The Next Steps in Developing the Triple Helix Model: A Brief Introduction to National Open Innovation System (NOIS) Paradigm

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Abstract
On the basis of beliefs on open innovation, online social networks and Web 2.0, we propose a new type of approach based on people-to-people interaction to support national innovation activities. With the aim of generating new ideas, our National Open Innovation System (NOIS) combines two rival innovation sources: (1) technology and social foresight research, and (2) customer needs and experiences (i.e. customer orientation strategy), while following the principles of latest incarnation of Triple Helix model. The resulting NOIS is an effective and comprehensive open innovation structure where university students and senior citizens are engaged as a significant resource for the business community, in order to fulfil the national innovation strategy as defined by the government.

Keywords: Open innovation, National Innovation System, Triple Helix, Foresight, Customer orientation, Innovation management

1. INTRODUCTION

Innovations are important building blocks of today's economies. Organisational and individual knowledge and creativity are used for creating novel processes, products and services [1, 2, 3]. Innovations have a major impact on national economies, and are a big factor in creating competitive advantages for nations [4]. Thus the most competitive countries in the world typically have extensive and sophisticated national innovation systems (later NISs), whose theoretical foundations were built in the late 1980s [5, 6]. Recently, there has been increasing attention on the concept of "open innovation", both in academia and in practice. In his book Open Innovation: The New Imperative for Creating and Profiting from Technology, Henry Chesbrough [7], who coined the term "open innovation" describes the shift of organisations so-called closed innovation processes to a more open way of innovating. Open innovation can thus be described as combining internal and external ideas and internal and external paths to market, in order to advance the development of new technologies [7].

Since the 1990s, the commercialisation and rapid growth of the Internet and World Wide Web (later the web) has created the most promising platform for connecting people and communication. As a result of this technological transformation, we predict that innovation environments in general will change radically in coming years. One of the main change drivers of the moment seems to be online social networks (later OSNs) based on Web 2.0, which are generally communities and hosted services facilitating collaboration and sharing between users [8]. In principle, OSNs facilitate interaction among members by providing a dynamic/multimodal platform which enables versatile services such as discussions, sharing of multimedia content, organisation of social events and information-sharing, among others. The OSNs people use in their free time have gained unprecedented popularity in recent years and we have witnessed the birth of significant commercial success stories such as Facebook in a short period of time. In addition to leisure, we believe that OSNs can be utilised as a critical part of NISs. Therefore, in this article we make a brief proposal regarding a new National Open Innovation System (NOIS) paradigm, while following the principles of Triple Helix and supporting Finland's national system of innovation and education.

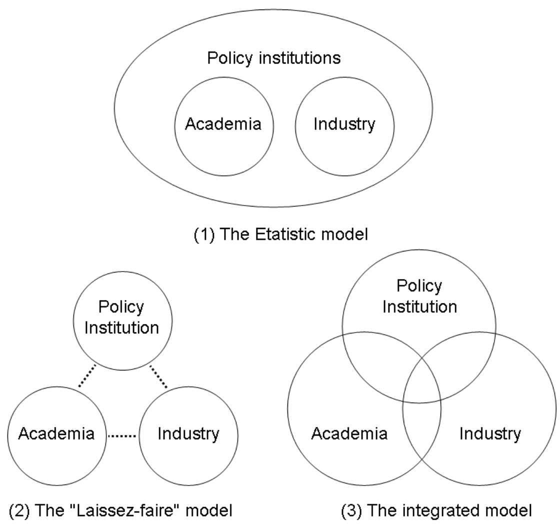
The paper is structured as follows: in the next section, we briefly present the existing body of knowledge on the Triple Helix Model and open innovation. We then present and discuss our NOIS concept. Finally, we draw conclusions.

2. TRIPLE HELIX

The Triple Helix model is one of the best-known frameworks for describing the collaboration between university-industry-government relations and explaining structural development in innovation driven knowledge-based economy (see e.g. [9, 10]). In the Triple Helix model, each actor has its own task:

universities produce research, industries manufacture, and the government secures a level of stability for maintaining exchanges and interaction. The Triple Helix regime operates on these complex dynamics of innovation as a recursive overlay of interactions and negotiations among the three institutional spheres. The partners engage in collaboration and competition as they calibrate their strategic direction and niche positions. The Triple Helix denotes that this social world is more complex than the natural one. Over time, the following three alternative Triple Helix models have evolved (Figure 1): (1) the Etatistic model, (2) the "laissez-faire" model and (3) the integrated model [11].

Figure 1: Three alternative Triple Helix models



According to Etzkowitz, information production has moved from universities to university-government-industry interaction, or towards Mode 2 [9]. As a result only the integrated model is argued to really support innovation in knowledge societies. Is is possible that the "Etatistic" and "laissez-faire" Triple Helix models are cooperation models, which have, in fact, often actively discouraged novel innovations. Would-be innovators can become frustrated by bad management and conservative management processes that were built to ensure discipline, alignment and conformity rather than to provide support for creativity, innovation and experimentation.

Recently Leydesdorff [12, 13] summarized the origins of the Triple Helix, explained the differences between various versions and suggested how new dimensions can be added algorithmically including such as local–global or more generic N-tuple of helices. Relating to new dimensions for example adding consumers and/or end-users a.k.a. consumer or user driven innovation can constitute *Quartet Helix*: (1) The Academia, (2) the Industries, (3) the Government and (4) the Consumers, so called AIGC stakeholders [14]. In practice Quartet Helix approach is closely related to the network economy [15] and open innovation approaches [7], which associate business success with the ability to co-operate with external resources. Thus, besides focusing on the innovation potential of individual persons or organizations it is also important to evaluate the innovation power of larger networks such as National Innovation Systems (later NISs) (e.g. [5, 6] or regional level implementations of the NIS [16, 17, 18].

The newest step in the Triple Helix discussion has been the concept of *Triple Helix Systems of innovation* (Ranga and Etzkowitz, 2013 [19, 20], which was recently introduced as an analytical framework that synthesises the key features of Triple Helix interactions into an 'innovation system' format, defined according to the systems theory as a set of components, relationships and functions. In this new format, among the components of the Triple Helix Systems, a novel distinction has been made between: (1) R&D and non-R&D innovators; (2) "single-sphere" and "multi-sphere" (hybrid) institutions; and (3) individual and institutional innovators. The new strategic relationships between components are synthesised into five main types of operations:

(1) technology transfer,
(2) collaboration and conflict moderation,
(3) collaborative leadership,
(4) substitution, and
(5) networking.

These new elements of relationships help innovation managers to understand more deeply the dynamics of the Triple Helix, especially because the most postmodern societies have moved from industrial logic to knowledge society logic. Today knowledge networks are playing much bigger role in innovation processes than before. Conventional industries are in many innovation processes substituted by value networks and knowledge brokers [21, 22].

3. MEETING THE FRONTIERS OF OPEN INNOVATION

Open Innovation term derived from experiences from open source software development (e.g. [23], and it was first coined by Chesbrough [7]) who suggested following definition: combining internal and external ideas as well as internal and external paths to market to advance the development of new technologies. Basically open innovation strategy suggests that instead of doing everything by yourself, you should look also for help from external resources. Most importantly, an effective open innovation strategy includes inbound and outbound processes. One should not only search for new technologies and ideas outside (i.e. inbound) of the firm but also export (i.e. outbound) those ideas and technologies which do not fit the firm's current strategy. There are many ways to construct research questions and research programmes based on the open innovation paradigm [24].

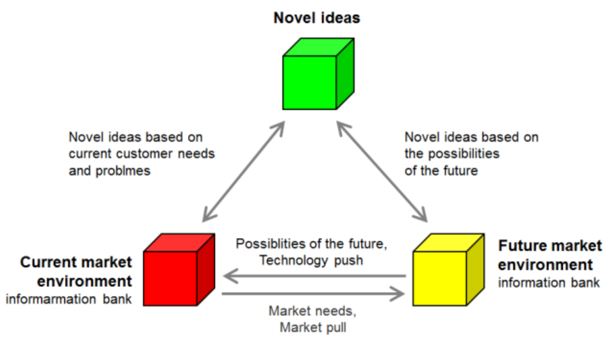
Besides open innovation processes between companies, also customers and users as an important idea source have been emphasised by scholars (see e.g. [25]). The NOIS paradigm has already been linked to open innovation paradigm. Human motivations have be seen as a key issue in the NOIS-based innovation management process [26, 27]. The suggestions of open innovators are in-line with the network economy believers who associate business success with the ability to co-operate with external resources and the circulation of know-how [15].

As usual in rather recent and undeveloped academic literature, the term open innovation appears to be somewhat blurry. In a study by Elmquist et al. [28] an effort was made to clarify the definition and the future research needs relating open innovation. As a result inter alia they identified a tendency towards a broader definition then original application of the term. However, as a main outcome of their study, they suggested two-dimensional framework grounded on the locus of the innovation process and the extent of collaboration, as a model to understand open innovation process. In this study, we are mainly focusing in the high number of collaborators and outside process quadrant, which in other words can be defined as mass collaboration also sometimes known as mass innovation (e.g. [29, 30]). Mass innovations and a novel thinking outside the box can emerge when combining a wide range and large group of people and their different but complementary insights and creative interaction via loose voluntary networks with the help of communication technologies (adapted from [31, 32]). As a result of open innovation theoretical construct, the need to collaborate with external resources has been verified. Thus, there is also a need to identify suitable and motivated partners for collaboration.

3. DEFINING THE NATIONAL OPEN INNOVATION SYSTEM (NOIS)

Introducing the innovation triangle. Figure 2 presented the general Innovation Triangle framework, which consolidates our National Open Innovation System (NOIS) for Finnish context.

Figure 2: The Innovation Triangle



Our framework includes two complementary innovation sources: *first*, future market environment information (i.e. the box on the right in the figure) and *second*, current market environment information (i.e. the box on the left). In order to create a solid interaction interface between the three banks, a common content classification scheme based on Finnish regional innovation policy was defined. Since our NOIS is an online social network (OSN) we also present the profile of the online community members. Together these individual functional components and the interaction interface between them form the overall functionality, which we named the National Open Innovation System (NOIS). Below we present in more detail our framework, the interfaces between the main functional components and the resources which will produce the content in our NOIS.

Innovation source 1: future market environment information bank.

The right-hand box in Figure 2 represents the future market data bank. The theoretical basis of this bank derives from futures research and foresight theories. The European Union's foresight best practice project FOR-LEARN [33] gives the following definition for foresight: "Foresight is a systematic, participatory, future-intelligence-gathering and medium-to-long-term vision-building process aimed at present-day decisions and mobilizing joint actions. Research and innovation policies are based on (implicit or explicit) visions of the future of science, technology and society." This is interesting, because it combines foresight research with innovation policies such as NISs.

In foresight people typically follow: (1) trends and anti-trends, (2) expected future scenarios (either explorative forecasting or normative back-casting scenarios) or (3) emerging weak signals and seeds of change. Often analytical foresight analysis starts by analysing existing dependencies. This part of the study can be called (1) hindsight (focused on historical trends) pr (2) insight analyses (focused on current problematic situation). Typical parts of foresight exercises are: (1) designing an exercise, (2) running the exercise and (3) evaluative follow-up of the exercise. Strategically there are two basic alternatives for foresight research in relation to an innovation: (1) before the actual innovation is identified and (2) after the innovation is identified. Typically the innovation process is seen as linear, with three phases: (1) R&D phase, (2) production phase and (3) marketing phase. Innovations are typically expected to happen in the linear form of the conventional R&D phase [33, 34, 35]

According to Kaivo-oja [36], we can connect foresight systems and innovation systems in the following seven alternative ways, which are non-linear rather than the conventional linear [34], see details in Appendix 1). We present seven theoretical alternative interaction models, which all are possible in modern firms and corporations. We consider that foresight systems can play and actually often do play an important part in relation to innovation systems.

Foresight activities are often performed by knowledge-intensive business companies and these kinds of companies are also co-producers of innovations. Theoretically these kinds of complex interactions can explain the new empirical findings of Leiponen and Drejer [37]. We can expect that the five technological or innovative regimes – (1) the supplier-dominated regime, (2) the production-intensive regime, (3) the scale or science-based regime, (4) the market-driven regime and (5) the passive/weak innovation regime – are based on different kinds foresight system/innovation system interactions. Table 1 connects the technological and innovative regimes of Leiponen and Drejer [37] to the foresight/innovation interaction models presented above [17].

Table 1 Technological/innovative regimes and likely interaction models between foresight systems and innovation processes (source: Kaivo-oja, [36])

Technological/ innovative regime	*Most likely interaction models*
Supplier-dominated regime	IFO (innovation concerning supply chains or sub-contractor relations lead to foresight process), IOF (innovation concerning supply chains or sub-contractor relations lead changes in production), OFI (changes in supply chains or sub-contractor relations lead to foresight process), OIF (changes in supply chains or sub-contractor relations lead to innovation process), ISP (general model)
Production-intensive regime	OFI or OIF (changes in production and marketing lead to foresight analysis or novel innovation process), ISP (general model)
Scale or science-based regime	FIO (science-based foresight leads to innovation), FOI (science-based foresight leads to production changes),

	IFO (science produces innovation and needs for foresight analysis), IOF (science produces innovation and fast changes in production), ISP (general model)
Market-driven regime	OFI (production or market change leads to foresight and innovation), OIF (production or market change leads to innovation and innovation-related foresight), FIO (foresight concerning production and market development leads to innovation and related changes in production and marketing), FOI (foresight concerning production and market development leads to changes in production and this change creates innovation), ISP (general model)
Passive/weak innovation regime	No remarkable interaction, ISP (general model)

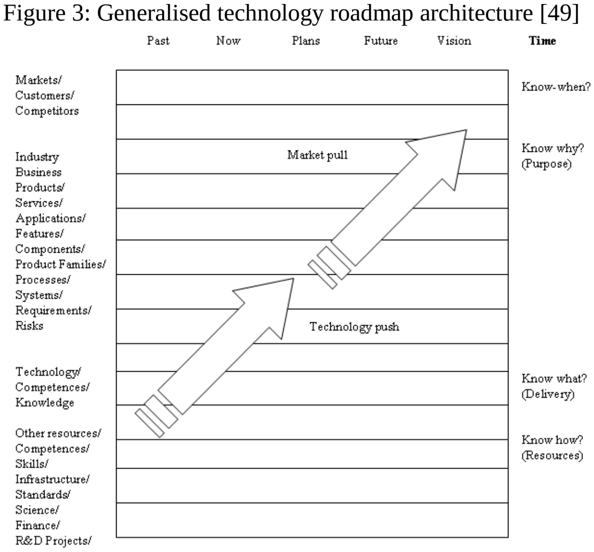
Innovation source 2: current market environment information bank. The left-hand box in Figure 2 represents the current market data bank. The theoretical basis of this bank derives from customer and market orientation strategy literature. A customer orientation strategy, which is commonly linked to market orientation strategy [38, 14], can be defined as a strong desire to identify customer needs and the ability to answer recognised needs. Others authors have presented similar definitions (e.g. [39, 40, 41]. The theory is grounded in the basic belief that companies that satisfy their customers' individual wants and needs better will eventually have higher sales [42].

In order to fully understand customer behaviour, companies should systematically collect and analyse a significant amount of data on their customers' behaviour and their competitors' actions. With such in-depth analyses, companies can apply e.g. customer segmentation strategies or so-called cradle-to-grave strategies, which emphasise the lifetime value of a customer [43, 44]. From an organisation's point of view, extensive idea-generation based on customer data might be problematic, as this process is typically very resource-intensive. Even though the Internet has significantly helped companies collect customer feedback (on e.g. problems or needs), more in-depth interviews or large-scale focus groups with customers are still often avoided due to high expenses. As the data collection process in general has become easier, companies now produce more customer behaviour data, which can be used as a foundation for idea-generation. However, a large proportion of these huge amounts of available data is often unused due to understaffing problems. Interestingly, this resource shortage might be overcome with the help of an extensive human resource network such as NOIS. A good practice is to build consumer scenarios to identify key issues of consumer behaviour and consumer needs (cf. Alexander and Maiden, [45]). It is also possible to use Customer Experience Management (CEM) and Customer Relationship Management (CRM) tools (cf. e.g. Meyer and Schwager, [46]). In order to understand the current market environment the NOIS framework classifies the current market environment according to the following categories: 1) customer needs, 2) customer problems, 3) occurrence and 4) competitor action.

Technology push and market pull creating dynamic interaction between market data banks. It is important to recognise the technological push and pull factors in innovation processes. According to the "technology-push" theory, research leads to inventions, which then lead to the development, production, marketing, and introduction of innovations to the market. Radical new inventions lead to the emergence of completely new industries and create renewed momentum for economic development. The supply of new technologies is, therefore, more important than adaptation to the existing patterns of demand (see e.g. Dosi, [47]). As for the "demand-pull" theory, Schmookler [48] found that the time series for investment and patents showed a high degree of synchronicity, with the investment series tending to lead the patent series more often than the reverse. He found that it was investment that usually led the upswing from economic troughs during fluctuations. On the basis of this evidence, Schmookler argued that fluctuations in investment could be better explained by external events than by the course of invention and that, on the contrary, upswings in inventive activity responded to upswings in demand.

Concerning both innovation sources 1 (i.e. future market environment information) and 2 (current market environment information), a good policy support tool for integrating demand- and supply-side analyses would be *a generalised technology roadmap*. It is obvious that a NOIS that includes a significant amount of data needs some kind of integration tool for innovation management. As a result, a technology roadmap which nicely summarises the technology push and market pull approaches would be a very good tool for these kinds of practical integration needs (see Figure 3).

Figure 3: Generalised technology roadmap architecture [49]



Community members' profile: young people, the aged and customers as content providers. Content, including new ideas, market forecast information and customer problems/needs will be produced by two main opposite target groups: young people and the aged. This polarised arrangement is expected to increase dynamics, resulting in unforeseeable positive outcomes.

Young people. The Finnish higher education system (ISCED classification group 5) is based on a dual model [50], consisting of two complementary sectors: universities and universities of applied sciences. Universities focus on scientific research, whereas universities of applied sciences are work-oriented. In principle, universities of applied sciences offer a more practical alternative, with theory and practice in balance and focused on the requirements set by the labour market. More than 100,000 students taking Bachelor's degrees in universities of applied sciences will be the main human resource for providing and sharing content in the defined Innovation Triangle concept. The supervision of student work will be integrated into everyday teaching tasks, while the overall resource allocation will be conducted with the help of the institutions' own curricula.

The aged. In Western countries especially, forecasts of the size of the available workforce have shown an unhealthy trend [51]. Esa Swanljung, chief executive of the Finnish Pension Alliance TELA has stated that in Finland there is already a labour shortage in many industries [52]. Moreover, those who are already retired provide the most significant available labour reserve. On the other hand, there is a growing need to activate the aged and retired [51]. Finland is not the only European country that has these concerns regarding problematic demographic changes. Finland, with its just over five million inhabitants, has more than a hundred thousand civic organisations and non-profit associations on which the Finnish welfare state has historically relied. This voluntary workforce will be engaged as content providers alongside the more organised resource of students from universities of applied sciences. In principle, the active members of the aging group will have access to sharing and communicating their experiences with young people. Marketing and resourcing this possibility will be conducted through the network of voluntary organisations.

The customers. Initially, businesses, local authorities and public administration are defined as the customers of our concept (i.e. players who do not actively participate in the content production, but use the content produced by others). Customers also have the possibility of participating in content production. *Firstly*, businesses can set up competitions in any of the three main content areas (i.e. forecasting, current market information needs, idea requests). By providing incentives for the top performers in a competition, companies can increase the chances of the community solving their particular task instead some other company's. *Secondly*, since our concept is based on the open innovation ideology, anybody, including the employees of customer organisations, can participate in the content production.

Allocating resources with the help of regional innovation policy. In the NOIS we have 100,000 students and senior citizens operating without a genuine centralised management system, which makes effective resource allocation very demanding. In a "fully" open innovation setup, there is a significant risk that a great majority of resources will devote their time to the exact same task (e.g. trying to generate ideas around the same narrow topic). From the point of view of coverage and effectiveness, this is a clear drawback and a waste of valuable resources. In our concept this problem is overcome by integrating the Finnish regional innovation policy and the specific curricula of universities of applied sciences. This interaction is logical and rational, as besides the requirement of training professionals in response to labour market needs, the network of universities of applied sciences in Finland has an obligation to promote regional development.

In Finland, government bodies including the Ministry of Trade and Industry, the Ministry of Education and the Ministry of the Interior have implemented a regional innovation policy through a specific Centre of Expertise Programme (later CEP). In principle, the CEP aims to improve the innovativeness and knowledge base of regions in accordance with national targets. Finland has widely adopted a so-called cluster approach to innovation science and education policies (cf. [53, 54, 55, 56, 57]). The cluster approach has now also been adopted in European and OECD innovation policies [46]. An obvious conclusion is that open innovation banking systems can benefit from these kinds of cluster analyses. In Finland this approach has recently been adopted in the Finsight foresight and science policy project (cf. [58]), which was used in national technology and science policy strategy processes. Based on the CEP, a total of 13 national expertise clusters (i.e. content areas) have been defined, including ubiquitous computing, well-being and digital contents. In our concept this classification will be used as a main resource allocator among students. In practice, based on their individual competence and regional profiles, the universities of applied sciences participating in our social network will select the CEP clusters they find interesting. As the players' competence and regional profiles vary, it can be expected that the distribution of resources will be naturally balanced.

DISCUSSION

In the proposed National Open Innovation System (NOIS), we have created a model based on online social networks that integrates the following three players: (1) higher education students and faculty members and senior citizens as content providers, (2) the Finnish regional innovation policy as stated by the government, and 3) businesses, local authorities and public administration bodies as customers. Thus we argue that we have actually defined a novel and cost-effective fourth-generation Triple Helix Model, which should deepen interaction and dynamics between higher education, government and corporations. It can be assumed that the previously defined Triple Helix models and our forth model, based on social networking, are hardly the end of this institutional evolution. The information revolution brought by computers and telecommunication technology has had and will surely continue to have a major impact. Moreover, new technologies enable new cooperation forms in data bank and innovation policies. Yet it is obvious that the Triple Helix framework in general requires a supportive and catalytic approach such as a NOIS to bring dynamic interaction to a whole new level. We argue that after implementation, the NOIS should produce significant competitive advantages for Finland and other European countries whose higher education is based on state-owned free education. In principle, the NOIS embodies a new and significant development resource for industry that has previously clearly been underutilised. Our argument is in line with other suggestions, which see the Triple Helix models as alternative future frameworks for European innovation policy [59].

CONCLUSIONS

In this study we have proposed a new approach based on people-to-people interaction, which we named the National Open Innovation System. We have integrated the Triple Helix model with social networking ideologies to form a new model, which we argue will change the current practices of interaction between higher education, industry, and government. By following our concept, young university students with their fresh ideas can effectively combine forces with senior citizens and their significant practical knowledge in an open innovation-based social networking community.

From a theoretical point of view, the presented NOIS is an open-source model for emerging online social networks (OSNs). OSNs have gained unprecedented popularity in recent years. We have pointed out that OSNs can also play a technologically and socially important role in the commercialisation process of novel ideas and inventions. OSNs can support the commercialisation of new ideas, inventions and innovations on a large scale. The new NOIS model has many interesting characteristics, both socially and technologically. We predict that with the support of OSNs we can expect improved success rates and wider involvement of social networks in commercialising novel ideas, inventions and innovations. The presented NOIS is one concrete and conceptual framework for implementing new kind of open innovation policy in Finland and in other countries. To gain more in-depth insight to the proposed NOIS concept [26, 30], following conceptual and empirical studies are suggested for further reading: content recommendation support to individual creativity in context of NOIS [60], NOIS as a digital business ecosystem (DBE) [61], NOIS rewarding model [27], implementing NOIS as a part of Finnish higher education system [29, 62], evaluating student's motivation to participate in NOIS [63] and evaluating NOIS as a business model innovation from Stage-Gate Process point of view by [64].

Due to the nature of our study (aimed to define a concept), the validity of our arguments calls for future research. In order to prove our points regarding utility, we should empirically verify our value promises.

REFERENCES

[1] Huiban and Boushina, Z., 1998. “Innovation and the quality of labour factor”. Small Business Economics, 10, 389-400.

[2] Kenney, M., 2001. “The temporal dynamics of knowledge creation in the information society”, in: Nonaka, I. and Nishiquchi, T. (Eds.), Knowledge Emergence, Social, Technical, and Evolutionary Dimensions of Knowledge Creation, Oxford University Press, New York, pp. 93-110.

[3] Taatila, V., Suomala, J., Siltala, R., Keskinen, S., 2006. “Framework to study the social innovation networks”. European Journal of Innovation Management, 9(3), pp. 312-326.

[4] Tuomi, I., 2002. Networks of Innovation. Change and Meaning in the Age of Internet, Oxford University Press, New York.

[5] Freeman, C. 1987. Technology Policy and Economic Performance: Lessons from Japan. London, Pinter.

[6] Lundvall, B.-Å., 2007. “National Innovation Systems-Analytical Concept and Development Tool”, Industry and Innovation. Sydney: Vol. 14, Iss. 1, p. 95.

[7] Chesbrough, H., 2003. Open Innovation: The New Imperative for Creating and Profiting from Technology. Harvard Business School Press. Harvard.

[8] Cachia, R., Compañó, R., Da Costa, O., 2007. “Grasping the potential of online social networks for foresight”, Technological Forecasting and Social Change 74(8), pp. 1179-1203.

[9] Etzkowitz, H., L. Leydesdorff., 2000. “The dynamics of innovation: From national systems and ‘Mode 2’ to a Triple Helix of university-industry-government relations”. Research Policy 29, p.p 109-123.

[10] Etzkowitz, H., Leydesdorff, L., 1999. “The future location of research and technology transfer”. Journal of Technology Transfer 24 (2–3), pp. 111–123.

[11] Gergils, H. 2005. Dynamic Innovation Systems in the Nordic Countries? A Summary Analysis and Assessment. VINNOVA. Sweden.

[12] Leydesdorff, L. 2012a. The triple helix, quadruple helix,…, and an n-tuple of helices: explanatory models for analyzing the knowledge-based economy?. Journal of the Knowledge Economy, 3(1), pp. 25-35.

[13] Leydesdorff, L. 2012b. The Triple Helix of University-Industry-Government Relations (February 2012). Encyclopedia of Creativity, Innovation, and Entrepreneurship, Springer, New York.

[14] Kaivo-oja, J. 2011. Futures of Innovation Systems and Systemic Innovation Systems: Towards Better Innovation Quality with New Innovation Management Tools. FFRC eBOOK 8/2011. Finland Futures Research Centre. University of Turku. Turku. Available in the Futurium Database of the Digital Agenda for European Union: http://ec.europa.eu/digital-agenda/futurium/en/content/futures-innovation-systems-and-systematic-innovation-systems

[15] Pöyhönen, A., Smedlund, A. 2004. “Assessing intellectual capital creation in regional clusters”. Journal of Intellectual Capital, 5(3), pp.351 – 365.

[16] Cooke, P. 2002. “National innovation systems: General findings and some new evidence from biotechnology clusters”. Journal of Technology Transfer, 27, pp. 133-143.

[17] Kuhlman, S. 2001. “Future governance of innovation policy in Europe –three scenarios”. Research Policy, 30(6), pp. 953-976.

[18] Kuhlman, S., Edler, J. 2003. “Scenarios of technology and innovation policies in Europe: Investigating future governance”. Technological Forecasting and Social Change, 70(7), pp. 619–637.

[19] Ranga, M., Etzkowitz, H. 2012. “Great expectations: An innovation solution to the contemporary economic crisis”, European Planning Studies, 20(9), pp. 1429 -1438.

[20] Ranga, M., Etzkowitz, H. 2013. “Triple Helix systems: analytical framework for innovation policy and practice in the Knowledge Society”. Industry and Higher Education, 27(4), pp. 237-262.

[21] Etzkowitz, H., Ranga, M., Dzisah, J. 2012. “Wither the university? The novum trivium and the transition from industrial to knowledge society”, Social Science Information, 51 (2), pp. 143-164.

[22] Kidwell, D.K., 2013. Principal investigators as knowledge brokers: A multiple case study of the creative actions of PIs in entrepreneurial science. Technological Forecasting and Social Change, 80(2), pp. 212–220.

[23] West, J., Gallagher, S. 2006. Challenges of Open Innovation: The Paradox of Firm Investment in Open-source Software. Faculty Publications. Paper 3:2006. Organization and Management, Department of at SJSU ScholarWorks. San Jose State University, San Jose, US.

[24] Torkkeli, M., Kock, C.J., Salmi, P.A.S., 2009. “The “Open Innovation” paradigm: A contingency perspective. Journal of Industrial Engineering and Management”, 2(1), pp. 176-207.

[25] Piller, F.T., Walcher, D. 2006. Toolkits for idea competi-tions: A novel method to integrate users in new product development. R&D Management 36(3), pp. 307-318.

[26] Santonen T., Kaivo-oja J, Suomala J., 2007. Introduction to National Open Innovation System (NOIS) Paradigm, Finland Futures Research Centre, Turku School of Economics, Finland, Turku.

[27] Santonen, T., Kaivo-oja, J., Antikainen, M., 2011. “National Open Innovation System (NOIS): Defining a

solid reward model for NOIS". International Journal for Innovation and Regional Development, 3(1), pp. 12-25.
[28] Elmquist, M., Fredberg, T., Ollila, S. 2009. Exploring the field of open innovation: a review of research publications and expert opinions. European Journal of Innovation Management, 12(3), pp. 326-345.
[29] Kaivo-oja, J., Santonen, T. 2010. Open Innovation in a Systemic Innovation Context: Analyzing Online Mass Innovation Process from Systemic Perspectives. In Torkkeli, M. (Ed.) Frontiers of Open Innovation. Lappeenranta University of Technology. Department of Industrial Management. Research Report 225. Lappeenranta, pp. 69-90. Web: http://stratnet.jalusta.com/files/download/LUTResearchReport225-TorkkeliEdit.-FrontiersofOpenInnovation.pdf
[30] Santonen, T. 2012. Massidea.org:.a greener way to innovate. In Boye, J.I., Arcand, Y. (Eds.) Green Technologies in Food Production and Processing. Springer Science & Business Media, Heidelberg, pp. 541-565.
[31] Marquardt, R. 2008. The progressive potential of local social policy activism. Canadian Review of Social Policy (60/61), pp. 21-38.
[32] Tapscott, D., Williams, A.D. 2006. Wikinomics: How Mass Collaboration Changes Everything, Portfolio Trade, New York.
[33] FOR-LEARN 2007. "The FOR-LEARN Online Foresight Guide". Available online at http://forlearn.jrc.es/guide/0_home/index.htm. IPTS. Seville.
[34] Takeuchi, H., Nonaka, I., 1986. "The new product development game". Harvard Business Review. Jan-Feb 1986, pp.137-146.
[35] Salmenkaita, J.-P., Salo, A., 2002. "Rationales for government intervention in the commercialisation of new technologies". Technology Analysis & Strategic Management 14(2), pp. 183-200.
[36] Kaivo-oja, J. 2006. Towards Integration of Innovation Systems and Foresight Research in Firms and Corporations. The Classical Takeuchi-Nonaka Model Reconsidered and Reformulated. Finland Futures Research Centre. Turku School of Economics. FFRC Publications 2: 2006. Turku.
[37] Leiponen, A., Drejer, I., 2005, "Technological regimes or strategy: Intraindustry heterogeneity in the organisation of innovation activities". Paper at the DRUID Tenth Anniversary Summer Conference 2005 on Dynamics of Industry and Innovation: Organisations, Networks and Systems. Copenhagen, Denmark.
[38] Kohli, A.K., Jaworski, B.J. 1990. "Market Orientation: The Construct, Research Propositions, and Managerial Implications", Journal of Marketing, Vol. 54, No. 2, pp. 1-18
[39] Narver, J., Slater S., 1990. "The Effect of a Market Orientation on Business Profitability", Journal of Marketing, 54 (4), pp. 20-35.
[40] Deshpande, R., Farley, J.U., Webster, F.E.Jr., 1993. "Corporate Culture, Customer Orientation, and Innovativeness in Japanese Firms: A Quadrad Analysis", Journal of Marketing, Vol. 57, No. 1, pp. 23-37.
[41] Gatignon, H., Xuereb, J., 1997. "Strategic orientation of the firm and new product performance", Journal of Marketing Research, Vol. 34 No.February, pp.77-90.
[42] Pine, III, J., 1993. Mass Customisation: The New Frontier in Business Competition, Harvard Business School Press
[43] Pitta, D., Franzak, F., Fowler, D., 2006. "A strategic approach to building online customer loyalty: integrating customer profitability tiers", Journal of Consumer Marketing 23, no. 7 (November 10), pp. 421-429.
[44] Zeithaml, V.A, Rust, R.T, Lemon, K.N, 2001. "The customer pyramid: Creating and serving profitable customers". California Management Review, 43(4), pp. 118-142.
[45] Alexander, I.F., Maiden, N., 2004. Scenarios, Stories, Use Cases. Through the Systems Development Life-Cycle. John Wiley & Sons. Chichester.
[46] Meyer, C., Schwager, A., 2007. "Understanding customer experience". Harvard Business Review. February 2007, pp. 117-126.
[47] Dosi, G., 1982, "Technological paradigms and technological trajectories". Research Policy, 11(3), pp. 147-162.
[48] Schmookler, J. 1962. "Economic sources of inventive activity". Journal of Economic History, 22(1), pp. 1-20.
[49] Phaal, R., 2002, Foresight Vehicle Technology Roadmap—Technology and Research Directions for Future Road Vehicles. UK Department of Trade and Industry, URN 02/933.
[50] Ahola, S., 2006. From "different but equal" to "equal but different". Finnish AMKs in the Bologna process. Higher Education Policy 19(2), pp. 173-186.
[51] Katajisto J., Kimari M., 2005. Education, Training and Demand for Labour in Finland by 2015. Finnish National Board of Education. Helsinki.
[52] TELA 2007. Available online at http://www.tyoelake.fi/Default.aspx?Lang=2
[53] Porter, M.E., 1990. The Competitive Advantage of Nations. Macmillan Press Ltd, London.
[54] Porter, M.E., 1985. Competitive Advantage: Creating and Sustaining Superior Performance. The Free Press, New York.
[55] Jääskeläinen, J., 2001. Cluster ― Between Science and Policy. From Industrial Policy to Social Policy. A33 Series. The Research Institute of the Finnish Economy. ETLA. Helsinki.
[56] Pentikäinen, T., 2000. Economic Evaluation of the Finnish Cluster Programmes. Working Papers No. 50/00. VTT Group For Technology Studies. Espoo. Finland.
[57] Roelandt, T., den Hertog, P. 1999. "Cluster Analysis and Cluster-Based Policy Making: The State of the Art", in: Boosting Innovation: The Cluster Approach, OECD Proceedings.
[58] Finnsight 2015. "The Outlook for Science, Technology and Society". Tekes and Academy of Finland. Helsinki.
[59] Leydesdorff, L. and Etzkowitz, H., 2001. "The transformation of university-industry-government relations". Electronic Journal of Sociology 5(4).
[60] Santonen, T., Suomala, J., Kaivo-oja, J., (2008), Brief Introduction to the National Open Innovation System (NOIS) Paradigm: Supporting individual creativity in an online social network with content recommendation, In: K.R.E. Huizingh, M. Torkkeli, S. Conn and I. Bitran (eds). Proc. of the XIX ISPIM Annual Conference. Open Innovation: Creating Products and Services through Collaboration.
[61] Santonen, T., Karhu, K., (2010), Massidea.org: Defining a digital business ecosystem (DBE) for massinnovation, in Proc. of the 3rd ISPIM Innovation Symposium, Managing the Art of Innovation: Turning concepts into reality, Quebec City, Canada, 12 - 15 Dec., Huizingh, K.R.E.; Conn, S.; Torkkeli, M.; Bitran, I. (Eds.).
[62] Santonen, T., (2009), Creating the Foundations for Mass Innovation Implementing National Open Innovation

System (NOIS) as a Part of Higher Education, In proc. of The 2nd ISPIM Innovation Symposium - Stimulating Recovery - The Role of Innovation Management, New York City, USA on 6-9 December 2009

[63] Santonen, T., Lehtelä, M., (2010), Higher education student's motivation to participate in online mass innovation, in Proc. of The XXI ISPIM Conference - The Dynamics of Innovation - Bilbao, Spain

[64] Santonen, T., Schallmo, D. (2011), Evaluating Industry Business Model Innovation Stage-Gate Process: Case Massidea.org: in the The XXII ISPIM Conference – Sustainability in Innovation: Innovation Management Challenges - Hamburg, Germany on 12-15 June 2011

Appendix 1. The models of interaction between the foresight system and the innovation process

Figure 1 Model I: Innovation-Foresight-Other processes (IFO) model

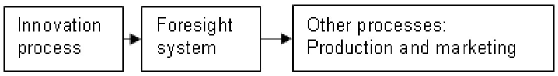


Figure 2 Model II: Foresight-Innovation-Other Processes (FIO) model

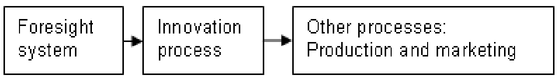


Figure 3 Model III: Other industrial processes-Foresight-Innovation (OFI) model

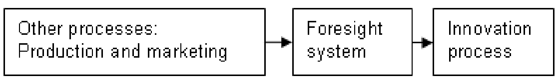


Figure 4 Model IV: Other industrial processes-Innovation-Foresight (OIF)

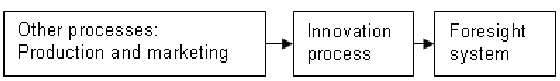


Figure 5 Model V: Foresight-Other industrial processes-Innovation (FOI)

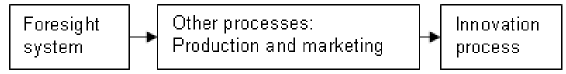


Figure 6 Model VI: Innovation-Other industrial processes-Foresight (IOF)

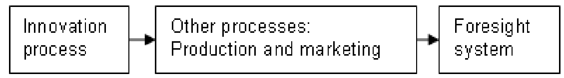


Figure 7 Model VII: Interactive simulative process model (ISP)