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System Thinking Approach in Solving Problems of Technology Transfer Process

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Abstract

The role of knowledge creators and accumulation like universities is consistently growing and obtaining new forms of operation. New knowledge and ideas, used by researchers themselves, in spite of its great value to education system i.e. remaining separated from innovation, do not give much to economic growth. Competitive research may result in scientific carrier and high worldwide reputation, but remaining with negligible relevance for the innovation system. For a stationary economy, where entrepreneurs are engaged in reproducing the given, this poses no difficulty. But as soon as development enters, and comparative advantages based on given products and technologies are eroded by newly industrializing economies, the situation transforms fundamentally. The production of new knowledge, to become an economic activity with high value added, has to become embedded into new combinations of resources. This requires a structural coupling of the science with economic development level of society. The traditional division of labour and functions between academic science and academic teaching, industry and society (applied research, development, innovation, societal benefits) becomes insufficient. Today university activities crosses traditional boundaries through linkages with the socially economic development level, it should develop new ways to interact between each other. The role of efficient technology transfer system, providing conducive to spillovers environment and society ready to promote technological adoption, implementation and application determines also new role for regional universities or research centres. Less developed countries have an advantage to adopt new knowledge created by technology leaders. The ability and capacity to absorb secondary or tacit knowledge may increase competitiveness on different levels. The aim of this paper is to systemize linkages of technology transfer process in less developed country into proper system model scheme as well as to stress problems of technology transfer enforcement.

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Keywords: Technology Transfer, Innovations, University Industry Collaboration, System, Model

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1. Introduction

In recent years technology transfer has become a buzzword in the context of higher education, it is not a new practice. Technology transfer is the process of developing practical applications for the results of scientific research. While conceptually the activity has been practiced for many, the present-day term technology transfer is used to describe various practices in which a relationship between at least two entities is formed with the intent of capitalizing on research for commercial purposes. In the case of universities, the research or invention is usually provided by the academic research, while the mechanism of commercialization is provided by for-profit entity and eventually commercialization organization.

The aim of the research paper is to highlight of feedbacks in technology transfer process management model. In this work there was considered the principles of systems thinking approach to technology, transfer processes and channels, there was discussed technology transfer raising role in the competitiveness of the company, there was made an analysis of the situation in Latvia, using systems approach. Successful management of technology transfer model is needed to achieve a balanced interaction of three components: basic science, management and technology transfer industry, where one of the prerequisites is immediate internal fundamental science support increase (the national budget of the EU funds with its high value alone could not provide necessary development of R&D and technology transfer).

2. Literature Review And Hypotheses

Traditional approach assesses technology transfer as a knowledge transfer between research laboratories and industry and is influenced by four main components: (a) level of collectivisation or / and globalisation; (b) availability of new facts (knowledge); (c) personnel skills and abilities to adapt, use, improve and innovate and (d) availability of advanced machines and equipment. Innovation is a driver of companies' competitiveness leading to increase of productivity and efficiency of production. The role of knowledge creators like universities is consistently growing and obtaining new forms of operation. Several authors covered by Etzkowitz H., Leydesdorff L. (2001) have outlined that since 1990s university-industry partnership was guided by interaction with government in a systematic way to promote economic and social benefits and outputs for society.

Triple-Helix theory emphasizes importance of commercial return from university, introduces entrepreneurial university model and distinguishes several routes of knowledge and technology transfer. One study informed that MIT graduates have funded 4000 companies with annual revenues for USD 232 billion worldwide. More detailed approach considers importance of knowledge flows in regional or national innovation systems (Etzkowitz (2001)) and EC (2001)). In essence, the model of interaction has more complex mode. Sometimes the best way how universities may transfer their knowledge to industry and society is via soft or indirect channels, like publications, exhibitions, conferences, consultations, informal exchange or unpaid advices. Non-linear approach to innovation processes requires more wide focus to understand clear role of both industry and university. Kautonen (2000) presents several categories of companies involved: customers, suppliers, competitors and partners. As a result of substantial private and public investment in research activities it is important to manage existing interactions in a way to get maximised return back. Sources of new knowledge might be classified as follows:

- research organisations (we can name them as R&D);
- customers (C);
- other research driven firms (B);
- intermediates (here we classify also educational and training institutions,
- it could be better to name it as external expertise class; I);
- individual persons (P).
-

The variety of existing technology transfer channels, the main routes for commercial return - B2R&D, B2B, B2C, B2P, R&D2R&D we described in our previous work, where we identified main TT channels between R&D and

industry. There is growing importance of intangible components of technology transfer process: role of formal and informal linkages as well as skills and abilities to transfer, imitate and copy are increasing.
Dalkir (2005) proposes three main steps in knowledge transfer and management model:

1. knowledge assessment, sharing and dissemination;
2. knowledge understanding, acquisition and application;
3. knowledge capture and / or creation including adjustment or update of captured one.

Wood (2011) introduces a process model approach to explain academic entrepreneurship as a serious of separate events. The weakness here is that we replace earlier fundamental research system with fragmented and not interacting technology commercialisation actions.

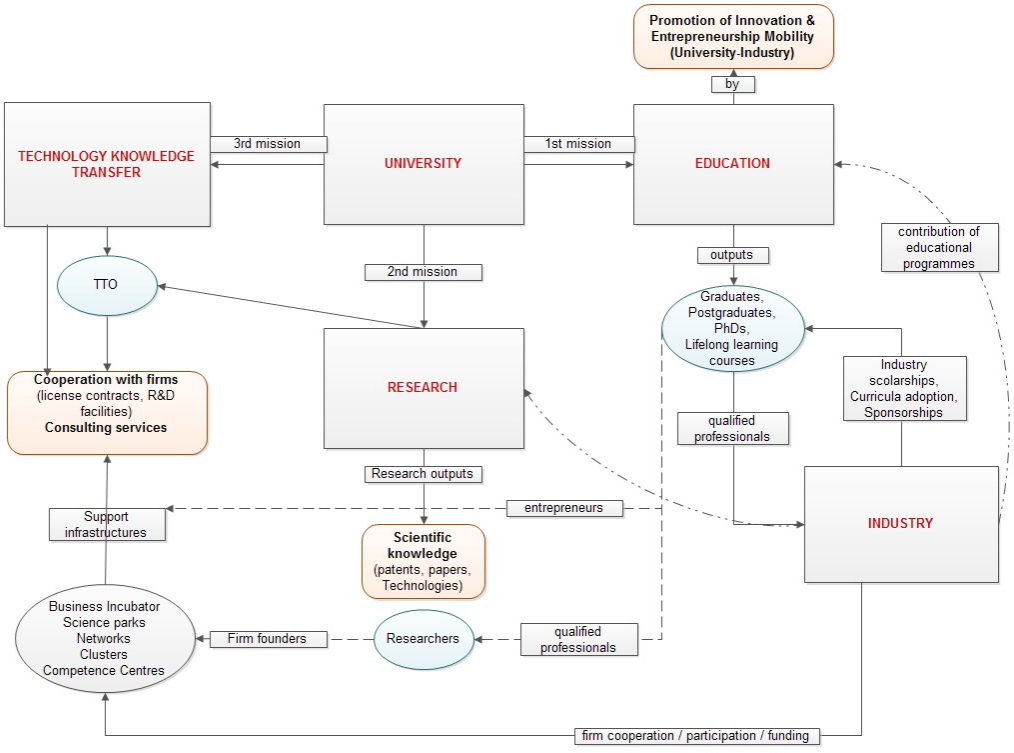

Fig.1 The model of university with three strategic priorities

Almost all large public universities in Latvia have structure of departments where research institutes with few exceptions are sub-structures of departments with a highest priority to provide qualitative education services up to PhD level studies. Research activities are more integrated within PhD studies with aim to renew university's professorship and to keep education – research linkages thus getting feedback to teaching process. The large emigration outflow of young talents and graduates abroad and low birth rates with followed with essential decrease in number of students, aging professorship with limited rotation caused by requirement to provide lectures mainly in Latvian, determine need for strategic changes in local university policies and administrative mindset. Estonian and Lithuanian universities not speaking about other more developed Baltic Sea Region countries show much higher flexibility, will, operate with larger resources and outperform Latvian ones. The comparatively new regional university colleges (established in average before 15-18 years) have a role of catalysts of regional growth and might be more adaptive to new situation compared to less flexible national-wide universities with slow decision time and lack of willingness to change.

Companies are occupied with short term revenue opportunity finding and in-house innovation execution, because they think universities cannot perform research for them, scientists are slow, there is information asymmetry and small size of business.

The Republic of Latvia urgently needs a new development policy and active technology transfer could be the cornerstone in it, where the high absorption capacity would be "The key". The policy to promote external knowledge transfer and adoption, incremental process and organisational innovations, which would allow to revitalise knowledge-based national development strategies. But it is not the whole story. According to presentation of president of Latvian Innovators Union from November 29th, 2013, combination of different political and economic factors in Latvia finds expression shown on Fig 2.

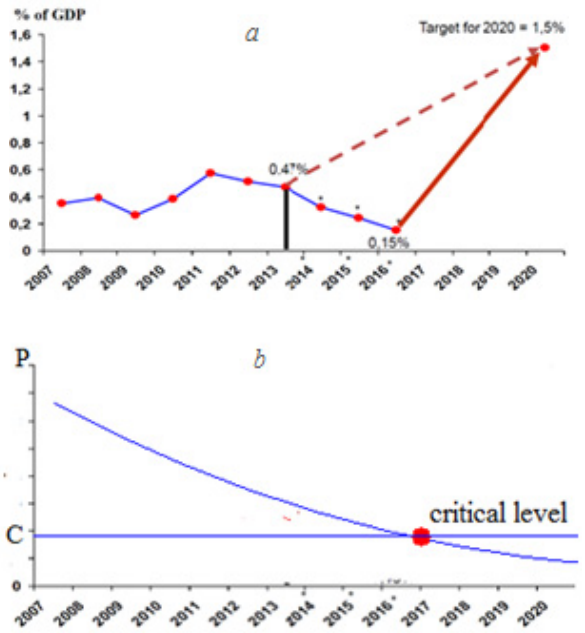

Fig 2. The allocation of funds for R&D+I in Latvia (in total)
Source: Ivars Kalviņš, President of Latvian Innovators Union, Latvia; November 29th, 2013, Riga, Latvia; http://conference.scientificservices.eu/sites/default/files/09_30%20Ivars%20Kalvins_Innovation%20in%20Latvia%20-%20Problems%20and%20Solutions.pdf

Fig.2 (a) shows planned (dashed line) and real situation of investment in science and research in Latvia in period from 2007 till 2020 year. During these years negative tendencies accumulate. Second graph 2(b) shows that parameter P, which accumulates scientist age structure, lack of scientists, professional qualification, public evaluation of science ect. after reaching some critical value C can lead to the degradation of R&D system. R&D system can not be renewed fastly even if the input of large amount of foundation appears. Near this critical point technology transfer seems to be vague. The second graph shows that parameter P, which accumulates scientist age structure, lack of scientists, professional qualification, public evaluation of science ect. after reaching some critical value C lead to the degradation of R&D system. R&D system can not be renewed fastly even if the input of large amount of foundation appears. Near this critical point technology transfer seems to be unrealistic. Let us consider system thinking model of technology transfer (TT) system (Fig. 3). Main elements of model are: educational level, government R&D funding, number of graduates, flow of brain drain, attractiveness of science field for young researchers, industry (firms and firms output), environment of technology transfer system, decision making level

and information level of public. Linkages between all system elements as well as several delays (parallel lines) are shown.

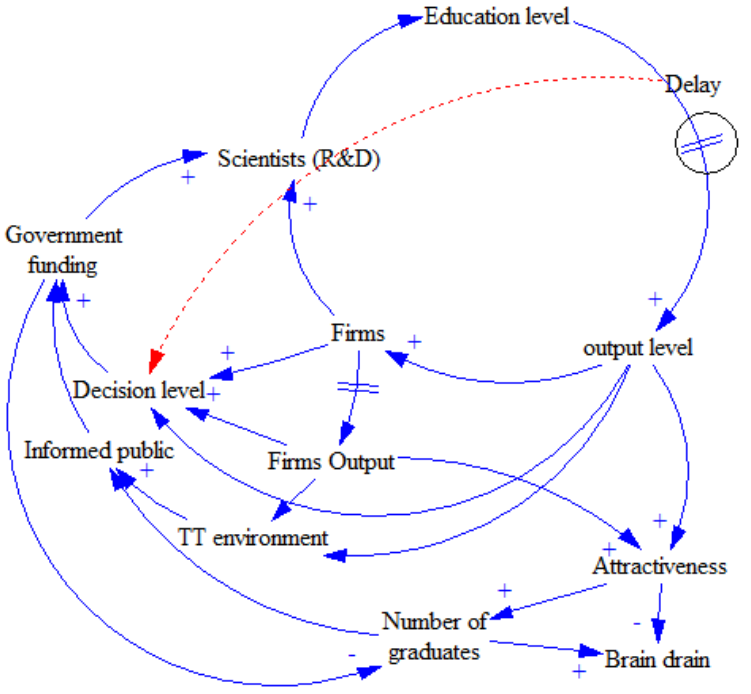

Fig. 3. Model of feedbacks between main elements

Each system has its own internal cycle time (response time) and delay between corresponding elements of system plays crucial role. If delay time is greater than the government functioning time (as it usually is), decision-makers become unmotivated to support long-term actions.

As an example, on average, a specialist lead time is 4 (bachelor's degree) + 2 years (master's degree). From graduation to the scientist is 5 years. Now, if you will be making decisions about education reform, the first results will be visible after 5-10 years. Despite the aid granted funding, long bureaucratic processes (evaluation, contracting procedures, procurement, reporting, validation, etc.) prevents the development of enterprises.

The main problems of technology transfer system in Latvia may be summarized:

- Low productivity level of enterprises and low share of innovative companies
- Lack of market-driven access to capital, difficulties to attract foreign direct investments
- Underdeveloped advanced business services and slow take-up e-commerce
- Fragmented RTD&I system
- Shortage of skilled labour
- Failings of the Latvian judicial system

These problems are located in different places of system (Fig.3).

As soon as technology transfer environment is gradually created all scheme's elements get to be influenced by it. Figurally speaking, (Fig. 3) becomes to be immersed in the TT field. All elements of the scheme become interconnected and R&D and educational system as well as funding systems act in selfconsitent way. On the initial stage the system is rather fragmented. One of the decisive requirements to initiate selfconsistance (or selforganization) is a sharp increase of R&D funding together with R&D structural changes. Common observed

decision makers practice: promise to fund R&D after the structural reforms would be carried out; lack of understanding and ignorance of long-term effects, attemptions to carry out structural reforms by the administrative methods without necessary resources - leads to the permanent backwardness.
We suppose that the same problems take place in other postsoviet countries which demonstrates a low innovation potential.

3. Methodology

Several research methods have been used while carrying out research: empirical/experiential method, questionnaires, analysis of statistic data, visual modeling tool in Vensim environment, to demonstrate the basic operation of dynamic models.

4. Conclusion

No one of system elements can't be developed separately, only system approach and self-consistence between the elements of system can guarantee successful technology transfer.

Collaboration between university and industry will work appropriately only in the scope of all system. Lack of innovation culture / conducive environment, lack of innovation demand, gaps in entrepreneurship education, role of technology intermediates (networks, clusters, science parks, brokers) to boost technology transfer and absorption capacity, low concentration of talents and needed tech-absorption readiness assessment tool overcome gradually taking into account their interdependence in the system (system with necessary energy (funding) from different sources).

The future research will be devoted to investigate further the proposed ecosystem using system dynamic approach Technology transfer and absorption ability in line with increase of local and national innovation policy capacity building will be included in this model. Papers results can be also used for Latvian technology transferring and innovation system (model) creation and delivery. As this paper will identified the key factors for success in technology transfer, these are clearly defined institutional, organizational and individual factors to be considered simultaneously when trying to understand why technology transfer works or does not work and the "outputs" of university technology transfer depend on the quantity and quality of discoveries. This paper will show differences between traditional technology transfer process and its differences in crisis time.

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