each criterion also has a range of feasible values. The weights are set up by the administrator. He also decides, which method of overall result calculation to choose. The Decision Maker (DM) is asked to choose the value of every criterion from the feasible range. After that, in every round, for every DM the overall result is calculated in the following way.

We start with evaluating and normalizing the results using the formulae

$$y_{ij}^k = \frac{M_{ij} - x_{ij}^k}{M_{ij} - m_{ij}} \quad (3)$$

when the criterion is minimized and

$$y_{ij}^k = \frac{x_{ij}^k - m_{ij}}{M_{ij} - m_{ij}} \quad (4)$$

when it is maximized. Here x_{ij}^k denotes the initial value of the criterion *j* in the area *i* gained by the DM *k* , m_{ij} and M_{ij} are the minimum and maximum values of the criterion among all the DMs and y_{ij}^k is the normalized value (equal to 0 for the worst and 1 for the best DM). Now the normalized values are transformed, depending on the preferences of the administrator. Three types of function can be used. First is the neutral, linear function F1:

$$F1(x) = x. \quad (5)$$

Second one is the exponential function, preferring extraordinary growth in some area:

$$F2(x) = \frac{e^x - 1}{e - 1}. \quad (6)$$

The third function, preferring the balanced growth, is the logarithmic function of the form:

$$F3(x) = \ln\big((e-1)x + 1\big). \quad (7)$$

Observe that all the above functions are increasing and satisfy the condition

$$F1, F2, F3: <0,1> \to <0,1>. \quad (8)$$

Finally we sum up all the transformed values, multiplied with the respective weights w_{ij} defined for the criteria, obtaining this way the total amount of points assigned to every DM for the area *i*:

$$X_i^k = \sum_j w_{ij} F_{ij}\big(y_{ij}^k\big), \quad (9)$$

where F_{ij} denotes the function (F1, F2 or F3) used in the case of criterion *j* in area *i*. Now the results are normalized to the values Y_i^k with respect to the areas, similarly as with the formula (4). They are scaled in such a way that the best DM in every area obtains 1 and the worst one 0. We transform the results again with the functions F1, F2 and F3 and sum it using the formula (w_i denote the weights assigned to the areas):

$$R^k = \sum_i w_i F_i(Y_i^k). \quad (10)$$

4. CONCLUSIONS AND FUTURE WORK

The SMG, or to be more precise, the SMG framework gives tutors broad possibilities to modify existing or to develop new scenarios all based on the course needs. It gives the possibility to model a reality based model concerning any commodity possible and it is not limited geographically, because of the fact that the scenario builder can choose any market, based on Google Maps API[2]. There are still areas where much can be improved. As for now, the system is limited to 4 variables per product/customer etc. This number should be extendable, allowing scenario builders to configure as many parameters as they would like. Moreover all functional areas introduced in the game (Sales and Marketing, Finance etc.) can be extended by additional options allowing the tutor to go into details in his chosen area. The proposed implementation would need a well designed configuration panel.

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2

[2] Application Programming Interface, allowing third party application to access and use Google Maps.