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MODELLING SMART ECONOMY AND EDUCATION-RELATED ENVIRONMENTS USING SYSTEM DYNAMICS PRINCIPLES

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Abstract

We live in a world powered by information. This truth gives us the potential to master as much information as we can in order to make our activity more efficient. The development of technology gives us both the means and the capabilities to gather and analyze this large amount of information so that we can use more efficiently the limited resources that we dispose of. Basically, this paper presents a modality of modelling smart university and smart enterprise environments based on the principles of System Dynamics, the model of economic map presented in previous papers and the concept of smartness within an environment. In these terms, smart is referred to the usage of new methodologies and technologies in order to optimize the activity in a controlled economy-based or educational environment.

Key words: *smart, education, enterprise, training, system dynamics, economic map*

INTRODUCTION

The educational background of the people working within a company is essential for the economic and social performance of the enterprise.
Moreover, this background potential is affecting positively both the career of the student and the image of the affiliate university [6]. As an adult, the educational background is kept and enlarged by training [7]. In this way, the training companies have also a benefit for creating the training process for various persons having educational needs.
The fast development of the technology in every domain [3] eases the intersected benefits of the three contexts: the university education, adult training and enterprise environment.
In this way, technology acts like a binding element between their parameters and helps at creating better education for more performant enterprises from economic and social point of views. Besides the actual technology aid to the structure and flows within the activity [4], universities give technology a boom due to immense amount of research.
In this matter, this paper presents the first steps of modelling an environment that borrows elements from university education, adult training and enterprise environments and the way it is influenced by the advances in technology, in a way that the literature refers to it as smart characteristic that forms smart universities, smart enterprises and, finally, smart education.
This model is created using a method known as System Dynamics, widely known for their capability to reflect the real character of an environment in a structured way using concepts such as flows, stocks and cause-effect feedback.
Practically, the paper will contain a short description of the method and the particular characters of its appliance for the issue. Then, we will start to apply it to our particular case and complete the first part of the method

consisting in the conceptualization of the model.

MATERIALS AND METHODS

The main three notions presented in the introduction are linked together so that changes in the economic and social space regarding one of them influences the others in different manners. The technology adds a greater degree of difficulty to the determination of the influence of the parameters on the market. Thus, we can consider them subsystems of a bigger more complex system. In this way, their behaviour can be modelled using various existing methods, one of them being known as based on the dynamic characteristic of a system.

System dynamics method is widely used in order to model a great range of systems, from theoretical issues, such as the behaviour of a spring in a period of time, to particular problems as the evolution of a contagious disease within a population or the dynamics of economic parameters within an enterprise. The unlimited and usual cases that can be modelled comprise management issues [2], environment cases [5] and economy optimization problems [8]. Starting from a particular situation, the method permits the users to obtain a graphical representation of the origin system of the problem. Usually, the final result is a diagram containing the parameters taken into account and the way that influence each other. Thus, the result is either a stock-and-flow diagram or a causal-loop diagram.

The method consists in going through several parts. The first one of them and also the most important is the conceptualization. The correct representation of the system in this point is crucial for the best approximation of the system behaviour.

Conceptualization has four main steps [1]:

-The definition of the modelling purpose, which means actually setting the objective of the modelling process. Defining the purpose let the modeler to focus on the final results and to obtain a valid usable diagram.

-The determination of the model boundary and the key variables, which consists in the setup of a context and the choose of the components that form the model.

-Drawing the behaviour of the variables presented above. This step requires gathering historical data about the components selected in the previous step or a trial of their description is data is not available.

-Finally, the modeler creates the mechanisms and the feedback loops, which is the final step of the conceptualization part.

The other three parts of building a model using system dynamics method are the formulation of the model, the testing and the implementation. While the formulation helps at converting diagrams to level and rate equations and testing does the validation part, the implementation applies the model to different policies and convert the results into readable data.

Regarding our particular case, the final result would consist in finding the influence of the technology on the three components described in the introduction. The purpose of the model building is to determine the degree of positive influence on the education and enterprise environment.

RESULTS AND DISCUSSIONS

The purpose of the model

Basically, the purpose of the model can be established in this form:

The purpose of the model is to determine to what extend technology helps at creating smart education in universities and training centres and smart performance in enterprises.

Having determined the objective of our research, we will go further to the next step.

The boundary and key variables

We will select the boundaries and the key variables based on some principles:

-the components must be necessary

-the similar components must be aggregated

-the components must be directional.

Also, we will split the list in two categories: endogenous and exogenous parameters.

In our case, the parameters considered for our model, as well as their classification, is presented in Table 1.

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Table 1. The key parameters considered for building the model

Parameter	Type [Stock/Flow]	Exogenous	Endogenous
Number of students	S	x	
Rate of enrolling	F	x	
Student level of education	F	x	
Potential students	S	x	
University research in technology	F		x
Number of training companies	S		x
Number of trainees	S	x	
Rate of register	F		x
Funds for training	S		x
Training cost	F		x
Training quality	F		x
Potential trainers	S		x
Profit investment rate	F	x	
Employer potential income	F		x
Employment rate	F		x
Technology investment	F	x	
Employer education level	F	x	
Potential employers	S		x
Number of enterprises	S		x
Potential entrepreneurs	S		x
Technology costs	F	x	
Available technology	S		x
Technology growth	F		x
Technology embodiment	F	x	
Graduation rate	F		x

Source: Own conception.

Reference modes

This step requires the plot of the system variables enunciated in the previous step over time. The major challenge of this step is the determination of this time of measurement, which may be relevant or irrelevant to the given issue and which may influence the analysis. For our case, the time taken into consideration is 5 years.

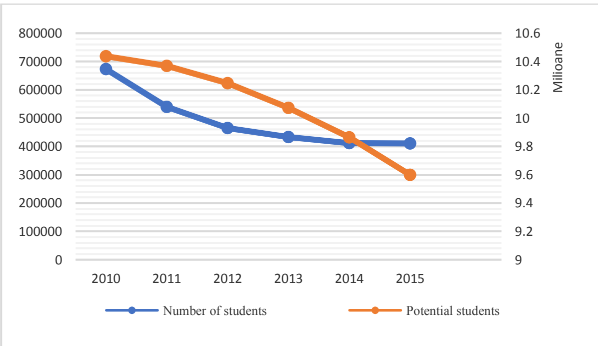

Fig. 1. University indicators
Source: NIS, Romania (http://statistici.insse.ro)

Other challenges refer to the historical or hypothetical character of the series of data referring to variables. If data is known for a variable, it may be helpful in further steps of the method.

The variables grouped in components are shown in the figures presented in this paper.

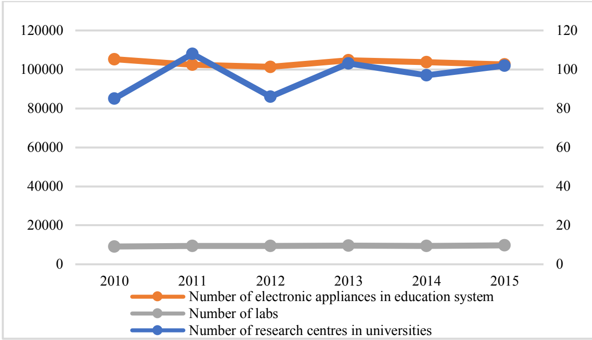

Fig.2. Technology research
Source: NIS, Romania (http://statistici.insse.ro)

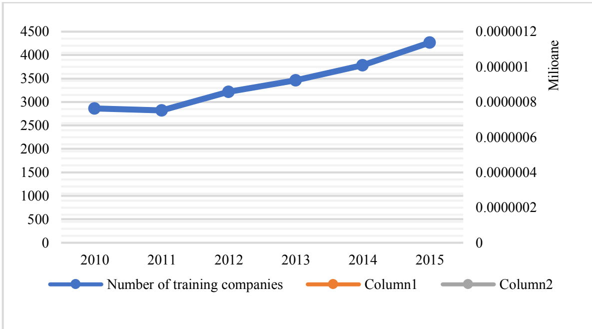

Fig. 3. Training indicators
Source: NIS, Romania (http://statistici.insse.ro)

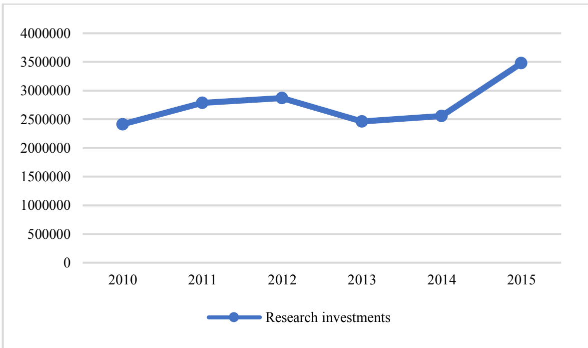

Fig. 4. Research investments
Source: NIS, Romania (http://statistici.insse.ro)

Building the mechanisms and feedback loops

Given the data above, we have created the scheme presented in Figure 5, which presents the relations between the variables taken into consideration. The scheme is a proposition that can be updated by modelling it after the exact situation given in reality. The scheme was obtained using a free version of Vensim Software.

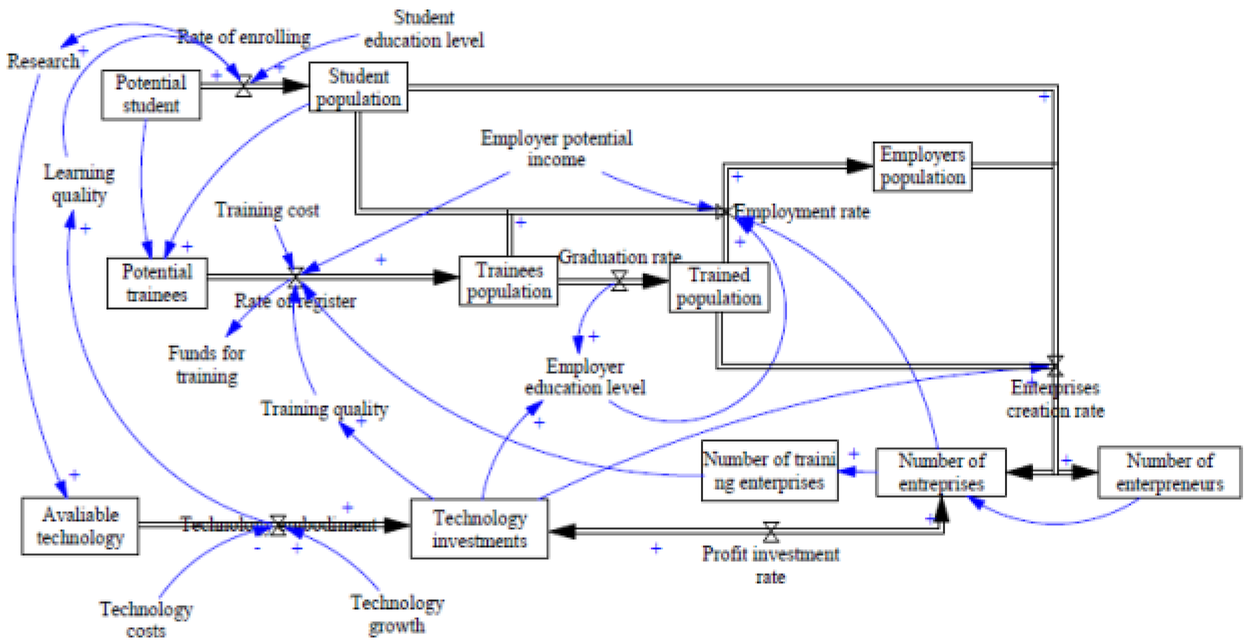

Fig. 5. Proposed diagram for the given issue
Source: Own design.

CONCLUSIONS

The given model is a basis support for a future development of a system dynamic complete analysis of the stated issue. This can be used for further research in order to observe the system behaviour and to use the results for further development. A future work would refer to the completion of the system dynamic development and the description of an actual implementation of technology in the three main components: education, training and enterprise.

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