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Justas NUGARAS

ASSESSMENT OF NETWORKING OF HIGHER EDUCATION INSTITUTION

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SOCIAL SCIENCES,
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Abstract

Networking phenomenon of a Higher Education Institution (HEI) is investigates in this dissertation, thus addressing the problem of networking assessment evolving from the need to use the networking for the strategic management of the HEI in a more extensive way. Also the possibilities of managing the networking of higher education more effectively are investigated in order to support growing networking based activities of internationalisation, collaboration and interdisciplinarity indicating the relevance of the thesis. At a scientific level, a lack of different tools for assessing and monitoring the networking and portfolio of the HEI can be noticed, which may assist in understanding the surrounding network on more systematic grounds. The object of the dissertation is the networking (entering and participation in the network and interaction with other institutions) of the Higher Education Institution. The core of the dissertation is the development and empirical testing of a Networking Assessment Model that would increase the strategic use of networking in order to improve the competitiveness of HEIs.

The dissertation consists of the introduction, three chapters, general conclusions and 9 annexes.

Chapter 1 presents networking phenomena in contemporary management and further proceeds with a review of networking in public sector management which leads to the analysis of network assessment methods and to the formulation of the scientific problem of the thesis.

Chapter 2 turns the structure and overview of the Network Assessment Model (NAM) into a more detailed explanation of three stages of the model: Stage 1 adapts multi-criteria methods for the assessment of networking, Stage 2 presents assessment applying network pictures and Stage 3 explains how to transform the results of network assessment into strategic insights.

Chapter 3 assesses the networking of Vilnius Gediminas Technical University in order to test the NAM and derives recommendations for strategies on developing more effective networking in the fields of research and studies.

6 publications focusing on the subject discussed in the dissertation have been issued: 4 of those have been included in internationally recognized databases, 1 represents conference material and 1 is a study.

Reziumė

Disertacijoje nagrinėjamas aukštojo mokslo institucijų tinklaveikos reiškinys ir sprendžiama tinklaveikos vertinimo problema, kuri kyla iš siekio tinklaveiką efektyviau įtraukti į aukštosios mokyklos strategijos kūrimo procesą. Darbe tyrinėjama, kaip pagerinti tinklaveikos valdymo efektyvumą aukštajame moksle. Jame vis didesnę svarbą įgyjantis tinklaveika grįstas tarptautiškumas, bendradarbiavimas ir tarpdisciplinišKumas daro disertaciją aktualia. Moksliniu lygiu trūksta tinklaveikos ir partnerių portfelio vertinimo ir stebėsenos įrankių, be to institucijoms sunku sistemiškai suvokti supantį partnerių tinklą. Disertacijos tyrimo objektas yra aukštojo mokslo institucijos tinklaveika (patekimas bei dalyvavimas tinkle ir sąveika su kitomis institucijomis). Pagrindinis disertacijos elementas yra tinklaveikos vertinimo modelis (TVM), kuris didina tinklaveikos panaudojimo AMI strategijos kūrime galimybes ir sudaro prielaidas pagerinti aukštosios mokyklos konkurencingumą.

Disertaciją sudaro įvadas, trys skyriai, bendrosios išvados ir 9 darbo priedai.

Pirmajame skyriuje pristatomas tinklaveikos reiškinys šiuolaikinės vadybos kontekste, kuris papildomas viešojo sektoriaus tinklaveikos nagrinėjimu ir pratęsiamas išsamia tinklaveikos vertinimo metodų apžvalga ir mokslinės problemos formulavimu.

Antrajame skyriuje pristatomas TVM, vėliau aprašomi atskiri modelio etapai: I etapas skirtas daugiakriteriam vertinimui pritaikyti aukštojo mokslo institucijos vertinimui, II etapu nagrinėjamas tinklo schemų vertinimui panaudojimas, III etapas skirtas atskleisti, kaip vertinimo rezultatai transformuojami į strategines įžvalgas.

Trečiajame skyriuje vertinant Vilniaus Gedimino technikos universiteto tinklaveiką atliekamas empirinis tyrimas ir modelio aprobavimas. Remiantis tyrimo rezultatais pateikiamos tinklaveikos plėtros studijų ir mokslo srityse strategijos.

Disertacijos tema paskelbtos 6 publikacijos: 4 straipsniai mokslo žurnaluose, referuojamuose duomenų bazėse, 1 – konferencijos medžiagoje, 1 – studija.

Notations

Symbols

S_j – the value obtained in the multi-criteria evaluation of the *j*-th alternative;
w_i – the weight of the *i*-th criterion;
r_{ij} – the normalized value of the *i*-th criterion for the *j*-th alternative;
$\tilde{r}_{IC}$ – normalized International Research Collaboration;
Ic_r – International Research Collaboration;
Ic_{rMax} – the maximum value of Ic_r values;
$\dot{N}_r, \ddot{N}_r, \ddot{\dot{N}}_r$ – research networking;
$\mathrm{I}_{\mathrm{N_i}}$ – the relationship between the average scientific impact of an institution and the world average set to a score of 1;
$\dddot{N}_r$ – research networking;
$\tilde{w}$ – normalized student mobility (including outgoing for exchange and placements) ratio;
$\tilde{k}$ – normalized personnel mobility;
So_s – student mobility ration;
$So_{s_{Max}}$ – the maximum value of student mobility ration;
$\tilde{k}$ – normalized outgoing personnel mobility;
Ti_s – personell mobility;
$Ti_{s_{Max}}$ – the maximum value of personnel mobility;
N_s – networking in the process of studies;
n – number of selected partners;
N – integrated research and study networking;
α – weigh coefficient for research networking;
β – weigh coefficient for study networking.

Abbreviations

HE – Higher Education
HEI – Higher education institution
KPI – Key Performance Indicators
NAM – Network Assessment Model
NPM – New Public Management
SNA – Social Network Analysis
VGTU – Vilnius Gediminas Technical University

Contents

[1] The annexes are available in the CD attached to the dissertation

Introduction

Formulation of the Problem

Empirical and theoretical research into networks and networking has proven that active participation in the network concerning private and public sectors is beneficial for participating entities. Such involvement may increase competitiveness, create access to complementary resources, improve profitability, encourage knowledge transfer and produce other synergy-related effects. A growth in internationalization, collaboration and interdisciplinarity as well as the specificity of the Higher Education (HE) sector generate huge potential for the use of networking; however, a critical review of literature has found the following problems important for management:

- The available methods of systematic networking assessment poorly reflect the needs for the management of HEIs having no methodologies for assessing networking in the process of strategy development; for this reason, networking assessment is either not conduced or is not performed systematically.
- Lack of abilities to monitor the networking process and to assess not only the performance of the institution in which a strategy is developed but also to evaluate the impact considering the partners' portfolio.

- Lack of assessment methods averts institutions from the effective, targeted integration of information on networking into strategies for HEIs thus neglecting the importance of external environment factors such as the development of new relationships, partner portfolio management and resource allocation for the most important partners.
- The existing methods for quantitative networking assessment reflect mathematical solutions; nonetheless, they are not adapted or interpreted concerning some particular situations and have limited application for the solution to contemporary managerial issues in the sector of HE. Qualitative assessment methods are predominant in the current literature and are very difficult to apply for large networks such as HEI network assessment.

Relevance of the Dissertation

The assessment of the networking of the HEI is an important issue because contemporary internationalisation, collaboration and interdisciplinarity are based on networking principles. There is a need for more effective and planed elaboration of networking activities and management that would assess not only the HEI as an autonomous entity but also its relational environment. From the theoretical point of view, there is an opportunity to apply business networking theories such as industrial networks, inter-organizational theory and the theory of networks in economic geography for developing the HEI, and thus expanding the scope of benefits recognized by the HEI. What is more, the fast growing importance of various ranking systems in the sector of HE makes effective networking management even more significant than rankings taking into consideration a number of networking related activities. From the empirical point of view, this thesis generates new empirical knowledge about the networking of HEI management and discloses new important insights into the analysis of an external environment and the development of the strategy for the HEI.

Object of Research

The object of research is the networking (building and acting in the network and interaction with other institutions) of the Higher Education Institution.

Aim of the Thesis

The goal of this thesis is to design and empirically test a model for assessing the networking activities of the Higher Education Institution. The presented model would strengthen the managerial and strategic use of networking in order to strengthen the competitiveness of the institution.

Objectives of the Thesis

To achieve the aim of the thesis the folloeing objectives were formulated:

1. To review literature on networking phenomena and revise methods for networking assessment in the field of contemporary management in order to investigate networking management problems and to set a theoretical framework for this dissertation.
2. To indicate the specificity of networking in the sector of Higher Education.
3. To make a model for assessing the networking of the HEI which should serve in the management of the HEI for the purposes of evaluating the external environment in the strategy development process and monitoring networking activities of the HEI. For working out the model quantitative methods, factors and data sources should be identified and used.
4. To make an algorithm for turning the result of networking assessment into strategic insights in order to strengthen the strategic management of the HEI.
5. To conduct empirical research and test the relevance of the model. To carry out empirical research with a purpose to test the NAM using data related to strategic management and networking and gathered at Vilnius Gediminas Technical University.
6. To propose guidelines on networking development for the HEI applying the results of the performed assessment.

Research Methodology

A critical review of literature along with the methods of interpretation and conceptualization has been used for defining the problem of networking

management. A review of techniques for networking assessment has been conducted employing comparative and network analysis methods. At Stage 1 of the comprehensive NAM, SAW and other multi-criteria evaluation methods for data normalization have been applied. Stage 2 of the NAM has been created using graph theory and Social Network Analysis (SNA) considering related calculations such as Newman algorithm and graphical statistical methods. For testing the model, empirical research has been conducted. Calculations and network pictures have been done installing *ORA software. The obtained results have been interpreted with reference to graphical analysis and logical abstraction methods.

Scientific Novelty of the Thesis

In the course of developing the thesis, the following significant results of management science have been achieved:

- A Comprehensive Network Assessment model for the HEI has been developed, which allows evaluating a general state of networking, the partner portfolio of the HEI and a position in the network.
- The NAM creates a precondition for systematic networking integration into the processes of strategy development and networking management.
- The quantification and adaptation of assessment and strategizing applying network pictures make methodical assumptions about the effective strategizing of the HEI.
- The considered application of SAW and Newman methods allows assessing the networking portfolio.
- The method of applying network pictures of the HEI has been worked out.
- The algorithm for transforming networking results into strategic insights has been created and directions towards the formation of the strategy for the HEI have been established.

Practical Value of Research Findings

The comprehensive NAM is significant for the HEI due to the following reasons:

- The model is universal and could be used for management purposes in all institutions from advanced large universities to small colleges and schools. It is also applicable and can be adapted to the needs of more research or study-oriented institutions and reflect strategic orientations of the HEI.
- The NAM has been developed in a way not only to disclose the perspective of the institution but also to assess a wider surrounding network and relations to other institutions as well as to identify the position of the HEI in the network that allows understanding the external environment, generating new strategic insights and strengthening the strategy development and networking management of the HEI.
- Generated pictures are more applicable for the top management of the HEI as they are easier to understand and compare as well as less efforts for monitoring networking are required.
- The results of the carried out assessment are important and could be used at the departmental level as a better understanding of partners. The list of core partners could be the direction to the further development for researchers, heads of study programs and coordinators of faculty internationalisation.

Defended Statements

1. Usage of networking perspective could strengthen the process of strategy development, as understanding a wider network would serve for a better analysis of the external environment of the HEI; also, more effective networking management would allow elaborating such networking benefits as gaining a competitive advantage, accessing complementary resources, increasing organizational learning and gaining access to information as well as international markets.
2. There is a scarcity of tools for assessing the specific networking of HEIs: the existing methods are mostly used in the business environment and can be hardly applicable to the large networks of HEIs.
3. The problem of networking assessment could be soveld applying NAM there multi-criteria and assessment methods applying network pictures are integrated. Using NAM more advanced strategy with a networking perspective could beworked out.

4. Using the NAM sub groups in higher education networks could be identified; partners' portfolio of the HEI could be found and position of the HEI in the network could be disclosed.
5. Vilnius Gediminas Technical University has strong study networking and weaker research networking; thus, strategies to strengthening the portfolio in study networking and the exploration of the portfolio in research networking should be used.

Approval of Research Findings

Six publications focusing on the subject of the dissertation have been issued: two – by foreign publishers, one study and one paper quoted by ISI Web of Science (Nugaras 2012a; Nugaras, Ginevičius 2014), three papers (Nugaras 2012b; Nugaras, Radzevičienė 2012; Nugaras, Radzevičienė 2010) in the databases approved by CSL and one paper – in peer-reviewed proceedings of international conferences (Nugaras, Radzevičienė, Nikitin, 2011). Two presentations on the topic of the thesis were given in the following international conferences (one of them were held abroad):

- Practice and Research in Private and Public Sectors, 2011: The 1st International scientific conference. Vilnius 2011.
- 29th Annual International IMP Conference, Atlanta, USA, 2013.
- One presentation was given in CSL conference „Doctoral Internships at International Research Centres 2012–2013, Vilnius 2013; also, seven presentations were delivered in doctoral seminars, two of which at a foreign institution.

Structure of the Dissertation

The dissertation consists of the introduction, 3 chapters, general conclusions, references, the list of author's publications, summary in Lithuanian and 7 annexes. The total scope of the dissertation is 114 pages, excluding annexes. 17 figures, 22 tables, 11 numbered formulas and 178 references have been included in the dissertation.

1

Assessment of Networks and Networking in Contemporary Management

The chapter reviews literature on the contemporary issues of networks and networking and mainly focuses on managerial questions relevant to the networking perspective of the HEI. The chapter starts with general theories and approaches leading to defining a scientific problem of networking assessment regarding the HEI. The findings of this chapter have been published in 2 scientific papers (Nugaras, Radzevičienė 2011; Nugaras, Radzevičienė, 2012).

1.1. Networks and Networking in Management Science: Theories and Background

1.1.1. The Concept of Networks and Networking

Attention to networks as an object of management science has been growing for 30 years. The contemporary networking theory is closely related to various fields of public and private management and is strongly affected by developing

the concept of the network in mathematics, computer science and sociology. Even with a constantly growing interest, still, there is no common agreement on the concepts and definitions of the network and networking. Table 1.1 shows a few most relevant definitions.

Table 1.1. Network definitions

Concept	Definition	Authors
Network	An object consisting of points, also called vertices or nodes, and lines, also called edges or links.	Euler (1736)
	The basic characteristic of the network is the maintenance of long-term directive correlations mutually facilitating achievements in the jointly recognized aim" and a network is "…appropriate when a number of different organizations become involved in a relatively continuous and long-term change process."	Herbst (1976)
	A set of relationships that binds a group of independent organizations together.	Gulati (1995;1998), Das, Teng (2002) Nugaras, Radzevičienė (2009).
	A set of autonomous organizations that come together to reach goals that none of them can reach separately	Chisholm (1998)
	A network is a set of interconnected nodes. A node is the point where the curve intersects itself.	Castells (2000),
	A set of actors connected by a set of ties. Actors (often called "nodes") can be persons, teams, organizations and concepts. Ties connect the pairs of actors, can be directed or undirected and dichotomous or valued (measured on a scale).	Borgatti, Foster (2003)
	Formal or informal relationships between individuals (e.g. entrepreneurs, employees) or organizations (e.g. firms, projects).	Glückler (2007)

The thesis accepts networking as involvement and participation in the network. The concepts of the network and networking are tightly related, or, according to the definition of the network proposed by Glückler (2007), even overlapping as involvement and participation could not be distinguished without a structure and the structure that is useless without participation; however, relation is more important than the structure. This is the main reason why difficulties in separating these two concepts maybe encountered – involvement and participation are analysed together with the structure.

It is worth discussing some related theories and background at the beginning of the theoretical part of this research. Networking related aspects of the *social capital theory*, *Transaction Cost Analysis (TCA)*, and *Resource Based View* (RBV) have been examined.

Social capital theory, in the most general terms, is the concept of the value of connections and ties to resource-filled others. It is the implication for management relating person's ties or the network position for significant outcomes such as power, leadership, mobility, employment, individual performance, individual creativity entrepreneurship and team performance (Adler, Kwon 2002; Lin 2001; Borgatti, Foster 2003). One of the aspects of social capital highly related to networking are the analysis of how actors deliberately choose their ties (i.e. manipulate the structure of the network) specifically in order to maximize gain. Studies on social capital seek for explaining variations in success (i.e. performance or reward) as a function of social ties, whereas studies on diffusion (Valente 1995) and social influence (Friedkin, Johnsen, 1999) look for clarifying homogeneity regarding actor's attitudes, beliefs and practices also as a function of social ties (Borgatti, Foster 2003).

The other related theory is the *Resource Based View* (RBV) of the firm that has emphasized the notion that resources owned or controlled by the firm provide a competitive advantage when they are inimitable and not readily substitutable (Peteraf, 1993). From the perspective of the RBV, an important source of creating inimitable value-generating resources such as information, access, capital, goods, services, etc. lies in a firm's network of relationships. A structural pattern of relations in the network can also be accepted as a resource (Zaheer *et al.* 2000). This concept is strongly related to the benefits of the network and will be discussed in the following section of the thesis.

As regards *Transaction Cost Analysis*, a company is engaged in relationships to reduce costs as it is cheaper to get products on the market comparing to in-house production. This factor implicates the need for companies to cooperate and is transformed to different structures of institutional governance (Williamson 1975). The main issue is to identify the governance mechanism in the marketing channel that will minimize transactions costs. There are three basic forms of economic organization developed by Williamson (1975): market, hybrid/cooperation and hierarchy. On the one hand of the continuum, there is the total integration or "hierarchy" of organizations where ownership gives a certain prerogative and control. On the other hand, there is a free market where transactions are governed by market forces. Each form of governance has its own costs and the vital issue is to choose a system that gives the lowest costs in each case.

The theory focuses on why and when activities are coordinated within (less likely among) firms and is based on two key assumptions: bounded rationality (limits to what agents can know), *opportunism* (agents are engaged in self-interest-seeking with guile) and how this influences the governance structures of firms. The so-called *agency-theory* holds that because bounded rationality actors have to trust each other; nevertheless, actors in the channel may behave opportunistically, which means they will hold back information not beneficial for them. It is argued that opportunistic behaviour is reduced in a hierarchy or an integrated structure because actors can establish better control mechanisms (Abrahamsen 2009; Rubach 2011). From the point of view of the transaction cost theory, networks and network relations are categorized as the hybrid/cooperation form. In the transaction cost theory, the firm is nothing more than a vehicle for reducing transaction cost. The key is to find the optimal governance structure where inputs, outputs and technology are seen as given (Rubach 2011). On the other hand, transaction cost does seem very consistent with the theory of embeddedness since it is an unmistakably relational theory. In a deeper sense, however, TC reverses the traditional logic of embeddedness by reasserting the primacy of economic performance as a driver of exchange behaviour (Borgatti, Foster 2003).

A number of scholars from different backgrounds refer to 'network theory' but it is worth mentioning that there are several scientific streams and branches developing networking theory from different aspects. Araujo and Easton (1996) identified eight approaches: (1) social networks; (2) inter-organisational theory; (3) actor-network theory; (4) networks of innovators; (5) network organisations; (6) policy networks; (7) networks in economic geography; (8) industrial networks. Later, one more major approach which is (9) network governance was developed (Olejniczak *et al*. 2012).

A deep analysis of all above-mentioned branches is not feasible in one dissertation and thus some limits should be set. The main focus of the thesis will be limited to the analysis of the inter-organisational theory, networks in economic geography, industrial networks and network governance (further discussed in Section 1.2.1). From the author's point of view, these theories are the most relevant and applicable for the analysis of networking management from the perspective of a single HEI as a unit. The social network approach analysing person-to-person networks, as well as actor-network theory examining and mapping relations that are simultaneously material (between things), semiotic (between concepts) and mainly concentrating on the analysis of the innovation process tightly related to the networks of innovators will be neglected. A network organisation approach is applicable for the HEI, but is more aimed at internal rather than external processes; however, this thesis will be limited to external processes. Policy networks mostly related to the wider

implementation of policies using the network concept would be applicable in case of the analysis of the HE system as whole, but is less relevant to the single HEI approach.

In order to better understand the selected approaches, some development review will be given. The beginning of formulating network theory started with the analysis of inter-organizational exchange, buyer and seller relationships and industrial networks. At a later stage, an attitude to commerce became more global, hypercompetitive and turbulent, and both markets and hierarchies displayed inefficiencies as the modes of organizing production. A network is a form of organization that combines the flexibility of markets with the predictability of traditional hierarchies (Snow, Miles 1992; Achrol 1997; Powell 1990; Borgatti, Foster 2003). The major milestones in the development of networking theory are presented in Fig. 1.1.

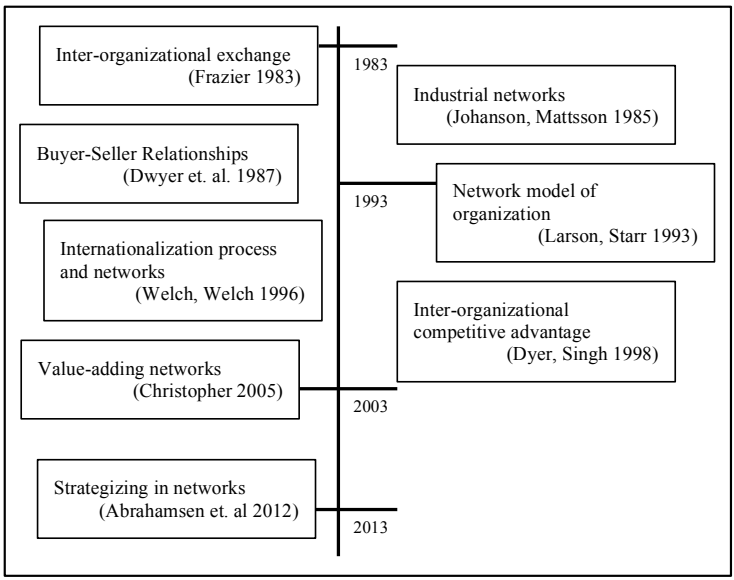


Fig. 1.1. Milestones in the development of networking theory. Done by the author according to Frazier 1983; Johanson, Mattsson 1985; Dwyer *et. al.* 1987; Larson, Starr 1993; Welch, Welch 1996; Dyer, Singh 1998; Christopher 2005, Abrahamsen *et al*. 2012

At the first stage of networking development, exchange between two organizations (inter-organisational networking) were strongly emphasized. Next, it was understood that inter-firm relationships could be a source of a competitive advantage (Dyer, Singh 1998) and network analyses focused on

the distinct types of interdependencies involved in inter-organizational collaboration (Lazzarini et. al., 2001). One of the most influential approaches to inter-decencies in business and networking formation, processes and structures is research done by the Industrial Marketing and Purchasing (IMP) group (Håkansson 1982; Håkansson, Snehota, 1989; Ford 1990; Håkansson, Snehota 1995; Gemunden, *et al*. 1997; Naude, Turnbull 1998; Ford 2002, Medlin, 2004, Abrahamsen, *et al*. 2012) that introduced the concept of interaction developed and proved by a number of empirical studies. *Interaction* is a process that occurs between companies and changes and transforms the aspects of the resources and activities of the companies involved in it and the companies themselves. Also, studies carried out by the IMP emphasize that the interaction between individually significant companies is a primary characteristic of the business landscape. The implication of this observation is that it is not what happens within companies but what happens between them form the nature of business. It is through combining resources and linking activities with each other actors develop, work out value for each other and address problems to each other. It is only through others that business actors can acquire their respective and collective identities and roles. It is through the interaction with others that business actors learn, teach, serve, utilize and become appreciated (Håkansson *et al.* 2009). However, as regards exchange relations, the parties tend to merge past, present and future in a continuum thus taking into account experiential learning in relation to past interactions with the same party and experience from other interactions with which the focal party has conducted or is conducting relationships (Webster 1992). This fosters collaboration between two parties and a longer term perspective. Collaboration represents a departure from discreteness that underlies spot market transactions toward a more relational approach. In collaboration, action moves from transaction to joint activities, including joint problem solving and joint planning (Dyer, Singh 1998; Heide, John 1990; Goldkuhl, Melin 2001; Claro D., Claro P. 2010). Interaction always affects resources and people that are involved in it and activities they perform (Wilk 1996, Håkansson *et al.* 2009).

All companies simultaneously interact with many others, and the interaction between any two companies affects their interactions with these others. This network of connections between interaction processes leads to modifications in activities, resources and companies across many organizational boundaries. Being a ubiquitous process, interaction also forms a working structure for the network and provides an element of stability to how different companies relate to each other in the network (Ford, Håkansson 2006; Håkansson *et al.* 2009).

Another approach adopted by the same IMP group is the *industrial network approach* that challenges the idea of an autonomous company making

autonomous decisions. Business relationships are explained from the view that companies engage in relationships in order to reduce costs and to exert control (Abrahamsen 2009). In addition to this, a company can select a marketing segment and obtain a desired position in this segment based on some autonomous strategy decision and hence develop a product that will attract the attention of potential customers through market communication activities, determine a pricing policy based on the forecasted demand and decide upon a marketing channel that most efficiently transfer the product from the manufacturer to end users (Kotler *et al*. 2009). Industrial network perspective challenges this general marketing perspective. In marketing, the customer's (B2C B2B) task is to act favourably in terms of buying the product in question, which finds the customer as being an active part of developing relationships. The success of a company may be explained by its ability to develop and handle the interconnectedness of its relationships and a wider network. This implies that the company is not an isolated unit making autonomous decisions; it is linked to the larger environment by its interconnected relationships (Håkansson, Snehota 2006; Abrahamsen 2009). In business, those approaches are realized in such forms as cooperation (Jaržemskis 2007; Stein, Ginevičius 2010; Zeng, et. al. 2010), strategic alliance (Gulati *et al.* 2006), partnership, supplier relation (Achrol 1997), joint venture, franchising, licensing, etc.

Networks in economic geography: the relation between geography and networks can be theorized in (at least) two ways: first, *proximity affects network formation.* The most widely used approach in economic geography aims at assessing the latent effects of physical proximity/distance on economic processes. Second, a *place makes a difference*. A place-specific resource profile conveys a source of contextuality, difference and contingency for economic development (Glückler 2007), but a geographical location is a non-relational condition that may strongly affect the evolution of the trajectory of the network. Both aspects are combined and investigated in the analysis of clusters (tight networks in some geographical location), either from the perspective of regional or sectorial development.

Despite of using the inter-organizational theory, networks in economic geography, industrial networks and network governance to investigate *vertical and horizontal structures* of networks are usually used and analysed (Boschma, Wal 2007; Mason *et al.* 2007; Jindraa, *et. al.* 2009; Gebauer *et al.* 2012).

Vertical networks are more applicable for value delivering activities in the product market and managing marketing channels. Literature mostly analyses vertical networks from the perspective of the systemic interaction of the focal company that supplies consumers (Golfetto *et al.* 2007; Zerbini, et. al. 2007; Dogan 2009). The development of vertical networks is closely related to the development of the value of client delivery. In the 1990's, this function was

seen as a competitive advantage as well as a complex process that could not be restricted to the border of an individual company. With the growth of understanding that, in order to improve the overall service offered to the end customer at minimum cost and with high flexibility, companies should cooperate and coordinate their activities (Jahre, Fabbe-Costes 2005). Companies and even the organizations of the public sector (see Section 1.2.1) worked hard with downstream and upstream partnerships as well as with those with the providers of their logistics. Participation helped several firms of the supply chain with forming complex network structures (Christopher 1998, 2005). However, the main player in the vertical network is a focal organization that performs very few core functions and is often referred to as an "integrator", i.e. the firm that organizes the network and coordinates all upstream and downstream firms. Thus, a vertical market network can be defined as the organization set of direct supply or distribution relationships organized around the focal organization best positioned to monitor and cope with critical contingencies faced by network participants in a particular market (Achrol 1997).

Horizontal networks concentre practices between the companies operating at the same level(s) in the market and capture network actors and activities across multiple value chains (Gebauer *et al*. 2012). Also, it is common to approach horizontal networks as those are usually made up of entities that bring distinctive competencies into collaboration. Such networks have been formed to be engaged in innovation activities and new product development and have been referred to as innovation driven horizontal networks (Oke *et al.* 2008). Horizontal relationships are more informal and invisible and are built mainly on information and social exchanges (Bengtsson, Kock 1999). Moreover, it is considered as one of the ways to manage costs down as well as achieve the required service levels and to extend the notion of collaboration on a horizontal plain to potentially include complimentary players and even competitors (Christopher 2005).

The above discussed concepts of the network and the main networking theories indicate multi-angle approaches and a complex field of the analysis of the relational environment that forms different structures effecting the understanding and management of business companies and public entities. The previous section has mainly focused on strengthening the understanding of structures and processes existing in the environment of the entity. The adopted more structural approach does not explain the main reasons and motivation for entities to participate in network structures – a close look at the main motivating criteria as well as the obtained results and outcomes are given in the next section also discussing networking implications for strategic management.

1.1.2. The Analysis of Implications for Networking in Strategic Management

The development and implementation of a strategy are highly related to the concept of networking and should be taken into account considering networking analysis. One common definition of the strategy, in the context of business and public management, finds it as the determination of the basic long-term goals and objectives of an enterprise as well as and the adoption of courses on action and the allocation of resources necessary for carrying out these goals (Chandler 1962). First, this definition reflects several aspects of the interest of a networking researcher: a long-term perspective is very common for the analysis of inter-organizational networking and industrial networks. Second, the industrial network approach emphasizes the impact of networking on the resources and courses of action in a particular environment. It is worth emphasizing that, regarding the industrial network approach, the environment is not a faceless entity but identifiable parties and unique counterparts with distinct identities (Håkansson, Snehota 2006). This indicates that networking is highly related to strategic processes of the entity. Moreover, the thesis mostly considers networking from the perspective of interaction with the external environment – one of the core elements to analyse strategy development. One of the central issues explored by networking scholars are the benefits that could be gained from relations with the external environment and studied in the strategy for a single institution. These benefits and outcomes of networking are summarized in Table 1.2.

The thesis accepts networking as a tool for reaching the above listed benefits, or as function that should be performed by the entity in order to survive in the contemporary environment. In this case, the aspects of networking should be considered as an important element of strategy development and implementation and have an impact on the strategizing process.

Four stages of the impact of networking on the strategy can be distinguished: (1) autonomous strategy; (2) ego-centric strategy; (3) strategy in wider network; (4) strategy with assessed managed portfolio of the partners.

At the stage of *an autonomous strategy,* the external environment is not analysed from the networking perspective, the impact of long term relations with partners is neglected, entities do not considering networking as a tool for gaining the above listed benefits and collaboration in networks takes place without a prescript plan and without the certainty of outcomes (Rubach 2011), or the so called unsystematic and unconscious participation, thus lacking strategic perception to network partners, partners (network) portfolio (key partners) and networking management (Parise, Casher 2003).

Table 1.2. Benefits and outcomes of networking

Benefits and outcomes of networking	Impact	Influential authors
Competitive advantage	Networking creates a unique and difficult to copy competitive advantage	Dyer, Singh (1998)
Complementary resources	Sharing human recourses could help with using synergy in the conscription of resources. Sharing could assist in buying more technologies; if technology is constant, less money could be spent.	Spekman, et. al (2000); Lavie (2006); Hakanen, Jaakkola (2012);
Decrease in opportunistic behaviour, risk sharing	Trust and close long term relations could prevent from the opportunistic behaviour of the partner	Moeller (2010),
Economy of scale, better usage of operational costs	Companies in horizontal networks of the same sectors use more or less the same materials, so they could use economy of scale in order to get cheaper materials	Joglekar, Lévesque (2013),
Development, survival and profitability of the participating entity, small business development	Networking increases the possibilities of entities in the network	Street, Cameron (2007); Gilsing *et al.* (2008); Busquets *et al.* (2009); Anon (2003); Oke, Idiagbon-Oke (2010).
Organizational learning and access to information, learning from partners Common language and shared mental models	There are better abilities to learn and access information for the companies in networks	Lawson *et al.* (2009), Dyer, Hatch (2012), Senge (2006).
Access to local and international markets	Participation in networks increases abilities to access local and international markets	Oke, Idiagbon-Oke (2010); Fletcher (2008).
Faster and better innovation, higher R&D, costs for a reduction in R&D	Synergy of resources, competitive advantage	Enkel *et al.* (2009),
Reduction in bureaucracy and management costs	Faster and cheaper value delivery	Park (1996)

As for the *ego-centric strategy,* some conclusions could be drawn: partnerships are respected, but interconnections between partners are neglected, understanding the network is very limited to the experience of people responsible for strategy development and a shallow understanding of

relationships that constitute the network. According to Möller, Halinen (1999), at this stage, there exists a lack of understanding that the better the vision of the network an entity has, the better chances of foreseeing strategic changes initiated by specific actors can be noticed, which embraces competitors, major customers, suppliers and government agencies as well as a lack of ability to develop a strategic net (supplier net, distributor net, R&D net) and to mobilize other actors; the abilities of the entity to offer products or services, process know-how and access to technology for useful partnerships are not seriously considered.

The main difference of the approach to the strategy in a *wider network* is that the interrelation and interdependencies between actors, along with their relationships and the rules guiding their interactions are understood and analysed; the developers of the strategy take into consideration that understanding the network should not only be experience, but also research based. One of the most recently developments of a wider network approach is strategizing through network development that also concerns how the firm perceives its network of connected relationships and how it acts in relation to these perceptions (Aaboen *et al.* 2012). Literature highly emphasizes two main aspects of strategies for the networking approach – the company should have both a strategy in place for network participation and an organizational structure suited for working in networks (Miles *et al.* 2005; Rubach 2011). It is worth stating at this point that the structure of working in networks is an object of the theory of network organizations and it is out of the scope of the thesis, however, the strategy for network participation is the core of the object of investigation. The other matter of consideration is how strategic changes predefined in the strategy for a particular entity will affect the whole network – a change may emerge and shift from any one part to another as different parts of the network are linked (Halinen, et. al 1999); moreover, if activities are linked, it would lead to jointly developed visions and decision making that could be implemented by managing the portfolio of partners.

As for the most advanced *partners portfolio* approach, networking is accepted not as a factor of the external environment, but as the object that should be taken into account by strategy and carefully managed, including not only the allocation of scarce resources but also the creation of new ones (Möller, Svahn 2003) thus targeting a position in network coordination between partners.

The origins of the portfolio theory lie in financial investment (Markowitz 1952; Sharpe 1963). Recently, the concept has also been widely adopted in other spheres of management such as strategic engagement and marketing as a mechanism for aiding decisions about resource allocation. This concept could be also understood as a mechanism for conceptualizing, configurating and

managing the sets of relationships that surround a firm (Zolkiewski, Turnbull 2001; Wassmer 2010; Zolkiewski, Feng 2011) as these portfolios are also known as alliance portfolios.

The concept of partners' portfolio management has not changed the nature, and the most common practice accepted by the public sector and business entities are still focusing on an individual bilateral alliance instead of looking at all relationships holistically. Emerging contemporary theoretical and empirical perspectives emphasizing synergies, constraints, interdependencies and forces look at relationships and manage alliances as a portfolio (Parise, Casher 2003). It is critical to understand how individual connections affect each other and a wider network. Due to the fact that most business strategies include more than one partner, success often depends on how the whole collection of alliances fit together. The portfolio approach considers linkages between each business partner and the focal entity; but the author also bears in mind linkages between partners and a wider network.

Despite of the approach taken on networking relation to strategy, four types of relationships, including cooperation (Ginevičius 2010), coexistence, competition and coopetition (Bengtsson, Kock 1999; Luo *et al.* 2006; Stein, Ginevičius 2010) provide companies with advantages in different ways, which means that there is a need for stipulating a goal towards actions taken by the firm on each relationship as well as on how the portfolio of relationships should be best arranged. While managing relations, the fact that relationships with other firms will change over time must also be taken into account. For example, at one point of time, content in relationships is coexistence, then cooperation, etc. (Bengtsson, Kock 1999).

To sum up the above section, it is worth emphasizing several important aspects: (1) a surrounding network could be treated as an external factor of the entity; also it could be affected by active and planed entering and participation understood as networking; (2) networking might be an efficient tool for reaching strategic goals and increasing competitiveness in order achieve which, it should be systematically managed as a process; nevertheless entities are still struggling to design and managing their key partner relationships for long-term value creation (Parise, Casher, 2003); (3) abilities to understand a wider network and manage it requires specific tools and techniques that are underdeveloped; (4) the most advanced concept of networking management is partners' portfolio approach.

The above analysed approaches, in the majority of cases, are derived and further applied in the business environment, but potential usage in the public sector is underestimated and could be more properly investigated. However, a more precise analysis of networks in the public sector is conducted in the following section.

1.2. Networking Related Issues in the Sector of Higher Education

1.2.1. Reforms in the Public Sector as a Precondition for Networking Development

The preconditions for the wider usage of network principles in public management started rising together with New Public Management (NPM), to be more precise, seeking to solve some obstacles that arise together with the implementation of NPM. Stress on competition and contractualisation eroded traditional public sector norms of cooperation. Highly emphasizing decentralization, more flexible, less hierarchical structures, as well as outsourcing and involvement of stakeholders the paradox has been recognized – vertical subordination and strict performance management from above made cooperation among different institutions even less possible. Also, a struggle from the side of new managers for involving professionals and civil society in their reforms and changes was seen (Olejniczak *et al.* 2012).

The intensive use of outsourcing has increased the complexity of delivering services; furthermore, for seeking to solve governmental problems, solutions had to involve more stakeholders. These transformations caused new governance problems (Klijn 2008). Governance is performed applying looser policy instruments such as contracts, outsourcing, alliance building, partnership, persuasion and public exhortation, rather than the direct use of hierarchy. There are two relevant main streams of networking research in the public sector. The first stream mainly concentrates on managerial issues appearing while public managers operate in settings involving public and other institutional actors networked in the patterns of interdependence. Much attention has been directed to explaining the emergence of networked public management contexts and to theorizing about how managerial action is likely to be influenced by and to influence such settings. In this case, network nodes can consist of units spanning agencies, governments and sectors, including public-private arrays (Meier, O'toole 2001). This approach is focused on governing the network either moving from direct hierarchies to more decentralized and independent structures, or implementing more systematic interaction in the already existing complicated network of public sector actors. These transformations have led to the so called *network governance model* where traditional sectorial boundaries are overcome by new hybrid forms of management such as Public Private Partnership (Eggers, Goldsmith 2004; Olejniczak *et al.* 2012) and the Open Method of Coordination implemented in the EU (Zeitlin 2011). Network governance is seen as an advanced form of NPM or a separate management pattern (Jeffares, Skelcher 2011; Klijn at el.,

2010; Sorensen, Torfing 2007). Governance networks could evolve from the bottom, be initiated from the top or be based on informal interaction and formalized internal or external structures (Sørensen, Torfing 2005). The model of network governance has increased the involvement of stakeholders and service professionals.

Reforms in public sectors are tightly related to the implementation of business like management and organizational activities, including not only such activities as strategic planning (Bivainis, Tunčikienė 2009) but also new networking related forms such as clusters, alliances and long-term strategic partnerships that have been increasing the possibilities of business to survive in a global and constantly changing environment (Jakubavičius et. al., 2008). Also, higher pressure on work under market conditions has increased the need for public and private companies to collaborate. While outsourcing activities, several providers, controlling agencies, stakeholders and end users could be involved. These multi-dimensional and multi-layer activities between more than two partners form network structures in the public sector. Networking activities and network governance tools are spreading widely within activities with the aim to solve *wicked problems* such as AIDS, global warming, poverty, etc. Efforts to solve such wicked problems involve plenty of players, and close and long lasting cooperation, coordination and interaction are needed (Klijn *et al.* 2010). In addressing such problems, network governance is used for several reasons: first, similar actions require a number of decentralized efforts, and networking is one of the ways to manage, coordinate and set priorities; second, the networking mode is good for long lasting relations as it develops through time.

Both vertical and horizontal networks are developing in the public sector. The attributes of vertical networking could be seen in providing medical services, for example, by local doctors working in cooperation with regional and national hospitals. Also, some chain elements could be seen in providing educational services from kindergarten and secondary education to vocational education and different levels of higher education.

Business or industrial networks and network governance are usually analysed separately and are the object of interest of separate scholars. Nevertheless, as regards business and the public sector, networks create similar benefits and rise similar managerial problems. Even in the analysis of private and public institutions, a lack of integrating different networking theories has been indicated after literature review.

There are two relevant main streams of networking research in the public sector. The first stream mainly concentrates on managerial issues appearing while public managers operate in settings involving public and other institutional actors networked in the patterns of interdependence. Much

attention has been directed to explaining the emergence of networked public management contexts and to theorizing about how managerial action is likely to be influenced by and to influence such settings (Meier, O'toole 2001). The second approach allows giving attention to governing the network either moving from direct hierarchies to more decentralized and independent structures, or implementing more systematic interaction in the already existing complicated network of public sector actors. Network theory and analysis are highly developed, but their utility has not been fully realized in the public sector (Luke, Harris 2007). As seen from literature review, even if the public sector is slightly different, management science could benefit from the wider implementation and application of theories empirically tested in the business environment.

1.2.2. Forms and Developing Possibilities of Networking in Higher Education and Higher Education Institutions

European higher education environment has been significantly affected by globalization, Bologna-driven reforms and European and national policies, including internationalisation, the growing importance of knowledge-led economies and increased global competition since 2002, as stated in the report prepared by the European University Association's (EUA) (Sursock *et al*. 2010). These transformations (Melnikas 2014) forced the sector of HE to shift towards more collaborative patterns of activities. Financial support programs Horizon 2020 and Ersamus+ newly launched by the EC also emphasize the importance and availability of financial support only in collaboration with partners almost in all cases. The growth of the need to collaborate, communicate with stakeholders and other institutions has simulated more intensive networking activities. The same EUA report states that internationalisation has been identified by HEIs as the third, most important change driver, in the past three years and is expected to move to the first place within the next five years. It is clear that the EU driven processes of innovation and knowledge-based societies will further multiply and deepen inter-links of higher education, including regional, national or international networks and partnerships (Sursock *et al*. 2010). The creation of international franchise programmes or branch campuses (Girdzijauskaite, Radzeviciene 2014), cooperation with local actors, joint e-learning programmes and joint degree programs are the most contemporary forms of networking in HE. Constant development and more advanced forms of networking indicate a growth in the relevance of the topic concerning this research.

Creating small global and European networks is a strategy frequently chosen by institutions to boost their *visibility* and combine strengths. The

networks increasingly used as institutional status markers provide face-to-face opportunities for exchange and partnerships as well as for a better understanding of the situation of higher education worldwide. Small, on the most strategic relations based networks are very in line with the approaches from industrial networking theorists and empirical studies worked on by the IMP group. In large scope of studies, researchers have investigated the core network (usually small) of the most important partners, and their very special and unique relations and benefits are discussed in Section 1.1.2. (Håkansson et. 2009; Abrahamsen *et al.* 2012). Also, accessibility to formal and informal networks is considered as a significant source of sustainable small business success (Anon, 2003), as this factor could be used as an opportunity for the development of small peripheral HEIs.

The EUA emphasizes that internationalisation and other forms of networking are very central to many institutional strategies: 31% of those find it as a way to develop their academic activities and 28% as a means to enhance reputation and visibility. The common elements of institutional strategies include developing educational or research alliances, maintaining membership in networks and associations, offering stand-alone courses and support services to international students, teaching in non-national languages, promoting staff and student mobility through improved information or financial support, requiring periods of mobility as a part of curricula, improving language teaching, fully implementing student-centred learning and the Bologna tools, particularly ECTS and the Diploma Supplement (Sursock *et al.* 2010). Policy-makers, research funders and research performing organisations now are paying increased attention to research internationalisation; despite this, the evidence base for the formulation of internationalisation strategy remains weak (Edler, Flanagan 2011).

A literature review indicates that even networking elements are considered important for strategies; they are lacking scientific and systematic analysis based on the incorporation of networking. There is a theoretical and empirical gap between several related issues: first, if networking activities are used for designing a strategy for the HEI, it should be possible to monitor performance and to have not only Key Performance Indicators (KPI) but also a general overview and measurement of networking activities of the HEI; second, in order to manage networking, there is a need for assessing the effectiveness of the partners' portfolio of the HEI. The science of management could not say much about the ways to evaluate the position of the institution in a broader network of HEIs (critical review of networking assessment methods, see Section 1.3). What is more, the process of strategy development requires insights to support decisions on targets for short-term and full-degree mobility, geographical targeted areas, target numbers of mobile students and the types of

the partner portfolio, including participation in specific networks (Sursock *et al.* 2010). These insights and decisions are usually done by intuition, experienced staff and top management that would reflect either an autonomous or ego-centric strategy development process discussed earlier. For more effective networking management, there is a need for more complex and more sophisticated networking assessment and therefore insight generation tools have been indicated in a literature review.

Another trend and phenomenon in the management of the HEI is the growth of impact and the importance of various *university rankings*. This phenomenon is also highly affected and makes an impact on the networking perspective of the HEI: first, it uses a number of internationalization and other networking related results for the purpose of comparing institutions; second, rankings shift the portfolios of HEI partners (Rauhvargers 2013) not only for those 1-5% of all 17500 universities included in rankings, but also for non-listed institutions, as the newly ranked ones become more selective (IBNLive, 2012; Olds, Robertson, 2012). As rankings are based highly on research outcomes, thus, there are many good higher education institutions worldwide that should be considered for partnerships taking into account other than a position in ranking criteria because they are more teaching-oriented or concentrate mainly on the arts and humanities (Rauhvargers 2013).

All higher education institutions are increasingly called on to use data on decision-making purposes and to document student and institutional success (IHEP 2009). A growing number of universities have started referring to data from rankings for analysis, strategic planning and policy making. The importance of universities in deciding which indicators are of the greatest interest in accordance with their strategic priorities, and in focusing on these alone has been underlined (Forslöw 2012; Yonezawa 2012). One of the reasons for universities reporting such data are to establish comparisons with rival universities (Proulx, 2012; Hwung, Huey-Jen Su, 2012). This process is complicated for non-listed institutions and still generates a very limited amount of information on the positions in the network and existing development opportunities for the HEI.

Understanding the network that surrounds the HEI is based on the previous experience of the managers of the HEI, and autonomous or ego-centric views dominate in the process of strategy development (Nugaras 2012b).

All mentioned above is summed up into the *scientific problem*: two major problematic aspects are distinguished considering the increased usage of the networking perspective in developing the strategy for the HEI: (1) lack of the ability to monitor the process of networking in a holistic way assessing not only the performance of the institution in which the strategy is developed, but

also the structure and performance of the portfolio of partners; (2) lack of the ability to generate and incorporate insights from data provided by a wider network (including inter-relations of partners and competitors, their positions in the network, clustering core institutions, targets for the development of strategic partnerships, etc.) into strategy development, e.g. sense making and strategizing with network pictures (Ford *et al.* 2006; Mouzas *et al.* 2008). This scientific problem leads to further theoretical analysis, a critical review of networking assessment and sense making methods.

1.3. Critical Review of Methods for Network Assessment

1.3.1. Overview of Theoretical Approaches to Networking Assessment

The most general approach to *networking assessment* (network analysis) is a set of techniques developed to study how individuals, communities, organizations and other entities connect and interact with one another (Durland, Fredericks 2006; Kilduff, Tsai 2003). The focus of network analysis is put on relations between agents (people, organizations, states among others) and how the pattern of relations can be used for understanding the processes and performance of the system (Valente *et al.* 2008). Since sociologists began dominating network research in the 1970s, the proposition that an actor's position depended on the established relationships in a network had consequences on the actor, occupied the central place in network thinking (Borgatti, Foster 2003) and was considered as the most basic principle of assessment. Gadde and Håkansson (2001) argue that the actor's position in the network is determined by attention it receives from other actors. This is labelled "identity". They argue that a proper match of identities is a prerequisite for interaction. Both external and internal factors shape the identity: it is formed by the resources the actor controls and resource ties it has to other actors. It is influenced by past actions and experiences (ARA method) and by the actor's position in the network. Hence, it is vital to develop a favourable identity in order to attract attention from the rest of the network (Abrahamsen 2009).

There are two main approaches to any network assessment, i.e. the ego level perspective and a wider network (level) perspective (Provan *et al.* 2007). These introduced perspectives are also employed for strategic management and have been previously discussed in the thesis. When we focus our attention on a single focal actor, we call it actor's 'ego' and name the set of nodes that ego

has ties with. The ensemble of ego and all ties among these (including ties to ego) is called an ego-network. Since ego-networks can be collected as unrelated egos (as in a random sample of a large population), studies on the ego-network blend a network-theoretic perspective with conventional, individual-oriented methods of collecting and processing data (Borgatti, Foster 2003). The analysis of the *wider network* consisting of multiple organizations linked through multilateral ties concentrates on the main issues such as how networks evolve, how they are governed, and, ultimately, how collective outcomes might be generated and what structures of the network might serve ego-networks best focusing on the structures and processes of the entire network rather than on the organizations that compose the network (Provan *et al*. 2007). A literature review has identified several most common features of a wider network: density, centralization, clustering and sub grouping, positioning and influencing (Lipparini, Lomi, 1999).

Since 1970, many more methods for specific ego and wider network assessment have been developed in relation with the previously discussed inter-organizational theory, networks in economic geography, industrial networks, and network governance – a critical review of the most advanced or most popular methods is presented in Table 1.3.

Table 1.3. Theoretical models for networking assessment

Assessment method	Features	Scholars	Advantages	Disadvantages
Activity-Resource-Actor (ARA)	The process and outcomes of interaction are explained considering three layers between counterparts: activity links, resource ties and actor bonds.	Håkansson, Johanson 1992; Håkannson *et al.* 2009	Universal approach, high applicability	Hard to apply to larger, more complicated networks, to use the whole network perspective; difficult to compare qualitative results
4R: R1 – products R2 – production facilities R3 – organization units R4 – organizational relationships	Investigate the interplay between 4 resources and how these are affected by being embedded in other resources across company boundaries (network).	Håkansson, Waluszewski 2002; Håkansson *et al.* 2009;	Good analytical method for an in-depth networking analysis of a few main business partners	Analysis is focused only on the layers of resources

Continuation of the Table 1.3

KPI related methods: growth Increase in competitive advantage, Operational efficiency	Networking is affecting KPI of the company, which is a way to assess benefits of networking.	Mouzas 2006.	Clear and measurable outcomes of assessment	More specific to apply for the public sector as profit and growth are not the main aims; KPI for networking is not defined
SNA (Social Network Analysis)	Set of quantitative analytical methods based on the graph theory.	Valente 1955; Freeman 2004;	Wide range of quantitative results	Results are useless without a specific interpretation of the field
Case study	Data analysis for identifying relations and their effects. Combining surveys, interviews and other data.	Valente *et al.* 2008; Karhu *et al.* 2014;	Indebt approach applicable for 'ego' and perspectives in a wider network	Case sensitive process is hardly feasible on larger networks
Longitudinal quantitative network analysis	Done to assess the process and changes in the network in the set of time.	Halinen, Mainela, 2013; Slotte - Kock, Coviello 2010;	Ability to grasp changes in the same network	Less feasible on larger networks; data comparison issues can be observed
Network assessment applying network pictures	Visualizing networks in order to better understand and use in the strategy	Ramos, Ford 2011; Håkansson *at al*. 2009; Mouzas *et al.* 2008; Henneberg *et al.* 2006.	Highly applicable for strategy development.	Empirically applied only to small networks.

Several additional remarks on summarizing the above table should be done: first, there is a tendency either to do a case study like research thus focusing on a small core network and the features of it, or, take less common research practice to investigate the features of a wider network. Therefore, all methods have advantages and disadvantages: in both, ego and wider network analysis, some threats can be faced. As for the analysis of the wider network, there is a possibility of focusing on the structure or configuration (structural topological features) of ties and neglecting the content of ties instead of inter-

relations and interaction. The other risk is to lose the essence of the network, or the so-called 'bigger picture' regarding concentration on a few indebt connections. Methods for networking assessment are lacking a more holistic approach to integrating both aspects structural configuration as well as the content of interaction. Also, the table indicates that only SNA is the quantitative method that could be feasible on larger networks. This method is very sensitive to the background of application and, in the specific area such as higher education, can be used only with additional scientific conceptualization and framework. For the purpose of strategizing, a longitudinal approach has core importance in order to monitor the results of the strategy and to be able to assess and contribute to SWOT analysis of the strategy. Unfortunately, the existing empirical studies are more oriented to theorizing networks but are lacking practical aspects to be applied in the development of the strategy.

One of the most promising and booming methods for networking analysis are assessing and strategizing with network pictures. As this method would be highly applied in the assessment of HEI networking, it would be discussed in a separate section.

1.3.2. Assessment Applying Network Pictures

The origins of the concept of assessment applying network pictures are related with the basic principles of the sense-making theory (Weick 1979) and conceptualization and interrelation between cognition and action in networks (Ford et. Al 2002). Also, it helps with understanding how actors make sense of their relationships and their wider network (Ford, Ramos 2006; Henneberg *et al.* 2006). Recent scientific efforts are mostly related to operationalization (Ramos, Ford 2011) and making this concept more practical and applied to strategizing (Abrahamsen *et al.* 2012).

These efforts shift the understanding and definition of network pictures: at the earlier stages of development, it was mainly understood as the actor's perception of the surrounding network, or how to catch that perception (Ford, Ramos 2006). In more recent works, network pictures are started to be understood as a research tool for analytical and managerial purposes. Ramos, Ford (2011) developed a theoretical analytical tool based on three main elements, including (1) scale and structure, (2) processes and (3) personal positioning, a more detailed description of which is given in Table 1.4.

A very similar approach is also delivered by Öberg *et al.* (2007) where network pictures have been considered to describe actors, activities, resources, network boundaries, network power and network centre/periphery.

A dominating approach to network pictures is finding them as not neutral but biased views on how actors perceive the network, themselves and their

place within the network. Moreover, the approach represents what managers subjectively perceive to be of importance in their business environment and what pertaining logic for actions and consequences of managerial activities in the business network are (Abrahamsen 2009).

Methodological efforts to d understanding networks are also reflected in the network insight approach (Mouzas *et al.* 2008) that put emphasis not only on the generation of knowledge about the network using pictures but also on the amplification of managerial methods for developing insight in business networks, which does not merely consist of the pictures of individual players but comprises the objectified knowledge of positioning and acting. Network insight is considered to be 'objectified' because it consists of a set of shared data, information or facts. Thus, the network insight can be seen as the outcome of continuous and iterative interplay between factual physical and social artifacts that surround actors in the networks of exchange relationships as well as the cognitive schemata constructed and shaped from actors' past experience and precedents, see Fig. 1.2 (Mouzas *et al.* 2008).

Table 1.4. The elements of the network picture based on Ramos, Ford (2011)

Elements of the network picture	Sub elements
Scale and structure	Actors' resources (assets and relationships), aspirations and problems and the position occupied in the network. Aspirations reflecting actors' goals.
Processes	The processes of the network are about the relationships that take place between the interacting actors using their power, commitment, closeness, trust, cooperation and understanding. Activities may reflect either a transfer or transformation of resources between actors.
Positioning	The position a particular actor occupies in the network may be determined by the surrounding of that actor and the co-existing web of actors, resource constellation and activity patterns. When implementing a strategic action, by mobilizing other actors and their resources, actors are looking to achieve a better position.

Transformation from network pictures to the network insight is done by combining actor's pictures (impressions, images identities) and network exchanges (multilateral exchange, manifold rationality, recursive time). This amalgamation process defines the mechanism of how the real and subsequently objectified view becomes apparent. It does not, however, occur instantly. There are a number of enablers and barriers to the amalgamation of cognitive views, and it is a time-consuming process the result of which is the network insight that is not an individual interpretation inferred from a variety of cues, because it is collective and objectified (Mouzas *et al.* 2008). According to Öberg *et al.*

(2007), network pictures have mainly been used for describing actors, activities, resources, network boundaries, network power and network centre/periphery.

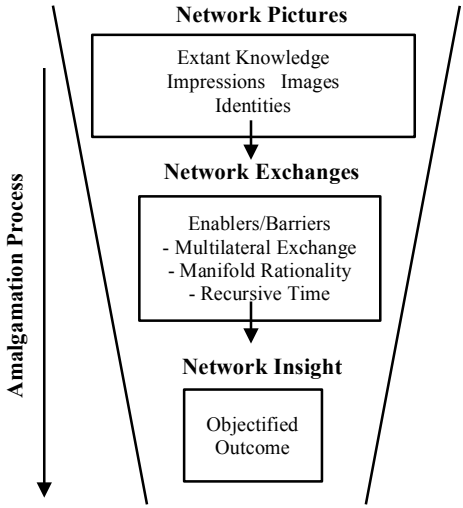


Fig. 1.2. Model for the network insight (Mouzas *et al.* 2008).

The tools for network pictures described above are based on the qualitative research approach and have integrated the main approaches described in the previous section. Still, the suggested data collection methods usually refer to the personal perception of the network participant, and that perception is captured using indebt interviews or long discussions done by the top management of network companies. The qualitative data collection method creates feasibility issues applying it on larger networks. Information from qualitative interviews is descriptive and unstructured, difficult to compare and use as a measurement in strategic management. Also, in case it is based on the discussion of top managers, it might be an issue of applying the method in a drastic change of the managerial body, as well as understanding the networks that have been functioning many years before managers took a position.

The concepts of network pictures and the network insight have been used for strategizing purposes in recent scientific works. Aaboen *et al*. (2012) suggest an approach to capturing the views of the past, present and future at different points in time by relying on a combination of narratives and network

drawings. Case study based empirical studies (Ramos, Ford 2013) have proved that network pictures could be useful for generating a general understanding of the whole network and for creating network insights that could be transformed into strategic insights. This concept is very novel and under-developed, and therefore there is a lack of ability to use less subjective data collection methods and the ability to generate pictures from larger networks where interviews and individual case studies would not be feasible. From literature review and theoretical point of view, there is a need for the network assessment tool (dimensional model) integrating relational and network information in order to generate network insight that could be transformed into strategic insights and incorporated in the strategy.

This theoretical structure would be useful in any network, but probably it would be sensitive to the application for a specific field or sector such as higher education. In order to effectively apply this structure, a more detailed analysis of network assessment practices and the availability of the empirical data in the sector should be investigated.

1.3.3. Critical Review of the Current Networking Assessment Methods Used in the Strategic Management of the Higher Education Institution

To begin with, it is worth discussing some limitations to the assessment of the HEI: first, the conducted analysis shows *international networking with other HEI*; second, it concentrates on the *institutional level*; third, an approach to a *wider network is predominant*. Positioning strategic actors has been discussed in the previous section and is understood as one of the core elements of networking assessment. The cooperation of the HEI with the business world is also highly related to networking but is covered by other theories such as actor-network theory and an approach to the networks of innovators; however, it would not be feasible to analyse these approaches together with the chosen ones in one dissertation, and therefore networking with the business sector has been left out of scope of this scientific work.

A literature review on methods for networking assessment in the field of HE has indicated three areas of interest in the perspective of networking assessment: the assessment of networking in research, the assessment of networking in studies (academic affairs) and integrated (common) systems that include networking assessment.

Scientific collaboration is one of the most developed fields of networking. There are some recent efforts in the field to measure international collaboration (Finkelstein *et al.* 2013, SCImago Research Group 2013a,b), but it is more statistical than system theory-based assessment. The most common

collaboration assessment refers to co-authorship and co-citation. These methods were first put in use in the last decade of the 20th century; nevertheless, they have not evolved so much. Research done by Finkelstein *et al*. (2013) could be a good summarising example as it concentrates on individual collaboration analysing sociological aspects of individual collaboration. This gives only a general understanding of the profile of the researcher and lacks an institutional perspective. Edler, Flanagan (2011) also point out the absence of assessment indicators and sufficient data on internationalisation in research to measure:

- international research activities of individuals, especially when it comes to mobility;
- positioning strategic actors;
- cooperation in innovation more broadly with sectorial and technological differentiation;
- embedding overseas actors within a host system;
- the extent to which international collaboration is pushed and financed through global endeavours;
- the scope of internationalisation of national policy and funding programmes.

Contemporary assessment practices of internationalisation have some critical limitations from the perspective of the networking theory summarized in Table 1.5.

The assessment of networking in studies or, in a more narrow approach, internationalization has been analysed more actively together with internationalisation goals worked towards strategies for the HEI. Hudzik and Stohl (2009) use the taxonomy of inputs, outputs and outcomes defined as follows:

- inputs: resources (money, people, policies, etc.) available to support internationalization efforts;
- outputs: the amount of various types of work or activity undertaken in support of internationalisation efforts;
- outcomes: impacts or final results.

These are usually most closely associated with measuring achievement and missions of institutions. This approach is similar to the ARA method discussed in the previous section but does not take into account the interactions of those elements, and assessment is more statistical on participation rather than takes a synergetic character. Internal mapping and assessment are more emphasized than the external one (Green (2012), and the core elements of an internal assessment of internationalization are summarized in Table 1.6.

Table 1.5. Contemporary assessment practises and limitations adapted from (Edler, Flanagan 2011)

Contemporary assessment practices	Limitations/Lack of assessment
Measuring the existence of an internationalisation strategy or plan with targets, priority areas and priority countries.	In practice, very few internationalisation strategies have explicit targets and, if so, they are mostly qualitative. Further, targets tend to be simply focused on increasing the scale of internationalisation (more collaboration, more researcher mobility, etc.) rather than on the contribution this delivers to the final goal(s). Lacking the application of the networking theory and more advanced managerial methods to empower more types of benefits are described in Section 1.1.2.
Measuring the existence of dedicated budgets and/or a central internationalisation unit to support international research activities. Share of income from international funding sources	Lack of understanding the whole network would lead to ineffective spending.
Number of international agreements at the university/organisation level	Number does not show activities of partners or activities between HEIs, student and teacher mobility, neglects portfolio and inter-connections.
Share of research projects with an element of international cooperation and/or using shared facilities, development over time.	Reasonable KPI, though does not show how to keep or improve the current situation.

The table shows it is clear that recent scientific work and the managerial practice of the HEI have indicated the ability to set goals for better performance and measure the results of implementing such strategy; however, there is a lack of the reflection of acting in the networked and interacting environment. Networking activities are not measured or properly installed in strategies for the HEI.

Other key contemporary issue in the strategic management of Higher education is the growth of the impact and importance of various University Rankings and other benchmarking systems. This phenomenon integrates research and the internationalisation of studies and is highly related to the networking perspective of the HEI in several aspects: first, it uses a number of internationalization and other networking-related results to compare institutions; second, rankings shift the portfolios of university partners (Rauhvargers 2013) not only for those 1–5% of all 17500 universities listed in rankings, but also for non-listed institutions, as the newly ranked institutions become more selective (IBNLive, 2012; Olds, Robertson 2012).

Table 1.6. Internationalisation indicators based on Green (2012); Hudzik, Stohl (2009); Brandenburg, Federkeil (2007)

Goal	Sample Inputs	Sample Outputs	Sample Outcomes
Strengthen international and global dimensions of the curriculum	Number of courses with an international focus Number and range of language courses Proportion of the faculty with international experience Number of joint or dual degree programs Number of courses offered in cooperation with an international partner Number of countries students coming from	Proportion of students enrolled in courses from foreign countries Proportion of students enrolled in language courses Proportion of students majoring in programs from foreign countries	Demonstrated specific student learning outcomes as evidenced by portfolios and intercultural competency inventories Demonstrated language proficiency Career choices or volunteer engagement of graduates
Enhance the international competence and experience of the faculty and staff	Proportion of the faculty and staff with international experience Number and proportion of the faculty and staff educated outside the country of the institution Proportion of the faculty staff who is multilingual	Growth in the proportion of the faculty engaged in international cooperation Growth in the number and proportion of the staff engaged with partner institutions Increase in the number of courses with international partners	Enhanced reputation and recognition for the international character and work of the institution Increased student interest in international programs as evidenced by course enrolment

As rankings are based highly on research outcomes, thus, there are many good higher education institutions worldwide that should be considered for partnerships taking into account other than a position in ranking criteria because they are more teaching-oriented or concentrate mainly on the arts and humanities (Rauhvargers 2013). All higher education institutions are also increasingly called on to use data for decision-making purposes and to

document student and institutional success (IHEP 2009); thus, a growing number of universities have started using data on rankings for analysis, strategic planning and policy making (Forslöw 2012; Yonezawa 2012). One of the reasons for university reports using such data are to establish comparisons with rival universities (Proulx, 2012; Hwung, Huey-Jen Su, 2012). This process is complicated for non-listed HEIs.

There are several world recognized ranking systems such as Academic Ranking of World Universities (ARWU) known as Shanghai ranking, recently developed by EU initiative U-multirank, Times Higher Education World University Rankings (THE), QS World University Ranking (QS), Financial times ranking for business schools (FT) and Ranking Web of Universities (Webometrics). Four of them are analysed and compared to illustrate and give an example of different aspects of networking assessment. What is more, this analysis evaluates how the measurements of the performance of the HEI used in rankings could be integrated in networking assessment and strategizing with a networking perspective. The specificity of the most important rankings is disclosed in Table 1.7.

The reputation based academic survey used by THE and QS where individual actors should evaluate the performance of other HEIs in their field of interest is a reflection of the ability of the HEI to make strong and valuable links and to perform activities with other HEIs on the actor basis. As it is confidential, there are very limited ways of how institutions could make an impact on that. This is good for ranking providers but gives no support for the strategy development process.

As regards the evaluation of teaching, several activity links are reflected. First, all career services, including higher salaries in FT rank and the employer survey, are highly related to the ability of the HEI to link its activities with companies in the labour market. This aspect should be understood not only by the placement of graduates in companies but also by content adaptations or improvements, joint activities in the knowledge delivering process (case studies, study visits, issues for students to solve, topics of theses, etc.), consultancy for career development and further studies. Also, web-links counted from other webs by webometrics are the reflection of activities done with partners (not necessarily in the field of teaching, but showing a general position of the HEI, including research and innovation activities). The section of *diversity and internationalisation* is very directly related to networking activities. The ability to attract international students reflects not only the prestige of an institution but also the systematic ability to organize enrolment activities and relationships in the international market, including agents, the organizers of exhibitions, governmental migration services, embassies, language centres, etc.

Table 1.7. The specificity of rankings

University ranking	Exceptional features	Networking related indicators
Times Higher Education World University Rankings (THE)	High concentration on research-led universities. Employs 13 carefully calibrated performance indicators. Ranking 400 institutions.	Citations per paper, international co-authorships. Reputation based academic survey. Internationalisation (staff and students).
QS World University Ranking (QS)	Constructed to support students' ability to evaluate institutions Ranking 700 universities.	Citations per faculty, co-authorships. Academic and graduate reputation based on the global survey of academicians and employers. Internationalisation (staff and students) mobility.
Financial Times Ranking for business schools (FT)	Created for internationally accredited business schools only. Based on two surveys completed by schools and by graduated students (The Financial Times Ltd 2012).	Internationalisation (staff and students) mobility
Ranking Web of universities (Webometrics)	Web indicator-based ranking better reflects the whole picture of the HE sector. Activities of institutions are indicated by web presence (formal e-journals, repositories, informal scholarly communication). It has the largest coverage with more than 19.000 HEIs.	External in-links that the University web-domain receives and the ability to generate the most cited papers from some scientific field.

Student exchange programmes are activities that require much effort by both sending and receiving respondents, and therefore institutions making these activities are very interconnected at the operational level. On the other hand, the ability to attract international staff as well as international co-authored papers is more related to actor bonds and interpersonal relations and contacts.

It can be claimed that the existing ranking systems are advanced enough, which is sufficient for the evaluation of the networking of the HEI. It is true in some cases as on the one hand, various university rankings have developed and scientifically proofed the systems of assessing some internationalisation aspects. However, they are too narrow from the point of view of the analysed

networking theory. On the other hand, those systems are made to generalize performance as much as possible. In this generalization, some important details are lost and the possibilities of improving strategic and tactical levels are hidden. Also, rankings are quite limited for smaller and less central institutions usually excluding the colleges and universities of applied sciences where the effectiveness of networking is not that important.

Taking into account this critical review, several facts could be summarized: in most cases, *individual performance* is measured – the methods lacking the *approach* to the *wider network* as well as the measurement of indicators neglect *network structure*. Moreover, assessment from the *portfolio perspective* does not exist; in this case, HEIs do not use their resources in the best way, and some of them are wasted on unimportant relations. The internationalisation approach (Kehm 2007) and criteria dominate in the methods assessing the HEI. Although it cannot be accepted as a disadvantage in general, there is an opportunity to implement approaches from the business sector analysed by the *inter-organizational theory, industrial networks and networks in economic geography* – better integration with these networking theories would generate new perspectives in developing networking management. On the other hand, assessment methods used in the analysed networking theories are hardly applicable in HE as most of them have been worked out to evaluate small core networks with reference to the quantitative approach. The usage of internationalisation indicators for strategies focusing on HEIs is quite high; however, they do not consider changes in the portfolio. Hence, further methodological integration of statistical data and networking theories is needed.

1.4. Conclusions of Chapter 1

1. The literature review of networking theory and practices in HEIs have indicated a need for considering networking activities at the strategic management level of the HEI. For more effective strategic management and, in order to gain more benefits from networking, understanding the external networked environment, including a position of the institution in a wider network and the structure of the partner portfolio, are required. Institutions are lacking tools and abilities to assess networking in a more holistic way. Such possibilities of the institutions not listed in rankings are even more limited. Assessment results should lead to strategic insights into SWOT analysis and empower the institution to monitor the general progress of networking, as strategy development of HEIs frequently

includes the identification of targets for short-term and full-degree mobility, geographical target areas, target numbers of mobile students at each degree level, the types of cooperation that fit their overall needs and specific HEI networks.

2. Two major problems could be distinguished in managing networking: (1) lack of the ability to monitor the process of networking and the ability to assess not only the performance of the institution but also to indicate and evaluate partners' portfolio; (2) lack of tools for incorporating broader information on networking in strategy development.

3. In order to assess the networking of the HEI and to use the networking perspective in strategic management, the following managerial issues should be addressed: (1) the ability to monitor networking activities in the fields of research and studies; (2) to evaluate a position of institutions in a wider network; (3) to be able to assess the performance of the HEI and portfolio referring to quantitative data on the institution and partners; (4) to indicate and assess the most important partners and their relations; (5) to estimate the importance of the partner to the portfolio; (6) to be able to transform network data into strategic insights about SWOT analysis and the development of networking management; (7) to have the ability to set quantitative indicators for strategic networking goals.

4. The model of networking assessment should integrate study networking and research networking, which would lead to a more systematic analysis of the external environment in the strategy development process and more effective networking as the process of managing the HEI. More effective networking management would have a positive impact on the competitiveness of the HEI.

2

The Model for Assessing the Networking of the Higher Education Institution

This chapter suggests and explains in detail the Network Assessment Model (NAM) for the HEI. The introduced model is aimed at evaluating international networking activities of the Higher Education Institution taking into consideration structural elements and their impact. The chapter starts with an in-depth analysis of the role in networking the strategy for the HEI where the general structure of the model is presented. The following sections discuss 3 stages of evaluation integrating multi-criteria assessment, analysis applying network pictures and the interpretation and usage of the results of strategic development. Quantitative methods such as multi-criteria assessment, social network analysis and statistical methods have been used. The findings of Chapter 2 have been published in 2 papers (Nugaras 2012; Nugaras, Ginevičius 2014).

2.1. Structure of the Model for Networking Assessment

The literature review has disclosed the scientific problem and a need for the NAM for HEIs. The section focuses on giving a general overview of the NAM and on an accurate description of the methodology in the following subsections. The most general idea of the model is to create a system offering components and linkages in order to assess the international networking of some particular HEI. In this case, particular does not mean it is created for one institution only, but rather denotes it should be known exactly what institution is assessed. Even if the results of this assessment had some new information on the HE sector in some economic geography unit, it would be constructed to strengthen the strategic development process of the assessed institution.

The Network Assessment Model (NAM) for networking evaluation of the HEI consists of 5 blocks: 1 block of strategy development, 1 block of data input, 2 assessment blocks and 1 generation block of strategy insights (Fig. 2.1).

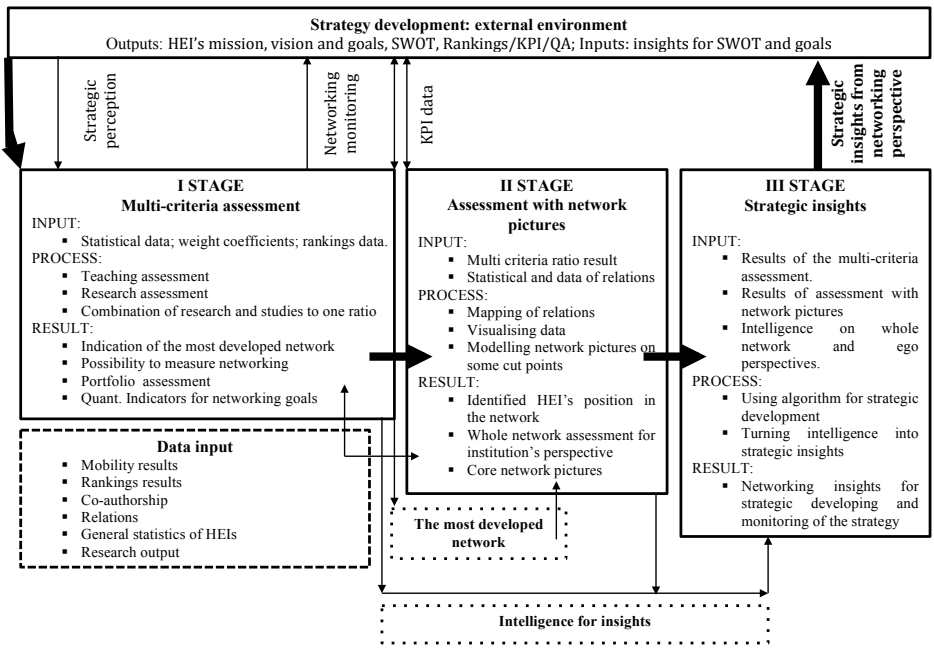


Fig. 2.1. General structure of the Network Assessment Model (Created by the author)

The strategy development block. As for the strategy development process, there is a need for taking into account networking assessment as the analysis of an external environment. This block provides background information on networking assessment, including a vision, a mission, goals, KPI indicators and information on ranking. Strategic insights generated in the same block, from the networking perspective, are used for the SWOT analysis and management of networking where monitoring networking is considered. The previous strategies and actions have formed the current position of HEIs in the network. The interactions between assessed and partner institutions have formed the state-of-the-art and current network structures. The developed insights will affect future interactions, which will involve specific actors, deal with particular aspects of activities and take place in a particular context. The parties involved in an interaction episode link the current issues to their experience of the previous interaction and adaptations that have been made.

This history will make an impact on their options, attitudes and behaviour. Such actor's approach to interaction will be affected by the view of whether a counterpart is likely to be the central feature of its future or to decrease importance over time. Any two entities are likely to make different interpretations of both history and future, and this, in turn, leads to ambiguity in the assessment of the current episode (Hakansson *et al.* 2009). An episode or strategic period, in the case of the NAM, is viewed as a part of changes that involve processes embracing learning, adaptation, commitment and distance-reduction over time (Ford *et al.* 2002). It also explains why this model is constructed for a particular HEI with orientation to assess from the institutional perspective, as a different institution would have a different understanding of what the network is and how it works; also, this approach is not directly applicable to generalize the HE sector. Fig. 2.2 illustrates the impact of time on interaction.

The mission and vision of the HEI is used as the main direction to support the institution with networking activities. Also, strategic development processes, in most cases SWOT analysis in the HEI, indicate the areas of advantage and development that could be strengthened with more conscious and systematic networking activities. A decision of institutions on considering particular HE ranking(s) as important seems to be one of the novel and contemporary features that would effect a networking perspective. As discussed in Chapter 1, criteria for some particular ranking system would affect some strategic directions as well as partner's choice and networking management. The NAM is created in a way to consider and adjust to the strategic choice of particular ranking(s). As regards strategies for HEIs, Key Performance Indicators (KPI) and other elements of Quality Assurance (QA) play the core roles; the NAM uses some institutional data and generates KPI or

the possibility of monitoring networking activities and portfolio performance in the quantitative way.

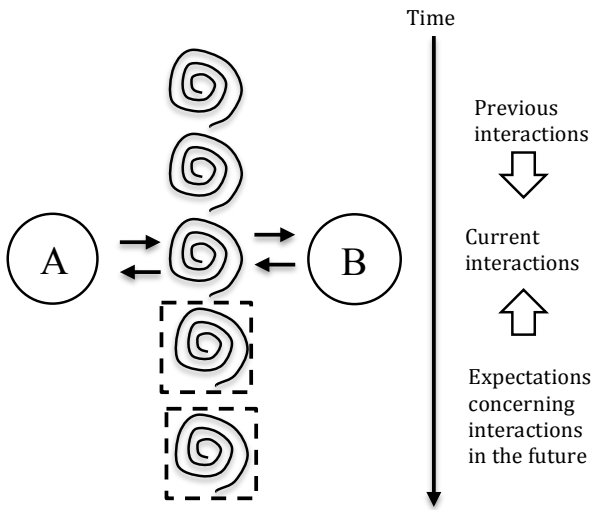


Fig. 2.2. Interaction and time (Hakansson *et al*. 2009).

In order to address all issues described in the Chapter dealing with scientific problems and model requirements, two approaches to assessment have been combined: *multi-criteria assessment*, including the possibilities of generating the ratio and assessment *applying network pictures* generating the pictures of a wider network. The complex evaluation approach has been chosen for several reasons: when using a single method, the strategy needs would be covered only in part, the measurement of the problem of networking activities could be solved using multi-criteria methods and the ability to set quantitative criteria for strategic goals will be developed. Evaluation using network pictures will be used for assessing the position of the institution in a wider network, including gathering intelligence with reference to relational activities of the partners and portfolio and preparing pictures for strategizing with network pictures. For multi-criteria evaluation, SAW and Normalization tools will be employed. For evaluation using the network picture, various tools for SNA and related analytical methods will be used.

Research and teaching (studies) have been chosen as the main points of attention in assessment blocks. This decision was made following the classic segmentation of HE; also, these are traditional sections in strategies for HEIs. Such separations also allow using only a part of the model for research

institutes. Both assessment blocks generate networking insights that, with the help of an algorithm, will be turned into strategic insights in the last block of the model.

A data input block consists of general information on the assessed and partner institutions and may include size, whereas output, in the researched case, it is the total output of scientific papers, whereas in teaching, it is the overall number of students. The second group of criteria is related to the measurement of networking activities; in the researched case, it is co-authorship with foreign authors and other business institutions. Detailed criteria for data selection are explained in the following sections describing the employed methods. Data include quantitative amounts and links between institutions. For data collection, only international partners will be considered. National partnerships are not accepted for several reasons: (1) competition dominates in the institutions at the national level; (2) separation of national and international collaboration better reflects highly emphasized issues of higher education internationalisation. Partnerships with a business has been excluded in Chapter 1 by a set of limitations to the theoretical framework; also it is worth stating that the nature of relations of the HEI to business is very different and would require separate investigation.

2.2. Multi-Criteria Assessment of Networking in Research and Teaching

The first stage of the NAM (multi-criteria assessment) deals with the following issues:

- the ability to monitor networking activities in the fields of research and studies;
- the ability to evaluate a position of an institution in a wider network (partly);
- the ability to evaluate the importance of the partner to the portfolio;
- the ability to assess the performance of the HEI and portfolio with reference to quantitative intelligence on the portfolio of partners;
- to indicate and assess the most important partners and their relations (partly);
- the ability to set quantitative indicators for strategic networking goals;

The detailed reasoning and descriptions of using methods are discussed in the following sub sections.

2.2.1. Multi-Criteria Assessment

The first pillar of multi-criteria assessment deals with research networking the assessment of which is related to various forms of international collaboration in scientific work that may em∑ brace international scientific projects, joint research activities, joint participation in scientific conferences, or some other more advanced forms of participation such as transnational research centres. However, in contemporary research, researchers are forced into a highly competing environment where the core output of research is usually considered as a research paper in a peer-reviewed journal. Even if a researcher participates in an international scientific project, or some other inter-institutional activities, it is most likely that results or experience will be reflected in the research paper.

Scientific publications are a reflection of the conducted theoretical and empirical research. Successful research activities may include multidisciplinary elements, knowledge transfer or joint idea development. These indicators show indirect results of inter-organizational activities performed by actors. Research is very personal and institutionalised activity, so actor bonds are of central importance; e.g. the number of citations is highly related to the abilities of the researcher and institution to make connections and promote their ideas to others, or to be embedded in the network of similar researchers and HEIs in the field. These actor bonds are created by participating in various scientific conferences and projects. The most frequently used indicators are the co-publications of the authors from two different locations ('basic' research) and the co-invention of more application-oriented research. Analyses explore absolute numbers, and the share of international co-publications out of all publications and out of all co-publications (Edler, Flanagan 2011). This assumption leads to the conclusion that the best way to assess the overall research networking is to count the amount of scientific papers written together with the authors from other countries. This kind of assessment is also commonly used in ranking systems as well as widely analysed by co-authorship literature (see Chapter 1). The *output of research* has been taken as the most general measurement. *Output*, or the number of scientific papers published in scholarly journals, reveals the ability of an institution to produce scientific knowledge. Output values are affected by institution sizes and research profiles, among others factors. The output indicator forms the basis for more complex metrics (SCI imago 2013).

For the combination and weighing several criteria, multi-criteria evaluation methods have been chosen. They are used in a range of assessment activities such as evaluating the reliability of banks (Ginevičius *et al.* 2010), determining the effectiveness of enterprise marketing (Ginevičius *et al.* 2012), selecting a contractor (Zavadskas *et al.* 2010), a complex proportional

assessment of projects (Zavadskas *et al*. 1994), etc. In the case of networking the assessment of the HEI, the SAW (Simple Additive Weighting) method has been chosen as a basis (see Formula 2.1).

$$S_j = \sum_{i=1}^{m} w_i \widetilde{r_{ij}}, \tag{2.1}$$

where S_j is the value obtained in the multi-criteria evaluation of the *j*-th alternative; w_i is the weight of the *i*-th criterion; $\widetilde{r_{ij}}$, is the normalized value of the *i*-th criterion for the *j*-th alternative. As can be seen from Formula (2.1), normalized values should be used for determining the quantity of multi-criteria evaluation. For normalization, Ginevičius (2008), the method of normalization is used, which relies on the largest value of the criterion taken as the largest quantity. First, networking research activities are evaluated. When using formula (2.2), the normalization of criteria for International Research Collaboration (institution's output ratio produced in collaboration with foreign institutions) is done. The values are computed by analysing the output of papers of an institution, which includes more than an address of one country. Institutional data and maximum values could be indicated by SIR World Report 2013: Global Ranking (SCImago Research Group 2013b; Bornmann *et al.* 2011) or any other sufficient data source.

$$r_{IC} = \frac{Ic_r}{Ic_{rMax}} \tag{2.2}$$

where $\tilde{r}_{IC}$ – normalized International Research Collaboration, Ic_r – International Research Collaboration, Ic_{rMax} – the maximum value of Ic_r values. Formula (2.3) suggests that, regarding research networking, scientific collaboration $\dot{N}_r$ and the impact (item oriented field normalized citation score average) of the instruction (Rehn, Kronman 2008; González-Pereira *et al.* 2010) should be evaluated

$$\dot{N} = \widetilde{r_{IC}} I_N \tag{2.3}$$

where the value ofI_{N_i} (in %) shows the relationship between the average scientific impact of an institution and the world average set to a score of 1, i.e. I_{N_i}score of 0.8 means the institution is cited 20% below the world average and 1.3 means the institution is cited 30% above average. In this case I_{N_i} is used as weight coefficient (SCImago Research Group 2013a) and only institutional results are reflected; nevertheless, the partnership portfolio and changes in the portfolio would not be exposed. Thus, we suggest employing the SAW method and considering the partners of the institution, as reflected in Formula (2.4).

$$\ddot{N} = \sum_i \widetilde{r_{ICi}} I_{N_i} \tag{2.4}$$

then, $i = 1$, and the results of the evaluated HEI are taken. Next, $i = 2 \dots n$, and the results of the partner institutions of the evaluated HEI are accepted. The list of partners could be generated in two ways: either partners listed in some particular strategically chosen ranking, or all partners have a formal agreement with the evaluated HEI. However, a strong weakness using Formula (2.4) can be noticed – the impact of the evaluated institution on the final result decreases if the number of partners increases. Empirical research shows it might be that the institution had more than 50 partners (Nugaras 2012). This method would be more applicable for evaluating the whole system in general, but assessment from the perspective of the institution is not correct. Thus, Formula (2.5) instead is suggested

$$\ddot{\ddot{N}}_r = \tilde{r}_{IC} I_N + \sum_{i=n}^{m} \frac{\tilde{r}_{ICi} I_{N_i}}{n}, \tag{2.5}$$

where $\ddot{\ddot{N}}_r$ – research networking , $\tilde{r}_{IC} I_N$ – research networking of the assessed HEI and $\tilde{r}_{ICi} I_{N_i}$ is the networking of the i-th partner institution. In this case, the results of networking assessment evaluate the portfolio of partners as well as the impact of the assessed institution.

As for the assessment of study networking, the same logic as that for the assessment of research networking should be applied. We suggest referring to the results of student and teacher mobility as an indicator for networking the assessment of studies. Student mobility indicates several important aspects of collaboration: first, exchanging students means that institutions trust each other and recognize the level of education; second, the numbers of students indicate in and out flows; third, it is commonly accepted and comparable not only across Europe but also in other continents. Teacher and staff exchange is more related to transferring more extensive knowledge, sharing best practices and developing new forms of collaboration such as Intensive Programs, joint degrees and research projects. What is more, joint degrees and other advanced forms of collaboration activities in the field of studies are reflected by these indicators, as student and teacher mobility in these programs is also organized under the exchange status.

Normalization is done using the same method as for normalizing research activities. Regarding formulas (2.6; 2.7), normalization is done in the following way.

$$\widetilde{w} = \frac{So_s}{So_{s_{Max}}}, \tag{2.6}$$

where $\widetilde{w}$ – normalized student mobility (including outgoing for exchange and placements) ration, So_s – student mobility ration, $So_{s_{Max}}$ – the maximum value of student mobility ration.

$$\tilde{k} = \frac{Ti_s}{Ti_{s_{Max}}}, \tag{2.7}$$

where $\tilde{k}$– normalized outgoing personnel mobility (including teaching and administrative staff), Ti_s – personell mobility, $Ti_{s_{Max}}$ – the maximum value of personnel mobility. Networking in the process of studies is calculated using the same principle as in research networking following Formula (2.8).

$$N_s = \left(\widetilde{w} + \sum_{i=n} \frac{\widetilde{w}_i}{n}\right) + \left(\tilde{k} + \sum_{i=n} \frac{\tilde{k}_i}{n}\right), \tag{2.8}$$

where N_s – networking in the process of studies, $\widetilde{w}$, $\tilde{k}$, normalized mobility ratios in networking studies, $\widetilde{w}_i$, $\tilde{k}_i$ ratios of the preselected partners from strategic ranking, n – number of selected partners.

2.2.2. Integration of the Results of Studies and Research Networking: Weighting Ratios

While networking the HEI, N is assessed regarding two main components: the assessment of networking research – N_r and the evaluation of the networking of teaching N_t (see formula 2.9). Networking components are weighted by coefficients α and β.

$$N = \alpha N_r + \beta N_s. \tag{2.9}$$

The idea of the above formula is to combine the assessment of the networking of teaching and research networking and into a single result that would evaluate the overall networking activities of the HEI, which is useful for monitoring networking indicators, as improvement in one could compensate smaller results in the other. Also, applying this logic institution could emphasize core activities with a bigger weight coefficient, e.g. the universities of applied sciences could give a larger weight coefficient for study networking and the research institute could more strongly emphasize research networking. In most cases, for applying multi-criteria evaluation methods, experts set weight coefficients (Ginevičius *et al.* 2010; Zavadskas *et al.* 2010; Ginevičius *et al.* 2012). As for the NAM, it is suggested to use a less expert sensitive method and to set weight coefficients according to the strategic orientation to the HEI to research and studies. α *and* β are weight coefficients that might be also defined by the strategically based selection of participation in ranking. These coefficients should denote similar weights as those representing *Teaching* (total) and *Research* (total) in ranking. The agencies organizing rankings take much effort and research resources to set weights for different areas of the HEI. Therefore, this way of setting weight would work in favour of reaching a better position in ranking as systems would be consistent. Table 2.1

compares 4 most respected rankings and the structure of their coefficients, illustrates different strategic orientations and proves that coefficients for the overall assessment of institutions could not be the same in all cases.

Table 2.1. Comparison of university rankings (THE 2013, QS 2013, Financial Times 2013, Webometrics 2013)

Criteria	Remarks on criteria and impact (%) considering the overall result			
	THE	QS/QS Stars	Financial Times	Webometrics
Research (total)	60%	60%/15%	10%	30%
Volume of papers	Thomson Reuters 6%	/Papers per faculty 4%	10% on 45 best journals	Rich scientific files on the site 15%
Citations	Citations per paper Thomson Reuters 30%	Citations per faculty Scopus 20%/Citations per paper 4%		Most cited papers. Scimago group (Scopus based) 15%
Reputation (academic survey)	18%	40%/4%		
Other	Income (research) 6%	Academic experts – 3%		
Teaching (total)	30%	30%/65%	71%	70%
Reputation (survey)	Scholar survey 15%	Employer survey 10%/5%	Survey on graduates 59%	Links from other webs counting 50%
Staff-to-student ratio	4.5%	20%/5%		
Doctorate (PhD) ratio	PhD to-bachelor's ratio 2.25%	-/4%	Faculty with PhD 5%; Number of graduates 5%	
Subject mix	Subject mix – volume of PhD awards in different disciplines 6 %	Accreditations 20%		Number of webpages under one domain 20%

Continuation of the Table 2.1

Employability		-/Completion- 4% Further studies 2% Employment 5% Carrier support 5%	2%	
Other	Total income of HEI 2.25%	-/Facilities10%, 5% engagement		
Diversity – internationalization (total)	7,5%	10%/15%	19%	
International to domestic students	2.5%	5%/2%	4%	
International to domestic staff	2.5%	5%/2%	4%	
Publications with international co-authors	2.5%	-/5%		
Student mobility		-/4%	2%	
Other		-/1 % religious facilities, 1% international diversity	2% foreign languages 2% intern. Board, 5% women equality	
Innovation	2.5%	-/5%		
Other	Earnings from industry 2.5%	-/5%		

The table above and literature review in Chapter 1 show that strategic orientation may vary from 10% to 60%. This suggested method makes the model more flexible and useful in the range of HEIs.

2.3. Assessment Applying Network Pictures for Research and Teaching Purposes

Assessment applying network pictures deals with the following goals of the NAM:

- the ability to measure and monitor networking activities in research and studies (partly);
- to evaluate a position of institutions in a wider network;

- the ability to assess the performance of the HEI and portfolio with reference to quantitative intelligence regarding the portfolio of partners (partly).
- to operate data on the most important partners and their relations.

There two approaches to the evaluation of networking applying network pictures (see Section 2.2): to analyse the whole (feasible wider) network, or to concentrate on the most important partners and analyse a specific, strategic approach to them. The picture could be used in both cases, bigger pictures have more sophisticated features of assessment, and the pictures of the most important partners are better used for tactics made for each core partner and for indicating the relationships among them. At Stage 2 of the NAM, both approaches will be combined.

The analysis of bigger pictures starts with mapping networking activities identifying nodes and linkages represented by a matrix, in this case, a network of higher education institutions (Formula 2.10).

$$G = \begin{bmatrix} n_{1,1} & n_{1,2} & \cdots & n_{1,n} \\ \cdots & \cdots & \cdots & \cdots \\ n_{n,1} & n_{n,2} & \cdots & n_{n,n} \end{bmatrix}, \tag{2.10}$$

where g_{ij} $(i, j = 1\ 2\ \ldots n)$ is the quantity of networking activities of the ith institution having networking activities with the jth institution. In this case, matrix G could be called network G. The network consists of N and E, i.e. $G = (\mathrm{N}, \Phi)$. $N = \{n_1, n_2, n_3 \ldots n_N\}$ is the amount of the node in the network. $E = \{e_{i,j} \,|i.j = 1\ 2 \ldots, N\}$, where $e_{i,j}$ is an orderly relationship formed by n_i and n_j (direct link or activity between n_i and n_j). The degree of node n_i $(i = 1\ 2 \ldots, N)$ is k_1, which is a number of activities performed together. In a direct network, the degree of the node can be divided into in-degree ad out-degree. In-degree k_i^{in} is the quantity of links $e_{1j,i}$ that point to the node, whereas out-degree k_i^{out} is the quantity of links that starts from the node.

Such kind of the matrix of relations allows quantifying information and using a wide range of the developed SNA methods to identify the quantitative features of the formed network; also, it makes possible to visualize the existing connections.

One of the key factors in assessment applying network pictures is to set limits on a larger network. As regards SNA, statistical sampling methods, as a part of all population, are not used. Rather, methods tend to include all actors in some population, or a specific feature of sapling is employed. Certainly, populations included in the analysis of the network may be a sample of some larger set of populations. Limits on the size of the population depend on resources, time and cognitive capacity to analyse (Hanneman, Riddle 2005). As

for this NAM, the snowball method (Hanneman, Riddle 2005), or all available data on relation should be used. Moreover, it should be noticed that the major potential limitations and weaknesses of snowball methods are as follows: first, not connected actors (i.e. "isolates") are not indicated by this method; second, if the start is in the wrong place or places, it may miss the whole sub-sets of the actors who are connected but not attached to our starting points (Hanneman, Riddle 2005). This kind of data collection also requires some additional information as it indicates the links between HEIs rather than real relationships. If the importance of a link is not known, assessment makes sense to indicate a wider network and the complexity and possibilities of interaction.

Using the strategy development block of the assessed institution, the boundaries of data collection are set (e.g. strong regional orientation, strong continental orientation, special subject orientation).

The network picture of the most important relations is developed by the identification of very limited (usually up to 10) core partners and their inter-relations. Relational content rather than the link itself is more important for this approach. The NAM suggests combining those two methods: first, to use snow ball technique and next, apply some quantitative data to indicate the most important relations and employ SNA assessment tools for having better insight into a wider network and most important institutions. The most effective SNA techniques used in the NAM are described in Table 2.2. (based on Wasserman 1994, Carrington *et al.* 2005). The most important relations are indicated according to institutional data. For the visualization of the most important relations, Ego-network tools should be used.

The idea of evaluation applying network pictures is created to address sense making and strategizing applying network pictures. The generation of the network picture is based on several institutional collaboration data in the fields of research and studies. The generation of network pictures is based on the suggested algorithm.

The identification of the base for relationships. The base for generating the network picture might be any form of institutional collaboration, e.g. co-authorship in research papers (Lundberg et. al. 2006), collaboration in the projects of studies and research, joint or double degree programs, student and teacher mobility, etc. It is recommended to choose the most developed network of the first layer as a basis for identifying links. The most developed network would have the major part of connections and players (nodes), which would indicate the strongest possibilities regarding a position in the network, gate keepers and mediators and would reflect the existing network in the most sophisticated way. If full assessment (Stage I) is done and the NAM is used, the obtained results of multi-criteria assessment allow determining the most developed network. Higher values in N_r or N_t would indicate the network that

could be chosen as a basis for evaluating pictures. Certainly, it is possible to use Stage 2 separately if the needs of institutions are lower, or it has a smaller amount of partners. In this case, it is a factor in the strategic choice of indicating a basis for identifying relationships. It is recommended to use the network of relationships that (1) is the most wide and developed; (2) has been developed for a longer time to be more stable and mature; (3) data on relations are constantly updated; (4) possible to get data on the most of the institutions in the selected network; (5) a basis for identifying relationships should be unified and commonly understood among all partners.

Table 2.2. Social Network Analysis methods for assessing network pictures

SNA methods	Formula	Explanation of the formula	Purpose of usage
Centrality	$C_D(v) = \frac{\deg(v)}{n-1}$ $C_D(G) = \frac{\sum_{i=1}^{\|V\|}[C_D(v^*) - C_D(v_i)]}{n-2}$;	Graph (G) with vertices n, the centrality of the degree of vertex v, node v^* with the highest degree of centrality.	To indicate the most central node in the network and to compare with the institution regarding the centrality based network picture.
Betweenness vertices that occur on many shortest paths between other vertices have higher betweenness than those that do not.	$C_B(v) = \sum_{s \neq v \neq t \in V} \frac{\sigma_{st}(v)}{\sigma_{st}}$;	σ_{st} is the number of the shortest paths from s to t, and $\sigma_{st}(v)$ is the number of the shortest paths from s to t that pass vertex v.	To indicate key players, to assess the portfolio of the betweenness based network picture.

Continuation of the Table 2.2

Clustering coefficient measuring the degree to which nodes in a graph tend to cluster together.	$C_i = \frac{2\left\|\{e_{jk}: v_j, v_k \in N_i, e_{jk} \in E\}\right\|}{k_i(k_i-1)}$;	Local clustering coefficient C_i for vertex v_i is then given by the proportion of links between vertices within its neighbourhood divided by the number of links that could possibly exist between them. Neighbourhood N_i includes $k_i(k_i-1)$ links that could exist among vertices within the neighbourhood.	To indicate key clusters in the network and the position of the institution in clustering based network picture.
Girvan–Newman algorithm identifying the community structure (groups) of tightly knitted network nodes. (Girvan Newman 2002).	Algorithm for using 1. Calculation of betweenness for all edges in the network. 2. Removing the edge with the highest betweenness. 3. Recalculate betweenness for all edges affected by removal. 4. Repeat from Step 2 until no edges remain.	Thus, the edges connecting communities will have high edge betweenness. By removing these edges, we separate groups from one another and reveal the underlying community structure of the graph.	To indicate and visualize subgroups in a larger network. To indicate the portfolios of partners. To indicate the position of the institution in different sub-groups.

Continuation of the Table 2.2

Ego-network analysis focusing on the position of an institution in the network and its opportunities to broker between other.	All above mentioned methods.		To visualize the position of the main institution and its links to others and to compare it with the position of competitors and partners.

The identification of the scope of assessment. As network pictures are suggested to be generated using Social Network Analysis (SNA) methods, it is worth deciding on taking all nodes and relations in the network, or setting some strategic limitations. Limitations concentrating on the specific type and size of the HEI, or any performance indicators like the number of study programs and general research output, could be selected in order to reduce the size and scope of the network which is done to make analysis more oriented to strategic goals or analytical work feasible. At Stage I, the amount of institutions does not change the feasibility of assessment, but at Stage 2, in some cases, the identification of relations of all institutions and data collection might be very resource sensitive.

The use of the snow ball method assists in identifying all nodes and links in the unlimited or limited network.

Selecting cut-points to develop network pictures. These sections should be developed in accordance with strategic needs. The selected network pictures should indicate the position of the HEI in the network, subgroups, clustering and possibilities of developing new strategic insights. These cut-points are very institutional and strategy specific, but some general principles of choosing cut-points could be indicated. First, network pictures should be generated in order to disclose bigger pictures of a wider network of the HEI and its features. This discloser shows strategic state-of-the-art and the possibilities of improving the current situation. Second, some specific features such as a position in rankings,

collaboration flows, more institutionalized relations like branch campuses, joint degrees or joint research projects, research output as well as the amount of exchange students could change the shapes of nodes and links in order to better assess networking. Some typical network pictures are described in Table 2.3.

Table 2.3. The cut-point of generating network pictures

Type of the picture	Description	Impact on the strategic insight
General overview-oriented	Network picture is oriented to the general features of the institution (country of origin, size of the amount of students, centrality in the features of the selected collaboration).	To assess a general position in the network, to make visible bigger pictures and to see the network not only the ego perspective.
Studies output-oriented	Network picture is created to show the scale of the hubs of studies and the impact of mobility on the overall students. The size of nodes and links is adjusted to the results of student mobility.	If taken in the longitudinal approach, generates the insights of student mobility trends. Possible strategies for agreements on further student exchange collaboration could be generated.
Research output-oriented	Network picture is generated to indicate research hubs and collaboration at the institutional level. The size of nodes adjusted to research output.	Links with the most productive research institutions could increase the productivity of the assessed institution – the assessment of the network picture could help with indicating state-of-the-art and possible development trends.
Position in the ranking-oriented	Rankings show status rather than collaboration, and thus this picture uses any other collaboration-focused picture as a basis, and the nodes indicate the position in ranking.	Possibility of indicating the structures of a better ranked institution and making a strategy for how to create stronger connections to two institutions.

One of the core activities identified at Stage I are the boundaries of the portfolio of the institution. This portfolio (or portfolios for separate activities) should also be reflected in the network picture. Visualisation would lead to a better conclusion not only concerning the position of the assessed HEI, but also considering the position of the portfolio in the network. It can be noticed if the portfolio is clustered or wide-spread and what the role (gate keeper, integrator, central or peripheral player) of the HEI in the portfolio is.

2.4. Algorithm for Incorporating Assessment Results in the Strategy for the Higher Education Institution

Stage 3 is dedicated to end the cycle and turn assessment results generated at Stages 1 and 2 into strategic insights. This stage of the NAM deals with the following tasks:

- to be able to transform network data into strategic insights for SWOT analysis and development of networking management.
- to make possible to set a quantitative indicator for the goals of strategic networking.

Using an algorithm not only deeper integrates the results of the suggested methods but also strengthens synergy between them. A theoretical framework for this algorithm is based on the integration of the suggested assessment methods and the adapted to the HEI model of Alliance portfolios (Parise, Casher, 2003). The essence of this model is to manage the network (alliance) portfolio so that to use the areas of synergy in your portfolio and leverage these synergies and knowledge sharing to their fullest potential. The model consists of three areas of interest: alliance portfolio design, individual alliance factors and alliance portfolio management (adjustment) that leads to network (alliance) and portfolio success (Fig. 2.3).

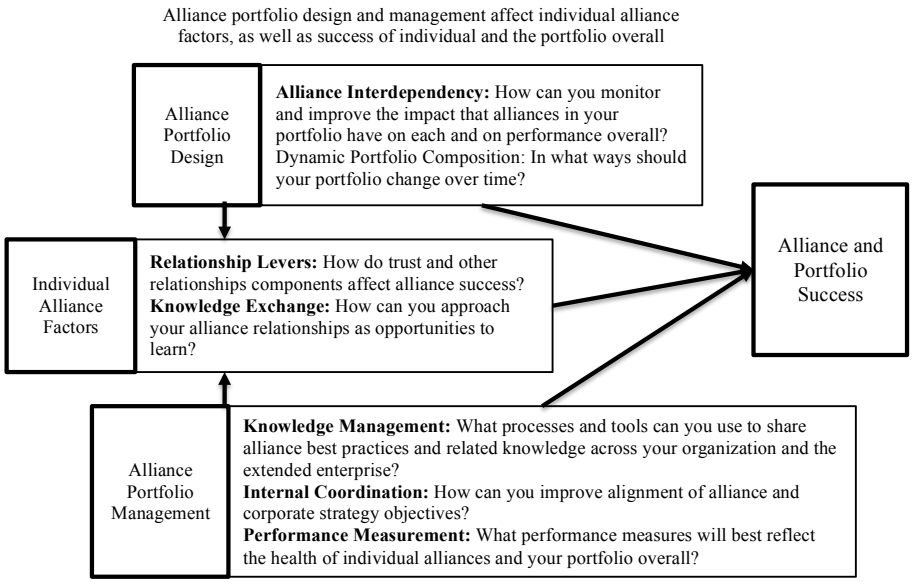


Fig. 2.3. Model for the alliance portfolio (Parise, Casher 2003)

Following multi-criteria assessment, the obtained results should be interpreted as performance $(A_r; A_t)$ vs. the portfolio of the partners (alliance portfolio) of the HEI approach $(B_r; B_t)$. Multi-criteria assessment is constructed to indicate separately the performance of the assessed institution and the performance of its portfolio. A full algorithm is presented in Fig. 2.4 A comparison of the portfolio and performance leads to the main direction of the strategy: strengthening the portfolio, keeping status quo of the position in the network and exploiting the portfolio. The algorithm should be used for teaching and research separately and then combined into one strategy. All general strategic directions are based on the assumption that the best synergies could be achieved working with similar or slightly stronger partners, and the portfolio should be adjusted as the situation varies constantly, and therefore changes a list of partners and the institutions themselves.

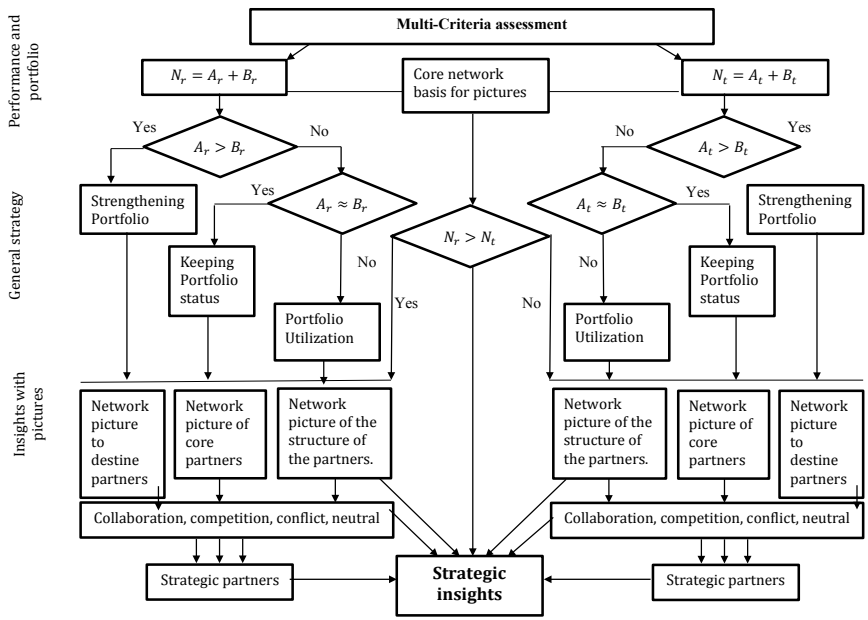


Fig. 2.4. The usage of assessment results in the strategy (Created by the author)

Strengthening the portfolio is in the case of $A_r > B_r$, or $A_t > B_t$ where research or teaching performance is higher than the performance of the portfolio. This situation prevents the HEI from development, as the portfolio is too week. The situation might be a result of several reasons: a week portfolio might be the indication of the initially weak partners or a decrease in their

networking activities. The second case is an increase in the results of the activities of the assessed HEI. This might be highly related to better results and to listing some specific rankings (see Section 1.2.2). In this case, besides all general network pictures, those of destination partners should be generated and analysed. The analysis of the picture of this network provides a possibility of indicating specific partners for new partnerships, including the analysis of the nature of partner relations indicating competition, conflict and collaboration neutrality. Strengthening the portfolio means that some relations should be denied and some new should be established.

A *general strategy* set directions for how to better use the results of assessment applying network pictures. The carried out assessment includes a number of pictures generated to understand the surrounding network. At Stage 3, a general direction for the strategy concerning the development of networking indicates the pictures more useful and necessary to be explored in a more detailed way. The network picture designates future partners that highly depend on the current position of the HEI in the network. The pictures would help with identifying connections of possible partners, clustering stronger partners, gatekeepers and possible connectors.

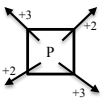
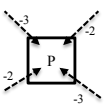
While *keeping the status of the portfolio* when $A_r \approx B_r$ or $A_t \approx B_t$, the portfolio is balanced. It does not mean that all partners in the HEI network are equal or equally developed (multi-criteria and network pictures would indicate significant differences among partners), but the set of partners on average is similar. In this case, the algorithm suggest not trying to change the structure and set of partners, but to strengthen the existing connections for the following reasons: with the help of development strategy for the most important partners, collaboration would be more conscious and strategic and would help with concentrating resources and gaining more synergy from the same network. In this case, the key factor is to indicate the most important partners and their position in the network. This aim can be achieved generating and analysing the network pictures of core partners and searching for better clustering with better opportunities of partners.

Portfolio utilization is used in case than multi-criteria assessment indicates a stronger portfolio than performance, i.e. $A_r < B_r$ or $A_t < B_t$. In this situation, the existing partners could be used in a better way to increase the performance of HEIs. Network pictures should be used in order to understand the structure of partner relations to explore them better. This situation can be resulted by several strategic actions taken in the previous strategic cycles, e.g. stronger activities in studies could lead to better partners, but the research profile could be still low for teaching oriented schools, or vice versa in more researcher-based HEIs. The network developed in one field could be re-utilized in the other. The main task of this general strategy is to indicate partners for

better collaboration and to support and increase interaction (to strengthen the existing relations) in the field targeting similar and stronger partners – to use the existing network opportunities.

Following the analysis applying pictures, some deeper examination should be conducted, which can be done by referring to a diagram of the impact of the portfolio Table 2.4 (Parise, Casher 2003).

Table 2.4. Interpreting the impact of the portfolio (Parise, Casher, 2003)

Impact		Study these alliances to understand
Partners having a highly facilitating impact on the portfolio		What is at the root of facilitating impacts? Leverage these synergies elsewhere in your portfolio. Even if this partner is of low strategic importance, continue investing in this alliance relationship.
Partners positively impacted by the portfolio		What is at the root of facilitating impacts? If this partner is of high strategic importance, ensure that these synergies continue to thrive. Consider pursuing multi-lateral partnerships with these existing partners, as additional relationships with these partners extend partner networks.
Partners having a highly constraining impact on the portfolio		What is at the root of constraining impacts? If this partner is of high strategic importance, several actions may be helpful. Demonstrate commitment to the relationship through increased resource allocation. Build trust at all levels of the relationship through both professional and informal activities. Lessen exclusivity in contracts with constraining partners, if appropriate.
Partners negatively impacted by the portfolio		If this partner is of high strategic importance, look for ways to create synergies with other alliance partners such as the multilateral partnerships described above. If a lack of interdependency persists, you may have flexibility in removing or replacing this partner with the one of similar capabilities without impacting your portfolio. Carefully examine alternatives offered by the partner.
Partners having no interdependency with the rest of the portfolio		If this partner is of high strategic importance, look for ways to create synergies with other alliance partners such as the multilateral partnerships described above. If a lack of interdependency persists, you may have flexibility in removing or replacing this partner with the one of similar capabilities without impacting your portfolio. Carefully examine alternatives offered by the partner.

This method could not be used at the early stages of network assessment, as it would be hardly feasible with a large number of partners. This algorithm supports better understanding and transforming assessment results into strategic insights; however, the networking perspective should not be seen as a

universal tool for all problems of the HEI also taking the networking perspective into strategic factors such as general competitive and student dynamics in the sector of Higher education. A periodical NAM, including the interpretation of impact of the portfolio would disclose the effects of adding, removing and replacing specific network partners in your portfolio (Parise, Casher, 2003). Using the algorithm could end the cyclic process of assessing and developing networking.

2.5. Conclusions of Chapter 2 and the Formulation of Tasks in Empirical Research

1. The following limitations to the NAM have been distinguished: (1) the model is constructed for assessing institutional networking – the one of some specified HEI; (2) the model is focused on the international inter-organizational networking of HEIs; (3) internal networking and networking with business or governmental units is neglected.
2. The core elements of networking identified in the process of studying and research networking allow suggesting an assessment model that serves for understanding the external environment regarding the development of the strategy for the HEI and enables more effective and evidence based networking management.
3. An integrated dual, quantitative structure of the model covering multi-criteria evaluation and assessment applying network pictures solves the problem of networking assessment regarding the HEI. The suggested algorithm enables the incorporation of results into the development of the strategy for the HEI and suggests portfolio strengthening, keeping status quo and exploring strategies. These tools may assist in generating new knowledge about networking, HEI networks and their development opportunities.
4. There is the need for conducting empirical research in order to test the suggested NAM. Empirical research should prove that the provided model is correct and has theoretical and practical significance. The obtained results of empirical research should be the means for developing a more advanced strategy for the assessed institution.

3

Test of Networking Assessment Model Using Case of Vilnius Gediminas Technical University

In this chapter the NAM is tested by conducting empirical research that assesses the networking of Vilnius Gediminas Technical University. Detailed guidelines for the application of the NAM are given in the beginning of the chapter. Three stages of implementing the NAM, including the evaluation of the strategic perception of VGTU, multi-criteria assessment and assessment applying network pictures as well as strategic insight development are covered in separate sections.

The conducted evaluation has measured the networking of the HEI, broadened understanding the position of VGTU in the network and identified the possibilities of strategic development concerning the networking perspective.

The results of this chapter have been presented in 2 scientific papers (Nugaras 2012; Nugaras, Ginevičius 2014).

3.1. Guidelines for the Application of the Networking Assessment Method

This section describes the gradual application of the NAM. The carried out assessment also could be used along with a longitudinal approach to indicating networking changes in the HEI over time, because it assesses not only the state-of-the-art but also portfolio measurements and generates network pictures. The detailed application of guidance on the NAM is given in Table 3.1

Table 3.1. The application guidance on the Networking Assessment Method

Implementation		Process
Strategic perception		1. To take the mission and vision of the HEI. 2. To indicate the core ranking of the institution. 3. Indication of the partners listed in the ranking (or taking information about all partners of the assessed HEI) 3. Secondary data collection: SWOT, KPI and statistical data.
STAGE 1 Multi-criteria evaluation	Research evaluation	1. Collection of data on the criteria. 2. Application of the formula $\ddot{N}_r = \tilde{r}_{IC} I_N + \sum_{i=n}^{m} \frac{\tilde{r}_{ICi} I_{N_i}}{n}$
	Teaching evaluation	1. Collection of data on the criteria. 2. Application of the formula $N_s = \left(\widetilde{w} + \sum_{i=n} \frac{\widetilde{w}_i}{n}\right) + \left(\tilde{k} + \sum_{i=n} \frac{\tilde{k}_i}{n}\right)$
	Overall	1. According to the decision made at the strategic level of the ranking system, weight coefficients α and β are chosen. 2. Applying the formula $N = \alpha N_r + \beta N_t$
STAGE 2 Evaluation applying the network picture		1. For using the strategic perception of the assessed institution, the boundaries of data collection should be set (e.g. strong regional orientation, strong continental orientation, special subject orientation, etc.). 2. The most developed network indicated at Stage 1 is taken as a basis for network pictures. 2. The assessed HEI is the entry point of the snow ball method used for indicating nodes and the relations of nodes. 3. Data on relationship from the most developed network (if the most developed network is teaching, it is recommended to choose data from Erasmus, or co-authorship data, in case research is the dominating network).

Continuation of the Table 3.1

	4. Indicating relations to the relational matrix. $G = \begin{bmatrix} n_{1,1} & n_{1,2} & \cdots & n_{1,n} \\ \cdots & \cdots & \cdots & \cdots \\ n_{n,1} & n_{n,2} & \cdots & n_{n,n} \end{bmatrix}$ Indicating the strength of relations taking into account the number of papers concerning the same institution. Using the strength of relationships if data are available. 5. Checking if the matrix is symmetrical, and fixing by adding all institutions in columns and rows in case it is not. 6. Adding the matrix to the computer program of SNA. In this work, *ORA will be used for network mapping and relation-based calculations. *ORA is a tool for dynamic meta-network assessment and analysis developed by CASOS at Carnegie Mellon University (Carley, Columbus 2012). 7. Adding the number of students, general research output, a country and region, a place in strategic ranking as additional data and as attributes to the program. 8. *ORA is used for generating pictures for a general understanding of networks (see Table 1). The cut-point for generating network pictures. 9. Formulating network insights
Error checking	1. Comparing the results of Stages 1 and 2 in order to check if they are consistent and follows general logics and tendencies in the sector of HE.
STAGE 3 Data interpretation	1. Applying the strategy algorithm for turning network insights into the strategic ones. 2. Generating additional (case specific) network pictures if needed. 3. Turning network insights into strategic insights. 4. Developing strategy. 5. Setting the values of the HEI and portfolio performance in networking activities as KPI. 6. Starting a new assessment cycle.

While keeping on the steps of this guidance, the following assessment of Vilnius Gediminas Technical University (VGTU) will be done.

3.2. Stage 1: Networking Evaluation Using Methods for Multi-Criteria Evaluation

3.2.1. Strategic Perception of Vilnius Gediminas Technical University

The section represents the results of an empirical analysis of VGTU. Investigating the current and historical data and documents of the university is a basis for following the state of the strategic perception of VGTU in order to

generate output for the strategy development block of the NAM. Short information about the university referring to its position on the website is as follows:

Vilnius Gediminas Technical University (VGTU) is an innovative Lithuanian University educating highly qualified and creative specialists. The University is the leader among the institutions of technological science education and ensures modern studies orientated to the labour market. Having more than 400 foreign high school partners, VGTU offers good opportunities for wide international studies and practices. VGTU is the leader in Lithuania by the number of students studying under the Erasmus Exchange Programme and belongs to the top four percent of the best universities worldwide according to data provided by international "2013–2014 QS World University Rankings" (VGTU 2014a).

- From positioning this statement, several elements of strategic orientation could be distinguished:
- Core orientation to technical education and research leadership is confirmed by the vision statement in the strategy (VGTU 2013).
- Strong emphasis on internationalization in the strategy is highlighted as a priority in the areas of studies and research (VGTU 2013).
- QS World university ranking is considered to be the main and strategic benchmarking system.

Table 3.2. summarizes the general figures of the university.

Table 3.2. Key figures of Vilnius Gediminas Technical University (VGTU 2014a)

Description	Figure information
Established in	1956
Alumni	Nearly 69.000
Current amount of students	More than 11.000
Key structural units	10 faculties; 14 research institutes, 2 research and 4 training centres, 33 research laboratories.
Academic staff members	940
Structure of studies	Over 100 study programmes based on the three-cycle structure: undergraduate, graduate and post-graduate studies
Partnerships	Over 310 business partners across Lithuania Over 410 high school partners worldwide

Taking into consideration the core goals of the institution, several aspects are important to the networking perspective: first, innovation and integration

into global markets and international recognition are considered as the main goals in the strategy for the institution. Such consideration is highly related to the benefits of the more effective use of the networking perspective discussed in Chapter 1. Also, the university strives to be the leader among the universities of the Baltic States in sustainable building, environmental and energy technologies, sustainable transport, mechatronics, information and communication technologies, technology management and economics, fundamental research on materials and processes. These factors should be taken into account as regards research applying network pictures as well as the elements decreasing the amount of relations and nodes in the carried out analysis and increasing the strategic orientation and feasibility of conducting the study.

The statements on internationalization studies highly correspond to the theoretical aspects discussed in Chapter 1: the HEI seeks for renewing study programs and increasing an international aspect of those as well as creating more joint-degree programs in order to raise quality (seeking know-how and knowledge transfer) and to use complementary or unreachable resources. Therefore, the development of internationalisation is accepted as a condition and way of acting to keep the level of the competiveness of the HEI in the global HE area. The University understands that unique portfolios of relations and the better usage of participation in networks and consortiums would benefit for development. As for the field of research, the strategy emphasizes high orientation to European research strategies and increase participation in research projects. As stated in the theoretical part, this could be achieved only by fostering collaboration between scholars and institutions in a more effective way.

The above mentioned strategic perceptions of VGTU indicate several important aspects of this thesis: first, it proves the relevance of the topic of the thesis and has strong theoretical and practical usage; second, the strategy for the HEI discloses the importance of the thesis, as the need for networking assessment and more effective networking management is clear.

While moving from the strategic plan to the more tactical ones such as the plan for 2014–2016 , the importance for networking is poorly reflected, as only an increase in the internationalisation of studies is mentioned in the document. Moreover, no indicators for measuring the success and state-of-the-art networking are suggested, as neither the institution nor portfolio performance is measured. At the operational level, from more than 500 criteria, about 20 are directly related to networking the most relevant of which are described in Table 3.3. Concerning these criteria, two major weakness could be pointed out: (1) there is no portfolio analysis and the number of international partners does not reflect neither state-of-the-art nor possible potential and strategic possibilities

and (2) a number of criteria can be difficult to manage, as it is difficult to demonstrate the overall effect without integrating them, which might be to detailed for strategic management.

Table 3.3. Networking related criteria at VGTU (VGTU 2014b, 2014c)

Studies	Research	Other
Number of joint degree programs. Lump sum of money for projects on international studies. Number of outgoing students and teachers on the ERASMUS program. Number of agreements on outgoing and incoming students.	Lump sum of money from international research projects. Number of leading international scientific projects. Supervision under international postdoc. Collaboration in international research.	International diversity. Staff mobility.

The above mentioned factors and general strategic perception of VGTU confirm the problems, importance and novelty of the thesis. It is clear that VGTU recognises networking related issues and benefits through internationalisation and has strategic willingness to improve this area, but still is lacking tools and better insights of the surrounding network. The analysis of strategic documents indicates importance, but there is a lack of implementation or networking development insights. In general, VGTU faces similar theoretical issues analysed in Chapter 1, and the NAM could be used for assessing the networking of this HEI. The generated strategic insights could be useful for strategy development and implementation, especially at tactical and operational levels showing improvement in networking.

3.2.2. Results of Multi-Criteria Evaluation

In 2014, data on multi-criteria evaluation were collected using QS ranking, SIR Global 2013 – Rank: Output 2007–2011, website information on HEIs and Erasmus statistics on all data (QS 2014; SCImago Research Group 2013b; VGTU 2014a; Agence Europe-Education-Formation France 2014). Detailed multi-criteria calculations and data are reflected in Annex D and Annex E. The general results of study networking are presented in Table 3.4 (not adjusted to the amount of students in the institution) and Table 3.5 where mobility results are adjusted to the amount of students in the institutions and combined with research networking

Table 3.4. Results of networking assessment concerning studies and research (mobility not adjusted to the size of the university)

Assessment criteria	Number of partners in the ranking	Networking of the assessed institution	Networking of the partner portfolio	Networking assessment
Networking in the process of studies	33	1.308	0.476	1.784
Student mobility (not adjusted to the size of the university)	33	0.308	0.241	0.549
Personnel mobility (not adjusted to the size of the university)	33	1.000	0.235	1.235

Table 3.5. Results of networking assessment concerning studies and research (mobility adjusted to the size of the university)

Assessment criteria	Number of partners in the ranking	Networking of the assessed institution	Networking of the Partner Portfolio	Networking assessment
Networking in the process of studies	33	2.00	0.331	2.331
Student mobility (adjusted to the size of the university)	33	1.000	0.248	1.248
Personnel mobility (adjusted to the size of the university)	33	1.000	0.082	1.082
Research networking	66	0.025	0.429	0.454
Combined networking assessment of studies and research				0.972*

Some limitations to these calculations can be noticed. Tables 3.4. and 3.5. show that the number of institutions differs in the fields of research and studies. These differences accrued due to data limitations, as statistics on the project Erasmus is still at the stage of development where a limited amount of data on institutions are publicly listed. However, as a half of institutions have been

taken into account, it is enough to notice the trend and assess the situation. Also, as indicated above, the results of further assessment are consistent with the information obtained in the process of analysis applying network pictures.

The networking of the process of studies assessing this institution indicates several factors in strategic importance. First, despite of calculating absolute or proportional values, the obtained results show a very strong performance of the assessed institution and a weaker portfolio. The indicator of personnel mobility is an absolute value and is equal to one. Taking into account this reflects only partners from the QS ranking, it presents strong performance among leading universities; however, from the institutional point of view, it should be understood that this portfolio of partners is too weak, and therefore strategies for developing relations with stronger partners should be developed. What is more, this assessment highlights that this institution could position itself as a strong performer of study networking.

These are quite opposite results of research networking. The portfolio is much stronger than the performance of the assessed institution. From the strategic perspective, it is also an indication that it should be moved from just having good networking portfolio to using it more intensively.

The shift from quantity to quality or from quantity to selective intensity could be the core of institutional networking in research strategy. Also, it might be worth developing or looking more carefully into strategies for the most important relationships and strong performers in research.

3.3. Stage 2: Networking Evaluation Applying Network Pictures

Stage 1 has indicated that study networking is more developed at VGTU, and this network should be taken as the basis to indicate nodes and relationships.

The application of the snowball method was started from the list of Erasmus partners on the website of VGTU. According to the strategic perception of VGTU, two major aspects were taken into account setting a framework for the analysis of network pictures: first, to focus research on the Baltic Sea region, as VGTU has to be the leader in the Baltic States, although the number of institutions is too small to analyse the network picture; second, to involve only institutions with high orientation to technological sciences (Annex A and Annex B). This decision was made in accordance to VGTU strategy (VGTU 2013). Those two choices were made in order to reduce the size of the sample, to have a more homogenous network and to make testing of this research model feasible. As the suggested methodology is created for assessing the networking of the institution, the snow ball method started from

the assessed connections of the institution The partners listed in the Erasmus program were included in the network. Then, all actors included in the list were tracked down, and the list of Erasmus partners was searched on the website of all listed partners. The process continued until no new actors and relations were identified.

Data collection: in 2012, data collection was done at Stage 2. The larger population was more than 300 universities from the Baltic Sea region. As smaller population (sample), 144 technical universities and those of applied sciences have been chosen. The distribution of institutions by countries are as follows: Baltic countries (Estonia, Latvia, Lithuania) – 6 institutions, Scandinavian countries (Finland, Sweden, Denmark) – 18; Germany – 86; Poland – 18. For data analysis and the generation of the pictures of networking, version 3.0.0.2 of *Ora- netScenes system was used (Carley, Columbus 2012; Carley *et al.* 2012). Considering the links of the institution, the network matrix indicated 144 nodes and 1260 links inside it (Annex B and Annex C).

In Fig. 3.1 a general overview of the network is generated, which indicates very high centrality of assessed institution U001 and correlates with the results obtained in multi-criteria evolution, as high results of student mobility require a large network and wide relations. Also, it shows that Baltic countries (Baltic HEIs are squares in yellow, Scandinavian are green, Polish are blue and German are electric) are the most central ones and has the largest network, which might be explained by the behavioural approach of late comers (Girdzijauskaite, Razdeviciene 2013), as the institutions blended in the European market of Higher Education only in late 90's together with the collapse of the Soviet Union. These institutions have been very open to any collaboration almost without the selection of partners. Also, it might be highly visible that the most central are middle size HEIs, as squares are adjusted to the number of students in the institution. Therefore, this picture indicates clustering Baltic, Polish and German institutions on the country basis, as they occupy a similar position in this network.

The central position of VGTU indicates several features of its networking: central nodes learn about information and other attitudes and actions at a higher rate than other nodes and thus may have more accurate perceptions of inter-institutional functioning (Rogers 2003). Nevertheless, the analysis of Fig. 3.1 and 3.2 shows that more advanced in research institutions are not so central and concentrate in the right down corner of the generated picture.

Fig. 3.2 shows that the size and colour of the node have been adjusted to the research output of the institutions. The results also correlate with those of multi-criteria evaluation: even this picture does not cover all partners in the QS ranking, because it is clear that the position of the assessed institution is far from a more productive one researching HEIs; also, it proves that stronger

institutions are more selective, concentrating on more important relations, or are more central in some other parts of a larger network.

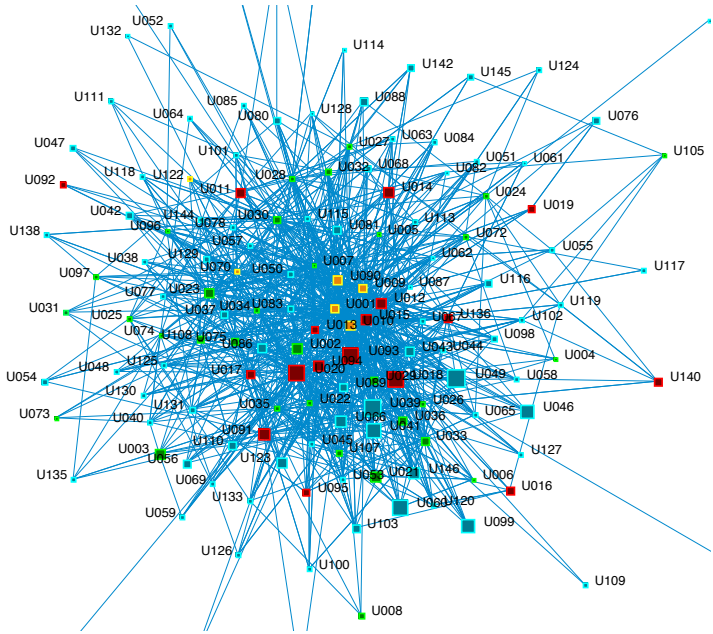


Fig. 3.1. Network picture: centrality and the size of the university considering the number of students, countries by colours (Created by the author)

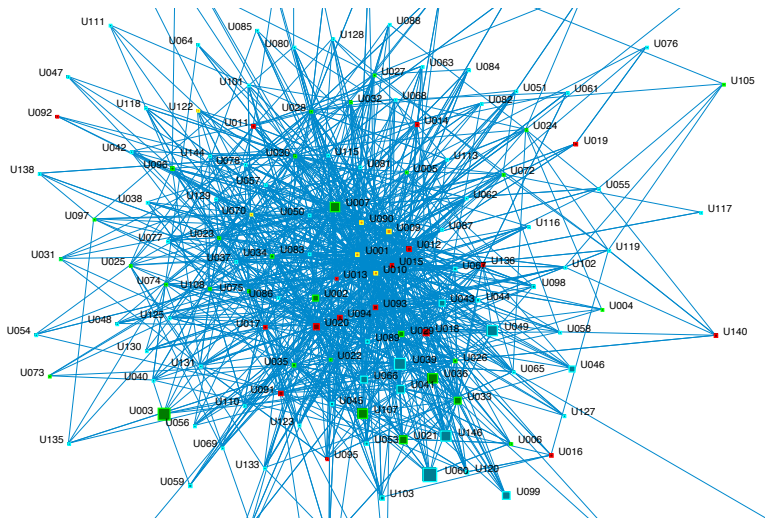


Fig. 3.2. Network picture: centrality considering student mobility, the size of the node adjusted to research output, colours by countries (Created by the author)

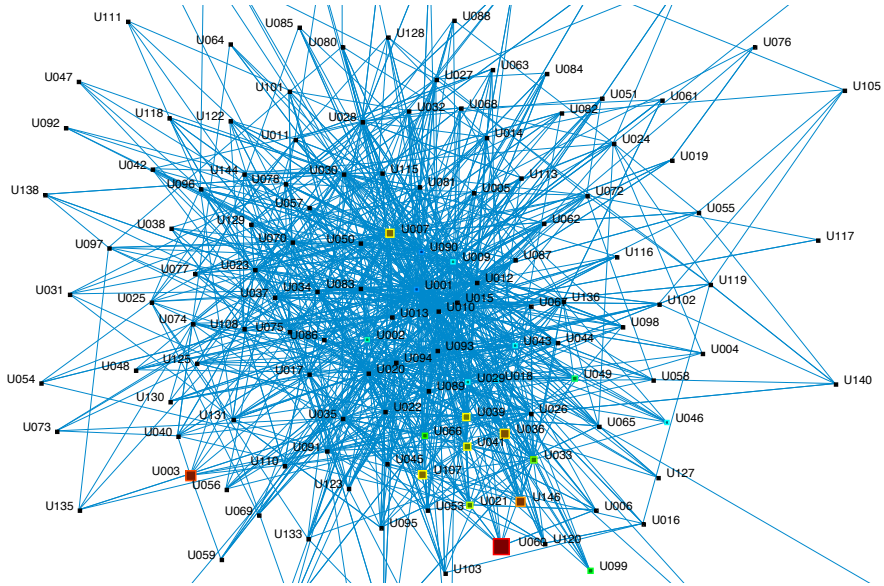


Fig. 3.3. Network picture: centrality considering student mobility, nodes inversely proportional to the place in QS rankings (Created by the author)

The other important factor in assessment is the position of highly ranked institutions. Fig. 3.3 reflects the position in the QS ranking. The conducted assessment clearly indicates that the majority of institutions are not listed; what is even more important is that those institutions are clustered at the bottom of the generated picture that confirms the factor that prestigious institutions are more selective, cluster together and form elite networks. If institutions are less central, it means they have less but more effective connections.

The overall position of VGTU in the network could be described as very central and highly connected to essential network members; however, Stages 1 and 2 indicate the need for more effective management of the partner portfolio and consideration of a wider network in external analysis.

3.4. Stage 3: Applying the Algorithm for the Usage of Assessment Results

The task of this section is to generate network insights and to turn them into the strategic ones in order to support the strategy development process in VGTU. The results of the multi-criteria assessment of networking studies and research on Stage 1 are summarized in Table 3.6.

Table 3.6. A comparison of the performance of the Higher Education Institution and portfolio

Field of networking	Performance	Portfolio	Comparison
Study networking	$A_t = 2.00$	$B_t = 0.331$	$\boldsymbol{A_t > B_t}$
Research networking	$A_r = 0.025$	$B_r = 0.429$	$\boldsymbol{A_r < B_r}$

A general strategy for study networking: in the case of $A_t > B_t$, the algorithm recommends generating a strategy for strengthening the portfolio. This strategy should be oriented towards new partnerships with HEIs that have a high profile. In this case, institutions with high technical orientation are listed in QS rankings. The following institutions could be targeted: ETH Zurich (Swiss Federal Institute of Technology) – the leading teaching and research institution holding about 400 exchange students per year, which is similar to VGTU; Ecole Polytechnique Fédérale de Lausanne; Ecole Polytechnique – the institution have sent 474 students for an exchange program and Lithuania and is considered as one of the core partnership countries (such consideration could be a good entry point); Eindhoven University of Technology – VGTU have had an agreement on collaboration, but no interaction turned to the suspension of the document from the side of VGTU. However, some more efforts could lead to stronger partnerships; École des Ponts ParisTech – similar high orientation to civil engineering; Technische Universität Darmstadt (TU Darmstadt) is an institution from the Baltic Sea Region that should strengthen the portfolio as the numbers of study networking are high, and this institution is a part of the QS network, which therefore will be discussed in the section of QS core partners of this chapter.

A general strategy for research networking: in the case of $A_r < B_r$, the algorithm recommends to generate a strategy for exploring the portfolio, which could be achieved through a deeper analysis of the existing relations.

As multi-criteria assessment indicated the need for developing the existing relations, it is worth looking deeper in the structure of relations in connection to research output. Only similar or bigger institutions, according to the output of research, are filtered in Fig. 3.4. The picture shows that the most productive

institutions are not that closely linked to each other and are very well connected to the assessed institution. This factor could be highly used in the strategy for the assessed institution, i.e. acting as "glue" – a mediator in strengthening building new strategic alliances/clusters and gaining better performance in research from partners. The universities from the Baltic States (U001, U009, U010, U090) have very similar research output; however, the assessed institution is better connected to leaders in research output. This is a competitive advantage and should be used for further strategic development.

The analysis of network pictures allows using tools for SNA: the application of Newman's Clustering Algorithm has assisted in identifying five clustering groups of the institutions in the Baltic Sea region (see Table 3.7 and Fig. 3.5). Bigger and the most productive institutions are presented in bold in Fig. 3.3). Group 2 have more key players inside the group, which makes this cluster more powerful in the network. Also, Group 2 has a very high clustering coefficient reaching 0,293, which also proves a theoretical assumption that elite institutions cluster together. What is more, even VGTU (U001) having the best centrality, takes the 1st position as regards other measurements of the key elements and participates in a strongly related (clustering coefficient = 0.491) but smaller and less powerful cluster. This fact shows that the institution has been chosen taking into account the quantity instead of quality of links. VGTU should try to change its position in the network towards Cluster 2. The identification of this direction should also be considered in the allocation of resources.

A comparison of Fig. 3.5 identifies and better shows that the most advanced institutions are clustered together and the strategy for the assessed institution should be moved towards the green cluster so that to strengthen relationships with those HEIs and allocate resources for the better exploitation of those relations.

Formation of the core network: Data and analysis on partnerships suggested by QS rankings could be seen as a strategy for integrating more studies and research. QS partners of the Baltic Sea region and their relationships are analysed in Fig. 3.6. Listing in QS rankings marks the quality of institutions, which is expected they would like to more actively collaborate with each other. The development of this list of institutions could be indicated as a clear aim of further positioning in the network – the assessed institution should formulate its strategy in a way that enables strengthening relations with the above mentioned institutions. As research output is one of the core criteria, the QS picture has similarity with the picture of research output and indicates even less interconnected HEIs that have higher rankings. This set of partners might be considered as the core network, or the most important partners having the most intensive relations with them should be developed. This picture also

clearly shows that the assessed institution has very good possibilities of approaching all strategic partners and developing access to the new collaborative structures and networks of higher importance. In order to understand collaboration details referring to this list of partners, secondary data analysis has been conducted. Mentioning search for the name of the partner-institution in 3 different data bases (university website, data base of the books in university library and scientific paper published under university name register) of the assessed institution has been done (Annex F).

Table 3.7. Newman's clustering. The most advanced Higher Education Institutions included in research are presented in bold, Vilnius Gediminas Technical University underlined

Group	Size	Density	Clustering coefficient	Members
1	48	0.077	0.148	U005, **U007**, U016, U022, U024, U027, U030, U037, U045, U052, U055, U062, U064, U065, U072, U073, U074, U075, U078, U081, U082, U083, U084, U085, U086, U087, U089, U090, U092, U094, U095, U096, U100, U102, U105, U115, U117, U119, U124, U126, U132, U134, U135, U137, U139, U140, U143, U145
2	35	0.176	0.293	U004, U006, U010, U012, U018, **U021**, U026, U029, **U033**, U035, **U036**, **U039**, U041, U043, U044, U046, **U049**, U053, **U060**, U066, U067, U091, U093, U098, U099, **U107**, U108, U109, U110, U116, U120, U121, U122, U136, **U146**
3	31	0.123	0.196	U002, U008, U015, U017, U020, U023, U025, U032, U034, U047, U048, U050, U069, U070, U077, U088, U097, U101, U103, U104, U118, U123, U127, U128, U129, U130, U131, U133, U138, U142, U144
4	28	0.104	0.491	**U001**, **U003**, U009, U011, U013, U014, U028, U031, U038, U040, U042, U051, U054, U056, U057, U058, U059, U061, U063, U068, U079, U080, U106, U111, U113, U114, U125, U141
5	2	1	0	U019, U076

The name of the partner-university in the above introduced three data bases directly and indirectly indicates the scope and scale of collaboration between these institutions: the number of entries in websites shows the general importance of relation and frequency important collaboration may appear.

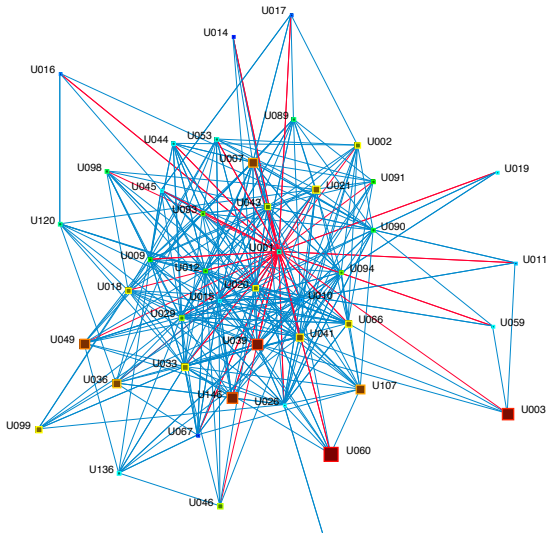


Fig. 3.4. Network picture: centrality considering partnerships in student mobility, the size of the node adjusted to research output, the number of the node reduced to a similar or bigger assessed institution (Created by the author)

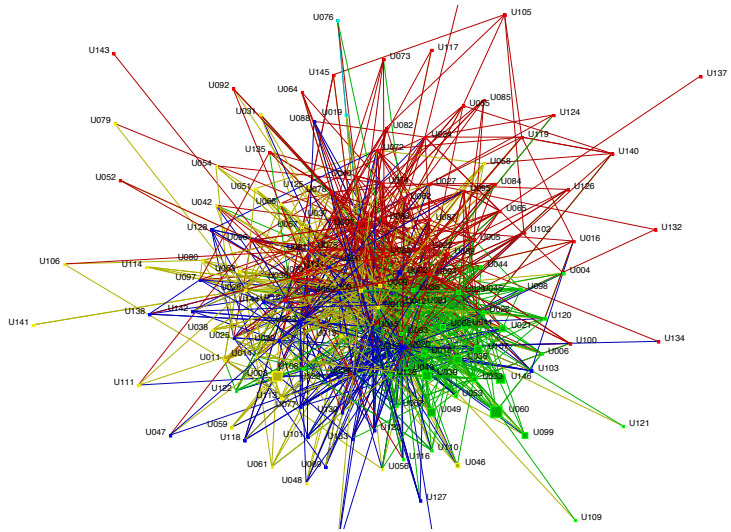


Fig. 3.5. Network picture: centrality considering partnerships in student mobility, the size of the node adjusted to research output and the colour of the node of Newman's clustering (Created by the author)

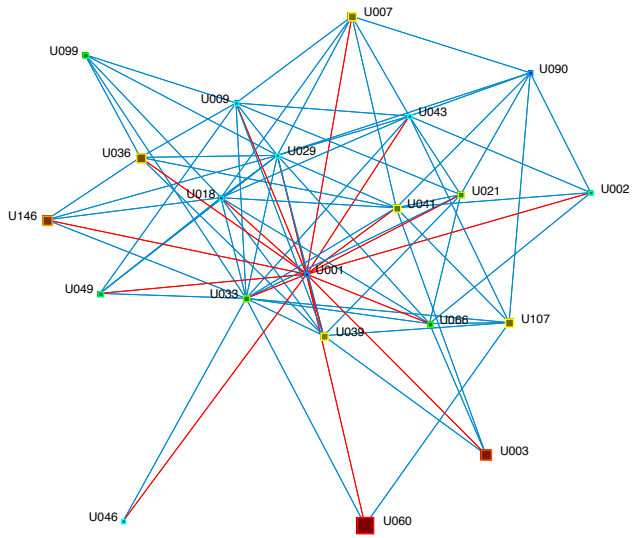


Fig. 3.6. Network picture: centrality considering student mobility selecting only the nodes listed in QS rankings and inversely proportional to the place in QS rankings (Created by the author)

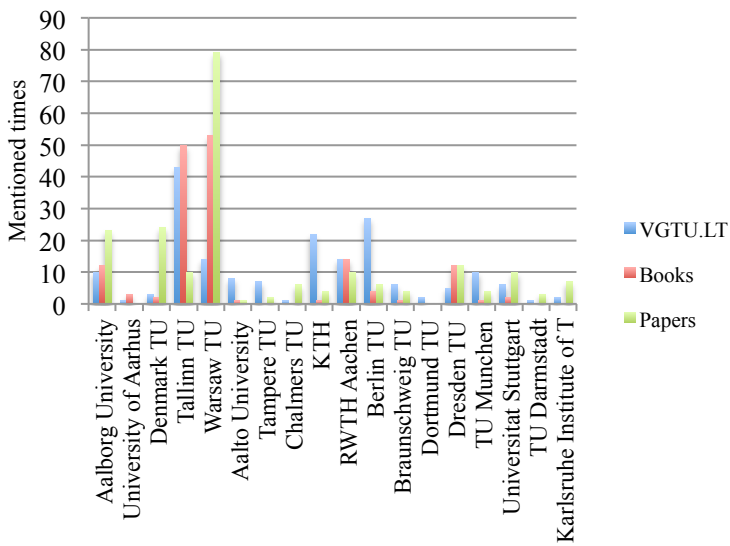


Fig. 3.7. Mentioning QS partners in VGTU data basis (Created by the author)

More teaching books naming the partner-university indicate deeper collaboration in the field of studies, and more scientific papers point to closer collaboration in research.

Fig. 3.7 reflects data about QS partners. The chart shows the most intensive partnerships with Warsaw TU and Tallinn University of Technology. Several strategic insights might be developed from an in depth analysis of the partner: (1) the identification of the possibilities of linking with disconnected institutions such as U099, but not attached to some others, as HEIs are in direct competition such as U090 (might be in deep or neutral, conflict or competing relations); (2) the identification of the existing patterns of collaboration with all connected institutions (how deep, how often, what are the key persons in both sides, what are common interests, what are conflicting interests); (3) the identification of the exact strategy for each partner (to expand, to keep the same status, to decrease intensity); (4) the analysis of the existing formalized networks or creating the new ones. The carried out research has identified more detailed tactics; however, the displayed data are very competition sensitive and has been presented to VGTU management, but cannot be disclosed in this dissertation.

This section of the dissertation demonstrates that the selected methods and created NAM are useful tools for the practical strategic management of HE, solves the problems of networking measurement, the networking of studies and research networking, helps with evaluating the position of the institution in a broader network that assists in generating network insights, assessing the portfolio and using the results of multi-criteria assessment so that the institution could set strategic quantitative and measurable goals.

3.5. Conclusions of Chapter 3

1. Empirical research has fulfilled the aim for testing the model: the suggested theoretical NAM is suitable for assessing research and study networking of HEI. The results obtained in the investigation such as numerical values and network pictures indicates that integrated methods are complementary and can be used for generating new knowledge about networking. The NAM could be treated as a tool for understanding and monitoring networking of HEI.
2. The obtained results of empirical research such as a better understanding of networking of the HEI, networking measures and network pictures for general and specific purposes are new and significant for management science. This research also helps with

understanding the structure of the portfolios of the partners and network structures and assists in empowering institutions to identify and concentrate on the most important partners.

3. The received results of empirical research are also new and useful for the development of the assessed HEI. From a practical point of view, institutions could employ this tool and develop better strategies for networking that could lead to new synergies, better allocation of resources and improvement in general performance. This adds relevancy to the dissertation and makes it usable for practical purposes.

General Conclusions

1. The literature review of the networking theory and practices in HEIs have indicated there is the need to consider networking activities at the strategic management level of the HEI. For more effective strategy development and in order to gain more benefits from networking there is a need for understanding an external networked environment, including a position of the institution in a wider network and the structure of the partner portfolio; hence, HEIs are lacking tools for the assessment of networking and for using insights into strategy development. Also, there is a need for monitoring the general progress of networking, as the strategy development of HEIs more often includes the identification of targets for short-term and full-degree mobility, geographical target areas, target numbers of mobile students at each degree level, the types of cooperation that fit their overall needs and specific HEI networks.
2. Most HEIs accept networking through the internationalisation perspective and do not taking into account the following benefits: learning from partners, creating a competitive advantage, gaining access to complementary resources, faster and better innovation and R&D, these benefits are underestimated and underused. Two major

problems could be distinguished in managing networking: (1) lack of the ability to monitor the process of networking and the ability to assess not only the performance of the institution, but also to indicate and assess partners' portfolio; (2) lack of tools for incorporating wider networking information on strategy development. More effective networking management would have a positive impact on the competitiveness of the HEI.

3. The suggested NAM has been limited to assessing international and inter-institutional networking. An integrated dual, quantitative structure of the model consisting 3 stages, covering multi-criteria evaluation and assessment applying network pictures solves networking assessment problem of the HEI, enables wider network understanding including position of the institution and serves for the creation of advanced strategies. The suggested algorithm enables the incorporation of results into the strategy development for the HEI and suggests portfolio strengthening, keeping status quo and exploration strategies. Moreover, the NAM could be used for monitoring networking activities in research and studies.

4. The conducted empirical research, with reference to the case of Vilnius Gediminas Technical University, has indicated that the features of the suggested NAM are complementary and help with understanding a larger surrounding network. The received results and trends at Stages 1 and 2 are consistent and could be used for improving the management of networking. In addition, empirical research has fulfilled the aim for testing the model: the suggested theoretical NAM is suitable for assessing the networking of research study. The integrated methods are complementary and useful for generating new knowledge. The NAM could be treated as a tool for monitoring networking. The obtained results of empirical research such as a better understanding of networking the HEI, networking measures and network pictures for general and specific purposes are new and significant for management science. This research also helps with understanding the structure of the portfolios of the partner and network structures and assists in empowering institutions to identify and concentrate on the most important partners.

5. The assessed HEI has a strong portfolio and weak results of networking as regards research activities and strong networking results and a weaker portfolio. In the field of research, the institution should make a strategy for developing more activities

with partners and for using the capacity of partners to strengthen performance. For the purpose of networking studies, the institution should strategize how to switch from a large quantity of relations to more effective ones, and to concentrate on more important (core) partners that have been distinguished by this empirical research.

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Summary in Lithuanian

Įvadas

Problemos formulavimas

Atlikti teoriniai ir empiriniai tinklų ir tinklaveikos tyrimai įrodė, jog dalyvavimas tinkle tiek privačiajame, tiek viešajame sektoriuje yra naudingas dalyvaujančioms įmonėms ir įstaigoms. Toks dalyvavimas gali sustiprinti konkurencingumą, padidinti papildančių išteklių pasiekiamumą, padidinti pelningumą, skatinti žinių perdavimą ir sukurti kitų su sinergija susijusių efektų. Augantis aukštojo mokslo internacionalizavimas ir aukštojo mokslo institucijų (AMI) specifika sukuria didelį tinklaveikos panaudojimo potencialą, tačiau atlikus kritinę literatūros šaltinių analizę išskiriamos šios aukštojo mokslo tinklaveikos plėtrai ir vadybos mokslui svarbios problemos:

1. Esantys sisteminiai tinklaveikos vertimo metodai, sukurti verslo sektoriuje, silpnai atitinka šiuolaikinės AMI vadybos realijas. Strategijos kūrimo procese AMI neturi integruotų tinklaveikos vertinimo metodikų, todėl tinklaveikos vertinimas neatliekamas arba atliekamas ne sistemiškai.
2. Nėra sukurti tinklaveikos proceso stebėsenos metodai, kurios sudarytų sąlygas ne tik įvertinti konkrečios institucijos tinklaveiką, bet ir išmatuoti šios institucijos partnerių įtaką, t.y. atlikti partnerių portfelio vertinimą.
3. Tinklaveikos vertinimo metodikų trūkumas neleidžia kryptingai ir sistemiškai integruoti tinklaveikos į AMI strategijas, neatsižvelgiama į naujų ryšių užmezgimo, partnerių portfelio valdymo, išteklių paskirstymo svarbiausiems partneriams svarbą.

4. Esantys kiekybiniai tinklaveikos vertinimo metodai daugiausiai atspindi tik matematines technikas, tačiau nėra pritaikyti ar interpretuojami konkrečioms situacijoms ir gali būti menkai panaudoti sprendžiant šiuolaikines AMI vadybos problemas. Literatūroje vyraujantys kokybiniai tinklaveikos vertinimo metodai yra sunkiai pritaikomi dideliems tinklams vertinti.

Darbo aktualumas

Aukštojo mokslo institucijos tinklaveikos vertinimas yra aktualus, nes tarptautiškumas, bendradarbiavimas ir tarpdisciplinišKumas yra grindžiami šiuolaikine tinklaveika ir yra laikomi svarbiais aukštojo mokslo sektoriaus kaitos ir plėtros stimulais. Atlikti teoriniai tyrimai atskleidė pramoninių tinklų, tarporganizacinės teorijos, tinklų ekonominėje geografijoje teorijų, kurios susiformavo remiantis verslo praktikomis panaudojimo AMI vadyboje galimybes. Šių teorijų panaudojimas AMI leistų išplėsti suprantamų tinklaveikos naudų spektrą ir rasti naujų tinklaveikos efektyvumo didinimo galimybių. Sparčiai auganti įvairių AMI reitingų svarba suaktualina ir efektyvios tinklaveikos vadybos klausimą, nes daug reitingų kriterijų yra tampriai susieti su tinklaveika. Empiriniu požiūriu disertacija sukuria naujų žinių apie AMI tinklaveiką ir jos valdymą, taip pat sukuria naujų svarbių įžvalgų išorės aplinkos analizei.

Tyrimo objektas

Aukštojo mokslo institucijos, kuri vykdo mokslo ir studijų veiklą tinklaveika – institucijos patekimas ir dalyvavimas tinkle (t. y. jos sąveika su kitomis institucijomis).

Darbo tikslas

Sukurti ir empiriškai patikrinti kiekybinį aukštojo mokslo institucijos tinklaveikos vertinimo modelį, kurio taikymas leistų priimti racionalius strateginius sprendimus, didinančius institucijos konkurencingumą.

Darbo uždaviniai

Darbo tikslui pasiekti iškelti tokie uždaviniai:

1. Siekiant išnagrinėti tinklaveikos valdymo problemas ir apibrėžti disertacijos teorinį pagrindą atlikti tinklaveikos reiškinio ir tinklaveikos vertinimo metodų šiuolaikinės vadybos kontekste literatūros šaltinių analizę.
2. Nustatyti tinklaveikos aukštojo mokslo sektoriuje specifiką.
3. Sudaryti AMI tinklaveikos vertinimo modelį, kuris kuriant AMI strategiją leistų vadovybei tinkamai įvertinti išorės aplinkos (supančių tinklų) poveikį ir sukurtų įrankį tinklaveikos stebėsenai atlikti. TVM turi būti parinkti kiekybiniai metodai, kriterijai ir duomenų šaltiniai.
4. Sukurti algoritmą, kuris leistų gautus tinklaveikos vertinimo rezultatus transformuoti į įžvalgas strategijai, kurios stiprintų AMI strateginį valdymą.

5. Atlikti empirinį tyrimą ir patikrinti modelio veiksmingumą, remiantis Vilniaus Gedimino technikos universiteto strateginėmis nuostatomis ir tinklaveikos duomenimis.
6. Remiantis tinklaveikos vertinimo rezultatais pateikti tinklaveikos plėtros rekomendacijas AMI.

Tyrimų metodika

Aukštojo mokslo institucijos tinklaveikos valdymo problemoms atskleisti naudota sisteminė ir mokslinės literatūros analizė, interpretavimo ir konceptualizavimo metodai. Tinklaveikos vertinimo kritinei analizei naudoti mokslinės literatūros, modelių lyginamoji analizė, tinklinės analizės metodai. Kompleksinio tinklaveikos vertinimo modelio I etapui buvo naudotas SAW ir kiti daugiakriterio vertinimo ir duomenų normalizavimo metodai, o II etapui naudota grafų teorija, socialinių tinklų analizės (SNA) ir susijusių skaičiavimų metodai, taikytas Newmano algoritmas, grafinės ir statistinės analizės metodai. Modeliui patikrinti taikytas empirinis tyrimas, matematinis įvertinimas. Tinklo schemoms vizualizuoti ir skaičiavimams atlikti naudota *ORA programinė įranga, rezultatams interpretuoti taikytas grafinės analizės ir loginės abstrakcijos metodai.

Darbo mokslinis naujumas

Pasiekti šie vadybos mokslui svarbūs rezultatai:

1. Sukurtas kompleksinis aukštojo mokslo institucijos tinklaveikos vertinimo modelis, leidžiantis įvertinti bendrą tinklaveikos būklę ir institucijos vietą tinkle kitų institucijų atžvilgiu.
2. Taikomas modelis sudaro prielaidas sistemiškai integruoti tinklaveiką į strateginio valdymo procesus.
3. Sukiekybintas tinklaveikos vertinimo pagal tinklo schemas metodas sudaro metodines prielaidas pagerinti AMI strategijos kūrimo efektyvumą.
4. Sukurtas Newmano algoritmo ir SAW metodų pritaikymas AMI leidžia identifikuoti ir įvertinti aukštojo mokslo institucijos partnerių portfelį.
5. Sukurtas AMI tinklaveikos vertinimo pagal tinklo schemas metodas.
6. Sukurtas tinklaveikos vertinimo rezultatų transformavimo į įžvalgas ir kryptis strategijai formuoti algoritmas.

Darbo rezultatų praktinė reikšmė

Kompleksinis tinklaveikos vertinimo modelis yra reikšmingas AMI dėl šių priežasčių:

1. Modelis yra universalus ir gali būti taikomas visoms AMI – tiek pažengusiems dideliems universitetams, tiek mažoms kolegijoms. Modelis priklausomai nuo AMI strategijos gali būti naudojamas ir pritaikomas institucijų, kurios prioritetu laiko studijų organizavimą ar mokslinius tyrimus, poreikiams.
2. TVM yra sudarytas taip, kad įvertintų tinklaveiką ne tik iš pačios institucijos perspektyvos, bet ir priimtų domėn išorės aplinkos ir platesnio

tinklo būklę, galėtų atskleisti kitų institucijų ryšius ir taip nusakyti AMI padėtį tinkle, pagerintų AMI strategijos kūrimo ir tinklaveikos valdymo procesus.

3. Sukurtos tinklo schemos tinka aukščiausio lygio vadovams informuoti, nes atsipindi strateginę situaciją ir duomenis pateikia agreguota forma be to užtikrina paprastesnę tinklaveikos stebėseną.
4. Tinklaveikos vertinimo rezultatai yra aktualūs ir gali būti panaudoti ne tik aukščiausio lygio vadovams priimant sprendimus, bet ir AMI padaliniuose, nes įvardijus pagrindinių partnerių tinklą, mokslininkai, studijų programų vadovai bei fakultetų tarptautiškumo koordinatoriai galėtų suformuluoti taktinius veiksmus ir tolesnes plėtotės kryptis ir gaires.

Ginamieji teiginiai

1. Efektyvesnis tinklaveikos perspektyvos panaudojimas sustiprintų strategijos kūrimo procesą, nes geresnis platesnio supančio tinklo supratimas sustiprintų AMI išorės aplinkos analizę. Be to efektyvesnė tinklaveikos vadyba leistų plėtoti tinklaveikos sukuriamų naudų, tokių kaip konkurencinis pranašumas, papildančiųjų išteklių prieinamumas, padidėjęs organizacijos mokymasis ir informacijos ir tarptautinių rinkų pasiekiamumas, panaudojimą.
2. Nustatytas AMI vertinimo įrankių ir metodikų trūkumas – dominuojantys versle taikomi modeliai sunkiai pritaikomi didelių AMI tinklų vertinimui.
3. Tinklaveikos vertinimo problema gali būti sprendžiama taikant sukurtą tinklaveikos vertinimo modelį (TVM), kuriame integruojami daugekriteris vertinimas ir vertinimas pagal tinklo schemas. Naudojant TVM sudaromos prielaidos sukurti pažangesnę strategiją su tinklo perspektyva.
4. Naudojant TVM nustatomos aukštojo mokslo sistemoje esančios samplaikos ir AMI partnerių portfelio struktūra, taip pat sukuriamos tinklo schemos, kurios atskleidžia aukštojo mokslo institucijos vietą tinkle.
5. Vilniaus Gedimino technikos universiteto turi stiprią studijų tinklaveiką ir tobulintiną mokslo tinklaveiką. Atsižvelgiant į šiuos rezultatus siūlomos partnerių portfelio stiprinimo studijose ir geresnio panaudojimo atliekant mokslinius tyrimus strategijos.

Darbo rezultatų aprobavimas

Disertacijos tema yra išspausdintos 6 mokslinės publikacijos, iš kurių 2 užsienio mokslo leidiniuose: studija ir straipsnis mokslo žurnale, įtrauktame į ISI Web of Science sąrašą (Nugaras 2012a; Nugaras, Ginevičius 2014), 3 straipsniai (Nugaras 2012b; Nugaras, Radzevičienė 2012; Nugaras, Radzevičienė 2010) – duomenų bazėse, vienas straipsnis (Nugaras, Radzevičienė, Nikitin, 2011) – tarptautinių konferencijų medžiagoje. Disertacijoje atliktų tyrimų rezultatai buvo paskelbti dviejose tarptautinėse konferencijose (kurių viena surengta užsienyje):

- Privatus ir viešasis sektorius: mokslas ir praktika-11: Pirmoji tarptautinė konferencija: vienijanti tyrėjus, akademikus ir praktikus, Vilnius 2011.

- 29-oje IMP grupės tarptautinėje metinėje konferencijoje ir doktorantų mokykloje, Atlanta, JAV 2013.

Taip pat disertacija buvo pristatyta Lietuvos mokslo tarybos konferencijoje „Doktorantų stažuotės užsienio mokslo centruose 2012–2013" ir šešiuose doktorantų seminaruose, iš kurių du užsienyje.

Disertacijos struktūra

Disertaciją sudaro įvadas, trys skyriai ir bendrosios išvados, 9 priedai. Darbo apimtis – 114 puslapių (be priedų), tekste panaudota 11 numeruotų formulių, pateikta 17 paveikslų ir 22 lentelės. Rašant disertaciją buvo naudotasi 178 literatūros šaltiniais.

1. Tinklų ir tinklaveikos vertinimas šiuolaikinės vadybos kontekste

Vadybos mokslininkų susidomėjimas tinklo struktūromis prasidėjo prieš tris dešimtmečius ir per šį laikotarpį leido suformuoti tinklaveikos teoriją, kuri aktuali privačioms įmonėms ir viešojo sektoriaus įstaigoms. Tinklaveikos teorija vadybos mokslo kontekste skirstoma į 9 pagrindines dalyvavimo tinkle tyrinėjimo kryptis: socialinių tinklų, tarporganizacinę teoriją, veikėjų tinklo teoriją, inovacijų tinklus, organizacijas, veikiančias kaip tinklą, politikos tinklus, tinklus, veikiančius tam tikrame ekonominės geografijos vienete, pramoninius tinklus, tinklaveikinę viešąją vadybą. Nustatant šio darbo apribojimus buvo nuspręsta remtis tarporganizacine teorija, nagrinėti tinklus, veikiančius ekonominiame geografijos vienete, ir analizuoti tinklaveikinės viešosios vadybos aspektus – šie teoriniai apribojimai buvo pasirinkti tiksliau apibrėžiant ir tyrimo objektą, kuris apribotas iki tarptautinės tinklaveikos tarp aukštojo mokslo institucijų. Pasirinkus tokį tyrimo objektą nenagrinėjama institucijos vidaus tinklaveika ir asmeniniai ryšiai, tinklaveika su verslo sektoriumi, tinklaveikos aspektai formuojant nacionalinę ar tarptautinę politiką.

Tinklaveikos vertinimo poreikis siejamas su dviem pagrindiniais aspektais: siekiu strateginio planavimo procese geriau įvertinti išorės aplinką ir siekiu pasinaudoti tinklaveikos kuriama nauda, kaip būdu didinti konkurencingumą. Strateginio planavimo procese išskirti 4 tinklaveikos įtraukimo lygiai: (1) kai institucija kuria autonomišką strategiją neatsižvelgdama į tinklaveikos poveikį; (2) į tinklaveiką yra atsižvelgiama, bet ji vertinama naudojantis tik institucijos patirtimi ir tinklo suvokimu, taip neatsižvelgiant į partnerių tarpusavio ryšius ir santykių dinamiką; (3) strategija kuriama atsižvelgiant į platesnį supantį tinklą ir tinklaveikos procesus jame; (4) strategija kuriama įtraukiant tikslų tinklaveikai nustatymą ir partnerių portfelio valdymą. Taip pat mokslininkų atliktais empiriniais tyrimais yra įrodyta, kad vykdant tinklaveiką galima pasiekti geresnį konkurencinį pranašumą, geriau panaudoti papildančiuosius išteklius, sumažinti oportunistinę elgseną ir su partneriais dalytis rizika, panaudoti masto ekonomiją, padindinti pelningumą ir išlikimo rinkoje galimybę (ypač smulkiajame versle), sustiprinti organizacijos mokymąsi ir žinių perdavimą ir prieinamą informaciją, padidinti tarptautiškumą, pagerinti MTEP veiklas. Pažymėtina, kad tinklaveika vis labiau naudojama ir viešajam valdymui, taip pat aukštojo mokslo tarptautiškumo didinimas, prisitaikymas prie globalizacijos ir Bolonijos procesų,

Europos finansavimo mechanizmų tokių kaip Erasmus+ ir Horizontas 2020 panaudojimas yra sietinas su tinklaveikos efektyvumo didinimu. Literatūros analizė parodė, kad net jei tinklaveika yra laikoma svarbia, tačiau jos vertinimas kuriant AMI strategijas yra atliekamas retai ir nesistemiškai, nėra įrankių ir metodų efektyviai stebėti tinklaveikos pasiekimus ir institucijos poziciją tinkle, įvertinti, stebėti ir valdyti institucijos partnerių portfelį, formuoti įžvalgas strategijai. Atsižvelgiant į literatūros apžvalgos rezultatus išskiriami du pagrindiniai darbo probleminiai aspektai: (1) nėra sukurtų įrankių holistiškai įvertinti AMI tinklaveiką, atsižvelgiant ne tik pačios institucijos, bet ir jos partnerių portfelio rezultatus ir poziciją tinkle; (2) nėra įrankių generuoti tinkamų ir platesnę tinklo struktūrą (įskaitant partnerių ir konkurentų tarpusavio ryšius bei jų poziciją tinkle) įvertinančių įžvalgų ir jų panaudoti kuriant AMI strategiją.

Siekiant išspręsti įvardytas AMI tinklaveikos problemas buvo atlikta kritinė tinklaveikos vertinimo metodų analizė, kurioje aptarti daugiausiai paplitūsių metodų: veiklų, išteklių veikėjų (angl. Activity-Resource-Actor ARA), 4R (produktų, gamybos įrangos, organizacinės struktūros, organizacijų santykių), socialinių tinklų analizės, atvejo analizės, logitudinės, kokybinės analizės, tinklų vertinimo pagal tinklo schemas panaudojimo AMI tinklaveikai vertinti privalumai ir trūkumai. Daugiausiai tinklaveika tiriama naudojant atvejo analizės metodus ir dažniausiai nagrinėja nedidelės apimties ašinį tinklą, dominuoja pačių institucijų perspektyvos, o ne platesnio tinklo vertinimas. Kaip vienas pritaikomiausių metodų išskirtas tinklų analizės ir strategijos kūrimo pagal tinklo schemas metodas, leidžiantis įvertinti tinklo apimtį ir struktūrą, procesus ir tam tikro tinklo mazgo poziciją tinkle, integruoti turimus kitus statistinius duomenis ir generuoti strategines su tinklaveika susijusias įžvalgas. Tačiau šis metodas dažniausiai naudojamas atliekant kokybinius tyrimus ir nėra pritaikytas AMI specifikai, kai reikia vertinti didelius ir sudėtingus tinklus, kuriuose vienas mazgas gali turėti daugiau nei 300 partnerių. Kritinė analizė taip pat parodė, kad dažniausiai yra vertinami tik vienos AMI pasiekimai, neatsižvelgiama į jos partnerių portfelio sudėtį ir pasiekimus, o tai neleidžia koncentruoti išteklių svarbiausių tinklinių veiklų plėtrai. AM sektoriuje dominuoja tinklaveikos per tarptautiškumo didinimą požiūris, iš esmės jis nėra klaidingas, tačiau yra siauresnis nei disertacijoje nagrinėjamos tarporganizacinė teorija, pramoninių tinklų teorija, tinklų ekonominės geografijos vienete teorijos, kurios sukurtos remiantis verslo sektoriaus praktika ir nagrinėja daugiau aspektų, kurių supratimas ir taikymas AMI leistų padidinti jos konkurencingumą. Tvaresnė šių požiūrių integracija suteiktų naujų plėtros idėjų, vestų į kokybiškai aukštesnį institucijų valdymo lygmenį. Skyriaus gale apibendrinami ir suformuluojami pagrindiniai AMI tinklaveikos vertinimo ir įtraukimo į strategiją aspektai:

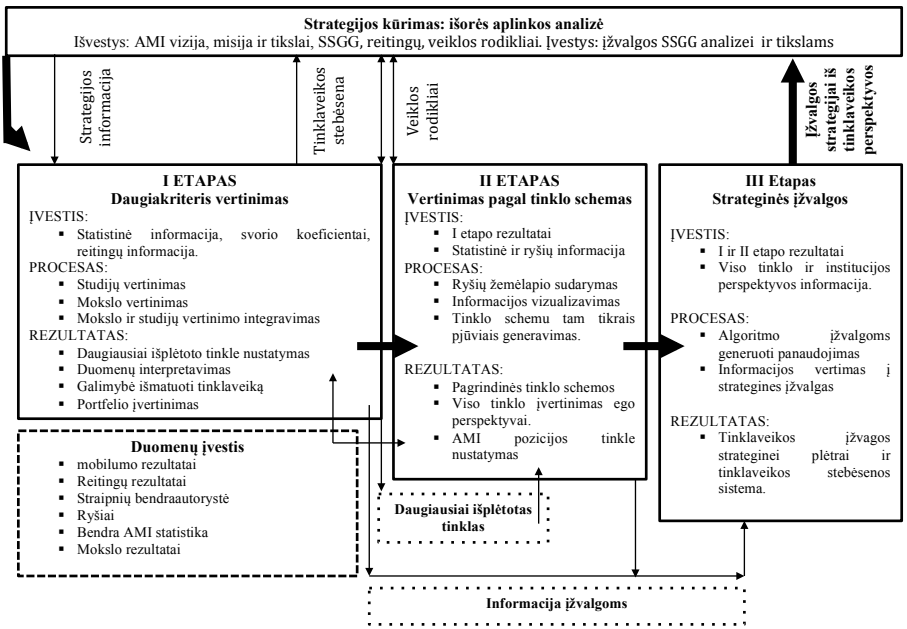
1. Būtinybė stebėti ir galėti išmatuoti tinklaveiką mokslo ir studijų veikloje.
2. Turėti galimybę įvertinti AMI poziciją platesniame tinkle.
3. Turėti galimybę įvertinti AMI ir portfelio pasiekimus naudojant institucijos ir partnerių kiekybinius duomenis.
4. Nustatyti institucijai svarbiausius partnerius ir jų santykių ryšius.
5. Gebėti įvertinti institucijos svarbą partnerių portfeliui.

6. Gebėti tinklo informaciją versti į tinklaveikos ir strategines įžvalgas, kurios būtų naudojamos strategijos kūrimui ir tinklaveikos valdymui.

2. Aukštojo mokslo institucijos tinklaveikos vertinimo modelis

Siūlomas tinklaveikos vertinimo modelis (TVM) yra skirtas konkrečios AMI tinklaveikai įvertinti ir susideda iš 5 dalių. Strategijos kūrimo: išorės aplinkos dalyje suformuojamas poreikis atlikti tinklaveikos vertinimą, siekiant gauti išsamesnius išorės aplinkos vertinimo rezultatus. Šioje dalyje suformuojamas tinklaveikos vertinimo kontekstas įskaitant AMI viziją, misiją ir tikslus, pagrindinius veiklos rodiklius, reitingų informaciją (kur įmanoma). Taip pat šioje dalyje panaudojami tinklaveikos vertinimo rezultatai ir į SSGG analizę įtraukiamos strateginės įžvalgos.

Siūlomi trys vertinimo etapai (1) daugiakriteris vertinimas, (2) vertinimas pagal tinklo schemas ir (3) įžvalgų strategijai generavimas, modelyje taip pat parodytos statistinių ir kitų duomenų įvestys (S1 pav.).



S1 pav. Bendroji tinklaveikos vertinimo modelio schema (sudaryta autoriaus)

Daugiakriteriu vertinimu sprendžiami tinklaveikos matavimo ir stebėsenos, partnerio svarbos portfelyje nustatymo, AMI ir portfelio veiklos vertinimo, kiekybinių tinklaveikos tikslų nustatymo klausimai ir iš dalies sprendžiami svarbiausių partnerių ir institucijos pozicijos platesniame tinkle nustatymo klausimai. Etapo ašimi buvo

pasirinktas SAW metodas, kuris buvo pritaikytas specialiai aukštojo mokslo tinklaveikos vertinimo problemai spręsti. Daugiakriteris AMI vertinimas apibendrintas S1 lentelėje.

Vertinimu pagal tinklo schemas sprendžiami šie TVM keliami uždaviniai: tinklaveikos stebėjimo ir matavimo mokslo ir studijų veikloje (iš dalies), institucijos pozicijos platesniame tinkle vertinimo, AMI ir partnerių tinklaveikos vertinimo (iš dalies), informacijos apie svarbiausius partnerius ir jų ryšius rinkimą.

Tokios strateginės nuostatos kaip stipri regioninė ar kontinentinė orientacija, specifinės mokslo ir studijų kryptys, institucijos tikslai ir pan. gali būti panaudotos vertinimo pagal tinklo schemas apribojimams nustatyti, nes siekis išanalizuoti visą aukštojo mokslo tinklą būtų sunkiai įgyvendinamas, o duomenys dėl ryšių gausos būtų arba labai agreguoti ir nebeatspindėtų šiame darbe pasirinktos AMI perspektyvos arba dėl gausos būtų sunkiai interpretuojami.

S1 lentelė. Daugiakriteris tinklaveikos vertinimas

Esminiai daugiakriterio vertinimo etapai	Etapo aprašymas
Tinklaveikos mokslo veikloje vertinimas	Tinklaveika moksle yra vertinama pagal formulę: $\ddot{\tilde{N}}_r = \tilde{r}_{IC} I_N + \sum_{i=n}^{m} \frac{\tilde{r}_{ICi} I_{N_i}}{n}$; čia $\ddot{\tilde{N}}_r$ tinklaveika moksle, $\tilde{r}_{IC}$ – normalizuotas tinklaveikos moksle rodiklis, I_N– institucijos vidutinio mokslinio poveikio ir pasaulinio vidutinio mokslinio poveikio santykis, $\tilde{r}_{IC} I_N$ – vertinamos AMI tinklaveika, $\tilde{r}_{ICi} I_{N_i}$ i-tojo partnerio tinklaveika moksle. Ši formulė leidžia įvertinti pačios institucijos ir portfelio tinklaveiką, n – portfelio partnerių skaičius.
Tinklaveikos studijų veikloje vertinimas	Tinklaveika studijose yra vertinama pagal formulę: $N_s = \left(\widetilde{w} + \sum_{i=n} \frac{\widetilde{w}_i}{n}\right) + \left(\tilde{k} + \sum_{i=n} \frac{\tilde{k}_i}{n}\right)$; čia $\widetilde{w}$ – normalizuotas studentų mobilumo rodiklis (įtraukiant studijų ir praktikų mobilumą), $\tilde{k}$– normalizuotas išvykstančio personalo mobilumas (įskaitant mokymo ir administracinį personalą), n – portfelio partnerių skaičius.
Mokslo ir studijų tinklaveikos integravimas į vieną rodiklį	Tinklaveikos moksle ir studijose vertinimų integravimas atliekamas priskiriant svorio koeficientus $\alpha; \beta$. Šie koeficientai priskiriami pagal institucijos strateginį pasirinkimą dalyvauti/patekti į tam tikrą reitingą ir to reitingo suteikiamus svorius mokslui ir studijoms ir skaičiuojami pagal formulę: $N = \alpha N_r + \beta N_t$

Pirmame vertinimo etape identifikuotas stipresnis tinklas turėtų būti naudojamas kaip ryšių nustatymo schemoje pagrindas, nes daugiau ryšių gali atskleisti daugiau galimybių, o institucijos dažniausiai bendradarbiauja ir studijų, ir mokslo srityse. Tinklo schemos pradedamos konstruoti identifikuojant ryšius su partneriais ir partnerių

ryšius – naudojamas sniego kamuolio metodas, o informacija pradedama rinkti nuo vertinamos institucijos ryšių analizės. Šiuo metodu yra sudaroma ryšių matrica (žr. formulę), jei yra pakankamai duomenų, nustatomas ir ryšių stiprumas.

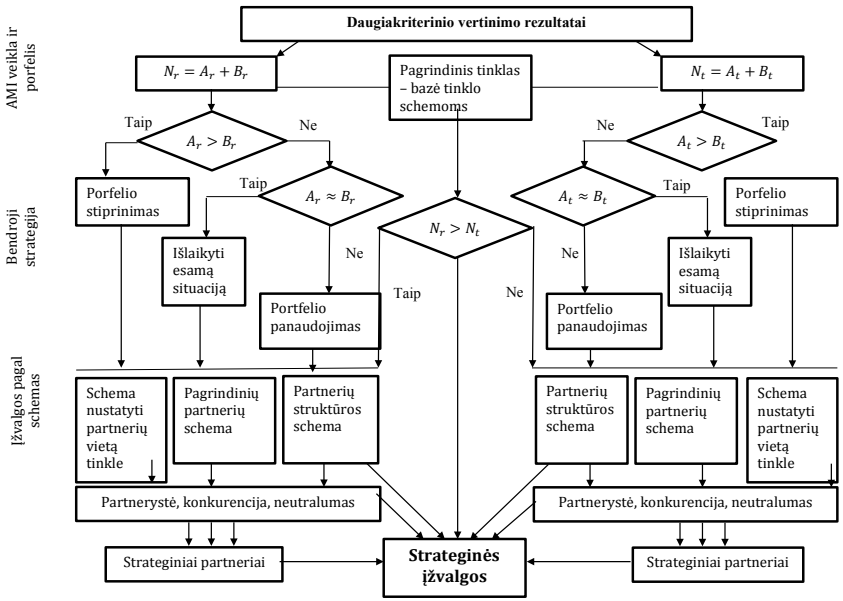
$$G = \begin{bmatrix} n_{1,1} & n_{1,2} & \cdots & n_{1,n} \\ \cdots & \cdots & \cdots & \cdots \\ n_{n,1} & n_{n,2} & \cdots & n_{n,n} \end{bmatrix} \quad \text{(S1)}$$

Ryšių matrica talpinama į socialinių tinklų analizės (SNA) paketus, šiame darbe buvo naudotas *ORA dinaminis metatinklų vertinimo ir analizės įrankis (Carley, Columbus 2012), kuriuos generuojamos tinklo schemos. Darbe buvo išskirti AMI tinklams analizuoti būtini pjūviai (schemos), jų apibendrinimas pateikiamas S2 lentelėje.

S2 lentelė. Tinklo schemų generavimo pjūviai

Tinklo schema	Aprašymas	Reikšmė tinklo įžvalgoms
Bendros tinklo apžvalgos schema	Schema skirta partnerių tarpusavio ryšiams ir bendrosioms AM institucijų savybėms (šaliai, studentų skaičiui ir t.t.) ir AMI centriškumui pagal vieną požymį (pvz. studijų mainų ryšius) pavaizduoti.	Įvertinti bendrąją poziciją tinkle ir vizualizuoti partnerius ir jų ryšius, eliminuojant tik pačios institucijos perspektyvai būdingą tinklo supratimą.
Studijų rezultatus atspindinti schema	Tinklo schema sukuriama sambūriams ir jų įtakai studijų srityje atskleisti. Mazgų ir sąryšių dydis priderinamas prie studijų mobilumo rezultatų.	Taikant longitudinį požiūrių galima stebėti studentų mobilumo tendencijas. Galima kurti būsimas studentų mobilumo ir partnerių pasirinkimo strategijas.
Mokslinių tyrimų rezultatus atspindinti schema	Tinklo schema kuriama sambūriams mokslo srityje atskleisti. Mazgų dydis pritaikomas pagal mokslo rezultatus.	Ryšiai su našiausiomis mokslo institucijomis gali pagerinti vertinamos institucijos mokslo rezultatus. Analizė pagal tinklo schemą gali padėti atskleisti esamą situaciją ir plėtros galimybes.
Pozicijas reitinguose atspindinti schema.	Reitingai rodo institucijos statusą, tačiau ne tarpinstitucinį bendradarbiavimą, todėl šioje schemoje bendradarbiavimo ryšiams nustatyti naudojami kiti duomenys. Mazgų dydis proporcingas institucijos vietai reitinge.	Galima atskleisti tinklines struktūras geriau reitinguojamų institucijų struktūras ir sukurti plėtros ir ryšių stiprinimo strategijas.

Gautų tinklaveikos vertinimo rezultatų įtraukimo į strategiją algoritmas: III TVM etapu pagal sukurtą algoritmą I ir II vertinimo etapo rezultatai paverčiami įžvalgomis strategijai, kurios naudojamos SSGG analizei atlikti, ir taip užbaigiamas TVM pavaizduotas ciklinis vertinimo ir strategijos kūrimo procesas S2 pav.



S2 pav. Vertinimo rezultatų panaudojimo strategijai algoritmas (sudaryta autoriaus)

Taip pat šiame etape institucija gali nusistatyti, o vėliau įvertinti tinklaveiklos tikslus ir kiekybinę jų pasiekimo išraišką. Algoritmas leidžia pagal gautus daugiakriterio vertinimo rezultatus interpretuoti vertinamos institucijos veiklą $(A_r; A_t)$ ir jos partnerių portfelį $(B_r; B_t)$. Institucijos veiklos ir portfelio įverčių palyginimas leidžia nustatyti vieną iš 3 institucijos tinklaveikos plėtros krypčių: (1) portfelio stiprinimas, (2) esamos padėties, pozicijos tinkle išlaikymas, (3) geresnis turimo portfelio panaudojimas.

3. Tinklaveikos vertinimo modelio patikrinimas remiantis Vilniaus Gedimino technikos universiteto atveju

Tinklaveikos vertinimo modelį buvo nuspręsta empiriškai patikrinti atliekant Vilniaus Gedimino technikos universiteto tinklaveikos vertinimą, naudojant algoritmą vertinimo rezultatus interpretuoti ir paversti strateginėmis įžvalgomis. Duomenys daugiakriteriam vertinimui buvo surinkti 2014 metais, naudojant QS reitingo, SIR Global 2013 – reitingo: 2007–2011 rezultatus, institucijos ir jos partnerių interneto

puslapiuose pateikiamą statistinę informaciją apie AMI veiklą, Erasmus statistikos visiems duomenis. Daugiakriterio vertinimo rezultatai pateikiami S3 lentelėje.

Institucijos tinklaveikos vertinimu studijose buvo atskleista svarbių ir iki šiol institucijai mažai žinomų veiksnių: pirma, nepaisant, ar skaičiuojama absoliučiais ar proporciniais, dydžiais institucijos tinklaveikos vertinimo rezultatas rodo labai stiprią institucijos ir silpnesnę portfelio veiklą. Įvertinant tai, jog čia nagrinėjama tik partnerių iš QS reitingo tinklaveika studijose, rezultatai pabrėžia vertinamos institucijos elitiškumą. Nepaisant to, žvelgiant iš institucijos perspektyvos, partnerių portfelis yra per silpnas ir turėtų būti įgyvendinta portfelio stiprinimo strategija.

S3 lentelė. Tinklaveikos vertinimo rezultatai studijų ir mokslo veikloje

Tinklaveikos vertinimo kriterijai	Partnerių skaičius reitinge	Vertinamos institucijos tinklaveika	Partnerių portfelio tinklaveika	Bendras tinklaveikos vertinimas
Tinklaveika studijose	33	2,00	0,331	2,331
Studentų mobilumas (atsižvelgiant į AMI studentų skaičių)	33	1,000	0,248	1,248
Personalo mobilumas (atsižvelgiant į AMI studentų skaičių	33	1,000	0,082	1,082
Tinklaveika mokslo veikloje	66	0,025	0,429	0,454
Integruotas studijų ir mokslo tinklaveikos rezultatas				0,972*

* Skaičiuota pagal duomenis atsižvelgiant į institucijos studentų skaičių.

Tinklaveikos mokslo veikloje rezultatai rodo gana priešingą studijų tinklaveikai rezultatą – čia partnerių portfelio rezultatai yra gerokai geresni nei institucijos. Turėtų būti siekiama ne tik turėti stiprius partnerius, bet ir panaudoti portfelį gerokai intensyviau. Institucijai vertėtų pasirinkti strategiją, kuri leistų gerinti tinklaveikos kokybę arba intensyviau bendradarbiauti su turimais partneriais.

Atlikti tyrimai nustatė, kad VGTU turi daug stipresnę tinklaveiką studijose, todėl analizei pagal tinklo schemas buvo pasirinktas partnerių studijose tinklas, kurį panaudojant būtų galima plėsti ir mokslo tinklaveiką. Dėl partnerių gausos buvo taikomi tam tikri tyrimo pagal tinklo schemas ribojimai – atsižvelgiant į VGTU strategiją veiklą koncentruoti į technikos mokslus ir tapti regiono lyderiu, buvo nuspręsta tinklo schemų metodą taikyti Baltijos jūros regiono techninį aukštąjį išsilavinimą teikiančioms institucijoms, taip sumažinant partnerių ir jų ryšių skaičių iki

įgyvendinamos tyrimo apimties. Tinklo schemą sudaro 144 universitetai ir 1260 ryšių tarp jų, vidutinis studentų skaičius institucijoje 9007.

Analizė pagal tinklo schemas parodė institucijos centriškumą, nustatė stipresnių partnerių studijų ir mokslo tinklaveikoje buvimo vietą. Tinklo schema S3 paveiksle atskleidžia, kad institucijos, kurių mokslo rezultatai geresni telkiasi apatiniame dešiniajame schemos kampe. Šios institucijos pasirinkdamos partnerius yra išrankesnės. Jų tinklaveika moksle didesnė. VGTU turėtų pasirinkti strategiją, kuri leistų judėti iš dabartinės pozicijos tinkle į poziciją, artimesnę minėtam telkiniui.

Rezultatų panaudojimo strategijai etape tinklaveikos vertinimo rezultatai ir įžvalgos naudojant algoritmą transformuojamos įžvalgomis VGTU strategijai. Palyginus veiklos ir portfelio rezultatus (S4 lentelė) nustatytos bendrosios strategijos: tinklaveikai studijose siūloma portfelio stiprinimo strategija, o tinklaveikai moksle portfelio panaudojimo strategija.

S4 lentelė. VGTU veiklos ir portfelio rezultatų palyginimas

Tinklaveikos sritis	Veiklos rodiklis	Portfelis	Palyginimas
Tinklaveika studijose	$A_t = 2{,}00$	$B_t = 0{,}331$	$\boldsymbol{A_t > B_t}$
Tinklaveika moksle	$A_r = 0{,}025$	$B_r = 0{,}429$	$\boldsymbol{A_r < B_r}$

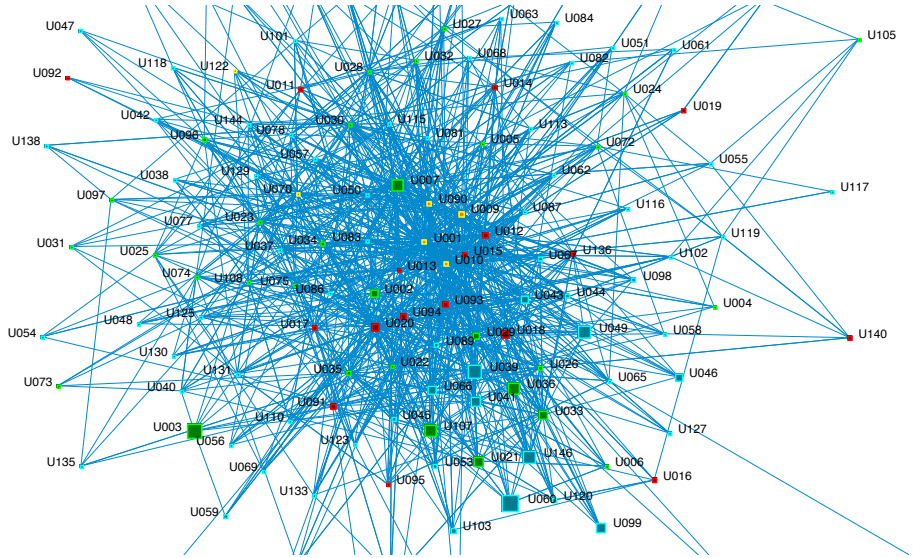
Naujos partnerystės studijose galėtų būti siejamos su institucijomis, kurių tinklaveikos rezultatai geri arba vidutiniai, tokiu būdu sustiprinant portfelį. Detalesnės tinklo schemos identifikavo institucijas, su kuriomis VGTU nebendradarbiauja, ir jų pasiekimo būdus.

Mokslo tinklaveikos plėtros strategijai naudota tinklo schema (žr. S4 pav.), kuri vaizdavo tik institucijas, kurių mokslo rezultatai panašūs ir geresni už VGTU.

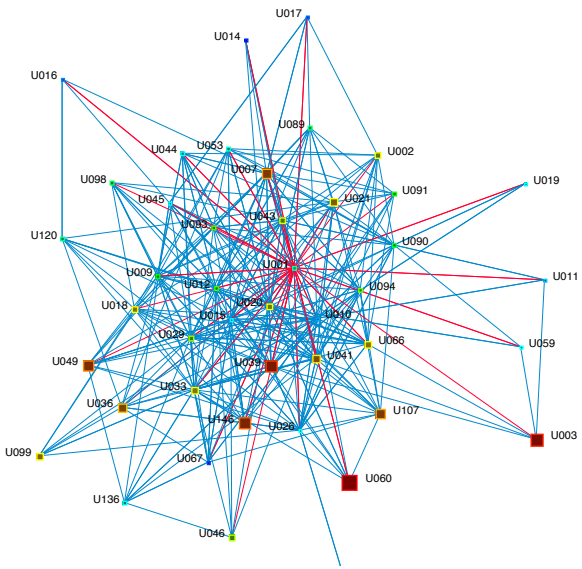
Schema rodo, kad institucijos, kurių mokslo rezultatai geriausi nėra gerai išplėtojusios tarpusavio ryšių, bet yra gerai susijungusios su vertinama institucija. Šis faktas galėtų tapti esminiu strategijos aspektu, kur VGTU prisiima integratoriaus – jungiančios institucijos vaidmenį, siekdamas sukurti naujas strategines samplaikas ir aljansus.

Pagrindinio partnerių tinklo nustatymas ir kūrimas: naudojant QS reitingo duomenis galima sukurti geriau studijų ir mokslo tinklaveiką integruojančią strategiją. Patekimas į QS reitingą pažymi institucijos prestižą, todėl tikėtina, kad tokios institucijos sieks glaudesnio abipusio bendradarbiavimo, todėl ryšių su šiomis institucijomis plėtra galėtų būti ilgalaikis vertinamos

Pagrindinio partnerių tinklo nustatymas ir kūrimas: naudojant QS reitingo duomenis galima sukurti geriau studijų ir mokslo tinklaveiką integruojančią strategiją. Patekimas į QS reitingą pažymi institucijos prestižą, todėl tikėtina, kad tokios institucijos sieks glaudesnio abipusio bendradarbiavimo, todėl ryšių su šiomis institucijomis plėtra galėtų būti ilgalaikis vertinamos institucijos pozicionavimo tinkle tikslas. institucijos pozicionavimo tinkle tikslas.



S3 pav. Tinklo schema: Partnerių centriškumas pagal studentų mobilumą, mazgų dydis ir spalva simbolizuoja mokslo veiklos rezultatus (sudaryta autoriaus)



S4 pav. Tinklo schema: centriškumas pagal studentų mobilumo partnerystes, mazgų dydis proporcingas mokslo rezultatams, vaizduojamos tik institucijos, kurių mokslo rezultatai panašūs ir geresni už VGTU (sudaryta autoriaus)

Technikos universitetai, patenkantys į QS reitingą ir priklausantys Baltijos jūros regionui, turėtų būti laikomi pagrindiniu institucijos tinklu, o bendradarbiavimo su šiuo tinklu plėtra skirstant išteklius prioritetizuojama. Analizė pagal schemas (pvz. S4 pav.) parodė, kad vertinama institucija turi labai geras partnerių pasiekimo galimybes, todėl gali sukurti naujas aukštos kokybės tinklines struktūras.

Bendrosios išvados

1. Atlikus tinklaveikos teorijų ir AMI taikomų praktikų literatūros apžvalgą buvo nustatytas poreikis kuriant strategiją atsižvelgti į tinklaveiką. Efektyvesniam strategijos kūrimui ir siekiant gauti daugiau tinklaveikos naudos nutarta sukurti įrankį išsamesnei išorės aplinkos analizei atlikti įskaitant AMI vietos platesniame tinkle ir partnerių portfelio struktūros nustatymą. Pažymėtina, kad AMI stokoja įrankių tinklaveikai vertinti ir strateginėms tinklaveikos įžvalgoms generuoti. Taip pat nustatytas bendros tinklaveikos pažangos stebėsenos poreikis, nes strategijos kūrimo procese dažniausiai apibrėžiami trumpalaikio mobilumo ir laipsnio suteikiančių studentų rodiklis, pasirenkamos geografinės plėtros kryptys ir bendradarbiavimo formos, kurios atitiktų AMI tinklaveikos poreikius.
2. Nustatyta, kad aukštojo mokslo institucijos tinklaveiką dažniausiai supranta per tarptautiškumo didinimą, todėl tokia tinklaveikos nauda, kaip mokymasis iš partnerių, konkurencinio pranašumo kūrimas, papildančiųjų išteklių siekimas, greitesnis ir geresnis MTTP ir inovacijų kūrimas yra nepakankamai vertinami ir panaudojami. Išskirtos dvi tinklaveikos valdymo AMI problemos: (1) tinklaveikos stebėsenos ir galimybės įvertinti ne tik institucijos bet ir partnerių portfelio veiklą trūkumas; (2) įrankių, leidžiančių įtraukti į strategijos kūrimą platesnio tinklo informaciją. Be to efektyvesnis tinklaveikos valdymas prisidėtų prie AMI konkurencingumo didinimo.
3. Pasiūlytu TVM vertinama tarptautinė, vykstanti tarp AMI institucijų tinklaveika. Modelyje naudojama trijų etapų, dualinė, kiekybinė struktūra, kuria integruojamas daugiakriteris vertinimas ir vertinimas pagal tinklo schemas. Šiuo modeliu yra sprendžiama tinklaveikos vertinimo problema, sudaromos prielaidos suprasti platesnį AMI supantį tinklą ir vietą tinkle. Pasiūlytu algoritmu tinklaveikos vertinimo rezultatai gali būti panaudoti strategijos kūrime, pasinaudojant portfelio stiprinimo, esamos situacijos išlaikymo ir portfelio geresnio panaudojimo tinklaveikos strategijomis.
4. Atliktu empiriniu Vilniaus Gedimino technikos universiteto tinklaveikos tyrimu buvo įrodyta, kad pasiūlyto modelio atskiros dalys suderinamos ir padeda suprasti platesnį supantį tinklą. Vertinimo rezultatai gali būti panaudoti tinklaveikos valdymo tobulinimui. Taip pat empiriniu tyrimu buvo pasiektas modelio aprobavimo uždavinys – pasiūlytas modelis yra tinkamas mokslo ir studijų tinklaveikai vertinti ir supratimui apie AMI tinklaveiką kurti. Gauti tinklaveikos vertinimo rezultatai tokie kaip geresnis tinklaveikos supratimas, tinklaveikos rodikliai ir gautos tinklo schemos, kuriamos bendriems ir

specialiems poreikiams, yra nauji ir reikšmingi vadybos mokslui. Šiuo tyrimu taip pat atskleidžiama AMI partnerių portfelio ir tinklo struktūra, sudaromos prielaidos institucijai sutelkti dėmesį į svarbiausius partnerius.

5. Vertinimu buvo nustatytas partnerių VGTU portfelio stiprumas ir tobulintini veiklos rezultatai mokslo tinklaveikoje ir geresni veiklos rezultatai ir silpnesnis portfelis studijų tinklaveikoje. Mokslo srityje institucijai rekomenduojama plėsti ryšius su esančiais partneriais ir pasinaudoti partneriais, kad būtų sustiprinta institucijos veikla. Studijų srityje institucija turėtų kurti strategijas, kaip nuo didelio ryšių kiekio koncentruotis į svarbiausius partnerius, kurie buvo nustatyti šiuo empiriniu tyrimu.

Annexes[2]

Annex A. University Population Matrix

Annex B. Limited University Relationship Matrix

Annex C. List of the Atributes of Universities

Annex D. Vilnius Gediminas Technical University Research Networking Calculations

Annex E. Vilnius Gediminas Technical University Study Networking Calculations

Annex F. VGTU QS Partners Analysis

Annex G. Agreements of Co-authors to Provide Published Material in the Disertation

Annex H. Copies of Scientific Author's Publications on the Subject of the Dissertation

[2] The annexes are available in the CD attached to the dissertation

Justas NUGARAS

ASSESSMENT OF NETWORKING OF HIGHER EDUCATION INSTITUTION

Doctoral Dissertation

Social Sciences,
Management (03S)

AUKŠTOJO MOKSLO INSTITUCIJOS TINKLAVEIKOS VERTINIMAS

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