

MODELLING AND ANALYSING AN INNOVATIVE COOPERATION TO SUPPORT OPERATION OF A SCIENCE CENTRE

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Abstract: A science centre was built in Debrecen with the purpose to extend natural scientific knowledge and increase commitment to science and innovation in an experience-focused way. In addition to science centres' original role of education and scientific communication, their function has been extended for today with showcasing innovation and innovation findings, thereby "grabbing their slice" of the regional innovation process. However, in order to succeed, it is indispensable to maintain these institutions in the long run and to constantly renew their innovation content. By integrating the process established with using the "Triple Helix" approach, it is possible to assure one of the most important principles of the institution in the long run, which is its constant renewal that provides a wide range of the society with experience-based "tangible" knowledge. By following the concept we use, it became obvious that a science centre – as an organisation which creates knowledge – calls for the direct collaboration of the government, science and business actors in order to successfully operate in the long run, to attain its goals and, consequently, to develop the innovation potential of the region. However, the accumulated knowledge as a result of strategic partnerships can only contribute to establishing regional knowledge if the user – the organisation of the Science centre in Debrecen – is able to convey it successfully to the members of the fourth and fifth helix.

Keywords: science centre, triple and quadruple helix, innovative cooperation, scientific communication
(JEL code: R11)

Introduction

In Hungary, the so-called "Pólus Program" provided European Union grants for several large cities to build Science centres. The topicality of this issue is strengthened by the fact that the concept and activity of such institutions – even though they have great traditions in Europe – are considered to be new in Hungary for the time being. Science centres have significant achievements in Europe in strengthening the role of informal education, more specifically in the field of the so-called tangible natural scientific methodology. Due to their novelty, the social scientific and regional economic examinations of these institutions have not been performed.

In 2008, the Local Authority of Debrecen City of County Rank decided to establish a science centre and involved the University of Debrecen into this project as a professional mentor. In the initial phase of the implementation process, the Local Authority and the University participated in a transnational project – namely 'Boosting innovation through capacity building and networking of science centres in the SEE region' – in order to obtain benchmark observations, knowledge and a system of relations which facilitate them in achieving their goals. In order to develop the innovation culture, the project partners representing seven countries share the goal of raising public

awareness for the importance of natural sciences, technology and innovation, which are the key factors of economic growth. The SEE Science project actively participates in redefinition of the roles of Science Centres, using most of the European practice and introducing new approaches.

It was one of the project duties to establish cooperations with regional and Debrecen-based institutions, companies and NGOs supporting and determining local innovation.

This study summarises the concept and methodology of this work, i.e. establishing the strategic system of relations with innovative organisations (stakeholders) in order to involve the "helix of users and the media- and culture-based society", i.e. the fourth helix.

Topic and objectives of the study

A Science Centre is built within the Debrecen Science Park project. The history of such institutions roots back to 1794, when the Louvre switched its functions. The concept of the so-called pure Science Centre model dates back to 1969, the opening of the Exploratorium (San Francisco) (FRIEDMAN, 2010).

The Science Centre is an environment of informal learning, where processes are centred around knowledge, the development of skills and the establishment of positive attitudes towards sciences. The Science Centre is a place where concepts about our natural world can be explored, examined and tested. In this place, knowledge is a unique source for families, students, teachers and the general public (ASTC, 2013). The primary objective of these institutions is to raise the interest of youngsters towards sciences and innovation by means of experience- and observation-based learning. Therefore, Science Centres are the environment of real knowledge establishment with high added value. (DARNAI, 2014).

In addition to science centres' original role of education and scientific communication, their function has been extended for today by showcasing innovation and innovation findings, thereby "grabbing their slice" of the regional innovation process. By virtue of this function, they are based on three main sectors on the regional level (university – government – enterprises), i.e. the central (hybrid) Triple Helix model and they can contribute to creating regional knowledge and developing the innovation capability of the region in the long run. However, in order to succeed, it is indispensable to maintain these institutions in the long run and to constantly renew their innovation content. It is the hypothesis of this study that direct collaboration between the government, science and business actors is necessary in order for the Debrecen Science Centre – as a knowledge conveying organisation – to successfully operate in the long run and to attain its goals and this collaboration can be provided with establishing a Triple Helix-based cooperation. We built the experiences of SEE Science project to establish this innovative cooperation. In addition, our hypothesis actually substantiated by the Economic Development Strategy of Debrecen where the Triple Helix approach has a central role therefore, it should also adapt in the project level.

Technical literature review

In 1956 and 1957, Robert Solow already published studies in which he concluded that long-term economic growth is based on the broadly interpreted technological development, i.e. innovation. Accordingly, an economic system which has significant innovation capability is able to develop and "rebuild itself" following an unfavourable environmental impact (PAKUCS – LÓRÁNT, 2003).

Innovation is the process of applying the attained knowledge, the renewal and improvement of products and services, as well as their markets, the application of new procedures in production, distribution, market work and management, organisation and work conditions, as well as the extension and renewal of the professional knowledge of workforce (PAKUCS – PAPANEK, 2006). Since the key role of knowledge and technology in economic growth became obvious, increased attention was drawn also to understanding the knowledge-based characteristic of the economy (LEYDESDORFF, 2010). In addition, in a knowledge-based economy, there is a close correlation between innovative capability and the regional

economic processes which are assumed to be favourable. By means of learning and innovative capability, regions attain unique resources which can help them in regional competition (BAJMÓCY, 2008).

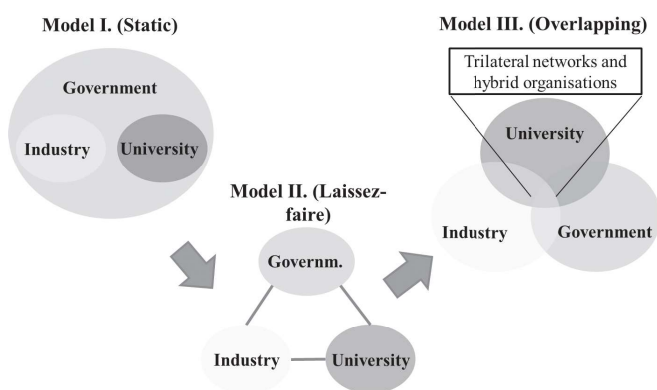
The examination of knowledge, knowledge creation and innovative capability has gained ground in several regional research projects, since there are numerous fields in the world in which the strategies of establishing especially successful leading high technology regions and technologies are built in order to achieve and improve these objectives (BAJMÓCY, 2011). Even though there were no empirical examinations which proved the general validity of these company seat-based local economic development initiatives (BAJMÓCY, 2011), the innovative capability and the resulting economic achievements of numerous technopolises around the world are indisputable. In addition to the Technopolis Framework, the establishment of Triple Helix-based interactions and a network-based character is the most important duty from the aspect of the establishment of these high technology regions, as well as their creative and innovative capability (GIBSON – BUTLER, 2013).

The Triple Helix model of the university-industry-government relations was introduced as a model describing the depth and complexity of the process of innovation and it provides an explanation for the establishment and development of knowledge-based economy by means of the interactions between the three spheres (Etzkowitz – Leydesdorff, 2000).

The main point of the model is the fact that innovation and economic development potential in the knowledge-based economy and society lie in the altered role of universities and also the system of relations of universities, the industry and the government which generates the appearance of new institutional and social forms, thereby contributing to the creation, transfer and use of knowledge (Etzkowitz et al., 2000). Three variants of the model were developed based on the development and nature of the relations between the government, the industry and the university (Figure 1):

- *Model I (Static)*: The state has the strongest role, affecting enterprises and scientific institutions, as well as the relations between them. Top-down bureaucratic coordination. The main role of universities is education.
- *Model II (Laissez-faire)*: The components are completely separated from each other with borders. Relations between each component are strictly determined. In addition to education, universities also have a main role in basic research.
- *Model III (Overlapping)*: Components are partially overlapping each other, i.e. there are common projects, research and associations. The government makes investments and performs regulation activities, the university also establishes enterprises and the industry is responsible for its traditional duties. New organisational forms are established with the aim to facilitate collaboration: industrial parks, venture capital companies, clusters. (PÖRZSE, 2011).

Figure 1. Variants of the Triple Helix model

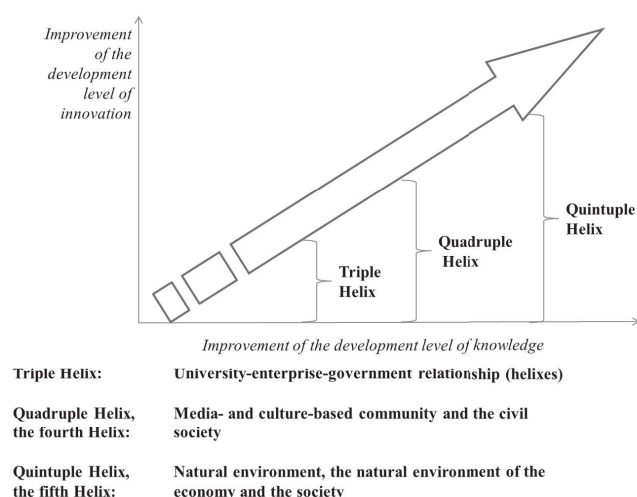


Source: own construction based on PÖRZSE, 2011

In general, it can be established that models II and III are mainly characteristic of modern market economies. In model I, there are few initiatives coming from the industry and universities; therefore, innovation developments cannot undergo at the proper rate (KOTSIS – NAGY, 2009).

Carayannis et al. (2012, 4) consider the “main model” of knowledge creation to be the Triple Helix model which was further developed into the Quadruple Helix model. In addition to the university-industry-government collaboration, this new model added a fourth helix being the media, more specifically the media- and culture-based community space and the medium of the civil society (CARAYANNIS et al., 2012; CARAYANNIS – CAMPBELL, 2012). In addition, the technical literature distinguishes a fifth helix, which is the social and economic (natural) environment, thereby specifying a broader context of the Quadruple Helix as the fifth helix was developed by means of its further examination.

Figure 2. The common development of advanced knowledge systems and innovation systems, from the Triple Helix towards the Quintuple Helix



Source: Carayannis–Campbell, 2012

If the Triple Helix, as a framework and the subject of analysis or examination, cannot be neglected, neither can the fourth and fifth helixes, since these provide broader opportunities to sustainable problem solving from the aspect of knowledge

and innovation (Figure 2). The more developed a knowledge-focused society is and the more advanced knowledge-based economies are, the more need there is for a shift to systems with broader perspectives (CARAYANNIS – CAMPBELL 2012).

Material and methods

Three main research activities were taken as a basis during the establishment and practical use of the concept. The establishment of the concept was mainly assisted with secondary research, mapping the regional innovative capability and identifying the “Triple Helix”-based innovation model which is the basis of economic development. As a next step, we examined how the Science Centre can be integrated into this model, how to interpret and integrate innovative capacities and what their role is in the regional innovation network. In order to achieve this goal, it is indispensable to survey the regional innovation actors (sectors), as well as the relations and network of these innovation actors in accordance with the “Triple Helix” principle.

The benchmark activity performed during the SEE Science project was an outstanding contribution in this process. During this project, we had the opportunity to observe the activities of several science centres, more specifically their innovative initiatives and enterprise relations, as well as their innovative services to enterprises. These benchmark observations also show that these institutions face an economic deficit due to their non-profit characteristic and their income covers around 40-50% of their expenditures (DARNAI, 2014); therefore, they heavily rely on external financial resources and direct enterprise relations.

Following the survey of the actors of regional innovations, we aimed to determine possible forms of collaboration of the Debrecen Science Centre and the innovative enterprise sector, as well as the form and method of directly involving these actors on the basis of the obtained benchmark observations. This research task was performed with a process-based approach, which facilitates the understanding of the cause and effect system of relations between each activity, and, consequently, the revealing of the sources of problems arising during elaboration, as well as the designation of areas to be developed. (NÉMETH, 2001).

According to our interpretation, a process is the series of activities in connection or interaction with each other which transforms inputs into outputs and values. Processes are planned and implemented under regulated circumstances in order to create values (MSZ EN ISO 9000:2001).

Our goal was to establish a structure which can be sustainable during the operation of a science centre and which creates values both for the science centre and the involved business partners, while also providing a “tangible” experience and knowledge for visitors. Accordingly, we were curious about the opinions of those affected even during the initial phase of establishing the process; therefore, we refined our concept to be presented to partners by means of focus group surveys during roundtable discussions.

In order for visitors to accept a certain product or service,

that given product or service should represent some kind of value to visitors. For this reason, value creation processes implement the conversion of enterprise resources into customer value (IFUA HORVATH & PARTNERS, 2006).

Research results and discussion

Objectives of the Debrecen Science Centre

The Debrecen Science Centre set the following goals:

- to draw the attention of the local community to technical and natural sciences and innovation, since these areas could be the basis of economic growth
- to draw the attention of youngsters to science, technology and innovation by means of making technical and natural sciences more tangible for them.
- to take a role of innovation catalyst due to the fact that the capacity building and knowledge shaping activities of the university are indispensable
- to use the gained experience of the already existing science centres and to enrich the common knowledge with its own findings
- to establish a strategic partnership in order to attain its goals
- to remain open to extending the scientific areas determined at the time of launching by means of constant development
- to overcome reservations against technical and natural sciences by means of everyday experiences and to present scientific novelties and the joys in innovation to visitors
- to inspire and support youngsters in their choice of career in natural science.

These declared objectives can be successful only in the long run; therefore, it was a clearly defined aspect during the formulation of the concept of this study to establish a Triple Helix-based strategic partnership with the aim to create knowledge in collaboration with the affected organisations. It was a further aim to promote the commitment of those affected, to provide the constant renewal of the services provided by the science centre and to contribute to the direct dissemination of the newest scientific and innovation findings of the region.

The concept of attaining the set objectives, involving stakeholders

According to Carayannis and Campbell (2012), the more developed a knowledge-focused society is and the more advanced knowledge-based economies are, the more need there is for a shift to systems with broader perspectives.

In our opinion, this correlation assumes timeliness, since the Science Centre deals with the development of sectorial collaboration along an original and new activity or service; therefore, the involvement of sectors (helixes) can be performed even consequently. Accordingly, the cooperation of the two helixes (sectors), the government (the local authorities of

Debrecen) and the university (University of Debrecen) can be perfectly interpreted at the regional level, since it was the pre-requirement of the Science Centre project to be implemented within the framework of the Agóra-PÓLUS project. Furthermore, this cooperation provided an opportunity to involve the third helix in the phase of project implementation and to regionally develop knowledge and innovation in the long run.

Table 1. Organisations playing a key role in the innovation structure of the region

Elements of the Triple/Quadruple Helix	Organisations/Groups
First Helix	Science
	University
	Research Institutes
	Knowledge Centres
Second Helix	Government
	Transfer Institutes
	Government and Local Authority Organisations
	Organisations of Regional Authority
Third Helix	Industry (enterprise)
	Innovative Enterprises
	Spin-Offs
	Clusters
Fourth Helix	Society
	NGOs
	Primary and High Schools
	Kindergartens

Source: own construction

Similarly to national systems, it is the basic requirement of the regional knowledge-based economic development to directly involve the third helix, i.e. the enterprise sector. This study considers the following of the triple and quadruple helix principle to be a requirement, according to which the social impact of a Science Centre (fourth helix) could be much more successful if the third – possibly market-based – actor is present even at the beginning in addition to the activity of creating experience and the visitor undergoing this experience. This third actor can present the logical bridge which helps in incorporating the obtained knowledge into people's everyday lives. This process can be manifested by influencing the sphere of interest or even modifying the focus of specific ideas of one's choice of career.

As a first step, the target group was involved by surveying the stakeholders which play a major role in the innovation structure of the region in accordance with the triple helix principle (Table 1). The next step was to involve the fourth helix – the media- and culture-based community and the civil sphere –, i.e. the “users” according to the dynamics of the quadruple helix model.

Potential forms of cooperation

Based on the obtained benchmark observations, European science centres try to establish their long-term partnerships in several ways, as their activities are basically non-profit. Accordingly, in conformity with the local regional circumstances and endowments and – as a matter of course – the efficiency of the Triple Helix principle, the forms of a possible long-term collaboration were identified.

The first and most innovative possibility is for the involved organisations *to integrate into the everyday activities of the*

Science Centre, thereby facilitating the use of the above described principles and to make this institution *perform its work along "their interests"*. *They should establish structures which also formally ensure this criterion*. Usually, a newly launched institution is more open to flexibly modify its program and organisation. Founding documents and regulations governing the operation of the organisations are put together in this phase; therefore, external organisations have the chance to enforce their "interest" in this period. The platforms to do so are the forums where the founder invites the major organisations and institutions of the city to contemplate and come up with collaboration alternatives. However, the institutional forms developed during these ad hoc discussions determine the organisational framework of collaboration in the long run. It is important to integrate this cooperation into the Organisational and Operational Regulations of the operational organisation. The organisational issues of the implementation of the contract to be entered into with the University and the method of involving other strategic partners have to be laid down in this document. In addition to the usual operational and supervision bodies, it is important to establish at least two operational units. One of these is a strategic advisory council with 10-14 members, including representatives of the Local Authorities and the University of Debrecen, as well as all organisations which either represent potential visitors (e.g. Office of Education) or are able to provide help in maintenance (the major high-tech companies in the city/region). The other body should consist of experts who represent various areas of science, such as the six department heads, representatives of partner enterprises/institutions, or even marketing and communication professionals (local TV and media). It could seem logical to invite the employees of similar organisations (not as competitors, but benchmark partners). It is the best if these two bodies hold their yearly session together.

The second opportunity to collaborate is to *use this space which was introduced to the market for the purpose of communicating their own activities and to raise the attention of visitors*. In practice, this can be done in various ways. It is a possible solution that the Science Centre provides an area for an external partner to showcase its own activity in a form which fits the profile of the "house". This could work as a satellite demonstration and it directs attention to the given professional area through the activity of a specific company. It is another alternative that an external organisation connects to an existing demonstration. Any solution could be viable in the program of the Science Centre as long as the purpose is to promote natural and technical sciences, innovation and innovation findings and at the same time provide experience and help connect these sciences to everyday life by means of life-like appearance.

The third alternative is to *establish a collaboration and generate relevant business models which result in business income for the institution considering mutual benefits and innovative services for the parties involved in the collaboration*. According to the current plans, the Science Centre, as a public

educational institution, attracts around 80-100 thousand visitors and has spaces which can be commercially utilised. Based on these two endowments, targeted services can be organised, which may include letting out rooms/spaces, or organising conferences and programs. Large events (innovation day, science days, thematic festivals and exhibitions) can also be organised where attendance fee is an accepted form. Solutions like this could be an outstanding opportunity for the institution to gain awareness and to improve its innovative image in addition to generating income.

Steps of implementation

1. *Determining and putting together the range of organisations planned to be involved into the collaboration*. The selection of organisations already has a background, since the large enterprises in the city are already in an active relationship with the scientific institutions of Debrecen, which is currently being organised along a special system of goals. *The specific task of the pilot project is to identify with the network of relations, as well as to name the organisations to be involved* and to invite them subsequently. As a matter of course, the range of potential actors is extended by the – mostly public utility-focused – companies which are under the proprietary control of the city of Debrecen. During the establishment of the list, the two strategic partners (the Local Authorities and the University of Debrecen) recommended certain organisations which represent the basis. This basis was then extended in accordance with the recommendations of the invitees and professionals. As a matter of course, this group is not closed and there is a possibility for any party which is able to help the operation in the above described spirit to join.
2. *Organising a roundtable discussion in order to communicate the aims and the methodology of collaboration*. This is the most important element of the whole process, since this meeting must convey a message to the participants that it is happening for them and in cooperation with them. This message is a certain form of validation which can be provided with key persons and organisations. In practice, this means that the inviting party should be at least the deputy mayor and the rector of the University of Debrecen, while invitees should be the primary heads of organisations. The discussion should be focused on communicating the aims and getting to know the position of invitees, as well as establishing commitment.
3. *Following the discussion assuring the mutual commitment of parties, each invited organisation will be visited one by one in order to clarify all details of this commitment* and to conduct a first round of discussion about the principles of specific cooperation. We consider it to be important that it should not be a legally interpreted commitment, but rather a conceptual offer which has to be followed by specific planning activities. This work has to be performed in a uniform and adequately documented form. In order to facilitate this process, we have put together a mini-project datasheet which will be filled with data during

the partner visits. These visits have a dual impact as not only do they become a delegated task/project within the partner organisation, but the range of opportunities which help the success of this initiative will also be extended.

4. *Mutual presentation of project ideas.* After each organisation worked out its own mini-project, these should be presented to each other and discussed *at a meeting*. This form provides an opportunity for *each participant to fine-tune their ideas by considering their partners' ideas to be a benchmark*, while this forum is also suitable for establishing collaborations and joint implementation of certain projects.
5. *Agreement.* The project datasheet contains the joint mini-project of the Science Centre and the organisations taking part in the cooperation. Due to the nature of this activity, *the implementation of a project automatically means commitment which should also be laid down in a contract* where the financial and operational issues can be regulated.
6. *Joint efforts were made in the form of workshops.* In order to facilitate these meetings in the future, we recommend to organise “legal successor” professional bodies within the framework of the Science Centre. The involved organisations can also delegate representatives into these bodies and their aim is to perform guidance and advisory functions in professional areas. From the legal point of view, these bodies have to be given a mentorship role instead of a formal management licence. The datasheet filled out by the organisations contains a certain kind of declaration about whether they will take any role in the bodies to be established.
7. *Presenting the services and functions* of the Science Centre, as well as the above described ideas *to the fourth helix* (schools, kindergartens and NGOs). More specifically, *surveying the needs of “users” in order to provide direct feedback* of activities and experiences before implementation. If possible, the form of implementation should be workshops coupled with a tour of inspection.

Conclusions and recommendations

The above described concept and its related implementation process were put together in the form of a pilot work which provides the opportunity to perform the activities described here, but this work – the establishment of long-term partnerships – cannot end here, instead, it is more of a beginning. The continuation of this work could be realised in the form of the bilateral agreement between the operational organisation of the Debrecen Science Centre and the involved institutions and enterprises.

In addition, it is definitely necessary to set up an “internal” professional advisory council that is organised along the above described concept which makes it possible to constantly supervise the launched and implemented mini-projects, as well as to provide feedback in relation to visitors. The systematic collection and analysis of this visitor feedback and the adaptation of these activities as an independent process can itself be a tool for involving or extending the fourth helix.

As a matter of course, the process implemented in accordance with the above described concept can only become successful, i.e. yield a real, “tangible” result if it is transformed into an activity by its integration into the service portfolio of the Science Centre, thereby providing the innovative environment needed for the regular renewal and establishing the constant development of activities, while the good relationship with existing partners is maintained and further partners are constantly being involved.

Last, but not least, the mini-projects resulting from the strategic partnerships established along the Triple Helix-based concept and the accumulated knowledge can contribute to establishing regional knowledge and the long-term development of the regional innovative capability only if the user, i.e. the Debrecen Science Centre is able to convey them to the members of the fourth and fifth helix. In order to do so, it is indispensable to set up an organisation which is adequately prepared professionally and to employ science- and innovation-focused human resources.

Main conclusions of the thesis

One of the most important morals and findings of the establishment of strategic partnerships by means of the practical use of the “triple and quadruple helix”-focused approach of knowledge-based economic development is that the first round of roundtable discussions resulted in 10 specific mini-project ideas which doubled by the time of the next discussion. In addition, the presentation of mini-projects as benchmark also had a significantly positive result, since it motivated new organisations to present their own innovative findings.

The concept had the following positive results:

- the stakeholder organisations became familiar with (and understood!) the functions and aims of the Debrecen Science Centre,
- the invited enterprises were absolutely open to collaboration,
- the invited parties clearly identified with the initiative and they became real “interested parties”,
- the existing relationships became even stronger.

We were absolutely convinced that the “Triple and Quadruple Helix” approach can contribute to providing constant renewal, which is one of the key elements of an institution and it can help in giving a broad range of society “tangible” knowledge, thereby contributing to the development of the knowledge-based economy of the region.

By following the concept we use, it became obvious that a science centre – as an organisation which creates knowledge – calls for the direct collaboration of the government, science and business actors in order to successfully operate in the long run, to attain its goals and, consequently, to develop the innovation potential of the region in the long run.

Summary

During the establishment of the Debrecen Science Centre, it was one of the main duties to implement cooperation with regional and Debrecen-based institutions, companies and NGOs supporting and determining local innovation. This study summarises the concept and methodology of this work, i.e. establishing the strategic system of relations with innovative organisations (stakeholders) in order to involve the “helix of users and the media- and culture-based society”, i.e. the fourth helix.

On the regional level, the social impact of a Science Centre could be much more successful if the third – possibly market-based – actor is present even at the beginning in addition to the activity of creating experience and the visitor undergoing this experience. This third actor can present the logical bridge which helps in incorporating the obtained knowledge into people's everyday lives.

Along the developed concept and by using benchmark observations, the possible forms of strategic cooperation were determined, similarly to the innovative process of establishing a long-term partnership. It is one of the most important morals and findings of the work that around 20 specific, feasible mini-projects were put together which motivated new organisations to present their own innovative findings.

As a result of the concept, the stakeholder organisations became familiar with (and understood!) the functions and aims of the Debrecen Science Centre. In addition, they clearly identified with the initiative and they became real “interested parties”.

It is important to note that the above described concept and its related implementation process were put together in the form of a pilot work which provides the opportunity to perform the activities described here, but this work – the establishment of long-term partnerships – cannot end here, instead, it is more of a beginning.

In order to successfully continue the launched activity, it is necessary to set up a professional advisory council to constantly supervise the launched and implemented mini-projects, as well as to provide feedback in relation to visitors. The feedback system incorporated into the process can itself be a tool for involving or extending the fourth helix.

The process implemented in accordance with the above described concept can only become successful, i.e. yield a real, “tangible” result if it is transformed into an activity by its integration into the service portfolio of the Science Centre.

Last, but not least, the mini-projects resulting from the strategic partnerships established along the Triple Helix-based concept and the accumulated knowledge can contribute to establishing regional knowledge and the long-term development of the regional innovative capability only if the user, i.e. the Debrecen Science Centre is able to convey them to the members of the fourth and fifth helix. In order to do so, it is indispensable to set up an organisation which is adequately prepared professionally and to employ science- and innovation-focused human resources.

The findings of this work show that a science centre – as an organisation which creates knowledge – calls for the direct collaboration of the government, science and business actors in order to successfully operate in the long run, to attain its goals and, consequently, to develop the innovation potential of the region in the long run.

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