Tero Rantala

OPERATIONAL LEVEL PERFORMANCE MEASUREMENT IN UNIVERSITY-INDUSTRY COLLABORATION

ACTA UNIVERSITATIS LAPPEENRANTAENSIS 888

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Dissertation for the degree of Doctor of Science (Technology) to be presented with due permission for public examination and criticism in Kalevi Aho Hall at Lahti Music Institute, Lahti, Finland on the 12th of December, 2019, at noon.

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Abstract

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Even though the third mission and entrepreneurial activities of universities are continuously growing issues within higher education and society as a whole, and even though different measures are currently used to evaluate universities, the entrepreneurial and third mission activities of universities are lacking implemented frameworks and tools for their operational level of performance measurement. Even though the importance of performance measurement of university-industry collaborations is recognized among different societal organizations and universities, there exist challenges related to measurement. In order to understand the performance measurement of the university-industry collaborations, and to support the development of performance measurement of these collaborations, this study explores the current performance measurement practices and challenges of these collaborations from different stakeholder perspectives.

As university-industry collaboration can be considered as a multi-level phenomenon involving different stakeholders with different organizational cultures and with different aims and goals in respect to the collaboration, this study utilizes an empirical qualitative research approach. While focusing on the operational level performance measurement in university-industry collaborations, the data for this dissertation were gathered from different university-industry collaboration projects in Finland.

The results of the study show that, even though both the practice and scientific literature show growing interest in the collaboration activities between universities and other societal organizations, comprehensive performance measurement systems are not actively designed, implemented, and used in contemporary university-industry collaborations. Even though the participating stakeholders share the interest in the performance measurement and evaluation of the societal level outcomes, the contemporary performance measurement practices are mainly related to fulfilling external reporting tasks and to following the aims and goals promised in the funding applications/project preparations.

Keywords: performance measurement, performance management, university-industry collaboration

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Tero Rantala
November 2019
Lahti, Finland

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This dissertation is based on the following research papers. The rights have been granted by publishers to include the papers in the dissertation.

I. Rantala, T., and Ukko, J. (2018) Performance measurement in university–industry innovation networks: implementation practices and challenges of industrial organisations. *Journal of Education and Work*, 31 (3), 247-261.

II. Rantala, T., Ukko, J., and Saunila, M. (n.d.). Performance measurement in university-industry collaboration projects: university and financier perspectives. *Triple Helix*. Submitted 2019.

III. Mäkimattila, M., Junell, T., and Rantala, T. (2015). Developing collaboration structures for university-industry interaction and innovations. *European Journal of Innovation Management*, 18 (4), 451-470.

IV. Rantala, T., Ukko, J., and Rantanen, H. (2018). Designing a performance measurement system for university-public-organization collaboration. *International Journal of Public Sector Performance Management*, 4 (3), 349-372.

V. Rantala, T., and Ukko, J. (2019). Performance evaluation to support European regional development – university-industry perspective. *European Planning Studies*, 27 (5), 974-994.

Author's contributions

In publication I, the author was responsible for the research design and conducting the research (empirical data collection, methodology, data analysis, and conclusions). The author had a main role in writing the publication.

In publication II, the author was responsible for the research design and conducting the research (empirical data collection, methodology, data analysis, and conclusions). The author was also responsible for writing the research publication.

In publication III, the author was part of the data analyzation phase of the research project and part of the publication design and writing process phase.

In publication IV, the author was responsible for the research design and conducting the research (empirical data collection, methodology, data analysis, and conclusions). The author was also responsible for writing the research publication.

In publication V, the author was responsible for the research design and conducting the research (empirical data collection, methodology, data analysis, and conclusions). The author was also responsible for writing the research publication.

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1. INTRODUCTION

1.1 Background of the study

Universities are organizations performing an important role within societies by generating new knowledge and educating the population (Kalar and Antonic, 2015; Perkmann et al., 2013). The increased demands on universities as a producer of societally, economically, and regionally significant science and education have led to the expansion of the universities' collaborative activities with other societies (D'Este and Perkmann 2011; Perkmann and Walsh, 2007; Schartinger et al., 2002;). In addition to knowledge producing and educating, universities are now also fulfilling their third mission of societal impact by fostering partnerships and collaboration activities with private, public, and third sector organizations. As such, the effects of university knowledge transfer, as well as research and collaboration activities as a part of the development activities of other societal organizations, has become the focus of increased attention from policy makers and academics (Bishop et al., 2011). The growing amount of literature on university interactions with industrial organizations emphasizes the positive impacts of universities collaborating with private and public sector organizations (Bishop et al., 2011; Isaksen and Karlsen, 2010; Link et al., 2007; Siegel et al., 2003).

Due to ongoing changes in the business and operating environments, organizations from the public, private, and third sectors more frequently establish collaborative partnerships with universities (Bishop et al., 2011; Perkmann et al., 2013; Piva and Rossi-Lamastra, 2013). Collaboration activities between contemporary universities and industrial or public sector organizations can be executed in formal and informal ways, and even the ones arranged with the formal framework can be multidimensional and complex by nature. For example, formal and informal collaboration activities can offer organizations access to new scientific knowledge pursued at the universities, as well as possibilities to improve their scientific and technical capabilities and recruit talented students and post-graduates (Azagra-Caro et al., 2017). Compared with the informal collaboration activities between universities and other societal organizations, such as individual consultancy (paid for or free), information exchange forums, and personal contacts (Ankrah and Al-Tabbaa, 2015), formal collaboration mechanisms are contract-based activities that are aimed to exploit the knowledge, equipment, and expertise in universities and organizations in order to produce, for example, new innovative products and services (Azagra-Caro et al., 2017; Cohen et al., 2002; Link et al., 2007; Perkmann, 2015; Perkmann et al., 2013; Perkmann and Walsh, 2008). These formal collaboration activities between universities and organizations, aiming toward larger societal advantages, are usually also supported by governmental research and development funding. Cross-national governmental funding programs, such as the European Commission´s Horizon 2020, highlight the importance of collaborative innovation, development, and research activities between private and public sector organizations in order to enhance economic growth, and to generate societal well-being (European Commission, 2011).

As mentioned above, for private, public, and third sector organizations' collaboration and common research, development, and innovation activities with universities offer different kinds of advantages. For universities, these collaboration activities create a foundation for their third mission of societal interaction. Collaboration and common research and development activities with other societal organizations ensure that knowledge, technologies, and innovations produced in universities are relevant from a societal perspective. As such, Kapetanoiu and Lee (2017) argue that universities have been increasingly asked to pay attention to other societal organizations' objectives during the last decades, while the collaboration activities have been intensified.

On one hand, ongoing changes in basic funding (specifically related to research and education) and other governmental funding mechanisms of universities are also forcing universities to obtain funding from different external funding sources. Thus, contemporary university-industry collaborations provide environments where societies and nations' expectations are high, for example, for solving current challenges related to sustainability, and for generating vital research related to the growing phenomenon of digitalization. On the other hand, these combinations of research and education organizations, private sector companies, public sector organizations, third sector organizations, funding agencies, governments, etc. create environments where different organizations either volunteer or are forced to participate in different types of research and development activities. From these collaborations, each participating group has different expectations and different goals that may vary. Further, even though university-industry collaborations are expected to play important societal roles and are of growing interest to different organizations, they have to operate with limited funding resources. Moreover, different funding programs and funding mechanisms to support university-industry collaborations are becoming increasingly competitive (e.g., Albats et al., 2018).

1.2 Purpose of the study and research problem

Collaboration activities between universities and other societal organizations are highlighted to be important mechanisms to transfer scientific knowledge and expertise to other societies, and they provide an attractive option for organizations to leverage their research and development activities. However, these collaborations, like other development and innovation activities, include challenges. In addition to traditional challenges related to establishing inter-organizational collaborations (Ellegaard and Andersen, 2015), the collaboration activities between universities and private or public sector organizations include some more challenges. That is because the organizations from different sectors have different organizational policies and cultures regarding such things as autonomy, flexibility, and speed. This is also the case in collaboration activities between universities and other societal organizations (Al-Tabbaa and Ankrah 2016). Universities are typically organizations that adopt an open approach to their research and development activities, knowledge creation, and dissemination (e.g., Al-Tabbaa and Ankrah, 2016; Perkmann et al., 2013). In contrast, research and development activities pursued among private sector industrial organizations are characterized as being closed environments, in which organizations secure and limit access to produced knowledge and

developed innovations (such as new products and services) aiming to create competitive advantages (Ankrah and Al-tabbaa, 2015; Al-tabbaa, and Ankrah 2016).

As there exist different types of culture among industrial organizations and the academic world, one of the challenges of the university-industry collaborations is related to their management. In many cases, the success of university-industry collaborations depends strongly on universities entrepreneurial orientation and their motivation and capabilities to manage collaborative activities with other societal organizations (Etzkowitz et al., 2000; Perkmann et al., 2011). Although university-industry collaborations can generate possibilities and advantages for both universities and other societal organizations participating in these collaborations, they can cause managerial challenges that are attributable to organizational differences between university-industry collaborations and other organizational characteristics (e.g., Azagra-Caro et al., 2017; Leischnig and Geigenmuller, 2018; Perkmann and Walsh, 2007).

Due to the increasing importance and difficulties arising in university-industry collaborations, scholars have examined different aspects and determinants of the collaboration activities, but according to Lin (2017), the results are consistent. Lin (2017) further argues that there exist two streams of literature that show the different effects of the collaboration activities between universities and other societal organizations on academic innovation. Scholars of the first stream have presented the benefits and advantages of the collaborations because, for example, of the ability to obtain funds for research projects, risk sharing, and gaining knowledge and problem-solving capabilities (e.g., Adams et al., 2005; Bruneel et al., 2010; Fabrizio and DiMinin, 2008; Heinze et al., 2009; Lee, 2000; Lowe and Gonzalez-Brambila, 2007; Van Looy et al., 2006; Zucker et al., 2007). Even though these studies have widely highlighted the possibilities and advantages of the university-industry collaborations, the researchers of the second stream demonstrate the negative impacts of these collaborations. Lin (2017) has argued that, according to researchers of the second stream, collaboration activities outside of academia are tasks added to the universities' other tasks of research and education, and these may hinder academic research (e.g., Czarnitzki et al., 2015; Hottenrott and Lawson, 2014; Toole and Czarnitzki., 2009; Welsh et al., 2008).

Even though the third mission and entrepreneurial activities of universities are continuously growing issues within higher education, and even though different indicators to evaluate universities have been used in a number of studies (ter Bogt and Scapens, 2012), according to Kapetanoiu and Lee (2017), the third mission activities of universities lack a comprehensive methodology for their performance measurement. There still does not exist common view, and in many cases, it can be challenging to define the operations and actions that should be included in the third mission of universities (Göransson et al., 2009). Even though the importance of performance measurement of university-industry collaborations is recognized among different organizations (e.g., Albats et al., 2018; Perkmann et al., 2011), there exist challenges related to measurement, and Piva and Rossi-Lamastra (2013) argue that designing and using of the performance measurement systems to evaluate partnerships between university and industry/public sector organizations is far from simple. In order to understand the performance measurement of the university-industry collaborations and to support the development of performance measurement of these collaborations, this study explores the current performance

measurement practices and challenges of these collaborations from different stakeholder perspectives.

According to Leischnig and Geigenmuller (2018), forming, maintaining, and developing collaborative research and development activities with different external organizations also requires managerial capabilities from the individual project managers and researchers, not only from the leaders of faculties and universities. This is also the case with the performance measurement of the university-industry collaborations. The main parts of these collaboration activities are the operational level research and development activities, such as individual research and development projects, in which the performance measurement activities are also pursued at the operational level. Usually, the persons responsible for the performance measurement of university-industry collaborations are operational level employees, such as project managers or individual researchers.

Thus, the aim of the dissertation is to explore *the role of operational level performance measurement in the university collaborations.*

The study is executed through two main research questions and their sub-questions

The research questions of the study are as follows:

1. What is the role of operational level performance measurement in university-industry collaborations?
   - How is the performance measurement used to support the evaluation of the collaborations?
   - What are the current challenges related to the performance measurement of the collaborations?

2. How can performance measurement systems be designed and built to support the evaluation of the university-industry collaborations?
   - What are the special characteristics of performance measurement design and building in the context of university-public organization collaboration?
   - What are the special characteristics of performance measurement design and building in the context of universities' regional development activities?

1.3. Definition of the key concepts of the study

1.3.1 Scope of the study

This study examines the phenomenon of the operational level performance measurement in university-industry collaborations. As such, the scope of the study is derived and adapted from two different fields of literature, namely performance measurement and university collaborations. The first part of the scope of the study, performance measurement, appears in the performance management literature stream that is related to the management research field. The second part, university collaborations, is integral to the literature discussing the

universities' roles in society, more precisely, the universities' entrepreneurial and third mission of societal interaction and effectiveness.

Two literature streams, forming the scope of the study, are combined in a way that the theories and concepts related to performance measurement are applied to university collaborations. Thus, by exploring the phenomenon of performance measurement in university collaborations from different perspectives, this study connects performance measurement research and research related to university collaborations by contributing to both fields of research. The scope of the study is presented in Figure 1.

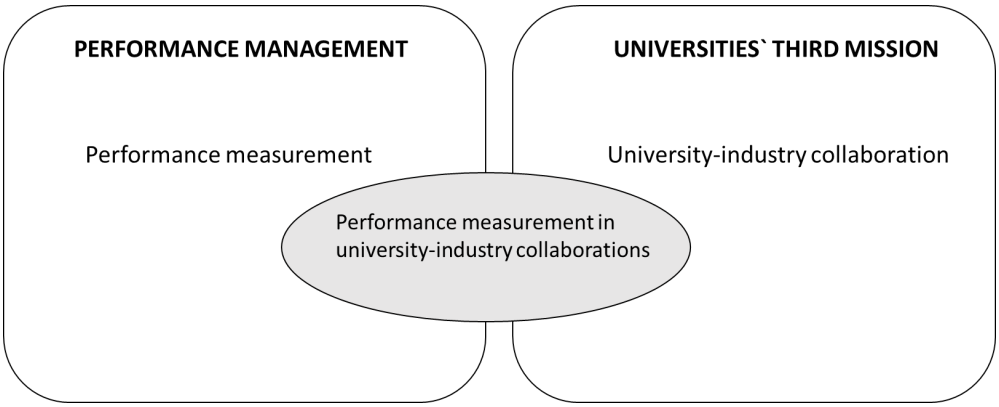

Figure 1. The scope of the dissertation.

1.3.2 Concepts related to performance management and measurement

Performance

According to Lebas and Euske (2002), the word performance is commonly used in all fields of management. However, the authors argue that, despite the common use of the term, its precise meaning is rarely clearly defined, even in the studies that are related to different aspects of performance. Lebas (1995) further states that the term itself might be challenging to define and that there does not exist a common consensus on what the term means: the meaning can change from efficiency, to return on investment, or to many of the other definitions, which have never been precisely articulated. Tangen (2005), in turn, presented the term performance as an umbrella term that can cover all different concepts related to success of organizations. Lebas and Euske (2002) have presented two different propositions for the term performance. The first proposition suggests that performance can only be expressed as a set of measures and indicators that are complementary, and that describe the processes and actions through which different outputs and results are achieved. The second proposition for the term suggests that, in order to understand the meaning of the performance, the causal model that describes how current operations affect outcomes of the future must be identified. As such, Lebas and Euske (2002) state that performance is not a one-time event. The authors further argue that the term

performance reflects the sum of the organizations' processes which lead to outcomes and results.

In this study, term performance refers to outputs and outcomes that are reflecting the aims and goals of the university-industry collaborations. Outputs are considered the results of the collaborative activities between universities and other societal organizations, which are realized and can be evaluated directly after the collaborations are finished. Outcomes are those results of these collaborations, which are realized and can be evaluated only after a certain time.

Performance management

Performance management, as a concept, refers to formal management practices through which organizations manage their performance. Such practices may include the selection of the organizations' strategic goals and practices to refine and improve development activities (Amaratunga and Baldry, 2002; Ferreira and Otley, 2009; Pavlov et al., 2017). According to Lebas (1995), performance management can be considered as a philosophy of an organization, which is supported by performance measurement. Lebas (1995) further states that performance management creates the context for – and the measures of – performance. As such, performance management can be considered as a management philosophy that is supported by performance measurement. In other words, performance management refers to the use of information provided by the proper application of performance measurement to be able to make correct and positive changes in organizations' businesses and processes, as well as in their organizational culture (Amaratunga and Baldry, 2002). Bititci et al. (1997) determined that the performance management process can be considered as the formal process by which organizations manage their performance in line with their corporate and functional strategies and objectives. More precisely, the performance management process defines how organizations use different systems and processes to manage performance (Bititci et al., 1997). In line with this, Amaratunga and Baldry (2002) argue that, in order for organizations to be able to use performance measurement outcomes effectively, they must be able make a shift from performance measurement to performance management.

In this study, performance management is considered as the formal management practices of university-industry collaborations, which are used and pursued by representatives from different participating organizations. As this study focuses on operational level activities of the university industry collaborations, performance management refers to management practices of the persons involved in operational level activities, such as university project managers and researchers, participants from industrial organizations, and financier delegates.

Performance measurement

As a part of the organizations' performance management practices, performance measurement is considered as actions to provide necessary information to support management practices. According to Lebas (1995), performance management and measurement follow each other in an iterative process: performance management both precedes and follows performance

measurement, and thus provides the context for its existence. Like performance and performance management, according to Neely et al. (1995), performance measurement is a topic which is often discussed but rarely defined. Neely et al. (1995) further argue that performance measurement can be considered as a process of quantifying organizations' actions, where measurement is the process of quantification and action leads to performance. Moreover, Neely et al. (1995) have noted that one of the most commonly used definitions for the concept of performance measurement is the following: "Performance measurement can be defined as the process of quantifying the efficiency and effectiveness of action." As such, Michele and Mari (2014) argue that research on performance measurement has often focused on frameworks and tools that are used to provide information in order to improve the efficiency and the effectiveness of organizations (e.g., Franco-Santos et al., 2007).

As a phenomenon, performance measurement has evolved from the use of traditional quantitative and financial measures to more comprehensive measurement practices, and the traditional accounting-based philosophy of performance measurement has been replaced by the performance measurement practices that are also focusing on the non-financial aspects of organizations' actions. Related to contemporary operating environments of the organizations, Michele and Mari (2014) argue that the need to develop connections between organizations' planning, decision-making, operational activities and their results has increased the interest in the measurement of organizational performance.

In this study, performance measurement refers to operational level measurement and evaluation activities of university-industry collaborations. By leaning toward the definition of Neely et al. (1995) of the process of quantifying the efficiency and effectiveness of actions, *efficiency* in this study refers to measurement and evaluation of research and development activities during the collaboration activities between universities and other organizations. Thus, the effectiveness of the collaborations is reflected in measurements and evaluations of the outputs and outcomes of these collaborations.

Performance measurement system

Even though there exists a large number of different definitions for a performance measurement system, in general, a performance measurement system can be considered as a framework, tool, or a set of measures that is used to gather and provide information to support performance management practices. There also exist different ways that the performance measurement systems can be categorized, and Speckbacher et al., (2003) state that there does not exist a single definition that can capture the complex nature of the contemporary performance measurement systems. Since Kaplan and Norton (1992) devised the most famous, cited, and applied performance measurement system/framework – the balanced scorecard – which is implemented and used to translate strategic objectives into a set of actions and performance measures, scholars from different areas of management research have widely examined the aspects related to design, building, implementation, and use of the performance measurement systems (Hall, 2008; Henri, 2006; Ittner et al., 2003; Michele and Mari, 2014; Neely, 1999).

According to Bititci et al. (1997) and Neely et al. (1995), a performance measurement system can be seen and defined as the information system or as the set of measures which enable the performance management processes to function effectively and efficiently in organizations. Lebas (1995) states that a powerful performance measurement system is built on the measures that support the cause and effect relationships, empower, involve, and give autonomy to individuals, and create environments and facilities for continuous improvement. As a performance measurement system is used to operationalize performance measurement processes, it provides an important part of organizations' management systems (Neely, 2005), and typically consist of a number of individual measures creating a functional entity (Neely et al., 1995).

Most recently, the utilization of a performance measurement system as part of the organizations' management activities is connected to facilitating strategy implementation and enhancing organizational performance (Franco-Santos et al., 2012). According to Franco-Santos et al. (2012), the contemporary performance measurement systems include both non-financial and financial measures that are linked to organizations' business strategies. In other words, the contemporary performance measurement systems are frameworks o and tools that use a balanced set of quantitative and qualitative measures that are applied to deliver a comprehensive picture of the organizations' operations. According to Franco-Santos et al. (2012), contemporary performance measurement systems typically utilize balanced scorecards (Kaplan and Norton, 1992, 1996, 2001) and different types of key performance indicators (Hall, 2008). Properly implemented performance measurement systems can also promote organizational learning by acquiring, storing, interpreting, and distributing data and information about an organization's performance (Garengo et al., 2007). Even though performance measurement systems are designed and implemented to turn strategic objectives into practice, the measurement should also occur and be related to other hierarchic levels of organizations, such as the operational level (Braz et al., 2011).

In this study, the performance measurement system refers to a framework/tool that is used to evaluate and steer the collaborative research and development activities between universities and other societal organizations. The utilization of the performance measurement system is intended to make the research and development activities flow effectively and to evaluate and capture the outputs and outcomes. As such, the performance measurement system in this study mainly refers to the above presented (Neely et al. 1995) definition of performance measurement system.

1.3.3 Concepts related to university collaborations

Universities' third mission

The third mission activities of universities refer to the transformation of research and knowledge from the university to make it available for other societal organizations. More precisely, according to Secundo et al. (2017), the third mission activities of universities are

related to the generation, use, application, and exploitation of research and knowledge with other societal stakeholder groups and organizations, in general. In addition, the third mission activities refer to innovation and development activities that universities perform in addition to their educational and research missions/tasks, not as residual operations (Loi and Di Guardo, 2015; Zomer and Benneworth, 2011).

During the last few decades, universities have shifted their focus from paying attention solely to their two other core tasks of teaching and research toward supporting other societal organizations' innovation and development activities and also toward the development of the regions in which they are located (Secundo et al., 2017). According to Gulbrandsen and Slipersaeter (2007), the engagement in third mission activities is one of the main strategies that universities have recently been pursuing. As a part of the universities' third mission activities, universities are more frequently acting as entrepreneurial entities that participate actively in collaboration activities aiming to promote economic and market development, for example, by commercializing generated knowledge to be used for industrial purposes (Huang and Chen, 2017).

In this study, the term universities' third mission refers to formal knowledge transfer, innovation, and development activities that universities are operating in addition to their other two core missions of research and teaching/education.

University-industry collaboration

According to Perkmann (2015), *university-industry relations* can be considered as an umbrella term that describes two different modes of collaboration between universities and organizations. The first mode is academic engagement, which refers to collaborative activities between universities and utilizers of knowledge produced in academic surroundings, such as private companies or public sector organizations. The second one refers to commercialization, which means the exploitation of universities' intellectual property by other members of society.

Even though there exist barriers and challenges related to university-industry collaborations (Bruneel et al., 2010), at a general level, university-industry collaborations should provide benefits for all the organizations included. For universities, these collaborations provide, for example, possibilities to ensure that the knowledge generated can be utilized by the greater society, possibilities to discover current problems, and agendas that need academic research to be overcome.

For private, public, and third sector organizations, reasons and motivations to collaborate with universities rely on several different possibilities. First, collaborating with universities in research and development activities provides possibilities for organizations to build and maintain their capabilities of scientific development and emerging technologies (Perkmann, 2015). In these science-oriented collaboration activities, the focus of the collaboration is on the generation and distribution of new knowledge instead of the development of commercialize technologies. Second, the reasons for other societal organizations to collaborate with universities rely on utilizing universities' problem-solving capabilities and facilities that could be used to support an organization's ongoing research and development activities (Perkmann,

2015; Perkmann et al., 2011). Governmental funding support is also motivating organizations to collaborate with universities and to utilize their problem-solving capabilities, as the cost of collaboration is usually much lower compared with research and development activities pursued in-house (Perkmann, 2015). Third, there also exist some generic reasons and motivations for other societal organizations to collaborate with universities. These reasons include, for example, possibilities to screen potential future employees.

In this study, university-industry collaborations refer to formal, contract-based research, development, and innovation activities among universities and other societal organizations, which, at a general level, comprise different types of interaction between universities and other societal organizations, such as contract research, consulting, or personnel exchange (Cohen et al., 2002; Link et al., 2007; Perkmann, 2015; Perkmann et al., 2013; Perkmann and Walsh, 2008). These collaborations include members from the university (project managers, research teams, or individual researchers) and participants from private, public, and/or third sector organizations.

1.4. Structure of thesis

This dissertation consists of two different parts. The first is an introduction which presents the background of the study, purpose, research problems, and questions, as well as the theoretical background. In addition, the first part presents a summary of the results, the discussion section of the study, and conclusions.

The second part consists of five scientific publications, which include empirical data from different collaboration activities between universities and other societal organizations. These publications are used to answer the research questions presented in the Introduction. The connection between the publications and research questions of the thesis is presented in Figure 2.

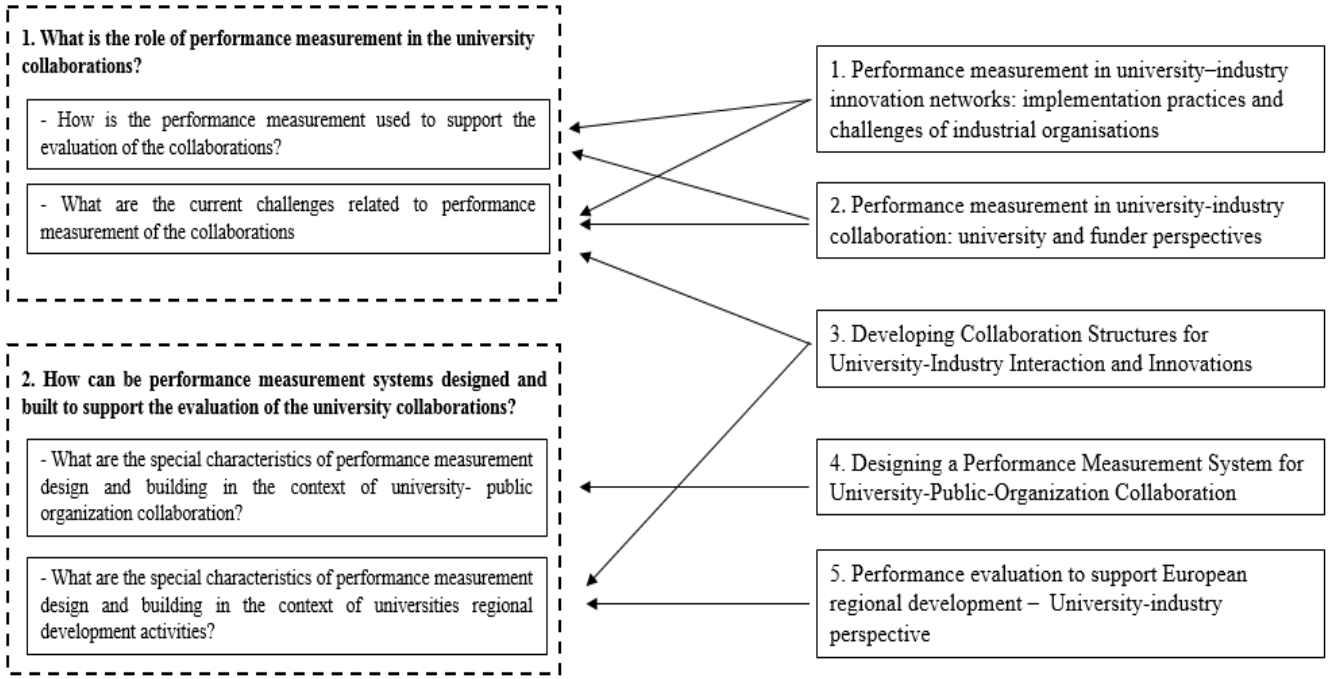

Figure 2. The interplay between publications and research questions of the dissertation.

2. THEORETICAL BACKGROUND

2.1 University-industry interactions

During the last few decades, universities have faced in-depth changes related to their strategies and core missions (Kapetanoiu and Lee, 2017). After the 1980s, university-industry collaboration activities as a part of societal development have increased and therefore gained growing interest among academics, politicians, and other societal stakeholders (Etzkowitz, 1998). The emergence of the "entrepreneurial university" was highlighted by Clark (1998) and Etzkowitz (1998) who have both argued about the changing role of universities. According to both authors, as a part of the third mission, the entrepreneurial activities of societal effectiveness, such as the generation and exploitation of the academic knowledge, will form the institutional objectives of universities in the future.

For example, in the context of the US, universities were already patenting their inventions in 1920s, and after that, many universities, both public and private, have been developing their policies in patenting and licensing their inventions and research findings (Movery and Sampat, 2004). In the US, a growing concern about the competitive advantages of the national manufacturing companies led to a common re-conceptualization of the public research systems in the 1970s (Coriat and Orsi, 2002; Grimaldi et al., 2011). During the following decade, the development and establishment of patenting strategies and policies, and the growing concerns of the national level of competitiveness, contributed to the passage of the Bayh-Dole Act, which was established with the aim of boosting licensing and patenting of the universities' inventions based on governmentally funded research activities (Movery and Sampat, 2004). This act was followed by remarkable expansion in licensing and patenting among US universities, and it has been considered the cause of the significant growth of the collaboration activities between universities and industrial organizations (Movery and Sampat, 2004).

During the following decades, the Bayh-Doyle Act led governments in many other OECD countries to establish policy initiatives that emulated the Bayh-Doyle Act of boosting the technology transfer and university-industry research collaboration (Movery and Sampat, 2004), which is one reason why, in OECD countries, business strategies for Research and development (R&D), and innovation have evolved significantly in governments and industry (Czarnizki et al., 2007).

Following the expansion of university-collaboration in the 1980s, the questions of why and how companies should engage in these collaboration activities and how these collaborations affect the common welfare emerged in the economic literature during the 1980s (Czarnizki et al., 2007). According to Czarnizki et al. (2007), from the viewpoint of industrial organizations, the focus of the literature and studies highlighted the significance of spillovers as part of the collaborative research activities (e.g., Katz, 1986).

2.1.1 Current state of university-industry collaboration

During the recent decades, the collaboration activities between universities and other societal organizations have become a focus of interest for governments, universities, and industrial organizations all around the world. According to Huang and Chen (2017), in the current era of the knowledge economy, universities play a crucial role in innovation systems through contributing to economic development of countries and regions, for example, by teaching and educating people and transferring knowledge and technology from academic surroundings to other members of society.

According to Kapetanoiu and Lee (2017), emergence of the universities' entrepreneurial and third mission activities of societal effectiveness and their role in developing industrial organizations' economic growth has expanded the traditional tasks of research and education. The emergence and expansion of the universities' third mission have recently increased the number of operations that universities have to fulfil (Kapetanoiu and Lee, 2017). In addition to research generation and education of people, universities are more frequently asked to participate in entrepreneurial activities that are actively involved in economic and market development, for example, by commercializing their research to industrial purposes (Huang and Chen, 2017). As such, alongside their research and education purposes, universities are currently expected to help other societal organizations to improve their capabilities and competitive advantages, and also to find answers and solutions to different social problems (Kapetanoiu and Lee, 2017). As such, collaboration activities between universities and other societal organizations have gained great interest among different stakeholders because they can generate advantages for all participating organizations and for society, in general (Franco and Haase, 2015; Muscio, 2010).

As a result of the continuously growing societal interest, contemporary universities are shifting their role from being traditional education and research organizations to being entrepreneurial universities with a strong collaborative relationship with industry and other societal organizations (Kalar and Antonic, 2015). By doing this, they are also encouraging the entrepreneurial and collaboration activities of their researchers (Kalar and Antonic, 2015; Krabel and Mueller, 2009). The changing and expanding role of the entrepreneurial university is not only to produce new scientific knowledge but also to more effectively transfer this knowledge to other industrial and societal organizations (Guerrero et al., 2012). The entrepreneurial universities are aiming to develop and create a culture to support researchers and scientists to disseminate their knowledge thorough collaboration and activities and through activities that are more entrepreneurial in nature (Kalar and Antonic, 2015; Philbott et al., 2011).

According to Klofsten et al. (2019), an understanding of the roles of the contemporary entrepreneurial universities is necessary to in determining how they operate as knowledge, technology, innovation, and economic development centers in the current knowledge intensive and competitive society. As governments, industries, and other societal organizations deliver financial resources for these collaboration activities, university researchers currently show an increasing interest in the strategic mechanisms of these collaborations (Klofsten et al., 2019). Due to this, university researchers are currently in a

situation where their working tasks and roles are expanding. In addition to their internal core tasks and missions of research and education, they now need to manage collaboration activities with external stakeholders from other societal organizations (Etzkowitz, 2016; Klofsten et al., 2019).

Even though the main driving force behind the universities' expanding entrepreneurial and collaboration activities seems to be growing societal interest, the nature of the interuniversity competition has changed, pushing universities into the global arena (Bouncken, 2018). Universities in many countries have to deal with continuously decreasing governmental funding and funding gathered from external sources. Thus, collaboration activities with other societal organizations is becoming a source of their funding. As such, universities are continuously finding new ways and forms of collaboration for gathering funding in order to be able to achieve their tasks of research and education.

2.1.2 Different types of university-industry collaborations

The contemporary university-industry collaboration activities encapsulate many of the growing demands on the universities to play a more visible role in facilitating the utilization of knowledge for greater societal development (Secundo et al., 2017). As such, university-industry collaboration activities are becoming more important to many societal stakeholders, and the forms and ways to execute these collaborations are multiple. Hsu et al. (2015) have found that the collaboration activities between universities and other societal organizations can include such things as launching technology start-ups, as well as providing collaborative research, contract research, technology licensing, graduate education, and exchange of research staff and resources. According to Ankrah and Al-Tabbaa (2015), the most common forms of university-industry collaborations that are pursued in the literature and practice, are joint ventures, networks, consortia, and alliances, and according to the authors, these different forms can vary in the degree to which the participating organizations are connected. Ankrah and Al-Tabbaa (2015) have determined and listed different forms of informal and formal university-industry collaborations in their study:

Personal formal relationships:

- Student internships, students' involvement in industrial projects, scholarships and postgraduate linkages, joint supervision of PhDs and Masters theses, exchange programs, hiring of graduate students, and use of university or industrial facility (e.g., database).

Personal informal relationships:

- Academic spin-offs, individual consultancy (paid for or free), information exchange forums, collegial interchange, conference, and publications, joint or individual lectures, and personal contact with university academy staff and industrial staff.

Formal targeted agreements:

- Contract research, patenting and licensing agreements, cooperative research projects, exchange of research materials of joint curriculum development, and joint research programs (including joint venture research projects with a university as a research partner or joint venture research projects with a university as a subcontractor).

Perkmann and Walsh (2007) defined various university-industry links as the following:

Research partnerships	Interorganizational arrangements for pursuing collaborative R&D
Research services	Activities commissioned by industrial clients, including contract research and consulting
Academic entrepreneurship	Development and commercial exploitation of technologies pursued by academic inventors through a company they (partly) own
Human resource transfer	Multi-context learning mechanisms, such as training in industry, graduate trainees and secondments to industry, and adjunct faculty
Informal interaction	Formation of social relationships and networks at conferences, etc.
Commercialization of property rights	Transfer of university-generated IP (such as patents) to firms, for example, via licensing
Scientific publications	Use of codified scientific knowledge within industry

As a summary of the current state of the collaboration activities between universities and other societal organizations, it has been proposed that the possibilities and options to establish different forms of collaborations are varying and different typologies and taxonomies exist in different countries. As presented earlier, in this study, university-industry collaboration refers to academic engagement, which at a general level comprises different types of interaction between universities and other societal organizations, such as contract research, consulting, personnel exchange, or informal collaboration activities (Cohen et al., 2002; Link et al., 2007; Perkmann, 2015; Perkmann et al., 2013; Perkmann and Walsh, 2008). More precisely, university-industry collaboration in this study refers to formal targeted agreements (collaborative research and development projects, and joint

research programs) involving participants from universities, industrial organizations, public organizations, and third sector organizations.

2.1.3 University-industry collaboration in European countries

As the collaboration activities and partnerships between universities and other societal organizations has most recently become a global trend (Arvanitis et al., 2008; Kalar and Antonic, 2015), the culture of promoting universities' role in knowledge and technology transfer has also been developing among European countries since the early 1990s (Grimaldi et al., 2011; Kalar and Antonic, 2015). During the recent decades, many countries in Europe Union (EU) have designed and built mechanisms to support and increase the collaboration between university and other societal organizations to bolster the knowledge and technology transfer (European Commission, 2007). Even though universities have been dealing with the same kinds of problems and barriers while shifting their role from traditional education and research organizations toward entrepreneurial universities (Guerrero et al., 2012), reforms in national level research policies and mechanisms intended to bolster the transformation of knowledge to other societies have had different types of effects for universities (Grimaldi et al., 2011; Kalar and Antonic, 2015). In addition, many European countries have adopted their own measurement practices to increase and support the knowledge and technology transfer.

Even though a wide range of good practices and solutions have been recognized to support European countries in transferring knowledge and technology from universities to the greater society, each country is responsible for developing and adopting the mechanisms and procedures that are the most suitable and effective in their own context (European Commission, 2007; Kalar and Antonic, 2015). For that reason, despite the similar idea of the role of the entrepreneurial university, there exist different forms of collaborations and transfer mechanisms in different countries and in the various fields of science. In addition, the type of industry or public organization affects the form of the transfer mechanisms. Thus, according to Guerrero et al. (2012), even though there exist similarities in strategic goals and comparable social and economic circumstances among European countries, the entrepreneurial culture and activities of contemporary universities differ from each other due their policies and traditions, which are the distinct characteristics to each university. The previous literature on university-industry collaborations (e.g., Abreu and Grinevich, 2013; Kalar and Antonic, 2015; Philbott et al., 2011) have indicated that scientific disciplines affect researchers' interests and motivation in technology and knowledge transfer. Abreu and Grinevich (2013) explain that, at a general level, researchers in natural sciences (e.g., physics, engineering, and biological sciences) seem to be more disposed to collaborate in all kinds of activities through which knowledge and technology can be transferred to other societies. Moreover, according to Abreu and Grinevich (2013), researchers in the social sciences (education, business, arts, and humanities) seem to be interested in less formal and non-commercial collaboration and development activities.

During the 21st century, university-industry collaboration in the EU has been encouraged through different innovation and entrepreneurship policies and promoted at national and

regional levels to support activities in this area (Ranga et al., 2016). Through these regional level collaboration activities, entrepreneurial universities can promote knowledge transfer that benefits entire regions (Klofsten et al., 2019). The EU has encouraged university-industry collaboration, for example, through the Framework Programmes for Research and Technological Development FP6 and FP7 (2002–2006 and 2007–2013, respectively). Recently, university-industry collaborations have been one of the main goals of the EU's Innovation Strategy Europe 2020, and is currently encouraged through various policies and funding mechanisms, such as the EU's Horizon 2020 Programme (Ranga et al., 2016).

2.1.4 University-industry collaboration in Finland

Universities in Finland have traditionally been driven by high autonomy and a close collaboration between science and education (Ranga et al., 2016). The development and encouragement of collaboration activities between universities and other societal organizations has been a part of the Finnish political innovation agenda since the 1990s, aiming at the development of a knowledge-based economy in Finland (Ranga et al., 2016). Over the last two decades, the development of collaboration activities between universities and other societal organizations has been growing (as well pressures) in Finland, and in addition to their core missions of education and research, Finnish universities are increasingly asked to act as entrepreneurial and market-driven economic operators (Ylijoki, 2014). As a distinctive feature to support universities' collaboration activities, and in contrast to many other European countries, Finland has a comparable public funding system and comparable policy mechanisms intended at bolstering business R&D and university-industry collaborations (Czarnizki et al., 2007).

Based on the welfare model characteristics of Nordic universities that consider higher education as a public good (Kohtamäki, 2019; Ylijoki, 2014), universities in Finland have public missions, and they receive public funding. The activities, tasks, and missions of research and education institutes in Finland are coordinated by the Ministry of Education and Culture, which also provides the main part of the governmental financing of the universities (The Ministry of Education and Culture, 2019). As a part of their annual budget planning, the Finnish Parliament determines the amount of basic governmental funding, which is allocated to universities through the Ministry of Education and Culture (The Ministry of Education and Culture, 2019). The governmental funding is allocated to universities mainly based on their performance in educational and research tasks. In addition to performance-based governmental funding, a part of the financing for universities is also allocated based on their strategies and strategic competences, which are constituted by the Ministry together with each respective university. Since 2013, the share of the universities' governmental performance-based funding has been 75% of the universities' funding budget, and during the past three years, it has been 72%, which indicates that the funding system of Finnish universities is highly performance-driven (de Boer et al., 2015; Kohtamäki, 2019).

Besides the core funding allocated by the Ministry of Education and Culture, a growing part of the universities' financing is coming from competitive external sources, which in many cases, is based on the collaboration activities between universities and other societal

organizations. Financiers of these nationwide external funding sources are, for example, the Academy of Finland, Business Finland (provides finance support for universities' research and development projects), various foundations, industrial organizations, the EU, and other international funding sources (The Ministry of Education and Culture, 2019).

Pursuing an increase in accountability has remarkably affected the contents of Finnish university policy during the last two decades. According to Hansen et al. (2019), the highlighting of the importance of higher-level accountability has led to the adoption of a performance-based funding model in Finnish universities. The new university legislation from 2010 kept the main tasks of research and teaching unchanged but highlighted the importance of universities' third mission activities and the role of entrepreneurial universities. The change in the legislation concerning Finnish universities also offered them legal possibilities and frameworks to act as independent financial and legal units (Kohtamäki, 2019). After the change in university legislation, both financial and governance funding mechanisms for universities were updated, driving universities toward competing for external national and international research funding. As such, the new university legislation highlighted the importance of gathering funding from collaborative research and development activities with other societal organizations (Hansen et al., 2019). The changes in the Finnish higher educational and governmental policies during the last 20 years (Kallio et al., 2015) are presented in Figure 3.

The contemporary Finnish higher education policy reform follows the concepts of new public management ideas that are also characteristic of the policy reforms in many other countries, such as the UK and the Netherlands (Kohtamäki, 2019). This policy reform which aims to increase universities entrepreneurial and collaboration activities is increasing universities' competition, market orientation, and performance management and measurement (Kohtamäki, 2019; Meek et al., 2010). With respect to the share of innovation and development activities supported by collaborative activities with universities, Finland has a rising trend of strengthening university-industry collaborations, which strongly follows the guidelines of national policy (Torregrosa-Hetland et al., 2019).

In response to the growing societal concerns and pressures, universities in Finland are continuously developing and increasing their collaboration activities with other members of society. By forming collaborations with other societal organizations, universities can ensure that the knowledge and research produced have practical value and can be utilized by others. It also provides possibilities for them to search for and find contemporary problems of industrial, public, and third sector organizations that could be supported by novel research. In addition to transference of research and knowledge, the collaboration activities provide universities with funding for the support of their primary tasks of research and education.

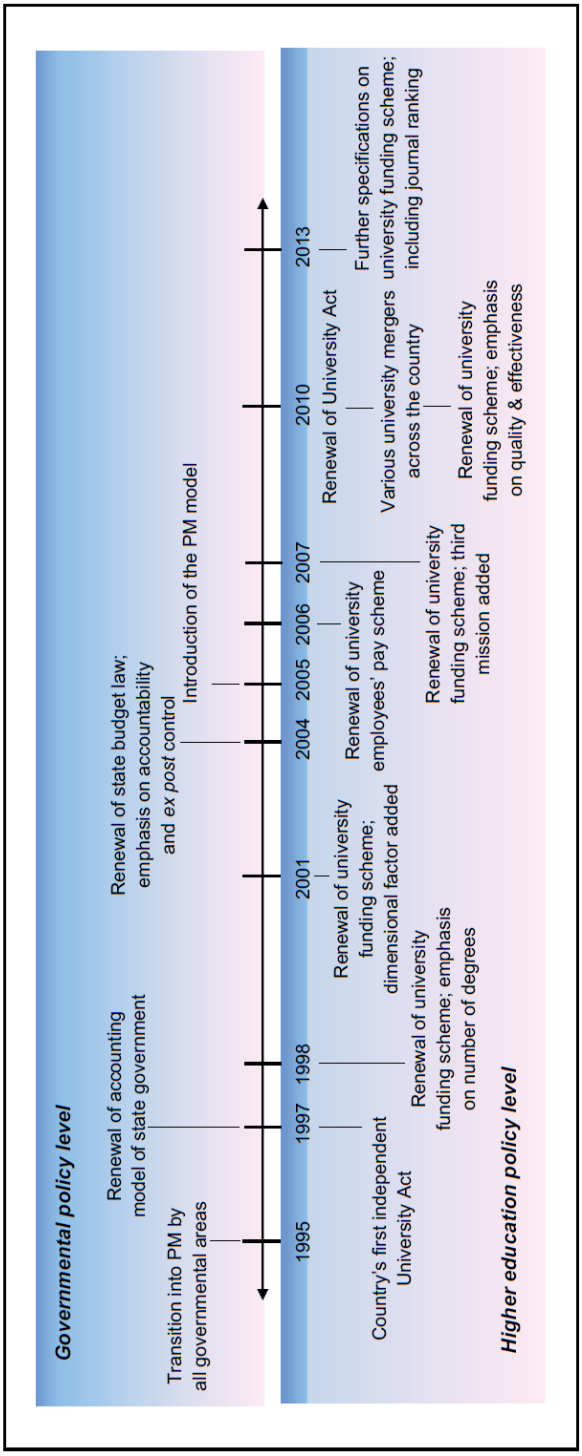

Figure 3. Changes in the Finnish higher education and governmental level policies during the last 20 years (Kallio et al., 2015).

2.1.5 Researchers' motivations in university-industry collaboration

As this dissertation focuses on operational level activities of university-industry collaborations, the motivations of universities to participate in these collaborations are next presented from the perspective of university researchers.

Even though the presented reasons for researchers to participate in university-industry collaborations rely mainly on the changing roles of entrepreneurial universities and on the growing societal expectations of transferring technology and knowledge, the actual motivations for individual researchers' participation are heterogeneous. The study of D'Este and Patel (2007) shows that, in expounding the frequency and variety of collaboration activities with organizations outside academia, researchers' personal characteristics play a key role, instead of the characteristics of their faculties or departments. Their findings further indicate that the researchers with previous experience of collaboration activities are more likely to frequently participate in different types of collaboration activities.

University-industry collaborations can increase researchers' understanding of other societal organizations' operations and, thus, increase the quality of the research and teaching activities (Arza, 2010; Franco and Haase, 2015). D'Este and Perkmann (2011) indicate that one main motivation for researchers to participate in these collaboration activities is to increase learning and understanding in order to support their research activities. The increase in understanding of the contemporary problems and needs of other societal organizations can be also lead to generating new research ideas and research tasks (e.g., Welsh et al., 2008). In addition to possibilities to increase understanding of the other societal organizations' operations, the researchers' motivation to participate in the collaboration activities can be also related to field testing of practical level applications, based on research findings (Lee, 2000), to gain access to recent industrial technologies, and to receive practical feedback from research knowledge that is produced (Arvanitis et al., 2008; Franco and Haase, 2015).

In addition to the possibilities to boost their academic careers by collaborating with other societal organizations, these collaborations also provide researchers with possibilities to seek and screen possible career options outside academia. Compared with the traditional short-term job interviews, one main benefit of university-industry collaborations is the long-lasting projects and processes where researchers have an opportunity to become familiar with representatives of other societal organizations and show their skills and personality. As such, university-industry collaboration provides researchers with great opportunities to enhance their reputation outside academia (Dietz and Bozeman, 2005). Even though collaboration activities outside academia provide possibilities and advantages for the individual researchers to find options for future careers, in many cases, they are forced to screen these future career options. In many countries, researchers, both PhD students and postdoctoral researchers, are working in fixed-term positions, which causes uncertainties about the continuity of pursuing an academic career.

Finally, related to the growing financial pressures that universities and individual researchers are currently facing, the researchers' motivation to participate in collaboration activities with other societal organizations relies on receiving and securing their funding. Dealing with possible shortages in basic governmental funding, collaboration activities can be driven by the requirement to gather complementary funding to finance researchers' other tasks of research and education (Ankrah et al., 2013; Franco and Haase, 2015; Welsh et al., 2008).

2.1.6 Other societal organizations' motivations in university-industry collaborations

Reasons and motivations for private, public, and third sector organizations to participate in collaboration activities with universities are also various. In general, the organizations' motivations to participate in collaboration activities with universities are related to the development of organizations' learning and problem-solving capabilities, the utilization of the most recent technologies and knowledge, and possible funding support for R&D activities. According to Perkmann et al. (2011), these reasons for firms to participate in collaboration activities with universities can be divided for four main types. First, the firms' motivations for collaboration can be related to leveraging of R&D funding, as there usually is governmental funding support available for organizations collaborating in research and development activities with universities (Grimaldi and von Tunzelmann, 2002; Perkmann et al., 2011;). Second, as a part of the collaboration, firms are able to access basic scientific knowledge. Third, in the collaboration activities with universities, firms can improve their capabilities through the knowledge and advice obtained from the university. Fourth, the collaboration activities can be seen as a source for new techniques and instruments that can provide generic benefits for the participating organizations.

Ankrah and Al-Tabbaa (2015) noted in their literature review of university-industry collaborations that, from the industrial perspective, the organizations' motivations to participate in these collaborations are related to six different contingencies that cover issues such as *necessity* (as a response to governmental policies/initiatives to be successful), *efficiency* (human capital development, cost savings, and commercialization of university-based technologies), *stability* (solutions to specific problems, risk reduction, sharing, and access to research networks), *legitimacy* (enhancement of corporate image), *reciprocity* (hiring of university researchers/students/other faculty members), and *asymmetry* (maintaining control over proprietary technology).

2.1.7 Challenges to university-industry collaboration

Even though university-industry collaborations have been accepted as ways to generate advantages and positive impacts on participating stakeholders and on other societies, the collaboration activities are not without challenges (Bruneel et al., 2010). According to Franco and Haase (2015), the motivations for the collaboration activities can be hampered by several institutional/organizational barriers. One of the main reasons for the challenges

in these collaborations is the different organizational logics, organizational structures, and goals for operations (Tartari et al., 2012; Villaini et al., 2017). While the focus of the universities strives for openness, transformation of knowledge, and creation of possibilities for new research agendas, the interests of other societal organizations are more directed toward outcomes that could create competitive advantages for them (Bruneel et al., 2010; Villaini et al., 2017). In other words, the focus of the universities and individual researchers seems to be on long-term development and creation of scientific knowledge, while other societal organizations seem to be more interested on short-term outcomes. Due to organizational differences in university-industry collaborations, there exists a gap between the knowledge produced by university researchers and the use of it in practice by other societal organizations (Siegel et al., 2003). As such, a great amount of the scientific knowledge created in universities does not pique the interests of other societal organizations or promise the creation of value for them (Sedlacek, 2013).

As the interests of organizations outside academia participating in university-industry collaborations in many cases rely on development of technologies on commercialized products/services (Soh and Subramanian, 2014), the ownership of the intellectual property rights might cause challenges. The external funding to boost and support the collaboration activities are usually provided through governmental funding programs, assuming that the results of the collaborations should be publicly available. However, the organizations participating in these collaborations may not be interested in sharing the outcomes of the development activities, which may cause difficulties in determining what is the property of the organizations and what part of the results should be publicly available. As such, increasing the level of the commercial dimension in university-industry collaborations can cause disputes among participants and distract them from their initial targets (Al-Tabbaa and Ankrah, 2016).

From the perspectives of researchers, the challenges to participate in university-industry collaborations are related, for example, to the lack of organizational support to knowledge transformation and encouragement for researchers to participate in collaboration activities (Debackere and Veugelers, 2005). In addition, insufficient resources for establishing collaboration activities with other societal organizations have been determined to be obstacles to researchers' participation (Franco and Haase, 2015; Mudambi and Swift, 2009). According to Leischnig Geigenmuller (2018) and Etzkowitz et al., (2000), the challenges are related to the organizational tasks of researchers; the university researchers are asked and trained to do academic scientific research and to teach and educate people, while collaboration activities are asking them for commercialization of technologies and knowledge. Thus, in spite the increasing governmental support for university-industry collaboration, these activities have been slow to gain traction (Ranga et al., 2016). In Finland, only every tenth university researcher is interested in collaboration activities and research commercialization, and even the ones actively participating in these collaboration activities seem to be more research-oriented than business-oriented (Ranga et al., 2016).

As a summary of the literature thus far described on university-industry collaborations, these activities can include participants from universities (e.g., researchers, project managers, students), from private sector organizations, public sector organizations, and third sector organizations. In this study, the explored collaboration activities are funded from different

types of funding programs, meaning they are also of interest to financier delegates. As receiving governmental funding support through different programs, these collaboration activities should be able to execute the aims and goals of the programs. In addition, all the participating groups have their own interests in collaborations, which has an effect on what activities are pursued. The framework of the university-industry collaborations explored in this dissertation is summarized in Figure 4.

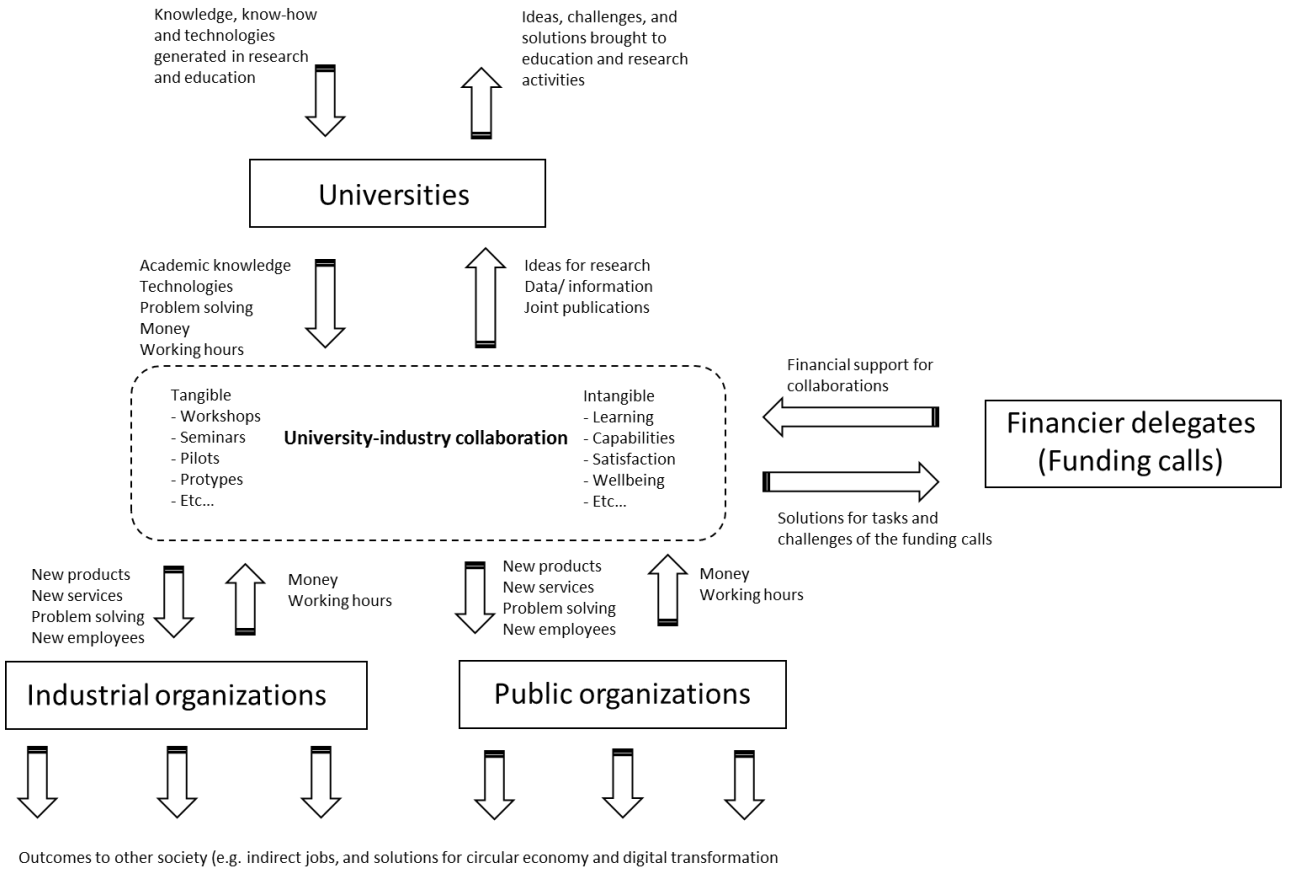

Figure 4. The framework of the university-industry collaboration.

2.2 Performance management in universities

Growing societal demands for universities to become more entrepreneurial and market-based by nature have increased the development of mechanisms intended to assess their organizational performance (Melo et al., 2010), and the changing roles of universities have raised challenges in respect to their management and reporting tasks (Secundo et al., 2017). The changes in the mechanisms of governmental funding support have given possibilities and flexibility for universities to use and allocate their resources, in exchange for increased demands in accountability. As such, university-industry collaborations and their effects on research, development, and innovation activities have received attention among different scholars in management studies, the economics of innovation, industrial organizations, the sociology of science and science studies, and science and technology policy (Agrawal, 2001; McMillan and Hamilton, 2003; Movery and Nelson, 2004; Perkmann and Walsh, 2007). As contemporary universities are shifting their operations toward entrepreneurial universities, in response to growing expectations from other societal stakeholders, the traditional form of higher education is subject to substantial reform as new forms of performance management practices are implemented in universities (Kallio et al., 2015). The changing role of market-oriented universities is now more frequently shaping the work of research groups and individual researchers. Universities have been adapting formal performance management practices that are used to evaluate the performance of individual researchers (ter Bogt and Scapens, 2012). Thus, the work of individual researchers is more frequently shaped and evaluated by the strategic level goals of the universities (Kallio et al., 2015; Sousa et al., 2010). This is currently reflected in the management practices of universities, highlighting the importance of performance management in efficiently allocating the available resources and ensuring, by the utilization of performance measurement practices, that the aims of the universities are being effectively achieved (Chandler et al., 2002; Kallio et al., 2015).

The changing role of the universities is also changing their performance management activities in response to finding a balance between fulfilling the expectations of other societal stakeholders and the expectations of the academic world. Overall, the changing role of entrepreneurial universities is affecting how the performance of contemporary scholars is managed (Kallio et al., 2015). From the perspectives of other societal stakeholders, the performance management activities reflect the universities' value generation for other members of society. Reflecting this perspective, the performance management activities of universities can be considered quite similar to those of other societal service providers (Engwall, 2007), as universities can be seen as service providers that are measured in terms of the use value they provide for their stakeholders (Ng and Forbes, 2009).

According to Pollitt and Bouckaert, (2000), a philosophy or ideology of managerialism is entering the universities, with performance management as integral part of it. In respect to the performance management activities of universities, Sousa et al. (2010) states that these performance management activities differ from traditional academic quality assessment via peer reviews in two discrete ways. First, the outputs generated by universities are compared with objectives and used for comparative benchmarking. Second, the outputs are connected to the inputs and used for assessing efficiency in the use of resources. The changing role of performance management in universities is summarized in Figure 5.

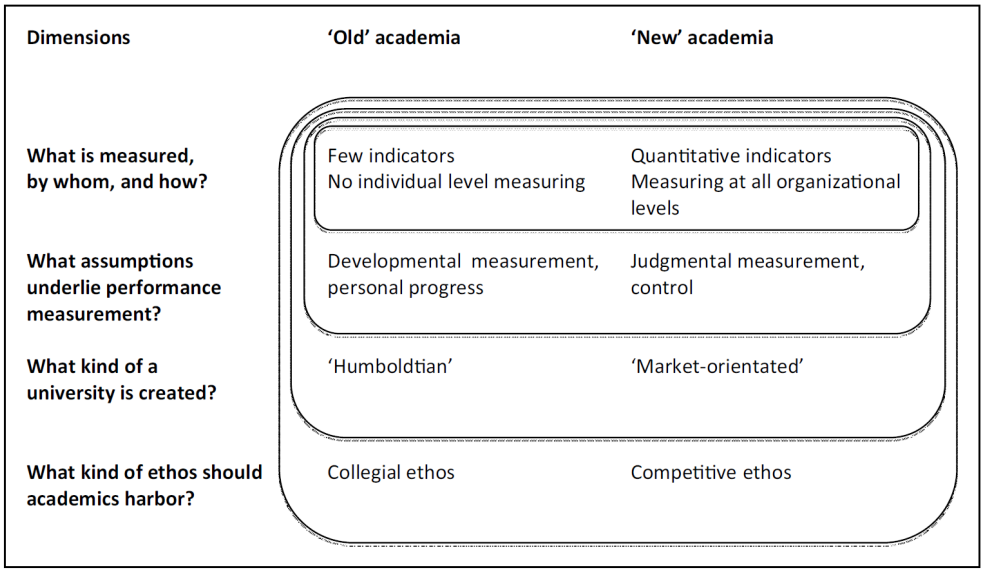

Figure 5. Dimensions of performance management in the old and new academia (Kallio et al., 2015).

Even though the implementation of performance management practices in universities is primarily based on the various institutional pressures and societal expectations, the main part of these performance management activities are still focusing on the evaluation of research and education activities. In spite of the growing interest and pressure for universities to collaborate outside academia, the main source for their funding foundation is still governmental funding based on the performance in research and education (ter Bogt and Scapens, 2012). Ter Bogt and Scapens (2012) argue that the universities' research performance is currently primarily evaluated and measured based on the quality and amount of the scientific publications in internationally ranked scientific journals. The performance management and measurement of education and teaching of universities is usually based, for example, on the number of degrees awarded and the quality of teaching provided. In addition, measurements related to performance measurement of universities' teaching and education are credits produced and the employment rate of graduates. In evaluation of the quality of teaching and education, students' experiences and perceptions play an important role (ter Bogt and Scapens, 2012). Due to the increase in performance management-based management culture, the external evaluation and audit practices of both education and research performance have become common in universities (e.g., Broadbent, 2007).

Mainly because of the evaluation of research and education of universities, the main part of the existing research on performance management and performance measurement in universities has tended to focus on macro level issues, such as the impact on governance and resource allocation (ter Bogt and Scapens, 2012). However, as established earlier in this dissertation, a growing number of researchers are participating in operational level collaboration activities with other societal organizations. The performance management practices of universities have been criticized for not paying sufficient attention to these

external operational level collaboration activities. As individual researchers are currently being judged by and rewarded for their research and teaching performance, the external collaboration activities from the perspective of their individual performance can be considered even harmful for their academic careers. The results of ter Bogt and Scapens (2012), for example, reveal that the way in which new performance management practices are implemented causes stress and anxiety for individual researchers and may negatively affect their daily work.

As individual researchers' work in universities is contemporary and, thus, affected by the performance management and increase in collaboration, the performance management and measurement activities of these collaborations should be more carefully understood and implemented in a way that would support researchers instead of causing unnecessary stress and harm. Even though academics have been suggesting some indicators for evaluating and measuring the third mission activities of universities, according to Secundo et al. (2017), there do not exist comprehensive measurement systems that would address both the need to provide information for management and reporting of universities. Moreover, the contemporary performance management in universities seems to rely on evaluation of the first and second task of research and education, and according to Montesinos et al. (2008), the third mission activities lack methodology for understanding what universities actually do in the collaboration activities.

2.3 Performance measurement in university-industry collaborations

From a strategic perspective, the performance measurement of universities' third missions and collaboration activities should focus on highlighting the dialogue inside universities and between their external stakeholders and society as a whole (Secundo et al., 2017). The growing interest in the collaboration activities between universities and other societal organizations has resulted in the demand for more comprehensive performance measurement processes for all participants (e.g., Secundo et al., 2010). Despite the increased focus on strategies and processes to develop the collaboration activities, universities seem to lack specific information and frameworks with which to evaluate the performance of their entrepreneurial activities (Wright et al., 2004), in particular the third mission activities of societal effectiveness (Secundo et al., 2017).

Since the collaboration activities in general have been increasing, a growing amount of research has been conducted focusing on the management and the role of performance measurement in collaboration activities and collaborative networks (e.g., Tsai, 2009). As university-industry collaborations can be considered as different types of networks among participating organizations, the performance management and measurement practices developed to support the management of networking activities among organizations could also be utilized in the context of university-industry collaborations. For example, some theoretical studies have focused on performance measurement in collaborative organizations and networks (Busi and Bititci, 2006; Varamäki et al., 2008).

According to Perkmann et al. (2011), contemporary university-industry collaborations differ from other types of research and development activities and alliances in several ways. The

outputs of these collaborations are often intangible and likely to be complex (Perkmann et al., 2011). In addition, authors further argue that benefits from these collaborative projects might be realized but only a long time after the projects are finished.

An increasing number of the contemporary university-industry collaboration activities are pursued in different types of research and development projects that form networks and ecosystems around the participating stakeholders. Even though these collaborative research and development projects between universities and industry organizations are unique by nature, there exist plenty of similarities that could be measured and evaluated by utilizing the same measures and frameworks. Albats et al. (2018) state that earlier attempts to address the issue of developing comprehensive and universal measures and indicators have recognized deficiencies in the currently utilized indicators. The authors further argue that the utilized indicators are mainly focused on the macro-level evaluation and are applied by financier delegates and governmental funding programs.

The previous literature on performance management and measurement in university-industry collaborations have presented tools and frameworks to support the performance measurement of these collaborations (Al-Ashaab et al., 2011; Albats et al., 2018; Iqbal et al., 2011; Mora-Valentin et al., 2004; Perkmann et al., 2011; Tijssen, 2012). These studies suggest that the performance measurement frameworks and tools to evaluate university-industry collaborations should include a balanced set of measures that pay attention to needs of all participating stakeholders. Generally, the previous studies have identified four stages of university-industry collaborations (input, in process, output, impact/outcome) that should be paid attention to in performance measurement (Rantala and Ukko, 2018):

- Input: participating organizations' resources (time, money, and staff allocated to collaboration), and the capabilities and motivations of participants.
- In process: relevant research, high-quality research, and training and learning opportunities.
- Output: new technologies, services, and innovations, as well as new scientific knowledge, and skilled and trained persons.
- Impact/outcome: new ideas, new research and development plans, solution concepts, and human capital.

As university-industry collaborations can be considered different types of networks among participating organizations, Kaplan et al. (2010) indicate that understanding how to measure network-level performance can support the collaboration at the network level and enhance the participants' understanding of how to create a joint strategy and insure commitment. Thus, the performance measurement in university-industry collaborations should be designed, implemented, and made visible to all stakeholders to support evaluation and management of the collaboration activities. In other words, the designed and implemented performance measurement systems should pay attention to the aims and goals of the researchers, societal organizations, and financier delegates (in cases where the collaboration activities are receiving funding support from governmental funding programs/agencies).

An important part of the universities entrepreneurial activities is supplying other societal organizations with specialized knowledge, as well as acting as counterparts in innovation processes of organizations (Albats et al., 2018). The traditional performance measurement

theory suggests that performance measures at the organizational level for processes, teams, and individuals must be integrated and aligned and be used for reward and guidance purposes (Bourne et al., 2000; Ukko et al., 2008;). However, some challenges are apparent in the emerging networked, open-innovation environment, with the vague aim of its working processes and measurable outputs (e.g., Ulhoi, 2004). In addition to challenge to understanding the context of collaboration networks, where the participants' actions and performances are measured, it is not obvious how such measurements should be done. The open-innovation environment creates even more challenges, where it is not evident who the creator or owner of the new knowledge and intellectual capital should be and who should be responsible for the measurement.

The literature further recognizes the importance of innovation and development activities and the management of knowledge, innovation capabilities, and intellectual capital for the organization's future competitiveness. Adams et al. (2006) suggest that, although it is a difficult process, measuring and evaluating these elements are important in driving continuous improvement and creativity. However, the evaluation of innovation activities is usually divided into input, process, and output measures. The problem with this kind of measurement is that it is only suitable to certain types of innovation and collaboration activities. The type of evaluation seems to depend on the contextual factors and the type of innovation activity (Carayannis and Provance, 2008). Further, in the context of innovation-related collaboration activities between university and other societal organizations, focusing solely on measuring resources and outputs does not fully capture all the components of innovation capability. The measurement of innovation capabilities is an issue that has been given attention among academics during last decade. Saunila and Ukko (2012) have devised a conceptual framework for measuring innovation capability and its effects. They argue that simply knowing how many new innovative processes, actions, or products have been initiated is insufficient if there is no understanding about their connections to performance.

As a summary of the contemporary performance measurement activities in university-industry collaborations, the entrepreneurial and third mission activities of universities need an overall evaluation that pays attention to all participating stakeholders (this is displayed in blue in Figure 6). According to Secundo et al. (2017), the evaluation activities should go beyond the context-specific aspects, to pay attention to wider social and economic benefits, such as transformation of knowledge, the development of intangible assets behind the new venture process, and contributions to social, cultural, and economic development.

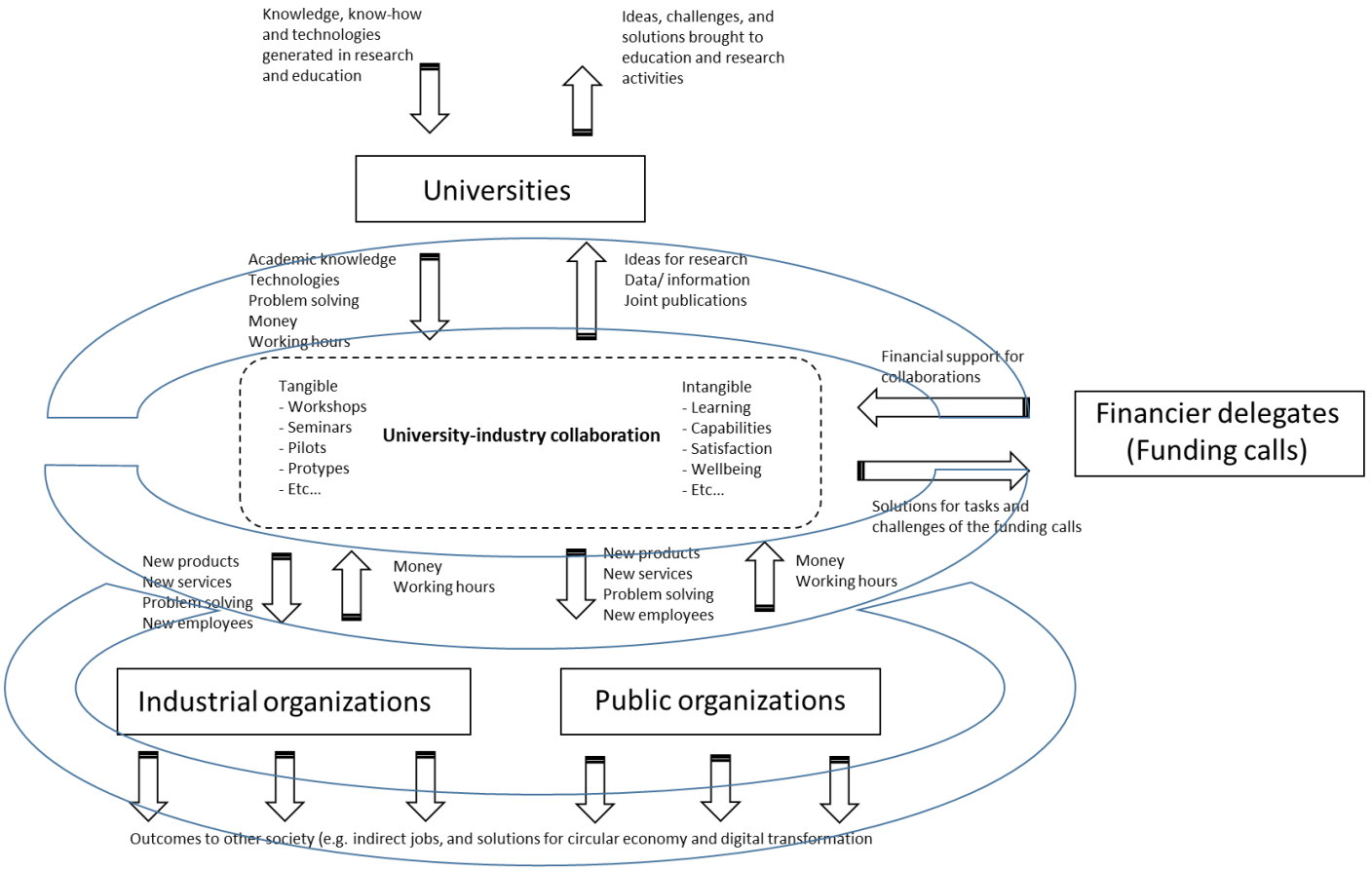

Figure 6. The framework of the performance measurement in university-industry collaboration.

3. RESEARCH DESIGN

This chapter presents the research strategy, research approach, and research methods of the dissertation. In addition, the processes and methods for data gathering are presented.

3.1. Research approach

According to Gummesson (2000), conducting science is a continuing search; it can be seen as a generation of theories, models, concepts, and categories. According to Crotty (1998), the basic elements of any research process can be divided to four different parts that are related to epistemology, theoretical perspective, methodology, and methods. Crotty (1998) further states that epistemology can be considered as the theory of knowledge embedded in the theoretical perspective and thereby in the methodology. According to Crook and Garratt (2005), a research paradigm can be considered as a conceptual framework that provides a model for adoption of particular coherent traditions of scientific research. Sparkes (1992) argues that the term *paradigm* refers to the different research frameworks or perspectives, including contrasting form of values, assumptions, and beliefs. According to Crook and Garratt (2005), these perspectives and frameworks deal with methodological, ontological, and epistemological considerations shaping the nature and conduct of research.

From the theoretical perspective, Crotty (1998) states that theoretical perspective of research refers to the philosophical stance informing the methodology and, thus, provides a context for the process and grounding its logic and criteria. According to Gummesson (2000), the subject of research paradigms is usually discussed in terms of an antithesis between two schools of philosophy: the positivistic, traditional natural science school and the humanistic school. In order to avoid confusion, the latter can be simply referred to as hermeneutics (Gummesson, 2000). Hirsjärvi et al. (2007) argue that, among the social sciences, there exists an antithesis between the phenomenological/hermeneutic and positivistic research approaches. Kasanen et al. (1991) explain that the focus of the research in business economics is related to a collision between the traditional positivistic research and its alternatives. Even though both hermeneutic and positivistic research seek objectivity, there exist differences in the level of objectivity achieved by these paradigms. The focus of research in the positivistic paradigm relies on explanation and description, trying to maintain a high level of objectivity. For the research related to the positivistic paradigm, the utilization of quantitative research methods and mathematical and statistical analyzation techniques are characteristic of the approach. The utilization of different statistical and mathematics tools and methods creates a distinction between facts and value judgements. In comparison, for the hermeneutic paradigm, it characteristically focuses on the understanding and interpretation, as well as generalizations, of research findings. In the hermeneutic paradigm, the distinction between facts and value judgement can be less clear. In other words, compared with the positivistic paradigm, the focus is not on achieving pure objectivity, but also on accepting the subjectivity as a part of the research findings in order to understand the holistic nature of the research objectives. According to Gummesson (2000), in

hermeneutics, when forming a preunderstanding for the research strategy and research objectives, researchers usually accept the influence of both personal experience and science.

In addition to the theoretical perspective of conducting research and the antithesis between research paradigms, Crotty (1998) argues that research methodology is related to the strategy of the research, the plan of different actions during the research, the selection and use of particular research methods, and linking the selection of the methods to the outcomes. As a part of the methodological choices, the research approach can typically be categorized as qualitative research and quantitative research. Where quantitative research usually refers to positivism, the approach of qualitative research is usually related to hermeneutics. Hirsjärvi et al. (2007) state that the idea of utilizing qualitative research is in understanding and describing real-life phenomena, including the idea of the varieties of reality and the real world.

Referring to the selection of research methods, Crotty (1998) indicates that research methods can be considered as the techniques or procedures used to gather and analyze data related to some research question and hypothesis. The understanding of the most applicable way of conducting the research and searching for this understanding and its supporting facts should provide guidance for the selection of the best research method. As a part of the qualitative research approach, there has been a recognition of the importance of bringing empirical level clarity and increased rigor to theory building by utilizing case studies. Gummesson (2000) argue that case studies, as a part of the qualitative research approach, provide powerful tools for researchers in management and business subjects that can be utilized to generate in-depth understanding of the explored phenomena and mechanisms. As an alternative for more positivistic statistical and survey-based research, operations management scholars have also embraced the utilization of qualitative and case study research (Barratt et al., 2011). As such, using case studies as a research approach has become more accepted as a scientific tool in management research (Gummesson, 2000), and a number of articles have demonstrated how to apply case studies among the different academic disciplines (e.g., Barratt et al., 2011; Bitektine, 2008: Eisenhardt and Graebner, 2007; Stuart et al., 2002; Voss et al., 2002; Yin, 1994).

The selection and utilization of a single case study or multiple case studies as a research method should usually be done based on the research problem to be explored. A single case study can be considered as an appropriate research method under the circumstances where an investigator or researcher has the opportunity to observe and analyze a previously inaccessible phenomenon (Yin, 2009). Voss et al. (2002) note the dilemma of choosing the correct number of cases, and they suggest that the fewer the number of cases creates possibilities for deeper observation. In contrast, the utilization of multiple cases can provide more robust and reliable data that can be applied in research and data triangulation in order to avoid possible observation biases (Barratt et al., 2011; Eisenhardt and Graebner, 2007).

As university-industry collaboration is a multi-level phenomenon involving different stakeholders with different organizational cultures, and with different aims and goals for the collaboration, an empirical qualitative research approach was selected for this dissertation in order to search for an in-depth understanding of the role of performance measurement in the university collaborations. As it searches for an in-depth understanding of the operational

level performance measurement in university-industry collaboration, this study can be considered as hermeneutic. As a research method, a single case study and multiple case studies were utilized.

3.2 Data gathering

As this study focuses on the operational level performance measurement in university-industry collaborations, the data for this dissertation were gathered from different university-industry collaboration projects in Finland. The scientific disciplines that the university participants represented were mainly related to industrial management, economics, and engineering.

Even though both qualitative and quantitative methods for data gathering can be utilized in case studies, and case studies can be considered as empirical research where contextually rich data are derived from real-life settings (Barratt et al., 2011), the utilization of qualitative research methods usually dominates the process of data collection (Gummesson, 2000). When utilizing case studies as a research method, there typically exist several different ways for data collection: interviews that can be either structured or semi-structured, research observations during the research projects, and some archival sources (e.g., organizations reports and statistics) (Barratt et al., 2011). Instead of using one specific method for data gathering, the utilization of different methods and multiple sources for data gathering increases the reliability of the data and analyzed results. The gathering and utilization of data from different sources also provides possibilities for data triangulation (e.g., Choi and Hong, 2002).

The empirical data for this dissertation was gathered from five different cases of university-industry collaboration activities in Finland.

- The data for the first publication was gathered from two single-case studies that explored the implementation practices and the challenges of performance measurement in university-industry collaboration. The phenomenon was explored in two university-industry SME innovation networks in Finland. The data were gathered through individual interviews, workshop observations, and a survey conducted for the participating organizations.
- The data for the second publication were gathered from interviews with twelve university project managers, representing three different universities in Finland. The interview participants were chosen by how actively they had been part of managing and measurement of these projects, which were funded by different external sources. In addition, two financier representatives from the European Regional Development Funds of Finland and two members of the Finnish Funding Agency for Technology and Innovation were also interviewed. Semi-structured interviews were conducted with the same themes and factors as were used with the university project managers to ensure comparability with the evaluation processes employed and the challenges that were included.

- The data for the third publication to support the understanding of the development of innovation and collaboration activities between Universities of Applied Sciences and industry were gathered through two different questionnaires, workshop observations, and semi-structured interviews from different regions in Finland.
- The empirical results for the fourth publication were gathered from the research and development project where a performance measurement system for the university-public organization collaboration was collaboratively designed. The data were gathered from interviews with the management team (including both public organization and university members), workshop observations, and a survey that was arranged for participants from public organizations.
- The empirical data for the fifth publication were gathered from two longitudinal Finnish case studies from European regional development activities established between university research units and private and public sector organizations operating in the same regional area. The data from two different research projects were gathered from the individual and group interviews, surveys, workshop observations, field notes, memos, and drawings.

While it might be possible to conduct research by utilizing a single specific research method, for example, observation (Gersick, 1988), the utilization of multiple methods in data gathering from different sources enables data triangulation (Barratt et al., 2011; Choi and Hong, 2002). Utilizing multiple methods and sources for data gathering increases the reliability of the data and research findings and produces stronger constructs and propositions (Eisenhardt, 1989; Voss et al., 2002). The utilization of multiple methods and sources for data gathering also reduces possible biases related to data gathering.

In addition to data gathering, a major part of the research strategy was related to data analyzation (Barratt et al., 2011; Eisenhardt, 1989; Stuart et al., 2002; Yin, 1994). According to Glaser and Strauss (1967), the data analyzation needs to occur simultaneously with the data gathering. Achieving the overlap between the data gathering and analyzation makes it possible for the researcher to capture and interpret the reality that the gathered data represent (McCutcheon and Meredith, 1993). The data gathering and analyzation is summarized Table 1.

Table 1. Data gathering and analyzation

	Publication I	**Publication II**	**Publication III**	**Publication IV**	**Publication V**
Title	Performance measurement in university-industry innovation networks: implementation practices and challenges of industrial organizations	Performance measurement in university-industry collaboration projects: university and financier perspectives	Developing collaboration structures for university-industry interaction and innovations	Designing a performance measurement system for university-public-organization collaboration	Performance evaluation to support European regional development – university-industry perspective
Data gathering	Individual interviews with 1–2 members of each participating organization managers (50 persons) Workshop observation from 15 workshops	Individual interviews 12 interviews with university project managers 4 interviews with financier delegates	Survey (65 answers from SMEs in southern Finland 12 interviews with SMEs having prior contact with Universities of Applied Sciences of various regions Workshop observations from 11 workshops Survey (in total 110 answers, 35 from SMEs, 75 from UAS)	Group interviews (a total of 4 semi-structured group interviews lasting approximately 2.5 hours were executed) Workshop observations from 2 workshops Survey (a total of 21 answers from participants from public organizations)	Data gathering from project 1 From three different cases: individual and group interviews, workshop observations, field notes, memos, surveys, and drawings Data gathering from project 2: Workshop observations from 3 different workshops (10–15 participants) Feedback gathered after the workshops
Data analysis methods	Qualitative content analysis, cross-analysis, quantitative analysis	Qualitative content analysis and cross-analysis	Qualitative content analysis, cross-analysis, Quantitative analysis	Qualitative content analysis, Quantitative analysis	Qualitative content analysis, cross-analysis, quantitative analysis
Role of the researcher	Facilitator, observer, interviewer	Interviewer	Part of the data analyzation and research triangulation	Facilitator, observer, interviewer	Facilitator, observer, interviewer

4. RESULTS OF THE STUDY

The results of this study are presented and summarized in this chapter. First, the main results of the study are presented in the following paragraphs, after which the main findings of each of the five scientific publications are presented.

4.1 Main findings of the study

The results of the study reveal that, even though there is a growing interest among academics and practitioners in better performance measurement practices in university-industry collaborations, the current situation is shaped by many challenges, and properly adopted and utilized performance measurement systems are rare. All participating and related stakeholder groups (university members, members from industrial and other societal organizations, financier delegates, and politicians/governmental decision-makers) have recognized the growing importance of the performance measurement methods and tools to support the evaluation of the university-industry collaboration. However, despite the growing interest of each of the stakeholder groups, they all seem to have individual evaluation activities and challenges, which are not collaboratively designed and adopted.

Even though the literature on performance management and measurement suggests that contemporary performance measurement systems should include a balanced set of measures that can be used to give a holistic understanding of the performance in university-industry collaborations, the current evaluation frameworks and methods seem not be balanced. The results of the study indicate that the main focus of the performance measurement activities in university-industry collaborations currently seem to be on supporting external communication and reporting tasks. Despite the growing interest and awareness related to organizations' internal performance measurement in collaboration activities, for example, to evaluate the innovation capabilities of different organizations, the performance measurement in university-industry collaborations appear to be focused on issues that are reported to external stakeholders. Even these external performance measurement activities seem to be partially deficient and to focus primarily on the issues that are reported to financier delegates involved in the collaborations.

The results further reveal that currently in university-industry collaborations, relatively few resources are used in designing and building performance measurement frameworks and tools. It is a quite common practice that, after the prepared university-industry collaboration has received the acceptance from the financier delegates, the collaboration activities are started by following the original research plan or funding application. There might be a meeting or two where the "ground rules" for the collaboration activities are discussed together with the participants. In these meetings, the discussion related to performance measurement usually focuses on following and meeting the goals that are promised in the funding application. There does not seem to exist a culture where performance measurement methods or tools are designed together with the participants of the university-industry collaborations.

The results also indicate that the responsibility of operational level performance measurement in contemporary university-industry collaborations lies mainly on the shoulders of the university representatives. More precisely, it is usually a practice that one or two persons, usually the university project manager, pursues the performance measurement activities. This practice leads to a situation where the understanding of the collaborations' performance personifies. It is of course good that the project manager has the best understanding of the project´s performance, but it also causes challenges for the evaluation if the person responsible for the performance measurement is unavailable for evaluation (for example, if he or she changes workplace during or after the collaboration activities).

As mentioned above, the main focus of the performance measurement in university-industry collaborations at the operational level seem to be on external reporting. Even though the university project managers mainly pursue the measurement activities, they do not generally focus on the internal and intellectual issues, such as increased learning, well-being of the university researchers, or the satisfaction of the participating organizations. Further, the focus of the performance measurement does not seem to be on the achievement of the universities or researchers' own goals, such as the number of high-level academic publications or the number of new project proposals. Instead, the focus of the performance measurement seems to currently be on reporting the collaborations' activities and performance to financier delegates. As mentioned above, the collaborations are mainly started without using time or resources to design and build the performance measurement systems. Due the lack of a collaborative design, the performance measurement activities are strongly connected to following the project application and reporting the results by reflecting them in terms of the original project application. This creates a situation where the measurement activities are mainly pursued by utilizing tangible measures, such as the amount of salaries and the number of workshops arranged.

From the perspective of the university, the results of this study show that, for the most part, in the university-industry collaborations, universities are the active players in designing and building the collaborations. University researchers usually prepare the project applications in response to certain calls from the financier delegates. During the preparation phase, they normally search for the possible industry or public organizations that they could collaborate with. The current situation of decreasing governmental funding support for university-industry collaborations is causing stricter norms and regulations for the financing of programs. For that reason, many of the participating organizations have to carefully consider which collaborations they can participate in with universities. Even though the topic and theme of the funding call might be attractive for industrial organizations, the fee for participation may be so high that, despite the interest, the organizations cannot afford to participate. For that reason, in many cases, university researchers are not interested in evaluating the most suitable partners beforehand, but are more likely to search for the candidates that are suitable and that can afford to participate in collaboration activities. As university researchers and project managers are not that interested in the performance measurement activities before the collaborations are started, their main focus of the performance measurement seems to be on the evaluation activities during the collaboration. The performance measurement activities are executed during the projects, and directly after

they are finished. In other words, the performance measurement activities focus on the evaluation of activities while they are running and the evaluation of short-term outputs that can be tracked right after the collaborations. Even though it has been recognized in previous studies on university-industry collaboration that the majority of the outcomes of these collaborations are only realized after a certain amount of time (e.g., three to five years), performance measurement activities with this long-term perspective are rare. After the collaboration activities are finished, university project managers and researchers are continuing on to new collaboration projects or to other university-related tasks. It seems to be the current situation that there do not exist collaboration activities where resources (salaries) would have been allocated to long-term evaluation.

Even though the performance measurement activities in university-industry collaborations are currently mainly pursued by university participants, the results of the study indicate that other organizations participating in these collaborations are also interested in the measurement. Industrial organizations participating in the collaboration activities seem to be interested in the evaluation of the outputs and societal-level outcomes of the collaborations, even though they face some challenges in understanding the interplay between the intellectual capital-related collaboration activities and evaluation of business-related outputs and outcomes. The results of the study also reveal that the involvement of the participating organizations (industrial, public, or third sector) in designing, building, and using performance measurement can increase the participants' understanding of and motivation for the collaboration.

The results of the study also shed light on the contemporary performance measurement practices and challenges of the financier delegates in university-industry collaborations. Compared with university participants, financier delegates use much more time and effort in the evaluation of the project applications before the collaboration activities. By doing so, they are attempting to find the best possible collaborations that should be financed and the ones that are the most suitable for the funding calls. In the current economic situation, financier delegates are also paying careful attention to the evaluation of the participating organizations' possibilities to "survive" through the collaboration. There have been several cases where industrial organizations participating in collaboration activities have faced bankruptcy during the collaboration. These situations naturally cause harm and challenges for other participants of the collaborations, and for that reason, the financier delegates are trying to avoid these situations by evaluating the participating organizations' economic situation. After the project applications are accepted and collaboration activities started, the financier delegates focus on the performance measurement to insure that the collaboration activities are executed as they were planned in the application phase and that they are achieving their goals. During the collaboration activities, challenges for the financier delegates arise when the collaborations are not following their original plans. As there usually do not exist performance measurement systems that would have been designed in the beginning of the collaborations, the changes in tasks and goals of the collaborations might be hard for the financier delegates to evaluate. For that reason, the results of this study indicate that it would to be easier for all the participating organizations and for the financier delegates to follow the project applications or project plans, even though, in some cases, it would not be reasonable. Compared with university participants, financier delegates use

more time and effort to conduct long-term performance measurement and evaluation of the university-industry collaborations. They are interested in finding good practices and long-term effective outcomes that could be used for other collaborations. However, despite the interests of the financier delegates in the long-term performance measurement of university-industry collaborations, the lack of collaborative performance measurement systems and the personification of the performance measurement also causes challenges for the financier delegates. If the person who was responsible for the performance measurement during the collaboration is not available for the long-term evaluation purposes, the measurement will be challenging.

The results of the study also reveal that, in university-public organizations, the collaborative performance measurement design and building process can be used to overcome the challenges related to evaluation of such collaborations. The results from the case study show that university-public organization collaboration combines performance measurement challenges that are characteristic for university-industry collaboration and public sector performance measurement. Based on the results of this study, the involvement of the participants at an early stage to performance measurement design and building process increases the participants' understanding of the role of performance measurement in university-public organization collaboration.

Finally, the results show that, related to regional development activities, university-industry collaborations are mainly pursued at the operational level, which also refers to performance measurement. As the participating stakeholders are primarily concerned about developing collaborative research and development activities at the operational level, the participants face challenges in understanding the connection between the operational level development activities and regional level development. When designing and building the performance measurement systems for such regional development-related university-industry collaborations, attention must be paid to connecting the operational level development activities to upper level programs and mechanisms.

The findings of the study are summarized in Figure 7. Even though the literature on performance measurement in university-industry collaborations has suggested that performance measurement activities should pay close attention to the interests of all participating stakeholders (Figure 6), the results show that the current reality differs from that situation (presented in blue in Figure 7). The current performance measurement activities in university-industry collaboration focus strongly on the measurement and evaluation of financier delegates' interests and the evaluation of tangible and short-term aspects of the collaborations.

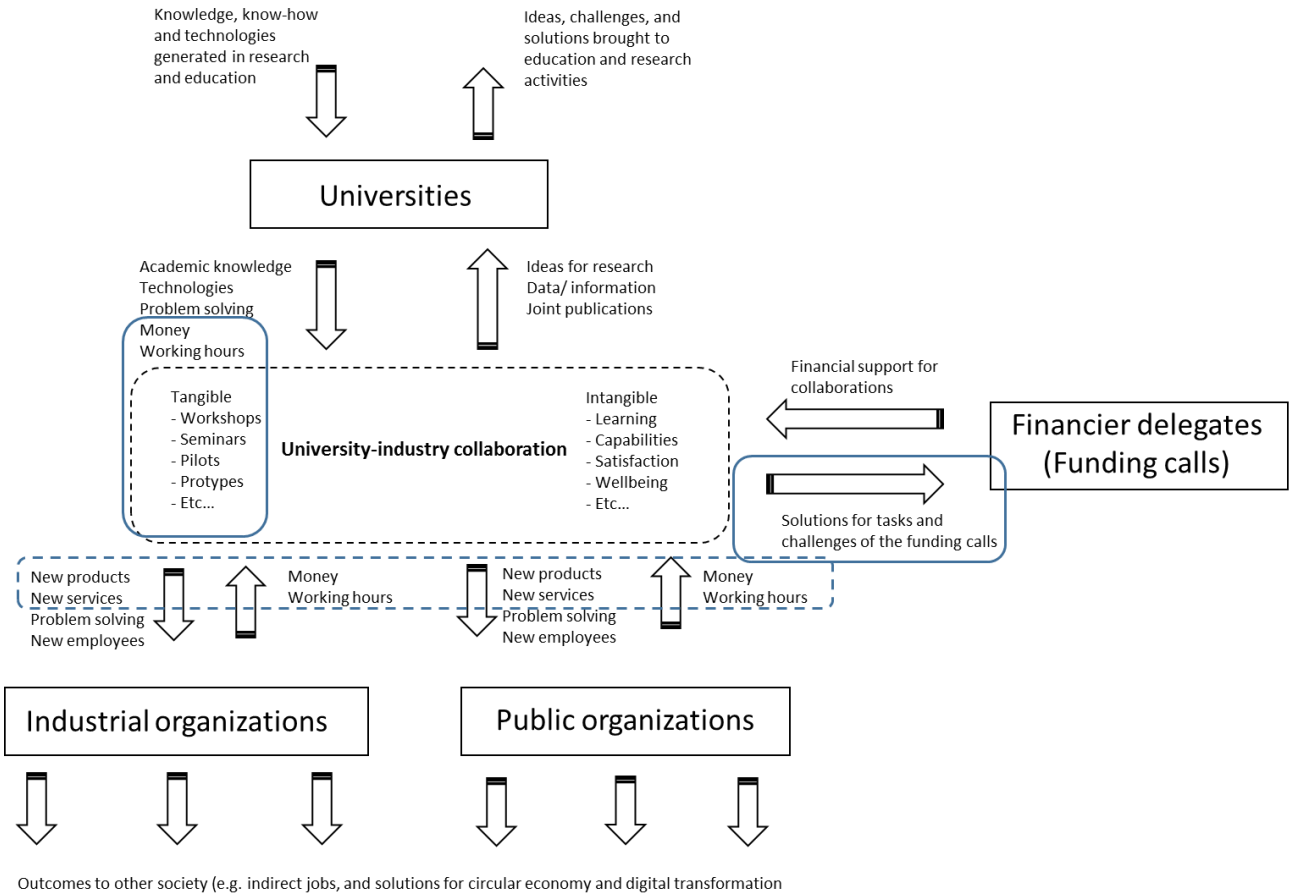

Figure 7. The current focus of the performance measurement in university-industry collaborations.

4.2 Summary of the publications

Table 2. Summary of the publications

	Publication I	Publication II	Publication III	Publication IV	Publication V
Title	Performance measurement in university-industry innovation networks: implementation practices and challenges of industrial organizations	Performance measurement in university-industry collaboration projects: university and financier perspectives	Developing collaboration structures for university-industry interaction and innovations	Designing a performance measurement system for university-public-organization collaboration	Performance evaluation to support European regional development – university-industry perspective
Main objective of the publication	To explore the current performance measurement practices and challenges of industrial organizations in university collaborations	To explore the current performance measurement practices and challenges of university project managers and financier delegates in university-industry collaborations	To provide examples of the current multifaceted management and evaluation challenges in university-industry collaborations	To explore and present the designing and building of the performance measurement systems in the context of university-public organization collaboration	To explore and present the designing and building of the performance measurement system in the context of university collaborations as a part of regional development
Main findings of the publication	The lack of understanding of the context and process of performance measurement seems to shift industrial organizations' focus to the content stage of the performance measurement and to the use of traditional performance measures and tools to estimate the advantages gained.	Project applications are used as a main framework for performance measurement activities, and there do not seem to exist performance measurement systems that are designed and implemented together with all participating stakeholders .	The study describes issues challenging the collaborative innovation activities and directions to focus on structural development to support interaction with parties having different backgrounds, goals, and strengths.	Even though the context of the performance measurement in university public-organization collaboration seem to be unclear to both participating stakeholders, the building of the performance measurement system for these collaborations can support the management of them.	The results of the study show that it is possible to use the evaluation systems to increase the understanding of the interplay between operational level development activities and regional development programs.
Contribution to the thesis	Increase the understanding of the performance measurement practices and challenges from the perspective of industrial organizations	Increase the understanding of the performance measurement practices and challenges from the perspective of universities and financier delegates	Provide an example of the collaboration activities where "traditional" performance measurement tools and frameworks should be supplemented	Provide a framework for designing and building a performance measurement system in university-public organization collaboration	Present a framework for designing and building a performance evaluation system for regional development activities between universities and other societal organizations

Publication I

Rantala, T. and Ukko, J. (2018) Performance measurement in university–industry innovation networks: implementation practices and challenges of industrial organisations. *Journal of Education and Work*, 31 (3), 247-261.

The aim of the first publication is to broaden the empirical understanding of performance measurement and university–industry collaboration by contributing to the understanding of the current performance measurement methods and practices that are implemented by industrial organizations. The publication also aims to enhance the understanding of the current challenges to performance measurement implementation that are faced by industrial organizations in university–industry innovation networks. The data for the first publication were gathered from two university–industry innovation networks that were established to support the long-term innovation activities of the industrial SMEs. The results of the study reveal that industrial SMEs are interested in the performance measurement of societal-level outputs by university–industry innovation networks, even though they face challenges in understanding the aims and goals of the funding programs. Furthermore, the results show that the industrial SMEs understand the intellectual nature of the university–industry innovation networks, but their performance measurement activities are business-related. Also the lack of understanding of the context and the process of the performance measurement in university–industry collaborations seems to shift industrial organizations' focus to the content stage of the performance measurement and to the use of traditional performance measures and tools to estimate the advantages gained.

The results also reveal some differences of opinion about who should be responsible for measuring the collaboration in university innovation networks. The participating industrial SMEs thought that the measurement of "university-related" operations, as well as the long-term societal-level performance measurement, should be implemented by the university operators. However, from the university's perspective, one challenge to evaluate these innovation networks is that industrial organizations often pursue proprietary strategies that involve secrecy and intellectual property protection. Although the idea of the working process in both cases is based on open innovation, the organizations are not eager to share with the researchers all the ideas, innovations, and contracts generated during the process.

Publication II

Rantala, T., Ukko, J., and Saunila, M. (n.d.). Performance measurement in university-industry collaboration projects: university and financier perspectives. *Triple Helix*. Submitted 2019.

The aim of the second publication is to increase the understanding of the current performance measurement practices and challenges of university–industry collaboration projects and support the future development of evaluation methods for such collaborations. The performance measurement practices currently used by universities and financiers in the university-industry collaboration projects are explored in the second publication. The

empirical data for the second publication were gathered from university-industry projects by interviewing university project managers and financier delegates.

The results of the second publication reveal the challenges of performance measurement in university-industry collaborations from the viewpoints of university project managers and financier delegates. The contemporary challenges, as well as methods used to evaluate the performance in university-industry collaboration, are explored from three different perspectives: before, during, and after the projects. One main finding of the second publication is that the performance measurement activities rely strongly on the project applications and project plans. Both university project managers, as well as financier delegates, seem to be satisfied if the projects strictly follow the original plan, and in many cases, the project applications are used as the only performance measurement framework. The measurements promised in the project applications are mainly related to external activities of the collaborations (such as workshops arranged, reports published, or companies established), and there does not seem to exist measurement practices that would pay attention to universities' internal aspects, such as increased learning, satisfaction, or motivation of researchers.

The results of the second publication further indicate that, because project applications are used as a main framework for performance measurement activities, there do not seem to exist performance measurement systems that are designed and implemented together with all participating stakeholders. Some individual measurements are usually taken from the project applications that are implemented and used to steer the collaborations and make results visible. These measurements usually follow the guidelines and instructions of funding agencies, but comprehensive performance measurement systems are lacking.

From the perspective of the financier delegates, the results of the second publication show that they are currently using evaluation criteria provided by the funding calls, as well as the aims and goals promised in the project applications, while evaluating the performance of university-industry collaborations. The biggest challenges they seem to face in these actions are related to cross-project evaluation. They struggle to find successful projects that could be used as benchmarks for other projects, and the comparison with different projects poses challenges. Even though some performance measurement tools have been suggested in the literature, the results of the publication's study indicate that both researchers and financier delegates are unfamiliar with them and do not systematically implement them. Based on the findings of the second publication's study, there does not appear to exist a culture where performance measurement activities have been commonly designed and adopted with university project managers, industry organizations, and financier representatives.

Publication III

Mäkimattila, M., Junell, T., & Rantala, T. (2015). Developing collaboration structures for university-industry interaction and innovations. *European Journal of Innovation Management*, 18, (4), 451-470.

The purpose of the third publication cited in this dissertation is to provide an example of the contemporary university-industry collaboration. From the perspectives of the dissertation, it

provides examples of the current management and evaluation challenges. Instead of focusing on traditional technology-based development activities, the aim of the collaboration and research and development project in the study is to create tools and operations models for SME-university collaboration for innovation activities and internationalization (Figure 8).

The aim of the project is to create tools and operations models for SME-university collaboration for innovation activities and internalization. The research focuses on developing enabling structures, models, and methods supporting cooperation and interaction in these actions and relationships. The third publication examines the doing, using, and interacting (DUI) mode of innovation activities in university-industry collaborations. In addition, the publication presents the importance of the role of interconnection of DUI, absorptive capacity, and social capital, while developing the collaboration structures and activities.

The publication presents contemporary issues challenging the collaborative innovation activities and directions to focus on structural development to support interaction with participants having different organizational backgrounds and aims for the collaboration. The publication highlights the importance of knowledge exchange between universities and firms, as well as the different learning modes related to innovation.

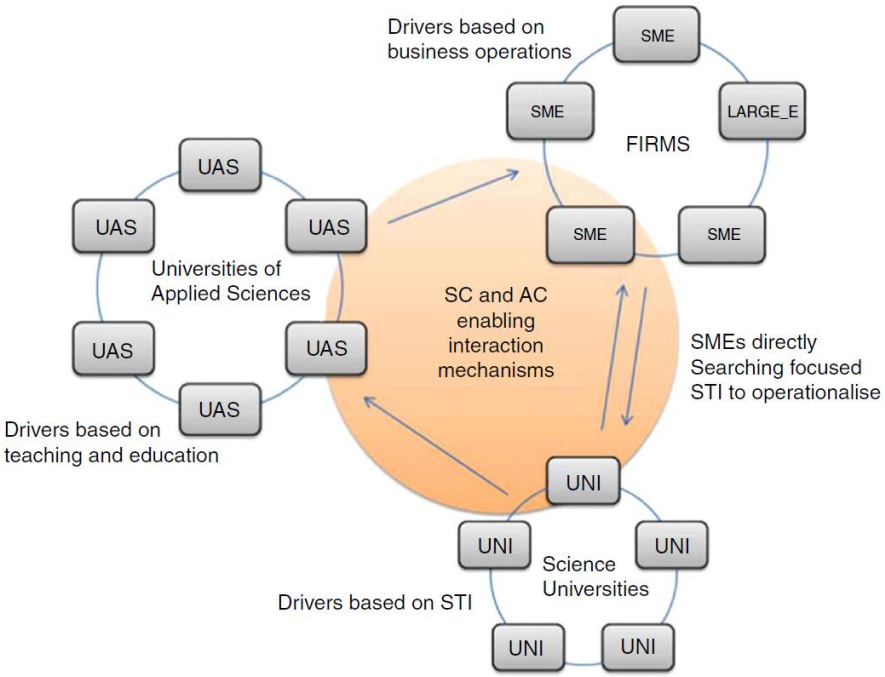

Figure 8. Doing, using and interacting (DUI), and Science, technology, and innovation (STI) sourcing from different contexts in university-industry collaborations

As the focus of the of the collaboration activities presented in the third publication of the thesis was to create tools and operations models for SME-university collaboration for innovation activities and internalization, it highlights the challenges of the evaluation of these collaborations. The publication as such provides an example of the collaboration activities where "traditional" performance measurement tools and frameworks should be supplemented by the measurements focusing on innovation capabilities, absorptive capacity, and social capital.

Publication IV

Rantala, T., Ukko, J., & Rantanen, H. (2018) Designing a performance measurement system for university-public-organization collaboration. *International Journal of Public Sector Performance Management,* 4 (3), 349-372.

The purpose of the fourth publication used for the dissertation is to explore and present the designing and building of the performance measurement system in the context of university-public organization collaboration. Based on the literature on performance measurement, university-industry collaboration, and public sector management, a model for the performance measurement design process is presented in the publication. After the construction of the process, based on the literature, the model was empirically tested. The empirical part of the fourth research publication was based on collaborative research and a development project between a university and a public dental healthcare organization.

The results of the fourth publication show that, even though the context of the performance measurement in university public-organization collaboration seem to be unclear to both public sector managers and university researchers and project managers, the building of the performance measurement system for these collaborations can support the management of them. Further, the results of the publication reveal that utilizing of a performance measurement system design process for university-public organization collaboration can reduce and even overcome some of the challenges related to performance measurement in such a context.

After the collaborative design and building of the performance measurement system for university-public organization collaboration, the results and findings gathered from the empirical part of the fourth publication were added to the process model that was constructed from the literature. The empirical findings and process phases that require careful attention were highlighted, and a comprehensive process model to design a performance measurement system for university-public organization collaboration was presented.

Publication V

Rantala, T., & Ukko, J. (2019). Performance evaluation to support European regional development – university-industry perspective. *European Planning Studies,*27 (5), 974-994.

The purpose of the fifth publication of the dissertation is to develop and present a framework for designing and building of a performance evaluation system to support the performance

measurement of regional development activities between universities and other societal organizations. Two longitudinal operational level collaboration projects are utilized to provide empirical evidence to support the development of the presented framework.

The presented framework for performance measurement design and building demonstrates the importance of the evaluation as a part of the learning development in regional development activities between universities and other societal organizations. The results of the fifth publication further reveal that contemporary university–industry collaborations are pursuing regional development programs and policies mainly at the operational level. As such, the performance measurement activities in these collaborations are mainly related to operational level development activities. However, involving the participating organizations, both university and industrial, in the performance measurement process could help to overcome the participants' lack of understanding of the connections between the operational level development activities and regional level development programs.

Overcoming the challenges of the interplay between operational level development activities and regional level development programs increases the participants' motivation to also achieve the development goals at the regional level. As such, the collaborative designing and building of the performance measurement system in university–industry collaboration in the context of regional development can create an environment in which operational level participants are more deeply involved in regional level development.

5. DISCUSSION

Even though the collaboration activities between universities and other societal organizations have gained a substantial amount of interest from different stakeholders during the last decades (Etzkowitz, 2016; Huang and Chen, 2017; Kalar and Antonic, 2015; Kapetanoiu and Lee, 2017; Klofsten et al., 2019), the results of the study for this dissertation support the findings of Kapetanoiu and Lee (2017) and Göransson et al. (2009), showing that the participating stakeholders lack comprehensive frameworks and tools to support the performance measurement activities of these collaborations. As the main reason behind the forming of these collaboration activities is the transformation and dissemination of scientific knowledge to increase societal well-being and economic development, the performance measurement should focus on the evaluation of these aspects. However, the results of the study show that the current performance measurement activities in contemporary university-industry collaborations focus strongly on the evaluation of goals and aims of the funding themes and tasks promised in collaboration and funding applications. Even though the evaluation and measurement of these aspects generate outputs and outcomes for societal-level development through the goals of funding programs and funding themes, the outcomes and effects generated through the universities and other societal organizations seem to be under-evaluated. In other words, the current performance measurement activities in university-industry collaborations seem to be predominantly highlighted by the evaluation of the viewpoints of funding themes and programs.

Despite the recognized challenges, the results of the study are further in line with Perkmann et al. (2011), showing that the participating stakeholders recognize the need for more comprehensive and balanced performance measurement practices, not only to make the achievements and outputs/outcomes of the collaborations visible, but also to steer and monitor the collaboration activities. However, despite this, there seems to exist a common agreement about the need for the development of better performance measurement methods and practices, and the results of the study show that the current performance measurement activities in university-industry collaborations are strongly personified on university project managers and researchers. While the performance measurement activities seem to be expected as tasks of the university project managers and researchers, the connection of these external tasks causes them challenges to create a connection between the collaboration activities outside academia and the other tasks of research and education. As such, the results support the findings of Secundo et al. (2017) and Wright et al. (2004), which show that, despite the growing interest in the collaboration activities, universities are currently lacking performance measurement practices to evaluate their entrepreneurial and third mission activities of societal effectiveness.

The literature on performance measurement (e.g., Bourne et al., 2000) has determined that there exist three typical stages in developing performance measurement systems: design, implementation, and use. Even though there exists a wide acceptance among academics that performance measurement systems should be designed and built together with participants and participating organizations, the results of the study indicate that university-industry

collaborations make a difference. These collaboration activities are mainly prepared together with university researchers and other societal organizations, after which applications for governmental funding support are directed to financier delegates. The results reveal that these project applications and preparations are in many cases used also as a performance measurement framework. However, in many cases, these applications and preparations are rejected, meaning they do not receive governmental funding support. Moreover, there exist other challenges related to these collaboration preparations, and no one seems to be currently interested in the resources that are sacrificed to rejected collaboration applications. It seems to be quite common that the majority of the project proposals and applications are rejected because of the current competitive situation. University project managers and researchers use numerous working hours writing project applications and proposals that are rejected and are not funded. Evaluations of how many resources are sacrificed to that work do not seem to exist. In the current situation, university researchers have to write, for example, two to three different applications in order to get one funded. Sometimes, some part of that work can be reused in later applications, but usually, that work will be forgotten. There exists a common acceptance among university researchers that there should also be performance measurement practices to evaluate how many resources are used for "unnecessary" work that could have been used, for example, for journal writing.

Even though Leischnig and Geigenmuller (2018) argue that forming, maintaining, and developing of collaboration activities with other societal organizations with different organizational cultures also require advanced managerial capabilities from operational level project managers and researchers, the results of this study indicate that capabilities related to performance management are partly inadequate. Even though the scholars and studies on performance measurement have suggested frameworks, methods, and Key performance indicators (KPI) for university-industry collaborations (Al-Ashaab et al., 2011; Albats et al., 2018; Iqbal et al., 2011; Mora-Valentin et al., 2004; Perkmann et al., 2011; Tijssen, 2012;), implemented and utilized performance measurement tools are quite uncommon. The results reveal that the participating stakeholders are unfamiliar with these suggested frameworks and tools, which causes challenges for their design and implementation. As such, the results of the challenges discovered from university-industry collaboration are in line with Busi and Bititci (2006), who argue that difficulties of developing a collaborative culture and common performance measurement practices have been the main barriers to the implementation and utilization of performance measurement. Though Lauras et al. (2010) state that each project manager should develop a range of key performance indicators for the projects, the results indicate that, in order to develop these KPIs, university project managers need more academic and practical-level support to better recognize the current performance measurement frameworks suggested by academics. This would enable them to develop and implement performance measurement practices and use existing models and processes to support planning, controlling, and evaluating the collaborations and collaborative projects.

Further related to changing and growing performance management and measurement practices in universities, the results also show that there currently exist challenges that are in line with Lin (2017) who argues that, in some cases, collaboration comes at the expense of basic research, determines the choice of research projects, and skews academic research. These collaborative commercialization and collaboration activities in many cases are extra

tasks for researchers that are not included in their salary systems. In other words, the researchers are participating in these collaboration activities because they are forced to and utilize them as tools to gather salaries for their main tasks of research and education. Even though the collaboration activities can sometimes produce joint publications with other organizations, in many cases, the gathered data are insufficient to be published in high-level journals and, thus, do not support the academic careers of researchers. The results show that university researchers find it difficult to connect the individual performance measurement activities of the collaborations to other performance management and measurement system of the universities, such as university rankings, which usually exist for the evaluation of first and second missions of universities (Secundo et al., 2017).

5.1 Recommendations to support the performance measurement implementation

To support the current performance measurement practices in university-industry collaborations, the creation of a collaborative design and implementation culture for performance measurement processes is needed to put the theoretical tools and frameworks into action. This culture should involve all the participating stakeholders, including the financier representatives, university project managers and researchers, and representatives of other organizations in designing, building, and implementing the measurement frameworks for university-industry collaborations, as well as supporting evaluation and management throughout the entire range of activities. This would enhance the measurement effectiveness of such collaborations at both the operational and societal levels.

To promote the successful implementation of performance measurement systems and practices, it would also be important to understand the form of the collaboration and the organizations' reasons and motivations for it. It is also essential to understand the goals of the different participating organizations. Failure to understand these factors can lead to difficulties or even result in the failure of the implementation of performance measurement practices in the university–industry collaborations. A significant issue causing confusion is with regard to "how the performance of the collaborative organization should be managed while also managing the performance of the participating organizations as a complete system" (Bititci et al., 2012). This challenge could be tackled by allowing organizations to first define their individual strategies and goals for the collaboration and then identify and consolidate common strategies and goals with their partners (Niebecker et al., 2010). One possible means of clarifying the joint vision and goal is to define the operations and activities that are included in the collaboration. This may help prevent misunderstandings and ambiguities about the shared collaboration goals and common measures (Niebecker et al., 2010), and it could help to better understand the designing and implementation of performance measurement.

Niebecker et al. (2010) also suggest that, through collaboration, KPIs could be exchanged and synchronized without threatening the expertise information privacy of the organizations involved because only relevant and predefined indicators would be monitored and controlled. This approach could serve to assure each participant's alignment with the collaboration strategies and goals, thus ensuring stakeholder commitment and defining the

performance measures collaboratively (Niebecker et al., 2008; Niebecker et al., 2010). Regarding the performance measurement of a single participating organization, Garengo et al. (2005) have found several obstacles to the implementation and the use of a performance measurement system, including the lack of human resources, inadequate managerial capacity, limited capital resources, a reactive approach, tacit knowledge, little attention given to the formalization of processes, and misconceptions about performance measurement. Because many of these concerns are still relevant, it would be negligent to assume that these obstacles would have no effect on the university–industry collaborations. For this reason, the clarity and the simplicity of a performance measurement system (Garengo et al., 2005) is also crucial for its successful implementation in university-industry collaborations.

The results of the study also show that the main parts of the performance measurement design and implementation activities are carried out in the early stages of the collaboration activities. Consequently, the participating stakeholders mainly track the original aims and goals of their participation, and they encounter challenges in implementing the measures of the side outcomes during the collaboration activities. Bititci et al. (2006) argue that a performance measurement system is not static but matures as the management and organizational culture evolves, which should also occur in university–industry collaborations. Because the forms and goals of university–industry collaborations evolve over time, performance measurement practices should be reviewed and updated regularly, based on feedback and by learning from the challenges encountered during the collaboration.

The results of the study indicate that societal organizations are somehow only familiar with the operational level collaboration with universities. Therefore, at the beginning of the collaboration activities, the participants should be familiarized with the aims and goals of the funding programs and with the societal-level targets. Because the uncertainty of "bigger picture" goals has caused the failure of the implementation of societal-level performance measurements, it is important that university researchers and project managers introduce the themes and goals of the funding programs in detail to other societal organizations.

Finally, this study's findings indicate that, as there are existing performance measurement challenges in the long-term evaluation of university-industry collaborations, the allocated resources might support these activities in the future. If there are some resources allocated and budgeted for the long-term evaluation of these collaborations, it would increase the university project managers interest and offer them possibilities for participating in these activities. In other words, the budgeted resources invested in pursuing performance measurement activities of the finished collaboration activities could very well support the long-term evaluation of the university-industry collaborations.

6. CONCLUSIONS

The aim of the dissertation was to explore the role of operational-level performance measurement in university–industry collaborations by exploring the current performance measurement practices and challenges from the viewpoints of participating stakeholders (university researchers/project managers, other societal organizations, and funding representatives). Although the practice and scientific literature show growing interest in collaboration activities between universities and other societal organizations, the results of the dissertation showed that comprehensive performance measurement systems are not actively designed, implemented and used in contemporary university–industry collaborations.

At the general level, the participating stakeholders recognized the importance of the performance measurement and evaluation activities as part of managing the collaborations. Despite the common recognition of the importance of performance measurement, responsibility for measuring the performance in the explored university–industry collaborations seems to lie mainly with university project managers. It seems that the university project managers and individual researchers are the ones who usually pursue performance measurement activities in these collaborations. The industrial, public, and third-sector organizations participating in these collaborations seemed to follow and evaluate their own aims and interests, and they agreed that the collaboration or societal-level evaluation of the university–industry collaborations should be executed by the university project managers. Although the participating stakeholders shared the interest of the performance measurement, and evaluation of societal-level outcomes, contemporary performance measurement practices are mainly related to fulfilling external reporting tasks, and following the aims and goals promised in the funding applications or project plans.

The results of the dissertation further showed that although the culture and philosophy of performance management and measurement have been adopted in Finnish universities during the last three decades, the evaluation of third mission and entrepreneurial activities is mainly seen as a separate and extra task. As part of contemporary management activities, universities use different types of rankings that are mainly based on their performance in research and education tasks. In addition, the personal rewarding and salary systems of university project managers and researchers are mainly based on their performance in research and education tasks, and collaboration activities with other societal organizations are seen as extra tasks that are not followed by their university faculties.

6.1 Managerial implications

The findings of this dissertation have several implications for different stakeholders, such as university project managers, researchers, university administration, industrial and other societal organizations participating in collaboration activities with universities, funding representatives of the university–industry collaborations, and policy makers.

As managerial implications, this dissertation increases participating stakeholders´ understandings of each other's performance measurement practices and challenges in university–industry collaborations. As it seems to be quite common that university project managers, representatives of other organizations, and funding representatives do not design performance measurement tools for these collaboration activities, the results of the dissertation can support their understanding of each other's viewpoints, and increase the interplay between them. Following only the instructions provided by the funding calls or following only the research plans causes challenges in performance measurement. To be aware of these challenges, and others' performance measurement activities, more comprehensive and suitable evaluation methods should be developed to support the management of university–industry collaboration.

6.2 Theoretical implications

From the perspective of theoretical implications, this study contributes to the academic discussion in performance management and university collaboration by increasing the understanding of the current performance measurement activities that university project managers, societal organization representatives, and funding representatives pursue in university–industry collaborations. In addition, the dissertation revealed the current challenges related to measuring the performance of these collaborations. Because university–industry collaborations seem to be of growing interest to academics and industry representatives, the results of this study could be utilized to develop better performance measurement tools and frameworks that could be more easily adopted in such contexts. While developing these frameworks, academics should also pay attention to the viewpoints, practices, and challenges of the funding representatives, and not focus only on universities' and industry organizations' perspectives.

6.3. Assessment of the dissertation

In general, the assessment of the quality of research should be done based on the validity, reliability, and generalizability of the research. According to Emory (1985), a commonly accepted view suggests that when assessing the quality of the research, good research should meet different tests. For example, the procedural design of the research should be carefully planned to yield results that are as objective as possible (Emory, 1985). Maylor and Blackmon (2005) argued that research can be considered valid if it captures the truth of the explored phenomenon, and is not affected by researchers' personal preferences or outside influences. According to Bryman (2016), validity refers to the integrity of the conclusions generated from the research.

To ensure the validity of this dissertation, multiple sources of evidence and triangulation were used. Theory triangulation (Patton, 2002) was used to combine theories from performance management, performance measurement, and university–industry collaborations to interpret and understand explored collaboration activities between

universities and other societal organizations. Referring to multiple sources of data collection and data triangulation (Patton, 2002), in each explored case, the findings are based on different methods for collecting data. For example, in the first publication on performance measurement in university–industry innovation networks, the data was collected in individual interviews and workshop observations, and in the fourth publication, in group interviews, a survey, and workshop observations.

When assessing the reliability of the research, the research procedures used should be described in sufficient detail to allow other researchers to repeat the research (Emory 1985). Regarding the reliability of the research in general, the objective is to be certain that if another researcher or research group follows the same procedures as presented in the original research, and conducts the same case study (or a similar one), the researchers repeating the original research should end up with the same findings and conclusions (Yin, 2009; Gummesson, 2000). In other words, the assessment of the reliability of research refers to the tendency of research to generate consistent results if measured repeatedly (Bryman, 2016).

As the reliability of the research refers to avoiding random errors, in this dissertation reliability was ensured by following a case study protocol (Yin 2009; Gummesson, 2000). Following the case study strategy or method makes it possible for other researchers to repeat the study. Although the number of cases in the dissertation was limited for practical reasons, the cases presented can be found elsewhere. There are many university–industry collaboration activities going on currently that can be utilized in case studies. Further, following the case protocol, the construction of the surveys and the interview protocol for gathering data in these cases is based on the previous literature, and presented in each case. As it might be characteristics of qualitative research that the gathered findings and evidence (e.g., from interviews) might include individual interpretations from the interviewees and researchers, the coding of the data provides an important part of the reliability of the research. In each case explored in the dissertation, the analysis and coding of the gathered data were carried out based on factors and themes based on previous literature. To further ensure the reliability of the dissertation, and avoid possible single-observer biases, the common view of the analysis and coding process was discussed among three or more researchers.

In addition to validity and reliability, the generalizability of the research provides an important part of its quality. According to Maxwell (1996), generalizability in qualitative research can be divided into internal and external generalizability. Internal generalizability of research findings and conclusions refers to their generalizability among the studied context and group. External generalizability of the research refers to the generalizability of findings and conclusions beyond the context and group of the research. Thus, the generalizability of the research is related to the issue of whether the findings and conclusions can be extended to a wider context.

The findings of the dissertation are applicable in different types of collaboration activities between universities with different scientific disciplines, and other societal organizations with different stakeholder interests. In these collaboration activities, there exist similarities in operational-level performance measurement and evaluation activities where the generalization of the findings the dissertation can be considered applicable. Further, beyond

the context of university–industry collaboration, as the explored cases were mainly pursued in the forms of research and development projects, the findings of the dissertation can be generalized to other operational-level performance measurement activities of different types of research and development projects.

6.4 Limitations of the dissertation

Several limitations related to the dissertation should be acknowledged. The first limitation is that the research was based on empirical cases and empirical data from a single country. Thus, the results might reflect country-specific characteristics that should be taken into account.

In addition to possible country-specific characteristics, the second limitation is related to data gathering from selected scientific disciplines. Although the selected scientific disciplines (management, engineering, and economics/business) provide examples of the academic circles that are currently actively collaborating with other societal organizations, the results might be different if the data were gathered and explored among collaboration activities representing scientific disciplines from the arts or humanities. There might exist differences in how performance management and measurement practices of universities third mission activities and university–industry collaborations are understood by academics at different universities, in different departments, and in different scientific disciplines.

This third limitation is related to the research methodology. Although empirical qualitative case studies can provide in-depth understanding of the explored phenomenon, limitations related to the number of the cases might exist. The research for the dissertation was based on several different cases, and the utilization of a large number of different data sources, but the findings are still based on a narrow part of the university–industry collaborations. Thus, this limitation should be noticed in the generalization of the findings of the dissertation.

6.5 Suggestions for future research

The results of the dissertation provide some interesting possibilities and starting points for future research. First, as the results for the study were gathered from one country and from a few chosen academic disciplines, future results from different countries and from different scientific disciplines would be important for understanding the explored phenomenon more widely. Further, as the results of the dissertation are based on qualitative case studies, they might be complemented by quantitative studies.

As the results revealed that the frameworks, methods, and tools presented to support performance measurement activities in university–industry collaborations are not currently actively utilized and implemented, further research should be carried out to remove the obstacles for implementation. In other words, further studies could be conducted to understand how performance measurement frameworks and tools could be more comprehensively transferred from theory to practice. As a part of this research gap, it would

be important to understand how the culture of collaborative performance measurement design and implementation could be developed in university–industry collaborations.

As this dissertation focused on operational-level performance measurement in university–industry collaborations, further research should be conducted to understand and support the connection of operational-level performance measurement and other performance measurement practices of university–industry collaborations. For example, it might be important to understand how operational-level performance measurement activities could be connected to universities' other performance measurement practices, such as those related to the evaluation of research and education activities.

REFERENCES

Abreu, M., and Grinevich, V. (2013). The nature of academic entrepreneurship in the UK: widening the focus on entrepreneurial activities. Research Policy, 42 (2), 408–422.

Adams, J.D., Black, B.C., Clemnons, J.R., and Stephan, P.E. (2005). Scientific teams and institutional collaborations: evidence from U.S. universities, 1981–1999. Research Policy, 34 (3), 259–285.

Adams, R., Bessant, J., and Phelps, R. (2006). Innovation management measurement: a review. International Journal of Management Reviews, 8, 21-47

Agrawal, A. (2001). University-to-industry knowledge transfer: literature review and unanswered questions. International Journal of Management Reviews, 3, 285–302.

Albats, E., Fiegenbaum, I., and Cunningham, J.A. (2018). A micro level study of university-industry collaborative lifecycle key performance indicators. Journal of Technology Transfer, 43, 389-431.

Al-Ashaab, A., Flores, M., Doultsinou, A., and Magyar, A. (2011). A Balanced Scorecard for Measuring the Impact of Industry-University Collaboration. Production Planning & Control: The Management of Operations, 22 (5–6), 554–70.

Al-Tabbaa, O., and Ankrah, S. (2016). Social capital to facilitate 'engineered' university–industry collaboration for technology transfer: A dynamic perspective. Technological Forecasting and Social Change, 104, 1-15.

Amaratunga, D., and Baldry, D. (2002). Moving from performance measurement to performance management. Facilities, 20 (5/6), 217-223.

Ankrah, S., and Al-Tabbaa, O. (2015). Universities–industry collaboration: a systematic review. Scandinavian Journal of Management, 31, 387–408.

Ankrah, S.N., Burgess, T.F., Grimshaw, P., and Shaw, N.E. (2013). Asking both university and industry actors about their engagement in knowledge transfer: what single-group studies of motives omit. Technovation, 33 (2/3), 50–65.

Arvanitis, S., Kubli, U., and Woerter, M. (2008). University-industry knowledge and technology transfer in Switzerland: what university scientists think about co-operation with private enterprises. Research Policy, 37 (10), 1865–1883.

Arza, V. (2010). Channels, benefits and risks of public–private interactions for knowledge transfer: a conceptual framework inspired by Latin America. Science and Public Policy, 37 (7), 473–484.

Azagra-Caro, J.M., Barberá-Tomás, D., Edwards-Schachter, M., and Tur, E.M. (2017). Dynamic interactions between university-industry knowledge transfer channels: A case study of the most highly cited academic patent. Research Policy, 40, 463-474.

Barratt, M., Choi, T.Y., and Li, M. (2011). Qualitative case studies in operations management: Trends, research outcomes, and future research implications. Journal of Operations Management, 29 (4), 329-342.

Bishop, K, D´Este, P., and Neely, A. (2011). Gaining from interactions with universities: Multiple methods for nurturing absorptive capacity. Research policy, 40, 30-40.

Bitektine, A. (2008). Prospective case study design qualitative method for deductive theory testing. Organizational Research Methods, 11 (1), 160-180.

Bititci, U., Carengo, P., Dörfler, V., and Nudurupati, S. (2012) Performance measurement: Challenges for tomorrow. International Journal of Management Reviews, 14, 305-327.

Bititci, U., Mendibil, K., Nudurupati, S., Garengo, P. and Turner, T. (2006). Dynamics of performance measurement and organizational culture. International Journal of Operations and Production Management, 26 (12), 1325-1350.

Bititci, U.S., Carrie, A.S., and McDevitt, L. (1997). Integrated performance measurement systems: a development guide. Journal of Operations & Production Management, 17 (5), 522-534.

Bouncken, R.B. (2018). University coworking-spaces: mechanisms, examples, and suggestions for entrepreneurial universities. International Journal of Technology Management, 77 (1–3), 38–56.

Bourne, M., Mills, J., Wilcox, M., Neely, A. and Platts, K. (2000). Designing, implementing and updating performance measurement systems. International Journal of Operations and Production Management, 20 (7), 754-771.

Braz, R.G.F., Scavarda, L.F., and Martins, R.A. (2011). Reviewing and improving performance measurement systems: An action research. International Journal of Production Economics, 133, 751-760.

Broadbent, J. (2007). If you can't measure it, how can you manage it? Management and governance in higher educational institutions. Public Money and Management, 27 (3), 193–198.

Bruneel, J., D'Este, P., and Salter, A. (2010). Investigating the factors that diminish the barriers to university–industry collaboration. Research Policy, 39 (7), 858–868.

Bryman, A. (2016). Social Research methods, 5thedition, New York: Oxford University Press.

Busi, M., and Bititci, U.S. (2006). Collaborative performance management: present gaps and future research. International Journal of Productivity and Performance Management, 55 (1), 7-25.

Carayannis, E.G., and Provance, M. (2008). Measuring firm innovativeness: towards a composite innovation index built on firm innovative posture, propensity and performance attributes. International Journal of Innovation and Regional Development, 1 (1), 90-107.

Chandler J, Barry, J., and Clark H. (2002). Stressing academe: The wear and tear of the New Public Management. Human Relations, 55 (9), 1051–1069.

Choi, T.Y., and Hong, Y. (2002). Unveiling the structure of supply networks: case studies in Honda, Acura and Daimler Chrysler. Journal of Operations Management, 20 (5), 469-493

Clark, B.R. (1998). Creating Entrepreneurial Universities: Organizational Pathways of Transformation. Pergamon, Oxford.

Cohen, W.M., Nelson, R.R., and Walsh, J.P. (2002). Links and impacts: the influence of public research on industrial R&D. Management Science, 48 (1), 1–23.

Coriat, B., and Orsi, F. (2002). Establishing a new regime of intellectual property rights in the United States: Origins, content and problems. Research Policy, 31, 1491-1507

Crook, C., and Garrat, D. (2005). The positivist paradigm in contemporary social science research. In Research Methods in The Social Sciences. Eds. Somekh, B., and Lewin, C. Sage Publications, London.

Crotty, M. (1998). The foundations of Social Research – Meaning and perspective in the research process. London: SAGE Publications Ltd.

Czarnitzki, D., Grimpe, C., and Toole, A.A. (2015). Delay and secrecy: does industry sponsorship jeopardize disclosure of academic research? Industrial and Corporate Change, 24 (1), 251–279.

Czarnitzki, D., Ebersberger, B., and Fier, A. (2007). The relationship between R&D collaboration, subsidies and R&D performance: empirical evidence from Finland and Germany. Journal of Applied Econometric, 22, 1347-1366.

de Boer, H., Jongbloed, B., Benneworth, P., Cremonini, L., Kolster, R., Kottmann, A., and Vossensteyn, H. (2015). Performance-based funding and performance agreements in fourteen higher education systems. Enschede: Center for Higher Education Policy Studies.

Debackere, K., and Veugelers, R. (2005). The role of academic technology transfer organizations in improving industry science links. Research Policy, 34 (3), 321–342.

D´Este, P., and Patel, P. (2007). University-industry linkages in the UK: What are the factors underlying the variety of interactions with industry?. Research Policy, 36 (9), 1295-1313.

D'Este, P., and Perkmann, M. (2011). Why do academics engage with industry? The entrepreneurial university and individual motivations. Journal of Technology Transfer, 36 (3), 316–339.

Dietz, J.S., and Bozeman, B. (2005). Academic careers, patents, and productivity: industry experience as scientific and technical human capital. Research Policy, 34 (3), 349–367.

Eisenhardt, K.M., and Graebner, M.E. (2007). Theory building from cases: opportunities and challenges. Academy of Management Journal, 50 (1), 25-32.

Eisenhardt, K.M. (1989). Building theories from case study research. Academy of Management Review, 14 (4), 532-550.

Ellegaard, C., and Andersen, P.H. (2015). The process of resolving severe conflict in buyer–supplier relationships. Scandinavian. Journal of Management, 31, 457–470.

Engwall ,L. (2007). Universities, the state and the market: Changing patterns of university governance in Sweden and beyond. Higher Education Management and Policy, 19 (3), 87–103.

Etzkowitz, H., (2016). The entrepreneurial university: vision and metrics. Industry and Higher Education 30, (2), 83–97.

Etzkowitz, H. (1998). The norms of entrepreneurial science: cognitive effects of the new university–industry linkages. Research Policy, 27 (8), 823–833.

Etzkowitz, H., Webster, A., Gebhardt, C., and Terra, B.R.C. (2000). The future of the university and the university of the future: evolution of ivory tower to entrepreneurial paradigm. Research Policy, 29 (2), 313–330.

European Commission. (2011). What is Horizon 2020? Available at: https://ec.europa.eu/programmes/horizon2020/en/what-horizon-2020

European Commission. (2007). Knowledge transfer between research institutions and industry – frequently asked questions. European Commission, Brussels.

Fabrizio, K., and DiMinin, A. (2008). Commercializing the laboratory: faculty patenting and the open science environment. Research Policy, 37 (5), 914–931.

Ferreira, A., and Otley, D. (2009). The Design and Use of Performance Management Systems: An Extended Framework for Analysis. Management Accounting Research, 20 (4), 263–282.

Franco, M., and Haase, H. (2015). University-industry cooperation: Researchers´ motivation and interaction channels. Journal of Engineering and Technology Management, 36, 41-51.

Franco-Santos, M., Kennerley, M., Micheli, P., Martinez, V., Mason, S., Marr,B., Gray, D., and Neely, A. (2007). Towards a definition of a business performance measurement system. International Journal of Operations and Production Management, 27 (8), 784–801.

Franco-Santos, M., Lucianetti, L., and Bourne, M. (2012). Contemporary performance measurement systems: A review of their consequences and a framework for research. Management Accounting Research, 23, 79-119.

Garengo, P., Biazzo, S., and Bititci, U.S. (2005). Performance measurement systems in SMEs: A review for a research agenda. International Journal of Management Reviews, 7 (1), 25-47.

Garengo, P., Nudurupati, S., and Bititci, U. (2007). Understanding the relationship between PMS and MIS in SMEs: an organizational life cycle perspective. Computers in Industry, 58 (7), 677–686.

Gersick, C. (1988). Time and transition in work teams: toward a new model of group development. Academy of Management Journal, 31 (1), 9-41.

Glaser, B., and Strauss, A. (1967). The Discovery of Grounded Theory: Strategies For Qualitative Research. Wiedenfeld and Nicholson, London.

Grimaldi, R., Kenney, M., Siegel, D.S., and Wright, M. (2011). 30 years after Bayh-Dole: reassessing academic entrepreneurship. Research Policy, 40 (8), 1045–1057.

Grimaldi, R., and von Tunzelmann, N. (2002). Assessing collaborative, pre-competitive R&D projects: the case of the UK LINK scheme. R&D Management, 32, 165-173.

Guerrero, M., Urbano, D., Cunningham, J., and Organ, D. (2012). Entrepreneurial universities in two European regions: a case study comparison. Journal of Technology Transfer, 1–20.

Gulbrandsen, M., and Slipersaeter, S. (2007). The Third Mission and the Entrepreneurial University Model. In Universities and Strategic Knowledge Creation. Eds. Bonaccorsi, A., and Daraio, C. Edward Elgar Publishing.

Gummesson, E. (2000), Qualitative Methods in Management Research. Thousand Oaks: Sage Publications.

Göransson, B., Maharajh, R., and Schmoch, U. (2009). New activities of universities in transferand extension: multiple requirements and manifold solutions. Science and Public Policy, 36 (2), 157–164.

Hall, M. (2008). The effect of comprehensive performance measurement systems on role clarity, psychological empowerment and managerial performance. Accounting Organizations and Society, 33 (2/3), 141–163.

Hansen, H.F., Geschwind, L., Kivistö, J., Pekkola, E., Pinheiro, R., and Pulkkinen, K. (2019). Balancing accountability and trust: university reforms in the Nordic countries. Higher Education, 78 (3), 557-573.

Heinze, T., Shapira, P., Rogers, J.D., and Senker, J.M. (2009). Organizational and institutional influences on creativity in scientific research. Research Policy, 38 (4), 610–623.

Henri, J.-F. (2006). Management control systems and strategy: a resource-based perspective. Accounting, Organization and Society, 31 (6), 529–558.

Hirsjärvi, S., Remes, P., and Sajavaara, P. (2007). Tutki ja kirjoita. 13. painos, Tammi, Keuruu (in Finnish).

Hottenrott, H., and Lawson, C. (2014). Research grants, sources of ideas and the effects on academic research. Economics of Innovation and New Technology, 23 (2), 109–133.

Hsu, D.W.L., Shen, Y.C., Yuan, B.J.C., and Chou, C.Y. (2015). Toward successful commercialization of university technology: performance drivers of university technology transfer in Taiwan. Technological Forecasting and Social Change, 92, 25–39.

Huang, M-H., and Chen, D-Z. (2017). How can academic innovation performance in university–industry collaboration be improved?. Technological Forecasting and Social Change, 123, 210-215.

Ittner, C.D., Larcker, D.F., and Randall, T. (2003). Performance implication of strategic performance measurement in financial service firms. Accounting, Organizations and Society, 28 (7/8), 715–741.

Iqbal, A., Shahid Khan, A., Iqbal, S., and Aslan Amat, S. (2011). Designing of Success Criteria-based Evaluation Model for Assessing the Research Collaboration between University and Industry. International Journal of Business Research and Management, 2 (2), 59-73.

Isaksen, A., and Karlsen, J. (2010). Different modes of innovation and the challenge of connecting universities and industry: Case studies of two regional industries in Norway. European Planning Studies, 18 (12), 1993-2008.

Kalar, B., and Antonic, B. (2015). The entrepreneurial university, academic activities and technology and knowledge transfer in four European countries. Technovation, 36-37, 1-11.

Kallio, K-M., Kallio, T.J., Tienari, J., and Hyvönen, T. (2015). Ethos at stake: Performance management and academic work in universities. Human Relations, 69 (3), 685-709.

Kapetanoiu, C., and Lee, S.H. (2017). A framework for assessing the performance of universities: The case of Cyprus. Technological Forecasting and & Social Change, 120, 169-180.

Kaplan, R.S., Norton, D.P., and Rugelsjoen, B. (2010), Managing alliances with the balanced scorecard. Harvard Business Review, 88 (1), 114-120.

Kaplan, R.S., and Norton, D.P. (1992). The Balanced Scorecard – measures that drive performance. Harvard Business Review 70 (1), 71–79.

Kaplan, R.S., and Norton, D.P. (1996). The Balanced Scorecard – Translating Strategy into Action. Harvard Business School Press, Boston, MA.

Kaplan, R.S., and Norton, D.P. (2001). The Strategy-Focused Organization: How Balanced Scorecard Companies Thrive in the New Business Environment. Harvard Business School Press, Boston, MA.

Kasanen, E., Lukka, K. and Siitonen, A. (1991). Konstruktiivinen tutkimusote liiketaloustieteessä. Liiketaloustieteellinen Aikakauskirja, 3/1991, 301–327. (in Finnish)

Katz ML. (1986). An analysis of cooperative research and development. RAND Journal of Economics, 17 (4), 527–543.

Klofsten, M., Fayolle, A., Guerrero, M., Milan, S., Urbano, D., and Wright, M. (2019). The entrepreneurial university as driver for economic growth and socialchange - Key strategic challenges. Technological Forecasting & Social Change, 141, 149-158.

Kohtamäki, V. (2019). Academic leadership and university reform-guided management changes in Finland. Journal of Higher Education Policy and Management, 41 (1), 70-85.

Krabel, S., and Mueller, P. (2009). What drives scientists to start their own company? An empirical investigation of Max Planck Society scientists. Research Policy, 38 (6), 947–956

Lauras, M., Marques, G., and Gourc, D. (2010). Towards a multi-dimensional project Performance Measurement System. Decision Support Systems, 48, 342-353.

Lebas, M.J. (1995). Performance measurement and performance management. International Journal of Production Economics, 41, 23–25.

Lebas, M. and Euske, K. (2002). A conceptual and operational delineation of performance. In: Neely, A., eds. Business Performance Measurement: Theory and Practice. Cambridge University Press, Cambridge, 65–79.

Lee, Y.S. (2000). The sustainability of university–industry research collaboration: an empirical assessment. Journal of Technology Transfer, 25 (2), 111–133.

Leischnig, A., and Geigenmüller, A. (2018). Examining alliance management capabilities in university‐industry collaboration. The Journal of Technology Transfer https://doi.org/10.1007/s10961-018-9671-7

Lin, J-Y. (2017). Balancing industry collaboration and academic innovation: The contingent role of collaboration-specific attributes. Technological Forecasting and Social Change, 123, 216-228.

Link, A.N., Siegel, D.S., and Bozeman, B. (2007), An empirical analysis of the propensity of academics to engage in informal university technology transfer. Industrial and Corporate Change, 16 (4), 641–655.

Loi, M., and Di Guardo, M.C. (2015). The third mission of universities: An investigation of the espoused values. Science and Public Policy, 42 (6), 855-870.

Lowe, R.A., and Gonzalez-Brambila, C. (2007). Faculty entrepreneurs and research productivity. Journal of Technology Transfer, 32 (3), 173–194.

Maxwell, J. A. (1996). Qualitative Research Design: An Interactive Approach. Applied Social Research Methods Series, Vol. 41, Sage Publications, Thousand Oaks, California.

Maylor, H., and Blackmon, K. (2005). Researching Business and Management, New York: Palgrave Macmillan.

McCutcheon, D.M., and Meredith, J.R. (1993). Conducting case study research in operations management. Journal of Operations Management, 11 (3), 239-256

McMillan, G.S. and Hamilton, R.D. (2003). The impact of publicly funded basic research: an integrative extension of Martin and Salter. IEEE Transactions on Engineering Management, 50 (2), 184–191.

Meek, V.L., Goedegebuure, L., Santiago, R., and Carvalho, T. (Eds.). (2010). The changing dynamics of higher education middle management (Vol. 33). Dordrecht, Heidelberg: Springer Science & Business Media.

Melo, A.I., Sarrico, C.S., and Radnor, Z. (2010). The influence of performance management systems on key actors in universities. Public Management Review, 12 (2), 233-254.

Michele, P., and Mari, L. (2014). The theory and practice of performance measurement. Management Accounting Research, 25, 147-156.

Montesinos, P., Carot, J.M., Martínez, J.M., and Mora, F. (2008). Third mission ranking for world class universities: beyond teaching and research. Higher Education in Europe 33 (2/3), 259–271.

Mora-Valentin, E.M., Montoro-Sanchez, A., and Guerras-Martin, L.A. (2004). Determining factors in the success of R&D cooperative agreements between firms and research organizations. Research Policy, 33, 17-40.

Movery, D.C., and Sampat, B.N. (2004). The Bayh-Dole Act of 1980 and university-industry technology transfer: A model for other OECD governments?. Journal of Technology Transfer, 30 (1-2), 115-127.

Movery, D.C. and Nelson, R.R. (eds) (2004). Ivory tower and industrial innovation: university– industry technology before and after the Bayh–Dole Act. Stanford: Stanford University Press.

Mudambi, R., and Swift, T. (2009). Professional guilds, tension and knowledge management. Research Policy 38 (5), 736–745.

Muscio, A. (2010). What drives the university use of technology transfer offices? Evidence from Italy. Journal of Technology Transfer, 35 (2), 181–202.

Neely, A. (2005). The evolution of performance measurement research: Developments in the last decade and a research agenda for the next. International Journal of Operations & Production Management, 25 (12), 1264-1277.

Neely, A. (1999). The performance measurement revolution: why now and where next. International Journal of Operations and Production Management, 19 (2), 205–228.

Neely, A., Gregory, M., and Platts, K. (1995). Performance measurement system design. A literature review and research agenda. International Journal of Operations & Production Management, 15 (4), 80-116.

Ng, I.C.L., and Forbes, J. (2009). Education as service: The understanding of university experience through the service logic. Journal of Marketing for Higher Education, 19 (1), 38–64.

Niebecker, K., Eager, D., and Kubitza, K. (2008). Improving cross-company project management performance with a collaborative project scorecard. International Journal of Managing Projects in Business,1 (3), 368-386.

Niebecker, K., Eager, D., and Moulton, B. (2010). Collaborative and cross-company project management within the automotive industry using the balanced scorecard. International Journal of Managing Projects in Business, 3 (2), 328-337.

Patton, M.Q. (2002). Qualitative research and evaluation methods,3rd edition. Thousand Oaks, CA: Sage.

Pavlov, A., Mura, M., Franco-Santos, M., and Bourne, M. (2017). Modelling the impact of performance management practices on firm performance: interaction with human resource management practices. Production Planning & Control, 28 (5), 431-443.

Perkmann, M. (2015). University-Industry relations. In: Concise Guide to Entrepreneurship, Technology and Innovation. Edited by Audretsch, D.B., Hayter, C.S., and Link, A.N. Edward Elgar Publishing. Cheltenham, UK.

Perkmann, M., Tartari, V., McKelvey, M., Autio, E., Broström, A., D'Este, P., Fini, R., Geuna, A., Grimaldi, R., Hughes, A., Kitson, M., Krabel, S., Llerena, P., Lissoni, F., Salter, A., and Sobrero, M. (2013), Academic engagement and commercialization: a review of the literature on university–industry relations. Research Policy, 42 (2), 423–442.

Perkmann, M., Neely, A., and Walsh, K. (2011). How should firms evaluate success in university–industry alliances? A performance measurement system. R&D Management, 41 (2), 202-216.

Perkmann, M. and Walsh, K. (2008). Engaging the scholar: three forms of academic consulting and their impact on universities and industry. Research Policy, 37 (10), 1884–1891.

Perkmann, M., and Walsh, K. (2007). University–industry relationships and open innovation: Towards a research agenda. International Journal of Management Reviews, 9 (4), 259–280.

Philbott, K., Dooley, L., O'Reilly, C., and Lupton, G. (2011). The entrepreneurial university: examining the underlying academic tensions. Technovation, 31 (4), 161–170.

Piva, E., and Rossi-Lamastra, C. (2013). Systems of indicators to evaluate the performance of university-industry alliances: a review of the literature and directions for future research. Measuring Business Excellence, 17 (3), 40-54.

Pollitt, C., and Bouckaert, G. (2000). Public Management Reform: A Comparative Analysis. Oxford University Press.

Ranga, M., Perälampi, J., and Kansikas, J. (2016), The new face of university-business cooperation in Finland. Science and Public Policy, 43 (5), 601-612.

Saunila, M., and Ukko, J. (2012). A conceptual framework for the measurement of innovation capability and its effects. Baltic Journal of Management, 7 (4), 355-75

Schartinger, D., Rammer, C., Fischer, M.M., and Fröhlich, J. (2002). Knowledge interactions between universities and industry in Austria: sectoral patterns and determinants. Research Policy, 31, 303-328.

Secundo, G., Perez, S.E., Martinaitis, Z., and Leitner, K.H. (2017). An intellectual capital framework to measure universities´ third mission activities. Technological Forecasting & Social Change, 123, 229-239.

Secundo, G., Margherita, A., Elia, G., and Passiante, G. (2010). Intangible assets in higher education and research: mission, performance or both? Journal of Intellectual Capital, 11 (2), 140–157.

Sedlacek, S. (2013). The role of universities in fostering sustainable development at the regional level. Journal of Cleaner Production, 48, 74–84.

Siegel, D.S., Waldman, D.A., Atwater, L.E., and Link, A.N. (2003). Commercial knowledge transfers from universities to firms: improving the effectiveness of university–industry collaboration. The Journal of High Technology Management Research, 14 (1), 111–133.

Sparkes, A.C. (1992). The paradigms debate: an extended review and celebration of difference. In A.C. Sparkes (ed.), Research and Physical Education and Sport. Lewes: Falmer, 9-60.

Speckbacher, G., Bischof, J., and Pfeiffer, T. (2003). A descriptive analysis on the implementation of balanced scorecards in German-speaking countries. Management Accounting Research, 14 (4), 361–388.

Soh, P.-H., and Subramanian, A.M. (2014). When do firms benefit from university–industry R&D collaborations? The implications of firm R&D focus on scientific research and technological recombination. Journal of Business Venturing, 29, 807–821.

Sousa C.A., De Nijs W.F., and Hendriks P.H. (2010). Secrets of the beehive: Performance management in university research organizations. Human Relations, 63 (9), 1439–1460.

Stuart, I., McCutcheon, D., Handfield, R., McLachlin, R., and Samson, D. (2002). Effective case research in operations management: a process perspective. Journal of Operations Management, 20 (5), 419-433.

Tangen, S. (2005). Analysing the Requirements of Performance Measurement Systems. Measuring Business Excellence, 9 (4), 46-54.

Tartari, V., Salter, A., and D'Este, P. (2012). Crossing the Rubicon: exploring the factors that shape academics' perceptions of the barriers to working with industry. Cambridge Journal of Economics, 36 (3), 655–677.

ter Bogt, H.J., and Scapens, R.W. (2012). Performance Management in Universities: Effects of the Transition to More Quantitative Measurement Systems. European Accounting Review, 21 (3), 451-497.

Tijssen, R. J. (2012). Co-authored Research Publications and Strategic Analysis of Public–Private Collaboration. Research Evaluation, 21, 204–215

Toole, A.A., and Czarnitzki, D. (2009). Exploring the relationship between scientist human capital and firm performance: the case of biomedical academic entrepreneurs in the SBIR program. Management Science, 55 (1), 101–114.

Torregrosa-Hetland, S., Pelkonen, A., Oksanen, J., and Kander, A. (2019). The prevalence of publicly stimulated innovations – A comparison of Finland and Sweden, 1970-2003. Research Policy, https://doi.org/10.1016/j.respol.2019.02.001

Tsai, K. H. (2009). Collaborative Networks and Product Innovation Performance: Toward a Contingency Perspective. Research Policy, 38, 765–778

Ukko, J., Tenhunen, J., and Rantanen, H. (2008). The impacts of performance measurement on the quality of working life. International Journal of Business Performance Management, 10 (1), 86-98.

Ulhoi, J. (2004). Open source development: a hybrid in innovation and management theory. Management Decision, 42, 1095–1114.

Van Looy, B., Debackere, K., and Callaert, J. (2006). Publication and patent behaviour of academic researchers: conflicting, reinforcing or merely co-existing. Research Policy 35 (4), 596–608.

Varamäki, E., Kohtamäki, M., Järvenpää, M., Vuorinen, T., Laitinen, E., Sorama, K., Wingren, T., Vesalainen, J., Helo, P., Tuominen, T., Pihkala, T., and Tenhunen, J. (2008). A framework for a network-level performance measurement system in SME networks. International Journal of Networking and Virtual Organizations, 5 (3/4), 415-435.

Villaini, E., Rasmussen, E., and Grimaldi, R. (2017). How intermediary organizations facilitate university-industry technology transfer: A proximity approach. Technological Forecasting and Social Change, 114, 86-102.

Voss, C.A., Tsikriktsis, N., and Frohlich, M. (2002). Case research in operations management. International Journal of Operations & Production Management, 22 (2), 195-219.

Welsh, R., Glenna, L., Lacy, W., and Biscotti, B. (2008). Close enough but not too far: assessing the effects of university–industry research relationships and the rise of academic capitalism. Research Policy, 37 (10), 1854–1864.

Wright, M., Birley, S., and Mosey, S. (2004). Entrepreneurship and university technology transfer. Journal of Technology Transfer, 29 (3–4), 235–246.

Yin, R.K. (1994). Case Study Research: Design and Methods (2nd ed.). Sage Publications, Newbury Park, CA (1994).

Yin, R.K. (2009). Case study research: design and methods,4thedition. Los Angeles, CA: Sage.

Ylijoki, O. (2014). University under structural reform: A micro-level perspective. Minerva: A Review of Science, Learning & Policy, 52 (1), 55–75.

Zomer, A., and Benneworth, P. (2011). The rise of the university's Third Mission. In: Enders, H., de Boer, F., Westerheijden, D. (Eds.), Reform of Higher Education in Europe. Sense Publishers, Rotterdam.

Zucker, L.G., Darby, M.R., Furner, J., Liu, R.C., and Ma, H. (2007). Minerva unbound: knowledge stocks, knowledge flows and new knowledge production. Research Policy, 36 (6), 850–863.

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Performance measurement in university–industry innovation networks: implementation practices and challenges of industrial organisations

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ABSTRACT

From the perspective of industrial small and medium size enterprises (SMEs), this study explores the implementation of performance measurement practices and challenges in university–industry innovation networks. In this research, two single-case studies were conducted to explore the implementation practices and challenges of performance measurement in university–industry collaborations. Thirty Finnish SMEs in the first innovation network and 10 Finnish SMEs in the second innovation network participated in university–industry collaboration that were established to facilitate their involvement in a long-term innovation process. The results of the study revealed that industrial SMEs are interested in the performance measurement of societal-level outputs by university–industry innovation networks, even though they face challenges in understanding the aims and goals of the funding programmes. Furthermore, the results showed that the industrial SMEs understood the intellectual nature of the university–industry innovation networks, but their performance measurement activities were business related. Also the lack of understanding of the context and the process of the performance measurement in university–industry collaborations seemed to shift industrial organisations' focus to the content stage of the performance measurement and to the use of traditional performance measures and tools to estimate the advantages gained.

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1. Introduction

The long history of university–industry partnerships and collaboration activities (cf. Bishop, D'Este, and Neely 2011) represents one means of increasing and supporting industrial organisations' competitive advantages and innovation activities. Currently, there is increasingly growing societal pressure on universities to act as operators for innovations and provide economic growth for society (Ankrah and AL-Tabbaa 2015). This is one reason why universities are actively forming partnerships with private sector organisations while fulfilling third-mission activities that facilitate the universities' engagement with society. Various funding programmes (e.g. Horizon 2020) often expect universities to collaborate with industry organisations to ensure that the research conducted in collaborations can be exploited throughout society. Additionally, continuously rising operation expenses (e.g. salaries and real estate costs) and decreasing basic governmental funding have increased universities' interest in seeking

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relationships with other organisations to secure and maintain the universities' subject areas and competencies. For these reasons, the last two decades have witnessed an increase in partnerships and collaboration activities between universities and industry in several nations, including European Union countries (Slotte and Tynjälä 2003; Gertner, Roberts, and Charles 2011; Ankrah and AL-Tabbaa 2015). University–industry collaborations include different types of interactions. Usually, they form two types of collaborations. The first is academic engagement, which refers to the collaboration between universities and the utilizers of academic science, such as private- and public-sector organisations. The second is commercialization, which is the exploitation of university-generated intellectual property (Perkmann 2015). More often, industrial organisations also perceive universities as attractive partners in supporting their innovation activities (e.g. Mäkimattila, Junell, and Rantala 2015). Additionally, large organisations are no longer the only ones seeking a competitive advantage from partnerships with universities; small and medium-sized enterprises (SMEs) are more frequently involved in these collaboration activities (Perkmann and Walsh 2007; Bishop, D'Este, and Neely 2011).

The increase in collaboration and innovation activities poses numerous challenges for the management of university–industry collaborations. One main issue that these challenges have raised is how the collaboration and development activities should be measured and evaluated (Perkmann et al. 2013; Albats, Fiegenbaum, and Cunningham 2017). Because of the increased interest in these collaborative activities, some frameworks were proposed to improve their management and evaluation (e.g. Al-Ashaab et al. 2011; Perkmann, Neely, and Walsh 2011). These frameworks and tools, however, are mainly theoretical and there is a need for further empirical evidence of the implementation and actual use of the presented models and measures. Perkmann and Walsh (2007) suggested that empirical research should address the question of the evaluation measures that implemented in collaborative university–industry networks. Thus, the present study aims to provide a greater empirical understanding of the performance measurement used in university–industry innovation networks. To accomplish this goal, the current study explores the currently implemented performance measurement practices and the challenges to them from the perspective of industrial SMEs. This paper presents two single case studies in which the phenomenon is explored in practice. Empirical data for this study were gathered from two university–industry innovation networks that were established to support the long-term innovation activities and processes of industrial organisations. This study focuses on the issue of performance measurement as part of the management of these innovation networks. The following research questions guide the study:

- RQ1: How is the implementation of performance measurement practices perceived by industrial SMEs in university–industry innovation networks?
- RQ2: How are challenges to the implementation of performance measurement perceived by industrial SMEs in university–industry innovation-networks?

There is limited holistic understanding of these phenomena, such as the role of performance management and measurement in SMEs that work and collaborate in open innovation-driven networks (Bititci et al. 2012). One reason is the absence of easily accessible cases of networks that researchers could study (Bititci et al. 2012). However, in the present study, the research group is included in two collaborative university–industry innovation networks. This study's results can be utilised by organisations that collaborate with universities, university researchers who participate and manage these collaborations, and corporate financiers and policymakers to develop better methods for managing and evaluating university–industry collaborations.

2. University–industry collaboration networks

Various collaborative networks have emerged in recent years in response to the changes in the operating environments of organisations (Camarinha-Matos and Afsarmanesh 2008). As industrial organisations continuously seek new methods to develop their businesses and promote new alliances to gain

knowledge and a competitive advantage, they also increasingly view universities as potential sources of innovation and knowledge. Consequently, an increasing number of organisations are pursuing knowledge and innovation by forming partnerships and collaborations with universities (Perkmann, Neely, and Walsh 2011; Perkmann et al. 2013; Cunningham and Link 2015). In industrial organisations, the prospect of collaborating with universities is tempting and can also support learning and information transfer between academy and workplace (Konkola et al. 2007; Reeve and Gallacher 2007). Because of the increased engagement, the effects of university research on the innovative activities of organisations have become the focus of academics and policy makers (Bishop, D'Este, and Neely 2011).

According to Ankrah and AL-Tabbaa (2015), the university–industry collaborations most common in practice and in the literature are alliances, networks, joint ventures, and consortia. These forms vary in the degree to which the participating organisations are connected. Through these different forms of collaborations, organisations can typically participate in projects focused on specific scientific or technical areas. However, in some cases, partnerships are formed based on long-term development and collaboration, instead of the need to solve a technical problem or to quickly create commercial products. From these long-term collaborations, organisations are interested in gaining more social capital and innovation capabilities, for example. Perkmann and Walsh (2007) suggest that university–industry partnerships and collaborations are commonly practiced although some differences might exist among various industries. These cited authors also demonstrate that open and networked innovation activities suggest that actual partnerships and collaborations between universities and industrial organisations – rather than generic links – play a stronger role in supporting the innovation activities and capabilities of the participating organisations. They highlight that organisations in these partnerships expect to see increased capacity for innovation rather than immediate commercialised tangible outcomes.

Collaborations with universities are no longer strictly the pursuit of large organisations. Both small and large organisations are forming collaborative networks to develop and support their innovation activities in order to generate value to markets and customers (cf. Bititci et al. 2012). In the future, SMEs will likely play even more important roles in economic growth, job creation, and innovation development. As such, the industrial SMEs are expected to form and work in collaborative networks, contributing to and benefiting from the emerging innovation environments (Bititci et al. 2012). Despite the importance of the management and the control of these networks, the current state of knowledge regarding performance measurement seems limited to studies from more traditional performance measurement perspectives. Moreover, university–industry collaborations provide open-innovation surroundings to complement traditional internal innovation and development activities (Coombs, Harvey, and Tether 2003; Ankrah and AL-Tabbaa 2015).

4. Performance measurement in university–industry collaborations

Since collaboration among organisations has increased, academic circles have begun to focus on the management and the role of performance measurement in collaborative activities and networks (e.g. Tsai 2009). When collaboration activities among organisations become more structured, they must be managed and evaluated properly, or the risk of failure in given tasks increases. In other words, if organisations aim to develop and sustain their competitive advantages through collaboration, the structure of the latter must be understood and managed, otherwise, the objectives will not be achieved and the aims of the partnership or collaboration will not be attained (Ukko et al. 2015).

According to Kaplan, Norton, and Rugelsjoen (2010), understanding how to measure and evaluate network-level performance supports collaboration activities that enhance management, strategy, and commitment at the network level. This performance measurement should be implemented, properly adapted, and visible to all participants to enhance decision-making that promotes the management of the collaboration and network activities. The literature on performance management has recognised the trend toward inter-organisational work, in addition to the changing contexts in which performance measurement is used (Bititci et al. 2012). According to Bititci et al. (2012), the thinking has already advanced from simple collaborative organisations involving a few partners to complex networks of

organisations that work together to innovate and gain a competitive advantage. However, there seems to be a lack of holistic understanding of the performance measurement and the challenges associated with such collaborative networks of organisations. According to Bititci et al. (2012), the problem is how the performance of the collaborative organisation should be managed while also managing the performance of the participating organisations as a complete system.

Another challenge to measuring and evaluating performance in these collaborative innovation networks is the involvement of a university. Organisations that collaborate in research and development projects with universities have recognised the need for systematic evaluation and measurement of the projects. Outcomes must be assessed and ongoing activities monitored in order to implement improvements during collaborations (Perkmann, Neely, and Walsh 2011). Consequently, the development of systems to measure the performance of organisations' innovation collaborations and to assess the results of these collaborations is of paramount importance for both industrial organisations and universities (Piva and Rossi-Lamastra 2013). Traditionally, university–industry collaborations have emphasised easily quantifiable output measures, such as patents or academic publications (e.g. Grimaldi and von Tunzelmann 2002). The participating organisations, however, may find it difficult to evaluate organisational operations and actions, the processes generating the outputs, and their actual effects on innovation capabilities. Additionally, the evaluation is often subjective, based on a participant's satisfaction with the process and the outcomes (Perkmann, Neely, and Walsh 2011). A fully unified set of performance measures for university–industry collaboration evaluation could not exist because each collaboration and alliance is unique and each case differs by characteristics such as the form of collaboration, its goals, resources, partners relationships, and goals (Rossi and Rosli 2015; Albats, Fiegenbaum, and Cunningham 2017). However, there also exist some similarities among university–industry collaborations. Thus, it would be important to define and implement performance measurement practices and key performance indicators (KPIs) that include elements common to all university–industry collaborations. In this way, the implemented measurement practices will support the evaluation by providing directions for improvement in current and future collaborative initiatives (Flores, Al-Ashaab, and Magyar 2009; Albats, Fiegenbaum, and Cunningham 2017).

Several studies on performance measurement have suggested that to understand how a performance measurement system (PMS) can be designed, built, and used, its context, process, and content must be captured (Pettigrew 1985; Cuthbertson and Piotrowicz 2011). In this approach, the participating organisations' roles and responsibilities, together with their joint vision, provide grounds for measurement and evaluation. Cuthbertson and Piotrowicz's (2011) framework, originally presented by Pettigrew (1985) and constructed for the supply chain context, incorporates the following elements:

- *Context*. Under what conditions does the measurement take place? These comprise factors that have impacts on the collaborative organisations' performance measurement, the organisational context (internal organisational factors), and the collaborative network context (factors specific to the collaborative network environment).
- *Process*. How is the performance measurement carried out? It involves the tools, methods, and frameworks used to measure collaborative network performance; the ways that data are captured, presented, and used, as well as the development of the measurement system.
- *Content*. What is measured? It includes metrics, levels, categories, and dimensions.

Several authors have also discussed the evaluation process for collaboration in general and university–industry collaboration in particular (Perkmann, Neely, and Walsh 2011; Albats, Fiegenbaum, and Cunningham 2017). Perkmann, Neely, and Walsh (2011) identified four stages of university–industry collaboration: inputs, in-process activities, outputs, and outcomes. Some metrics were presented in other studies (Perkmann, Neely, and Walsh 2011; Tijssen 2012; Albats, Fiegenbaum, and Cunningham 2017), which could be utilised in university–industry collaboration:

- Input: e.g. both parties' resources (time, money, and staff allocated to collaboration), and the capabilities and motivation of both parties.

- In process: e.g. relevant research, high-quality research, and training and learning opportunities.
- Output: e.g. new technologies, new scientific knowledge, and skilled and trained staff.
- Impact/outcome: e.g. new ideas, solution concepts, innovation, and human capital.

Although the literature shows increasing interest in the performance measurement of university collaborations and its benefits, many current collaborations fail in the implementation of the measurement practices. For that reason, comprehensive PMSs are not actively used in university–industry collaborations. Even though performance measurement practices are carefully designed and built, implementing and using them as part of management can be a challenging task. Hence, after constructing the PMS to university-industry collaboration, the focus should be on implementing the system. It has been suggested (e.g. Bourne et al. 2000) that the task of implementing and utilising PMSs is far from complete at the conclusions of the design and building phases.

5. Research design

This research involved two single-case studies that explored the implementation practices and the challenges of performance measurement in university–industry collaboration. The phenomenon was explored in two university–industry SME innovation networks in Finland. The two different cases were not used to perform a comparative study of the phenomenon but to try to gain a deeper understanding of the phenomenon through the collection of a large amount of data. A case-study strategy was used to answer 'how' and 'why' questions and gain an in-depth understanding of the phenomenon under study (Yin 2009).

Case studies focus on understanding a certain phenomenon (Eisenhardt 1989). For that reason, the case study approach was chosen and utilised in this study to explore the phenomenon of performance measurement in university–industry innovation networks. As university–industry innovation networks are a growing and under-studied research area, performance measurement as part of their management is not fully understood. In the present study, the researchers were able to study university–industry innovation networks in natural settings and real life contexts.

Although a case study is sometimes considered a single research method, it should be viewed as allowing the employment of various qualitative and quantitative approaches, such as analysing archives, conducting interviews, and using questionnaires (Gummesson 2000; Yin 2009). The possibility of employing different qualitative and quantitative approaches to gain in-depth empirical level understanding of the phenomenon was another motivating factor in our selection of the case study approach. This paper, thus, presents two single-case studies focusing on performance measurement in university–industry collaboration. The empirical data were gathered using a variety of methods, as presented in detail in Table 1.

With regard to the present case study, the review of the extant literature revealed minimal practical knowledge about the practices and the challenges of performance measurement implementation in university–industry innovation networks. Thus, the present case study provides new, practical information regarding the performance measurement in university–industry collaboration. In this study, 30 Finnish SMEs in Case A and 10 Finnish SMEs in Case B participated in university–industry innovation networks that were established to facilitate their involvement in a long-term innovation process. The data were collected in formal individual interviews with participating organisations in the building phases of both networks, during 10 group workshops at the working phase in Case A and during three group workshops in Case B. The data included the feedback provided after the workshops and in formal interviews with the participants during the evaluation phase of the collaboration. The participants in the group workshops were organisation representatives, university researchers, and project workers. Three to five university observers were present at each group meeting, which was documented. The researchers also participated in individual discussions with the participants before, during, and in intervals between the meetings. The interviews were structured beforehand and recorded for use in the data analysis. The individual discussions were informal, and they were documented in field notes.

Table 1. Summary of the data collection.

Data collection method	Respondents in each phase of data collection	Number of participants	Data analysis methods
Individual interviews	1–2 members of each participating organisation (CEOs, sales managers, development managers)	50 persons	Qualitative content analysis, cross-analysis
Workshop observation	Participating organisations: 10 workshops in Case A	Workshops involving 15–45 participants	Qualitative content analysis, cross-analysis
	3 workshops in Case B Data based on observations, discussions, and feedback during the workshops	Workshops involving 8–15 participants	
Individual interviews	Interviews arranged after the project to explore the evaluation and effects of the collaborative actions 1–2 members of each participating organisation (CEOs, sales managers, development managers)	10 from Case A 5 from Case B	Qualitative content analysis, cross-analysis
Survey	Survey arranged after the projects to explore the evaluation of the networks	10 from Case A 5 from Case B	Quantitative analysis

Researcher triangulation was used to validate the interpretations of the data, which were gathered with various methods. During the coding process of the data, investigator triangulation (involving three performance measurement researchers) and data triangulation were used to overcome the potential biases derived from single-observer and single-data-set studies.

5.1. Case descriptions

Universities have traditionally formed alliances and collaborative research and development projects with SMEs that operate in different manufacturing and production industries. However, in both innovation networks in Cases A and B, the study aimed to establish university-innovation networks with organisations operating mainly in service businesses. In both cases, the idea of the innovation and development activities during the processes was to support and develop long-term innovation capabilities of the participating organisations. In both cases, the innovation networks were constructed and established such that the participating industrial organisations could focus on and develop only the topics that they found necessary, which meant that they had autonomy in deciding the topics on which they wanted focus in collaboration with other organisations and university researchers.

Case A is a university-facilitated innovation network that was established to facilitate the participation of industrial SMEs in a long-term innovation process. Thirty Finnish SMEs were brought together to collaborate and develop innovation activities and capabilities and to generate new knowledge to support them. Traditionally, such collaborations or networks are built around defined fields of business or clusters. In this case, the network was built around three focal themes that were crucial for local regional business activities. The focus was on SMEs in the service sector. The idea was to increase the innovation capability, not only of individual organisations but also of the entire network, and decrease the SMEs' barriers to participating in partnerships and collaboration activities with the university. The established university-industry innovation network was a horizontal alliance in which open innovation tools were used to seek information and to build cooperation between industrial organisations and local university units. The working methods used during the networking were highly participatory, group-based activating methods that were developed and designed based on the themes of the group meetings.

In Case B, the basic structure of the university–industry innovation network followed the model presented in Case A. The established university–industry innovation network was a horizontal alliance

in which open innovation tools were used to seek information and to build cooperation between industrial organisations and local university units. Ten Finnish industrial SMEs collaborated in a long-term innovation network to develop and innovate how future technology solutions and tools could be utilised better as part of preventive healthcare services. The collaborative R&D project in this case was a follow-up to a research project that focused on the role of user-oriented gerontechnology in elder care services. The memory and reminiscence stick (mStick) and the health stick (hStick) for increasing user involvement in the services was developed during the project (Pekkarinen et al. 2013) that was conducted to follow up the innovation network. Thus, the SMEs participating in the network were in business areas related to IT services, healthcare services, and sports and recreation services.

5.2. Data analysis

Cross-case analysis was selected as a main method for this study because it can facilitate the comparison of the processes that are the units of analyses in selected cases. Cross-case analysis also enables researchers to explore concepts, theories, and hypotheses among different contexts and surroundings. In this study, the cross-case analysis aimed to explore the commonalities of performance measurement implementation in two different innovation networks**.** Data were collected in individual interviews with participating organisations in university–industry partnerships during the building phases of Cases A and B. These were analysed through a multi-coding process to generate patterns related to performance measurement implementation practices and challenges. During the coding process, these were structured into more generic factors. In the first round of the coding process, the data were analysed and arranged utilising Cuthbertson and Piotrowicz's (2011) framework, which incorporates context, process, and content factors. The aim of the first coding round was to find the patterns related to each factor. The second round of the coding process was undertaken when the cases were ongoing, utilising the data gathered from the interviews, the workshops, and the individual discussions with the participants. During this second round, generic patterns related to current challenges and practices of performance measurement in university–industry innovation networks were arranged by utilising the four-stage evaluation process model (input, in-process, output, outcome/impact) (Perkmann, Neely, and Walsh 2011). The aim of the second coding round was to find patterns related to the practices in the implementation of performance measurement in each stage as well as the challenges to them. In the third round of the coding process, the data gathered from the workshops and the individual interviews after the cases ended were used to identify the performance measurement implementation practices and challenges arranged to evaluate the success of the university–industry innovation networks. At each stage of the coding process, research triangulation was used to validate the structured patterns. Table 2 summarises the overall coding process of the data.

In the final round of the coding process, additional data collected in the survey were used to confirm the findings and patterns generated during the previous coding rounds. The patterns generated during the first and second rounds of coding were used to formulate the survey questions. The survey data were coded by calculating the mean and standard deviations for the responses to each question.

6. Results of the study

University–industry collaborations by universities and industrial organisations have larger societal effects and benefits. Their funding agencies (e.g. the European Commission's Horizon 2020, European Regional Development Funds, and National Research Councils and Foundations) also provide societal-level instructions and evaluation criteria for collaboration. Nevertheless, the SMEs participating these collaborations in the form of innovation networks were strongly oriented to the operational level. The study's results revealed that the primary focus of the participating organisations' collaboration and innovation networking activities seemed to be gaining more innovation capabilities and intellectual capital, for example, new organisational learning and development practices and familiarity with other organisations' businesses. These capabilities were perceived as enablers for business gains from the

Table 2. Summary of the coding process.

Coding	Data utilised	Aim of the coding	Main results
First round	Individual interviews/discussions: 1–2 members of the each participating organisation (CEOs, sales managers, development managers)	To arrange patterns related to implementation challenges and practices of performance measurement in university–industry innovation networks from the perspective of industrial organisations	• Implementation practices and challenges related to: • the context of performance measurement • the process of performance measurement • the content of performance measurement
Second round	Individual interviews/discussions: 1–2 members of each participating organisation (CEOs, sales managers, development managers) Workshop observations: 10 workshops in Case A 3 workshops in Case B	To arrange generic patterns related to the current implementation of input, in-process, and output measures in university–industry innovation networks	• Practices and challenges related to the implementation of: • input measures • in-process measures • output measures
Third round	Workshop observations: 10 workshops in Case A 3 workshops in Case B Interviews arranged after the project to explore the evaluation and effects of the collaborative actions 1–2 members of each participating organisation (CEOs, sales managers, development managers)	To arrange patterns related to performance measurement practices and challenges to the success of university–industry innovation networks To arrange patterns related to performance measurement practices and challenges to outcome and impact measures	• Practices and challenges related to the implementation of: • outcome/impact measures • collaboration success measures
Additional data analyses	Survey conducted after the projects to explore the evaluation of the networks	To confirm the findings and patterns arranged in the previous rounds of coding	• Implementation practices and challenges related to the context, process, and content of performance measurement • Practices and challenges related to the implementation of input, in-process, output, and outcome/impact measures

collaboration operations. The organisations' representatives offered the following reasons for participating in the collaboration activities:

- They wanted to become acquainted with other entrepreneurs. Personal relationships and trust have significant roles in formal contracts, so one main reason for participating was to accumulate social capital.
- They hoped to gain a better understanding of other organisations. Many of the participants had basic knowledge of the others' business ideas, but they lacked an understanding of how these businesses operated on a practical level.
- They were interested in promoting and marketing their own products and services. When the participants had the chance to meet the other organisations' representatives at the same time, they regarded it as a good opportunity for marketing their respective organisations.
- Some of the organisations' representatives also wanted to become familiar with the university (e.g. to obtain recent research results), but the university's most important role seemed to enable the organisations to collaborate with one another.

Reflecting on research question one, in contrast to the literature on the performance measurement of university–industry collaborations, in both Case A and Case B, the industrial organisations recognised the importance of the performance measurement of these activities. The participating SMEs mainly shared the opinion that a PMS should be created to evaluate the performance of individual organisations and the entire network. The results also showed that the actual purpose of the network-level PMS in university–industry collaboration activities was not as obvious to the industrial organisations. In normal business environments and as part of daily operations, the participants were familiar with evaluating and measuring the performance of individual organisations. However, they were unsure of the purpose of evaluating and measuring the performance of collaborative activities. The lack of understanding of the actual using purpose of the PMS was found to be one of the main challenges to the implementation of measurement systems and individual measures.

With regard to the first research question, the content of the performance measurement of the innovation network (Cuthbertson and Piotrowicz 2011) seemed to be clearer for the participating organisations than its context and process. Based on the reasons given for the organisations to participate in these collaborative networks, it seemed to be easier for them to understand what should be measured in these alliances (e.g. increased learning, increased social capital, and new innovations). These issues have received attention in academic circles over the last few years. Although several studies have confirmed the positive relationship between organisations' innovativeness and business performance, the literature lacks frameworks or models for measuring and evaluating innovation capabilities. Saunila and Ukko (2012) present a conceptual framework for measuring innovation capability and its effects. They emphasise that it is not enough to know how many new innovative processes, actions, or products have been initiated if there is no understanding of their connection to business performance. However, due to this phenomenon's novelty, even in academic circles, it was found to be unknown among industrial organisations, which caused the failure of the implementation. The industrial organisations did not seem interested in evaluating the process inputs in university–industry innovation networks. Their current focus and interest in performance measurement was the evaluation of process activities and process outputs and outcomes (e.g. new customer relationships, innovations, and strategic partnerships) with other industrial organisations. The role of the university in these innovation networks was mainly perceived as a facilitator for the research and development of industrial organisations and their innovation activities. For that reason, the participants expressed that they were not interested in the performance measurement of the activities and outcomes of their collaboration with universities. However, some participants said that the business-related effects and outcomes of the collaboration with the university could be measured. For example, new companies that were spinning off from the university to fulfil the university's third mission should be evaluated.

Regarding research question two, the SMEs participated in these collaborations to gain innovation capabilities and human capital, indicating that the participants were not capable of evaluating the societal level activities or effects of the collaborations. Many participants mentioned that although they would be interested in evaluating the societal effects of university–industry collaboration, they lacked a connection between their operational networking activities and the evaluation criteria provided by funding agencies. It was also commonly mentioned that the participating SMEs were not aware of the aims and goals of the funding programmes. From their point of view, they participated in individual research and development projects.

In further response to research question two, the findings reflected the challenges to understanding the purposes of the performance measurement. Specifically, the findings showed that the context (Cuthbertson and Piotrowicz 2011) of the performance measurement of the university–industry innovation networks was unclear to the participating SMEs. Moreover, the findings indicated that they were confused about the conditions under which the measurement should take place. This observation was supported by the results gathered during the workshops, which revealed that the participating SMEs found it hard to form a joint vision for the innovation network; thus, it was difficult for them to understand their roles and responsibilities as part of the network. With regard to the first research question, the results also revealed that the SMEs were mainly interested in measuring the innovation activities and the advances gained in the activities with other industrial organisations. The results indicated that although the motivations for participation in innovation networks were apparently related to intellectual capital, the performance measurement activities seemed to be strongly business related. Nevertheless, the participating organisations' representatives seemed to understand that it might take time for industrial organisations to realise that intellectual advantages could be gained from collaborating in innovation activities with other SMEs, including increased revenues or lower costs. For this reason, they acknowledged that during the process, innovation capabilities and intellectual capital should be evaluated even though they found it challenging.

Reflecting on both research questions, we see that in addition to the uncertainty about the context of the performance measurement in the university–industry innovation network, the participating SMEs faced challenges in the process state (Cuthbertson and Piotrowicz 2011) of the performance measurement. Instead of implementing performance measurement tools and practices that were designed for the university–industry context, they had tried to use existing ones to capture the performance of the collaboration from the perspective of their own performance. However, these tools and methods, normally used to evaluate operations during daily business activities, were not found suitable for evaluating the performance of the university–industry innovation network. These traditional tools and measurements were the so-called 'hard measures' that focused on tangible outputs and were mainly mentioned as related to business performance, not concentrating on intangible aspects and innovation capabilities that were set as parts of the main target of the collaboration. Table 3 summarises the current challenges and practices related to the implementation of performance measurement in university–industry innovation networks.

7. Discussion

An important aspect of university–industry collaborations concerns their effects on society (Rossi and Rosli 2015), which should be measured in order to show the utility of university–industry collaborations. The results of the study showed that instead of using performance measurement tools and practices to track the societal-level effects of university–industry innovation networks, industrial SMEs are interested in measuring societal-level outputs that are business related. The results also showed that the industrial SMEs were interested in implementing such measurements in the university-industry innovation networks while the projects were running. Nevertheless, they faced challenges in implementing the measurement practices and tools. The biggest challenges were related to challenges in understanding the connection of operational-level activities to the 'bigger picture' as well as the societal-level aims and goals of the funding programmes. Recent studies (Perkmann, Neely, and Walsh 2011; Rossi and Rosli

Table 3. Summary of performance measurement practices and challenges of industrial SMEs.

	Industrial SME's views on implementation of performance measurement practices	Challenges related to the implementation of performance measurement
Societal-level performance measurement of university–industry innovation networks	• Interest in the performance measurement of societal-level outputs of university–industry innovation networks.	• Industrial SMEs are not aware of the aims and goals of the funding programmes. From their point of view, they participate in individual research and development projects.
Network-level performance measurement of university–industry innovation networks	• Industrial SMEs recognise the importance of the performance measurement of network-level activities. The participating SMEs mainly shared the opinion that a PMS should be created to evaluate the performance of individual organisations and the entire network. • SMEs are mainly interested in measuring the innovation activities and advances gained in activities with other industrial organisations. Although the motivation for participation in innovation networks seem related to intellectual capital, the performance measurement activities seem to be strongly related to business.	• The purpose of the network level of PMS in university–industry collaboration activities did not seem obvious to the industrial SMEs. • The context of the performance measurement of the university–industry innovation networks seemed unclear for the participating SMEs, and they seemed to be confused about the conditions under which the measurement should take place. • Although the literature on the performance measurement of university-industry collaborations recognises the frameworks developed for such contexts, the industrial SMEs seemed to be unfamiliar with them and to lack the proper understanding and means to implement them.
Individual-level performance measurement of university–industry innovation networks	• Performance measurement of goals and tasks that were originally defined for the aims of collaboration. • The current focus and interest in performance measurement seemed to be evaluating process activities and process outputs and outcomes (e.g. new customer relationships, innovations, or strategic partnerships) with other industrial organisations. • Interest in the performance measurement of increased learning, increased social capital, and new innovations.	• Challenges in developing and implementing new tools and methods to evaluate or measure the results or effects that were secondary outcomes of the collaboration. • Industrial SMEs currently seemed to be unfamiliar with frameworks and tools for measuring and evaluating innovation capabilities, which caused the failure of implementation.

2015; Albats, Fiegenbaum, and Cunningham 2017) found that to achieve societal-level effects as a result of collaboration, the participants should organise joint public lectures or write press releases. However, the industrial SMEs viewed such activities and their measurement as the responsibility of the university. Hence, they should be implemented by university operators. One reason for the industrial SMEs interest in the measurement of societal-level outputs instead of effects, which supports the findings of Cunningham and Link (2015) and Albats, Fiegenbaum, and Cunningham (2017), was related to the different timeframes that the parties used. Although industrial SMEs participated in networking activities aimed at supporting long-term innovation, short-term performance measurement practices were implemented so that the business value could be tracked while collaboration activities were performed.

Regarding the context (Cuthbertson and Piotrowicz 2011) of the performance measurement of the university-industry collaboration, the industrial SMEs considered difficulties in forming a joint vision for the innovation network and understanding the purpose of the network-level PMS. Instead of developing and implementing network-level KPIs, the industrial SMEs implemented KPIs that measured the performance of their own operations as a part of the network. For example, the participating SMEs used impact measures such as strategic partnerships and change/renewal of business revenue structure, which Albats, Fiegenbaum, and Cunningham (2017) showed were among the most important KPIs in university-industry collaboration. According to these authors, as an indicator, the new strategic partner meant the possibility of future collaborations based on the experience gained in the current or recently finished joint projects (Perkmann, Neely, and Walsh 2011; Albats, Fiegenbaum, and Cunningham 2017). However, instead of evaluating the future collaborations with the university, the industrial SMEs seemed interested only in evaluating the future collaboration possibilities with other SMEs, which indicated that their interest in evaluating partnerships was business related. In addition to the challenges in the context of the performance measurement in university–industry innovation networks, the process (Cuthbertson and Piotrowicz 2011) of the performance measurement was considered difficult to implement. Although literature on the performance measurement of university–industry collaborations recognises frameworks that were proposed to improve their management and evaluation (e.g. Al-Ashaab et al. 2011; Perkmann, Neely, and Walsh 2011; Albats, Fiegenbaum, and Cunningham 2017), the industrial SMEs seemed unfamiliar with them. Therefore, these organisations lacked the means and understanding required to implement the proposed frameworks and measures. Therefore, the industrial SMEs mainly implemented the traditional performance measurement tools and methods that were originally developed to evaluate their daily business operations.

While the industrial SMEs faced challenges in understanding the context of performance measurement and implementing it in university-industry innovation networks, the results indicated that they were familiar with the content (Cuthbertson and Piotrowicz 2011) of performance measurement. It was perceived as deriving directly from the reasons and the motivations for participating. Some reasons included becoming acquainted with other entrepreneurs, accessing learning opportunities, creating innovation capability, and sharing knowledge. The challenges to understanding the context and process of university-industry innovation networks also caused the industrial SMEs to be interested in the measurement of the outputs (Perkmann, Neely, and Walsh 2011; Albats, Fiegenbaum, and Cunningham 2017) of university-industry innovation networks.

8. Conclusions

This study explored performance measurement implementation practices and challenges in university–industry innovation networks from the perspective of industrial SMEs. The implementation of performance measurement practices and the emerging challenges to it were studied in two university–industry innovation networks. The results showed that industrial SMEs seemed to collaborate in innovation networks with the university to gain more innovation capabilities and intellectual capital, such as new learning and development practices. However, their performance measurement activities seemed strongly related to business. First, regarding the content of the performance measurement, and based on the reasons why the organisations participated in these collaborative innovation

networks, it seemed easier for them to understand what should be measured in these collaborations, for example, increased learning, increased social capital, and new innovations. Second, regarding the context of the performance measurement, the participating organisations found it hard to formulate a joint vision of the innovation network; therefore, it was difficult for them to understand their roles and responsibilities in the network. The industrial SMEs seemed interested in societal- and operational-level performance measurement activities during the collaborations, and they expressed that the evaluation of outcomes and impacts should be done by the universities. Third, regarding the process of performance measurement in the participating organisations, they found it difficult to understand the purpose of the network-level PMS, which caused challenges in the implementation of network level performance measurement.

The reasons for industrial organisations' participation in collaborations and innovation networks with universities seem linked to intellectual capital and knowledge acquisition although they miss the clear connection between the advantages gained from the development activities and the actual business performance. Despite the apparent importance of measuring the performance of these university–industry innovation networks, the industrial organisations face challenges in recognising the performance measurement practices developed for university-industry collaborations, which is why they face challenges in implementing them. The lack of understanding of the context and the process of the performance measurement also seems to shift the industrial organisations' focus to the content phase of the performance measurement and to the use of traditional measurements and tools to estimate the advantages gained. However, these traditional tools and measures focused on tangible outputs and were mainly mentioned as related to business performance instead of emphasising intangible aspects and innovation capabilities that were set as parts of the main target of the collaboration. Furthermore, as industrial organisations are unfamiliar with evaluating issues such as innovation capabilities and intellectual capital, they do not know how to measure them more precisely in university-industry collaboration contexts. For this reason, they need more support in implementing performance measurement tools and frameworks to evaluate and manage their innovation and development activities with universities and to develop measurements that will assess intellectual aspects of these activities.

This study's limitation is that it is based on two different cases of university–industry innovation networks. However, because the study was aimed mainly to increase the empirical understanding of the implementation of performance measurement practices and the challenges in collaboration activities in university–industry innovation networks, the research findings can be utilised by different stakeholder groups interested in the evaluation of university–industry partnerships and innovation activities in general. Further research is suggested to develop both theoretical and empirical knowledge of the implementation practices and challenges of PMSs for innovation activities between universities and industrial organisations. Thus, the results of this study provide both academics and practitioners with valuable information about the implementation of PMSs in practice and the related challenges. Based on this information, academics and practitioners will be able to develop and implement better performance measurement frameworks and tools.

Disclosure statement

No potential conflict of interest was reported by the authors.

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References

Al-Ashaab, A., M. Flores, A. Doultsinou, and A. Magyar. 2011. "A Balanced Scorecard for Measuring the Impact of Industry–University Collaboration." *Production Planning & Control: The Management of Operations* 22 (5–6): 554–570. doi:10.1080/09537287.2010.536626.

Albats, E., I. Fiegenbaum, and J. A. Cunningham. 2017. "A Micro Level Study of University–Industry Collaborative Lifecycle Key Performance Indicators." *Journal of Technology Transfer* 43: 389–431. doi:10.1007/s10961-017-9555-2.

Ankrah, S., and O. AL-Tabbaa. 2015. "Universities – Industry Collaboration: A Systematic Review." *Scandinavian Journal of Management* 31: 387–408. doi:10.1016/j.scaman.2015.02.003.

Bishop, K., P. D'Este, and A. Neely. 2011. "Gaining from Interactions with Universities: Multiple Methods for Nurturing Absorptive Capacity." *Research Policy* 40: 30–40. doi:10.1016/j.respol.2010.09.009.

Bititci, U., P. Garengo, V. Dörfler, and S. Nudurupati. 2012. "Performance Measurement: Challenges for Tomorrow." *International Journal of Management Reviews* 14: 305–327. doi:10.1111/j.1468-2370.2011.00318.x.

Bourne, M., J. Mills, M. Wilcox, A. Neely, and K. Platts. 2000. "Designing, Implementing and Updating Performance Measurement Systems." *International Journal of Operations and Production Management* 20 (7): 754–771. doi:10.1108/01443570010330739.

Camarinha-Matos, L. M., and H. Afsarmanesh. 2008. *Collaborative Networks – Reference Modeling*. New York: Springer.

Coombs, R., M. Harvey, and B. S. Tether. 2003. "Analysing Distributed Processes of Provision and Innovation." *Industrial & Corporate Change* 12: 1125–1155. doi:10.1093/icc/12.6.1125.

Cunningham, J. A., and A. M. Link. 2015. "Fostering University Industry R&D Collaborations in European Union Countries." *International Entrepreneurship and Management Journal* 11 (4): 849–860. doi:10.1007/s11365-014-0317-4.

Cuthbertson, R., and W. Piotrowicz. 2011. "Performance Measurement Systems in Supply Chains: A Framework for Contextual Analysis." *International Journal of Productivity and Performance Management* 60 (6): 583–602. doi:10.1108/17410401111150760.

Eisenhardt, K. M. 1989. "Building Theories from Case Study Research." *Academy of Management Review* 4 (14): 532–550.

Flores, M., A. Al-Ashaab, and A. Magyar. 2009. "A Balanced Scorecard for Open Innovation: Measuring the Impact of Industry–University Collaboration." In *Leveraging Knowledge for Innovation in Collaborative Networks*, edited by L. M. Camarinha-Matos, I. Paraskakis and H. Afsarmanesh, 23–32. Berlin: Springer-Verlag.

Gertner, D., J. Roberts, and D. Charles. 2011. "University–Industry Collaboration: A CoP's Approach to KTPs." *Journal of Knowledge Management* 15: 625–647. doi:10.1108/13673271111151992.

Grimaldi, R., and N. von Tunzelmann. 2002. "Assessing Collaborative, Pre-Competitive R&D Projects: The Case of the UK LINK Scheme." *R&D Management* 32: 165–173. doi:10.1111/1467-9310.00248.

Gummesson, E. 2000. *Qualitative Methods in Management Research*. Thousand Oaks, CA: Sage.

Kaplan, R. S., D. P. Norton, and B. Rugelsjoen. 2010. "Managing Alliances with the Balanced Scorecard." *Harvard Business Review* 88 (1): 114–120.

Konkola, R., T. Tuomi-Gröhn, P. Lambert, and S. Ludvigsen. 2007. "Promoting Learning and Transfer between School and Workplace." *Journal of Education and Work* 20 (3): 211–228. doi:10.1080/13639080701464483.

Mäkimattila, M., T. Junell, and T. Rantala. 2015. "Developing Collaboration Structures for University–Industry Interaction and Innovations." *European Journal of Innovation Management* 18 (4): 451–470. doi:10.1108/EJIM-05-2013-0044.

Pekkarinen, S., P. Kuosmanen, H. Melkas, A. Karisto, R. Valve, and K. Kempas. 2013. "The Roles and Functions of User-Oriented Gerontechnology: mStick and hStick." *Journal of Medical and Biological Engineering* 33 (4): 349–355.

Perkmann, M. 2015. "University–Industry Relations." In *Concise Guide to Entrepreneurship, Technology and Innovation*, edited by D. Audretsch, S. Christopher, A. Hayter and N. Link, 227–233. Cheltenham: Edward Elgar.

Perkmann, M., A. Neely, and K. Walsh. 2011. "How Should Firms Evaluate Success in University–Industry Alliances? A Performance Measurement System." *R&D Management* 41 (2): 202–216. doi:10.1111/j.1467-9310.2011.00637.x.

Perkmann, M., V. Tartari, M. McKelvey, E. Autio, A. Broström, P. D'Este, R. Fini, et al. 2013. "Academic Engagement and Commercialisation: A Review of the Literature on University–Industry Relations." *Research Policy* 42: 423–442. doi:10.1016/j.respol.2012.09.007.

Perkmann, M., and K. Walsh. 2007. "University–Industry Relationships and Open Innovation: Towards a Research Agenda." *International Journal of Management Reviews* 9 (4): 259–280. doi:10.1111/j.1468-2370.2007.00225.x.

Pettigrew, A. M. 1985. *The Awakening Giant: Continuity and Change in Imperial Chemical Industries*. Oxford: Blackwell.

Piva, E., and C. Rossi-Lamastra. 2013. "Systems of Indicators to Evaluate the Performance of University–Industry Alliances: A Review of the Literature and Directions for Future Research." *Measuring Business Excellence* 17 (3): 40–54. doi:10.1108/MBE-01-2013-0004.

Reeve, F., and J. Gallacher. 2007. "Employer–University 'Partnerships': A Key Problem for Work-based Learning Programmes?" *Journal of Education and Work* 18 (2): 219–233. doi:10.1080/13639080500085992.

Rossi, F., and A. Rosli. 2015. "Indicators of University–Industry Knowledge Transfer Performance and Their Implications for Universities: Evidence from the United Kingdom." *Studies in Higher Education* 40 (10): 1970–1991. doi:10.1080/03075079.2014.914914.

Saunila, M., and J. Ukko. 2012. "A Conceptual Framework for the Measurement of Innovation Capability and Its Effects." *Baltic Journal of Management* 7 (4): 355–375. doi:10.1108/17465261211272139.

Slotte, V., and P. Tynjälä. 2003. "Industry–University Collaboration for Continuing Professional Development." *Journal of Education and Work* 16 (4): 445–464. doi:10.1080/1363908032000093058.
Tijssen, R. J. 2012. "Co-authored Research Publications and Strategic Analysis of Public–Private Collaboration." *Research Evaluation* 21: 204–215. doi:10.1093/reseval/rvs013.
Tsai, K. H. 2009. "Collaborative Networks and Product Innovation Performance: Toward a Contingency Perspective." *Research Policy* 38: 765–778. doi:10.1016/j.respol.2008.12.012.
Ukko, J., S. Pekkola, M. Saunila, and T. Rantala. 2015. "Performance Measurement Approach to Show the Value for the Customer in an Industrial Service Network." *International Journal of Business Performance Management* 16 (2–3): 214–229. doi:10.1504/IJBPM.2015.068726.
Yin, R. K. 2009. *Case Study Research – Design and Methods*. 4th ed. Thousand Oaks, CA: Sage.

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PERFORMANCE MEASUREMENT IN UNIVERSITY–INDUSTRY COLLABORATION PROJECTS: UNIVERSITY AND FINANCIER PERSPECTIVES

ABSTRACT

To support the future development of the evaluation and performance measurement of the operational-level activities of university–industry–government relations and to increase the understanding of the current performance measurement practices and challenges of university–industry (UI) collaboration projects, the performance measurement practices currently employed by universities and financiers are explored in this study. As part of the contemporary Triple Helix operations, universities are more and more frequently asked to collaborate with other social actors to generate knowledge that supports their innovation and development activities and to foster economic growth. In addition to research and education tasks, universities are developing formal and informal collaborations with industrial organizations in order to fulfill the third mission of societal effectiveness and to receive funding from research grants. These UI research and development projects, at the societal level and from the viewpoints of policymakers and financiers, aim to create economic growth and to support the innovation and learning capabilities of the organizations, among other benefits. One key challenge in managing these collaborations is related to their measurement and evaluation. The empirical data for this study were gathered from UI research projects in Finland. As part of the management of university–industry–government relations and Triple Helix operations, the results of this study reveal some challenges in the evaluation and measurement of the collaborative projects in the three phases explored: before the project, during the project, and after the project. To support the future development of the evaluation and performance measurement of university–industry–government relations, some propositions for overcoming these challenges are presented, and the potential implications of the findings for scholars, university members, financier representatives, and policy makers are discussed.

Keywords*: Triple-Helix, Performance measurement, Performance management, University–Industry collaboration, Project management*

1. INTRODUCTION

Collaboration activities between governmental organizations, industry, and academia have been acknowledged as important mechanisms for successful technology and knowledge transfer, which forms a foundation for global-, national-, and regional-level innovation and economic growth (Miller *et al*., 2016; Urbano and Guerrero, 2013; Etzkowitz and Leydesdorff, 1995). Currently, the Triple Helix of university–industry–government relations provides surroundings and frameworks for different organizations to overcome blockages to innovation in regional innovation systems (Champenois and Etzkowitz, 2018; Etzkowitz, 2008). Collaborative partners in innovation and development activities are no longer sought only by other public and private organizations; today, universities are commonly seen as important partners in these activities. Organizations of all sizes

are increasingly forming collaboration activities and research and development projects with universities to maintain and develop their competitive advantages (Peças and Henriques, 2006; Perkmann *et al*., 2011). As such, within recent years, the expansion of universities' entrepreneurial activities has resulted in various helix models, such as the Triple Helix model of government, academia, and industry (Miller *et al*., 2016). By participating in activities formed under Triple Helix models, (instead of isolated research and development activities), different organizations are for example looking for external governmental funding support by forming collaboration activities and projects with universities. While research into university–industry (UI) collaborations have traditionally focused on the transfer of intellectual capital (e.g., licensing and commercialization), some studies have contended that these alliances have more multiform natures (e.g., Agrawal, 2001, Mäkimattila *et al*., 2015). As part of the Triple Helix-related operations, traditional collaborations typically enable organizations to participate with universities in alliances or projects focused on specific technical or scientific subject areas. Today's partnerships and collaboration projects, however, are increasingly being formed on the basis of more open and innovation-based strategies (e.g. Bogers *et al*., 2017). In these collaborations, organizations are interested, for example, in gaining social capital or innovation capabilities rather than solving specific technical problems (Perkmann and Walsh, 2007, Pinheiro *et al*., 2016). As part of the Triple Helix-related operations, these more open strategies aiming to increase social capital and innovation capabilities create possibilities but also cause challenges for university-industry collaborations, and, thus, more research and understanding of the execution and management of these collaboration activities is needed.

Although many governments and universities around the world have allocated funding mechanisms and resources to support the forming of Triple Helix activities (Champenois and Etzkowitz, 2018; Croce *et al*., 2014) and although collaboration activities between universities and other societal organizations have been championed as likely to play significant roles in generating economic growth in the future, both types of activities must more and more often deal with limited resources and funding support. Economic recession has decreased the funding available to university-industry collaborations and research and development projects, and current grant competitions are ever more competitive. While making decisions concerning Triple Helix operations, politicians and financiers are in the challenging situation of finding the best possible partnerships and projects to support. For that reason, diverging stakeholders are asking better methods and practices for performance measurement to support the management of these collaborations (e.g. Rantala and Ukko, 2019). Even though a growing part of the Triple Helix operations are pursued in diverse types of research and development projects and even though the literature on project management (PM) has recognized and suggested performance measurement practices (Cao and Hoffman, 2011; Ling *et al*., 2009; Thomas and Fernandez, 2008), Perkmann *et al*. (2011) argued that a key challenge for the management of university-industry collaborations is how to assess and evaluate them. Further, Immonen and Cooksy (2014) found in their study that there were difficulties in developing indicators for the kinds of performance that research institutions are expected to demonstrate on outputs, outcomes, and impacts of these collaborations. In addition to performance measurement of the projects pursued by industrial organizations, the literature on the performance measurement of UI collaborations has suggested practices and indicators to support their management (cf. Albats *et al*., 2017; Perkmann *et al*., 2011). However, as in traditional industrial PM contexts, commonly implemented performance measurement frameworks and practices are rare in UI collaborations. Thus, in order to be able to evaluate and

manage Triple Helix operation, it is important to more understand both the meanings and aims of the performance measurement in these UI projects as well as the elements that support or complicate these activities.

Even though there seems to exist an interest towards the new and alternative methodologies of analyzing and evaluating university–industry–government relations (e.g., Park, 2014), the previously developed and suggested performance measurement frameworks and tools seem to remain insufficiently utilized in practice. As such, this study explores the current operational-level performance measurement practices employed and the challenges faced by university project managers and financier representatives as part of managing collaborative UI research and development projects. The empirical data for this study were gathered from Finnish UI research projects that were all receiving governmental funding support. The data for the study were collected from interviews with collaborative research project managers and financier delegates. As the majority of the performance measurement practices, reporting, and bureaucratic aspects of UI collaborations are usually handled by the university project managers and financier representatives, this study focuses on exploring the phenomena from these perspectives. The study is executed through the following research questions:

- RQ1 How is performance measurement used to steer university–industry collaborative projects at the operational level?
- RQ2 How are the actions, success, and effects of the university–industry collaborative projects evaluated at the operational level?
- RQ3 What challenges do the performance measurement of the university–industry collaborative projects raise at the operational level?

As part of the future development of the university–industry–government relations, the growing interest in collaborative UI projects necessitates research on performance measurement to obtain a better empirical understanding of their current practices and challenges. Therefore, we believe that all of the stakeholders in these collaborations can find the results of this study beneficial for developing better solutions for managing and evaluating university–industry–government relations and Triple Helix operations.

2. UNIVERSITY–INDUSTRY PARTNERSHIPS AND COLLABORATION ACTIVITIES

Universities as well as private and public organizations have been reported to play important roles in generating new economic growth, innovation, knowledge, and product development (e.g., Lundberg and Andersen, 2012; Perkmann *et al.*, 2013; Clark, 2001). In addition to the execution of the third mission, universities are also seeking increasing amounts of external funding from different sources, such as Horizon 2020, European Regional Development Funds, and national programs, to bolster their other operations and educational programs. Economic recessions are also forcing universities to modify their operations and compete for external funding. Universities, therefore, are under increasing pressure to interact with their surrounding society to support their research and development activities, as society's expectations of the economic returns from basic research and development activities have increased (Schartinger *et al.*, 2001; Lundberg and Andersen, 2012). As such, policymakers are more frequently encouraging universities to develop their third mission of fostering partnerships and collaboration between academic researchers and

knowledge users (Gulbrandsen and Slipersaeter, 2007). Among the various ways of establishing these activities, commercializing knowledge and licensing innovations have been the focus of attention, both in the academic literature and in the policy community (O'Shea *et al.*, 2008). While these are clearly important ways for academic research to contribute to both the economy and society, research is in fact transferred into practice in numerous ways (Rantala and Ukko, 2018). Not only by generating short- and long-term commercialized outcomes, but also by supporting intra- and inter-organizational development, UI projects play important roles in developing the innovation capabilities of organizations. It is not merely the traditional stakeholder groups in organizations (e.g., customers and competitors) that can produce knowledge that supports competitive advantages and organizational development; university research also plays an important role in the innovation activities of industrial organizations (Cohen *et al.*, 2002; Salter and Martin, 2001). The role of academic research and partnerships with universities, thus, is more than simply creating patents or licensed products; it also involves supporting organizations' learning processes and innovation capabilities. The academic and industry involvement in knowledge transfer include formal activities, such as collaborative or contract research, as well as informal activities, like advising and networking with practitioners (Perkmann *et al.*, 2013).

Because the funding programs in many countries require academics to make a societal impact outside of their universities, understanding how collaboration activities and partnerships result in such benefits, while still maintaining scientific quality, is of great relevance (Perkmann *et al.*, 2013). Further research on the impacts and effectiveness of collaborations could enable policymakers to make considered judgements as to which behaviors and forms of collaboration to promote and under which conditions they are most likely to achieve their scientific and economic objectives (Perkmann *et al.*, 2013). Although UI projects offer potential advantages, they are not without their problems. For one, the structural differences between universities and industrial organizations are a major challenge. While academic research tends to have a long-term orientation, organizations are more commonly interested in short-term outcomes and rapidly commercializable innovations (Perkmann *et al.*, 2011). Another problem is rooted in confidentiality. In order to allow the commercial exploitation of their research results, researchers might be required to delay or even forgo publication (Geuna, 2001). Researchers' publishing activities might also be hindered by academic journals' lack of interest in industry-connected work that is not perceived as novel or academically relevant. In addition, researchers might spend time and resources on activities that are not conducive to academic output (Calderini *et al.*, 2007; Perkmann and Walsh, 2009). Perkmann *et al*. (2011) presented aspects of how UI projects differ from traditional research and development projects pursued by industrial organizations. First, in collaborative projects that focus on generating scientific knowledge that is far from commercialization, the value of any project outputs are difficult to evaluate. Second, in UI projects, the outputs are likely to be more complex than in traditional settings. Third, project benefits may be realized only over the long term (Voytek *et al*., 2004). Given the long-term nature of some UI projects, many of the benefits derived from these collaborations might be realized only after a considerable time (Kerssens-van Drongele and Bilderbeek, 1999; Perkmann *et al.*, 2011).

In addition to their challenges and differences, the impact of industry partnerships and collaboration activities on universities has also drawn the attention of researchers; some have emphasized the benefits of partnerships, while others have feared that growing involvement in these activities might have negative effects on academic priorities (Perkmann and Walsh, 2009).

Perkmann *et al.* (2013) suggested there is a partial lack of understanding about the consequences of academic engagement and showed that evidence on these collaborations' impacts on other university activities, like research and teaching, is scarce; therefore, it cannot be assumed that collaboration activities are always beneficial and should be promoted. The knowledge transfers from universities to industries have been the interest of several academic studies (cf. Albats *et al*., 2017; Anderson *et al*., 2007), and the reverse direction of information and knowledge flow (from industries to universities) has also been examined (cf. D´Este and Patel, 2007). Even though the importance of the knowledge gathered from industry organizations in collaboration projects has been recognized as playing an important role in academics' careers, the evaluation of the gathered and transferred knowledge seems to be rare.

3. NEED FOR PERFORMANCE MEASUREMENT IN UNIVERSITY–INDUSTRY COLLABORATION PROJECTS

Organizations collaborating in research and development projects with universities have recognized the need for more systematic evaluation and measurement, both to assess their outcomes and to monitor ongoing activities in order to implement timely improvements (Perkmann *et al.*, 2011). Consequently, developing performance measurement systems for the organizations' collaborations and results is paramount, not only for the organizations but also for the universities (Piva and Rossi-Lamastra, 2013). In addition, for the performance measurement interests of industrial organizations and universities, less attention has been paid to the measurement practices and challenges of the financier representatives of these collaborative projects (c.f. Bark *et al*. 2016). However, some studies have shed some light on their evaluation perspectives (cf. D´Este *et al*., 2012; Plewa *et al*., 2013). Even though the evaluations of the UI collaborations have been studied from different perspectives, academics still emphasize the shortcomings in the existing performance measurement practices applied by external evaluators (Albats *et al*., 2017; Kauppila *et al*., 2015; Perkmann *et al*., 2011).

The literature on performance measurement recognizes the trend toward inter-organizational collaboration and regularly calls for more research to be conducted on performance measurement in collaborative organizations and projects (Bititci *et al.*, 2012). As with other types of collaborations, UI research and development projects involve organizations that work together in relationships of equality, commitment, and trust; that exchange information, share activities, and combine resources; and that complement and enhance each other's capacities in order to achieve mutual benefits and a common purpose by sharing risks, responsibilities, and rewards (Bititci *et al.*, 2004). In UI projects, organizations can utilize the external knowledge produced by researchers, who in turn can examine how their newest findings operate in real-world contexts. Several researchers have claimed, however, that in order to generate such advantages, the network structures of these collaborations need to be fully understood, carefully measured, and appropriately managed (cf. Bititci *et al.*, 2012; Verdecho *et al.*, 2009). For example, a study by Saunila and Ukko (2013) showed that the exploitation of external knowledge can be improved significantly through performance measurement. UI collaborations can be arranged in different ways, and the participating organizations may have different expectations for them. To support the performance measurement activities of collaborative projects and to increase the understanding of the context in which measurement and evaluation takes place, it is important at the beginning of the collaboration to ensure that all the participating organizations have a common understanding

of the partnership's and project's vision and targets (Busi and Bititci, 2006; Ukko *et al.*, 2015). The purpose and methods of the performance measurement should be defined jointly by the participating organizations, and common visions for and targets of the collaboration should be clarified.

As a result of the increased interest in these collaborative research projects, some frameworks and indicators have recently been proposed in an effort to improve their management and evaluation, for example:

- A Balanced Scorecard for measuring the impact of UI collaboration (Al-Ashaab *et al.*, 2011)
- Critical key performance indicators for UI collaboration (Albats *et al*., 2017)
- Criteria-based success evaluation model for assessing the UI research collaboration (Iqbal *et al.*, 2011)
- Factors in the success of R&D cooperative agreements between firms and research organizations (Mora-Valentin *et al.*, 2004)
- A performance measurement system to evaluate the success in UI alliances (Perkmann *et al.*, 2011).

These frameworks and tools, however, are mainly theoretical and show the need for more operational-level empirical evidence and understanding to support their implementation and further development (Perkmann *et al*., 2011).

3.1 PROJECT MANAGEMENT AND PERFORMANCE MEASUREMENT

Today, individual development activities among industrial organizations are often pursued and managed in the form of different types of research and development projects. PM has become popular, and visions, methods, and good practices that promote PM can be found (Korhonen, 1992; Lauras *et al*., 2010). One of the primary challenges in PM is to achieve all of a project's objectives and goals while adhering to project constraints (Harrison and Lock, 2004). As a part of PM operations, Project Management Information Systems (PMSIs) should provide project managers with decision-making support for organizing, planning, and controlling projects (Caniëls and Bakens, 2012). However, according to the literature on PM, most project managers seem to be dissatisfied with the information provided by the current PMSIs. Among the PMSIs, performance measurement plays an important role in ensuring a project's success and its usefulness to the participating organization(s) (Pillai *et al*., 2002). According to the authors, in a controlled environment, the organizational and project performances are known to be sensitive to the metrics of measurement.

Previous studies on PM have identified a wide range of practices that can be used to evaluate the outcomes of projects and the input characteristics that impact outcomes, for example, the two-step performance measurement approach (Cao and Hoffman, 2011), project scoping practices, time management practices, cost control practices, quality control practices, risk management practice, human resource management (Ling *et al*., 2009), and methods for evaluating IT-process success (Thomas and Fernandez, 2008). However, many of these practices are not widely implemented; for example, project schedules are still used as the sole project performance measurement in many organizations. Studies on project performance measurement have also used different methods

based on different viewpoints and factors that affect project performance (Xu and Yeh, 2014). For example, while measuring overall project performance, multicriteria decision-making methods have been used to aggregate multiple performance measures under various application contexts (cf. Marques *et al*., 2011; Barfod, 2012; Xu and Yeh, 2014). One of the proposed performance measurement approaches to support PM is cross-project learning, which has been identified as vital for organizations seeking to continuously improve PM practices (Cao and Hoffman, 2011; Lewis 2000). Cao and Hoffman (2011) posited that the first step in cross-project learning is to identify outstanding projects that can serve as role models. The authors further demonstrated that performance measurement allows the creation of incentives that will likely yield higher performance. Xu and Yeh (2014) argued that performance measurement of ongoing and completed projects would help establish benchmarks for high-performance projects (for cross-learning) and identify the inefficiencies in low-performance projects (for potential improvement) but stated that project assignment and project performance measurement are treated as two separate research problems in PM.

In summary, both academics and practitioners seem to be aware that project performance measurement plays an important role in the management of operational level activities of university-industry-government relations, but successfully implemented, comprehensive performance measurement systems seem to be rare.

4. RESEARCH DESIGN

The purpose of this study is to explore the current operational-level performance measurement practices and challenges of universities and financier representatives as a part of managing university-industry-government relations. These phenomena are explored from the viewpoints of the university project managers and financier representatives of the collaborative research and development projects conducted between universities and other societal organizations. As a majority of the performance measurement practices, reporting, and bureaucratic aspects of UI research projects are usually handled by the university project managers and financier representatives, the phenomena was explored from these perspectives. The empirical data for this study were gathered from 12 Finnish UI research projects that were established to find answers to certain problems identified by funding programs, to enhance and support organizations' innovation activities and capabilities, and to produce new academic knowledge. The selection of the explored projects was based more on their natures than their specifics (Perkmann and Walsh, 2009). As part of the Triple Helix operations and university–industry–government relations, the explored research and development projects focused on management, engineering, and economic issues as well as involved industrial partners who did not have long backgrounds or histories in collaborating with universities. The projects lasted between two and three years, which is considered a normal period for these kinds of applied UI projects.

The data for the study were collected from interviews with twelve university project managers representing three different universities in Finland. The interviews lasted from 60 to 90 minutes. The interview participants were chosen by how they had actively been part of managing and measurement of these projects, which were funded by different external sources. It is important to note these sources in order to ensure a common understanding and holistic picture of the different

evaluation methods used in different granting decisions: two of the chosen projects were funded by the European Commission's Seventh Framework program (FP7), three by the Finnish Funding Agency for Technology and Innovation, and seven by European regional development funds. The interviews were semi-structured and used the following themes from the current literature on performance measurement and UI collaborations as the basis for the data collection:

- The performance processes and methods used to evaluate the projects before they were undertaken (Al-Ashaab *et al*., 2011; Iqbal *et al*., 2011; Mora-Valentin *et al*., 2004; Perkmann *et al*., 2011)
- The performance measurement challenges before the projects were undertaken (Al-Ashaab *et al*., 2011; Iqbal *et al*., 2011; Mora-Valentin *et al*., 2004; Perkmann *et al*., 2011)
- The performance measurement processes and methods used to evaluate the projects while they were underway (Al-Ashaab *et al*., 2011; Iqbal *et al*., 2011; Mora-Valentin *et al*., 2004; Perkmann *et al*., 2011)
- The performance measurement challenges while the projects were underway (Al-Ashaab *et al*., 2011; Iqbal *et al*., 2011; Mora-Valentin *et al*., 2004; Perkmann *et al*., 2011)
- The performance measurement processes and methods used to evaluate the outcomes and effects of completed projects (Al-Ashaab *et al*., 2011; Iqbal *et al*., 2011; Mora-Valentin *et al*., 2004; Perkmann *et al*., 2011)
- The performance measurement challenges of the outcomes and effects of completed projects (Al-Ashaab *et al*., 2011; Iqbal *et al*., 2011; Mora-Valentin *et al*., 2004; Perkmann *et al*., 2011)

To explore these issues from the viewpoints of the project financiers, two financier representatives from the European Regional Development Funds of Finland and two members of the Finnish Funding Agency for Technology and Innovation were also interviewed. Semi-structured interviews were conducted with the same themes and factors as were used with the university project managers to ensure comparability with the evaluation processes employed and the challenges that were included. Table 1 summarizes the process of data collection.

Table 1. Data collection

Method of collection	**Participants' descriptions**	**Number of participants**	**Data analysis methods**
Individual interviews	• University project managers • Part of the evaluation and measurement of projects	12	Qualitative content analysis & cross-analysis
Individual interviews	• Financier representatives • European Regional Development Funds of Finland • Finnish Funding Agency for Technology and Innovation	4, two members from each agency	Qualitative content analysis & cross-analysis

4.1 DATA ANALYSIS

The data collected from the interviews were primarily analyzed through a multi-coding process to generate patterns, which, during the analyzing process, were structured into more generic patterns. In the first round of the coding process, the data were analyzed and arranged through patterning the role of performance measurement in UI research projects from the viewpoints of both university and financier representatives. A second round of coding was conducted with the more generic patterns related to the current performance measurement challenges and practices in UI research projects. Both university and financier representatives' viewpoints were arranged during the second round of the process. In the final round of coding, the patterns structured during the second round were further arranged into more generic patterns identifying the individual measurements that both university project managers and financier representatives used to measure the performance of these collaborative research projects. In each stage of the coding process, research triangulation was used to validate the structured patterns. The overall coding process of the data is summarized in Table 2.

Table 2. Overview of the coding process

Viewpoint	**1st round of coding**	**2nd round of coding**	**3rd round of coding**
University project managers' perspectives; Data from interviews	The role of performance measurement in UI research projects	Current challenges and practices of performance measurement in UI research projects	Individual measurements used to measure the performance in UI research projects
Financier representatives' perspectives; Data from interviews	The role of performance measurement in UI research projects	Current challenges and practices of performance measurement in UI research projects	Individual measurements used to measure the performance in UI research projects

5. FINDINGS

In this section, the findings of the research are presented according to three different phases of the UI projects. The first phase includes the performance measurement activities during the preparation of the projects, when they were not yet funded or had gotten the promise of funding but had not begun. The second phase includes the performance measurement activities while the projects were ongoing. The third phase includes the projects' evaluations after they were finished, from immediate to long-term evaluation activities.

5.1. PERFORMANCE MEASUREMENT BEFORE THE PROJECTS

The results from the interviews revealed that most of the explored projects did not determine any performance measurement methods or individual measurements for the projects before starting them. Although measurement methods were not determined at all or in only a cursory fashion in many of the collaborations, the university project managers mainly agreed that there should be better performance measurement methods for collaborative projects before they are launched or are in the preparation phase.

A leading reason that project managers cited for the lack of performance measuremen activities at the preparation phase was the current market situation. Many funding calls by Horizon 2020 or the Finnish Funding Agency for Technology and Innovation, for example, asked about the involvement of industry or other private-sector organizations. Private-sector organizations in Finland and many other European countries, however, are continuing to deal with a serious economic slowdown, so they are keeping a careful eye on any new development and collaboration activities, at least those executed with universities. This explains why the project managers commonly agreed that, in many cases, it is not possible to evaluate and design projects too carefully beforehand; universities are forced to collaborate with those partners that are willing to participate in projects. (Note: the quotations from the study participants have been slightly edited from the Finnish–English translations for clarity.)

> *There have been some cases where we did some preparations and tried to do some performance measurement related to evaluating the best possible partners beforehand. After searching for and exploring four or five suitable candidates, none were interested in collaborating with the project. We did not have the chance to change the project plan because of the theme of the funding call, and we had to pick the partners that were interested in collaborating with us, even though they were not the best ones. Since then, we haven't systematically evaluated partners beforehand.* (University project manager)

In addition to the challenge of finding suitable partners, there were serious challenges related to actual project preparation. Many of the project managers mentioned that it is quite common that the majority of the project proposals and applications are rejected because of the current competitive situation. They reported that university project managers use numerous working hours writing project applications and proposals that are rejected and are not funded. Evaluations of how much resources are sacrificed to that work do not seem to exist.

> *It is actually surprising that no one seems to be interested in the resources that are sacrificed to rejected project applications. In the current situation, we have to write, for example, let´s say four or five different applications in order to get one funded. Sometimes some part of that work can be re-used in later applications, but usually, that work will be forgotten. We should at least evaluate how much resources are used for "unnecessary" work that could have been used, for example, for journal writing. Moreover, we should somehow to be able to evaluate what we have learned from that work.* (University project manager)

The current market situation has also caused some problems for the financier representatives' measurement activities. In many cases, the funding calls asked that SMEs participate in the collaborative projects because a large part of today's economic and new job growth comes from SMEs and startups. These firms, however, have suffered even more from market challenges than large and multinational companies. Therefore, financier representatives have to evaluate whether a potential organizational partner actually has enough resources to participate in a collaborative project:

> *Over the last two years, we have had several cases where the SMEs faced bankruptcy while they were participating in a collaboration project with the university. After these cases, we have had to be much more careful in evaluating whether the SMEs have the resources to handle their daily operations throughout the course of the whole project.*
> (Financier representative, Finnish Funding Agency for Technology and Innovation)

After the preparation phase, but before the projects are launched, there are several challenges regarding project performance measurement. One challenge at this phase of a UI project is the lack of communication between academic project managers and financier representatives. Although universities, industrial organizations, and financier representatives are all interested in project performance measurement, few resources are deployed to establish common measurement methods and goals. There are no standard procedures by which to form collaborative research projects so that the aims and wishes of the participating organizations are defined and determined jointly with all parties. Even in those cases where there were a few agreed-upon measurements or evaluation methods, most university project managers wished there were better methods, both to steer the projects and to evaluate their outcomes:

> *Once the project application is accepted, it is common to just start the project by following the project plan. If there are several industrial partners involved, there is not usually a common view about the goals and wishes of the other project participants. The goals and aims promised in the project plans are used as the goals of the project. It quite often happens that industrial partners are unfamiliar with these goals. It might be a good practice to design some kind of measurement system or method both to explore and make explicit the expectations of all of the partners and to generate measures to follow them.* (University project manager)

Table 3 summarizes the current performance measurement practices and challenges of the university project managers and financier representatives before the projects are launched (and in the beginning of the projects).

Table 3. Performance measurement practices and challenges before the collaborative projects

Viewpoint	Current practices related to performance measurement	Current challenges related to performance measurement
University perspective (Before the project)	The issues and goals promised in the funding applications are commonly used as individual (and sole) measurements beforehand and in the beginning of the collaborative projects	The current market situation makes it challenging to evaluate suitable partners; universities are forced to collaborate with those partners willing to participate in collaborative research projects Lack of communication with the financier representatives and industrial participants causes confusion about the goals of the project, causing challenges for its measurement Lack of commonly designed and adapted measurement practices (considering the interests of university, industry, and financiers)
Financier perspective (Before the project)	The issues and goals stated in the funding applications are commonly used as individual (and sole) measurements beforehand and in the beginning of the funded UI projects	Current market situations cause challenges; financier representatives have to evaluate whether the industrial partners have enough resources to participate in projects and run daily operations

Measurement and evaluation of the participating organizations' (both university and industry) capabilities and resources to execute the project	Lack of communication with the university project managers and industrial participants

5.2. PERFORMANCE MEASUREMENT DURING THE PROJECTS

Although the university project managers felt that performance measurement practices should be more clearly designed with the participating organizations before a project begins, they thought they had thorough understandings of what was going on in their own projects. This indicates that they need better performance measurement methods or individual measurements, not to increase their own understandings of the projects, but, rather, to make the outcomes and results of the projects transparent to other stakeholders:

> *It's not that I don't know what is happening in the project; it's more like the other partners of the project are unfamiliar with the project's actions. We did not have any performance measurement or evaluation systems before the project. I think that by following up to see if the aims and wishes of the organizations had been reached, this might have helped steer the project. It also would have helped other partners to follow the actions in other cases and work packages.* (University project manager)

The interviews also revealed that it is fairly common to use the original project application as the steering and measurement framework for a project. Both the financier representatives and university project managers seemed to be quite satisfied if the project followed the original plan. The university project managers generally agreed that the measurements and goals determined beforehand did not overly restrict their activities during the projects, though some challenges remained:

> *We had a situation where we had a chance to attain a very radical innovation. If we had chosen to do that, we would have had to deviate from the original project plan. Once we weren't sure if we could reach that innovation, the project manager decided not to do it. It wasn't mentioned in the original plan, and it was much easier to report the use of the resources as they were meant in the beginning of the project. If we had had some kind of measure to try to evaluate the effectiveness of that possible radical innovation, and we had had a better understanding of the initial situation, trying to reach the innovation probably would have been easier.* (University project manager)

For the financier representatives, challenges arose when the projects did not follow the original project plans:

> *Of course, it's possible to make changes in the project while it's already underway. However, in many cases, it is quite difficult to evaluate these changes. Usually the situations where the changes are required are unexpected, for both the universities and the industrial organizations.* (Financier representative, European Regional Development Funds)

Other challenges that financier representatives faced during project performance measurement were lack of time and other resources. During different funding programs and individual funding calls, there are many different projects funded, and the financier representatives feel that in many

cases, they lack the time and other resources to focus on the projects' performance measurement. That is why they mainly focus on the measurement of the tangible aspects of the projects, for example, money and salaries used, workshops arranged, and reports published. When using this kind of measurement practice, they are mainly using the project application/project plan as a measurement framework.

From the viewpoint of the university project managers, systematic performance measurement of various elements during the project occur at a relatively low level, even though they are important from the perspective of their own operations and innovativeness:

- *Amount and quality of accumulated data*. The respondents noted that data quality is not usually evaluated. Rather, it is simply gathered from the project (e.g., from workshops, interviews, and surveys) and used afterward for research purposes.
- *Increased understanding and learning*. None of the interviewees mentioned that they had any measurement methods of their own to determine their increased understanding or changes in welfare or the work climate. The project managers also indicated that they were unaware of which university innovation capabilities could or should be evaluated. Despite the current lack of measurement, all the interviewees agreed that it would be very useful to evaluate these issues if there were suitable methods or frameworks to do so.
- *Satisfaction of industry partners*. Despite the importance of industry involvement, there did not seem to be a systematic evaluation of industry partner satisfaction. While no one suggested any one glaring cause, they did mention a few minor issues: "*It is not conventional to evaluate the satisfaction of the industry partners*;" *"No one asks for that information"* and *"The expectations of the industry organizations are not known, so it is hard to evaluate their satisfaction."*

Rather than measuring their own operations, the university representatives expressed more interest in using performance measurement to evaluate issues that need to be reported to project financiers. It is likely that a few measurements borrowed from the project application are used to steer projects. These tools, however, are usually quantifiable; for example, they could calculate the number of new companies or jobs directly resulting from a project without paying attention to the increased innovation capabilities that could be used in future projects.

The interviews also explored who should be responsible for the measurement of these UI partnerships and projects. It was commonly agreed that performance measurement activities should include members of both academia and industry. The university project managers noted that it was difficult to try to evaluate what was happening in the industry organizations during the partnerships if they were not actively involved in the measurement. The respondents also stated that it might be challenging for industry organizations to evaluate these activities by themselves. They usually lacked an understanding of the projects' academic elements, like data quality and publications, and were typically not interested in learning about those aspects:

> *It is basically impossible for a researcher to evaluate or measure the activities happening inside the industrial organizations. That is why someone should be named responsible for the evaluation of the organizations, as well.* (University project manager)

Table 4. PE practices and challenges during the collaborative projects

Viewpoint	Current practices related to performance measurement	Current challenges related to performance measurement
University perspective (During the projects)	Measurement executed by following the original project plan/application	The subjective nature of the collaboration activities
	Measurement related to use of resources - Salaries - Working hours	Lack of clarity about the goals Lack of time or other resources
	Number of the activities, e.g., workshops and meetings, arranged during the projects	Lack of clear measurement practices
	Number of the academic outcomes, e.g., publications and reports	Measurement of intangible aspects of the project (e.g., amount and quality of the data gathered during the project)
		Measurement of increase in own innovation capabilities and understanding/learning
Financier perspective (During the projects)	Measurement executed by following the original project plan/application	Lack of time or other resources
	Measurement focusing mainly on tangible aspects of the project (e.g., money and salaries used, workshops arranged, and reports and articles published)	Lack of commonly designed measurement frameworks to follow the intangible aspects of the project

5.3. PERFORMANCE MEASUREMENT AFTER THE PROJECTS

The performance measurement activities conducted after collaborative research projects are completed—not only to make a project's actual results and effects visible immediately after its completion, but also to track results in the ensuing years—posed a major challenge to both university project managers and financier representatives. In many of the cases, the project managers had the strongest understandings of the projects and their results. If they were unavailable during the follow-up period, evaluation was extremely difficult:

> *There have been a few collaborative research projects where we followed up with them three or five years after they were finished. However, in many cases, the people who were part of the original project were no longer available for this follow-up evaluation work: they either no longer worked there, or they were at a new position. There do not seem to be any measurements or evaluation methods that we could use to follow up with projects after they are completed. Normally, the results of a project are analyzed and reported straight after a project is finished, and then people move on to the next project. That makes*

following up with these projects extremely difficult. (Financier representative, Finnish Funding Agency for Technology and Innovation)

For the university project managers, the challenge was usually connected with the partnership or project funding. They received salaries from projects while they were running them, and after a project was finished, they usually moved on to the next one. Projects with salaries allocated for future performance measurement and evaluation work were extremely rare:

If there were some resources allocated to conducting follow-up performance measurement after the projects (say, one month of the year for five years), and if we had some proper evaluation methods, it would be possible to evaluate more meaningfully the actual effectiveness of the activities that were carried out during a project. (University project manager)

Policymakers' primary interests in funding programs are bringing innovations, new products, and novel services to the market. From this viewpoint, which is shared by innovation theory, UI research projects and partnerships should also create ideas and frameworks for future collaborative projects. The financier representatives also reported that it was difficult to compare the results and effectiveness of projects:

At the moment, we do not have the proper tools to evaluate and compare the effectiveness of projects that are carried out in different geographical areas. We get the results and the project reports from the organizations that executed the project, and after that, we are supposed to compare these results with the results from other areas. At the moment, however, this is very difficult to do. (Financier representative, European Regional Development Funds)

Table 5. Performance measurement practices and challenges during the collaborative projects

Viewpoint	**Current practices related to performance measurement**	**Current challenges related to performance measurement**
University perspective (After the projects)	Performance measurement is used to analyze and report the results achieved right after the projects	Lack of resources allocated to conducting follow-up measurement after the projects
	Performance measurement is arranged mainly using tangible measurements	Lack of measurement practices to track the results after the project
		Lack of measurement practices to assess and track the effectiveness of the project in the future (e.g., over the next few years)
Financier perspective (After the projects)	Final reports constructed right after the projects are used as evaluation tools to analyze the results and effectiveness of the projects	Lack of measurements or measurement methods that could be used to follow up with projects after they are completed
		Lack of proper tools to evaluate and compare the effectiveness of projects that are carried out in different geographical areas

6. DISCUSSION

In order to provide a more empirical understanding of the role of evaluation and performance measurement in university–industry–government relations, this study explored the current operational-level performance measurement practices and challenges of university project managers and financier representatives as part of managing UI research and development projects. Due to the increased interest in the evaluation of Triple Helix operations, performance measurement of the UI projects, performance measurement frameworks, individual measures, and indicators have been suggested in previous studies (Al-Ashaab *et al*., 2011; Albats *et al*., 2017; Iqbal *et al*., 2011; Mora-Valentin *et al*., 2004; Perkmann *et al*., 2011). This study, however, revealed that the university project managers and the financier representatives demonstrated a lack of familiarity with the presented frameworks and indicators and lack the proper process models to implement them. Even though there were some individual cases where performance measurement practices were slightly jointly designed by the university and industrial organizations, financier representatives have been excluded from these design activities. Further, there does not seem to exist a culture where performance measurement activities would have been collaboratively designed together with university project managers, industry organizations, and financier representatives. Though Lauras *et al*. (2010) argued that each project manager should develop a range of KPIs for the projects, we believe that in order to develop KPIs to support the evaluation of the collaborative research and development projects involved in Triple Helix operations, university project managers need more academic and practical-level support to better recognize the current performance measurement frameworks suggested by academics. This would enable them to develop and implement performance measurement practices and use existing models and processes to support planning, controlling, and evaluating the projects.

Some of the previous research on PM (e.g., Cao and Hoffman, 2011; Ling *et al*., 2009; Thomas and Fernandez, 2008) has revealed that, even though a wide range of practices and measures that can be used to evaluate and steer projects have been proposed, in many cases, project schedules are still used as the sole performance measurement approach. In contrast with the performance measurement practices of industrial projects, this study shows that, as part of the management of university–industry–government relations, the original project applications seem to be commonly used as the sole performance measurement framework to steer and evaluate UI research and development projects. These results are in line with Xu and Yeh's (2014) findings, which showed that project assignment and project performance measurement are treated as two separate research problems in PM. Though university project managers and financier delegates seem to be satisfied if the projects proceed according to the project applications, it causes challenges for evaluation. The projects' applications, and the tasks and goals promised in them, are written before the projects are started, and they are basically only educated guesses of how projects will be executed. As UI research projects evolve and change their forms and goals over time, it is also important to review and update the performance measurement frameworks and individual measurements during the projects. This would increase the dynamism of the measurements, better support the evaluation and management of the projects, and further support the management of university–industry–government relations.

Currently, as part of the Triple Helix operations and the collaborative research and development activities, university project managers' performance measurement activities seem to be focused on qualitative success measures executed during the project and immediately after the projects are

finished. Moreover, they seem to be focusing mainly on the issues that need to be reported to financier representatives. Though the knowledge flow from industry to university is an important part of academics' careers (e.g., D'Este and Patel, 2007), university project managers are not currently actively evaluating the quality of knowledge they can gather from the projects. Further, this study found that, though university project managers might have some ways to evaluate the most suitable partners for the projects and data gathering, they are commonly forced to collaborate with industry organizations that are willing and able to participate in projects, rather than with suitable partners. It was reported that once they knew they were not collaborating with the most optimal partners, they knew they probably would not get the best possible data and knowledge, and the project managers would have to deal with the data they got. The situation seems to be frustrating for the university project managers. The results support the findings of Perkmann and Walsh (2009), which showed that applied collaboration with industry organizations might distract academics from engaging in long-term academic research because, among other reasons, the data and results gathered from collaborative projects might not be publishable in academic journals because they are not sufficiently systematic.

Although universities participate in Triple Helix operations and collaborative research and development projects mainly to fulfill their third mission of societal effectiveness and meet funding program requirements for industry involvement, they should also pay attention to the measurement of their own improvements in innovation activities and capabilities. While universities are interested in the short-term benefits from these projects, for example, reaping academic publications and funding, their long-term aspects also warrant attention. The funding programs to support university-industry collaborations in many countries and at the European Union level will become increasingly competitive, thus requiring universities to pursue more innovative partnerships and collaborative research projects in order to succeed. Focusing solely on measuring resources and outputs does not fully capture all the components of innovation capability. The measurement of innovation capabilities is an issue that has received significant attention in academic circles in the last few years. Saunila and Ukko (2012) presented a conceptual framework for measuring innovation capability and its effects. They argued that simply knowing how many new innovative processes, actions, or products have been initiated is insufficient if there is no understanding about their connections to performance. This approach, however, remains novel and rare, even in academic circles. In addition to the challenges caused by unfamiliarity with the evaluation of innovation capabilities, the lack of continuity among university project managers causes further evaluation challenges. The majority of the interviewed project managers had fixed-term employment contracts. Commonly, there is uncertainty about future working possibilities in the universities and what will happen after the projects are finished. Several project managers argued that it is hard to focus on evaluating the long-term aspects of the projects (such as increase in innovation capabilities or changes in work climate) when they do not know if they are long-term parts of the organizations.

For the financier representatives, the most significant challenges in the performance measurement of UI projects as part of the evaluation of Triple Helix operations seem to be related to cross-project learning (e.g., Cao and Hoffman, 2011), meaning it is difficult for them to recognize outstanding projects and actions that might serve as role models for others. While some individual projects turn out to be successful and thus provide a valuable example of Triple Helix operations, there do not seem to be evaluation criteria that explain their success. Therefore, it is difficult to transfer the successful elements to future (or other ongoing) projects and collaborative operations

or use them as evaluation indicators. Thus, the financier representatives also face challenges when trying to compare different ongoing projects in different universities and different geographical areas. The lack of continuity among the university project managers also causes challenges for the financier representatives. The performance measurement activities and reporting are mainly handled by one person (usually the project manager), and if that person is working in another organization in the future, the future evaluation of the projects is extremely difficult. It was commonly suggested by the university project managers and financiers that more than one person should be responsible for the performance measurement in UI projects to support the operational-level evaluation of university–industry–government relations. It would not only support future evaluation activities but also help to distribute the lessons learned from the operational level projects more effectively. These findings are in line with the conclusions of Perkmann *et al*. (2011), which pointed out that the dissemination of the performance measurement should concisely communicate the objectives of the project to all the participants in the collaborative projects and, therefore, increase the motivation for evaluation.

7. CONCLUSIONS

As part of the university–industry–government relations and Triple Helix operations, UI activities and projects serve the interests not only of university researchers and industrial organizations but also of financiers and policymakers. Due to increased competition in the universities' and industry organizations' operating environments, policymakers are continually looking for better ways to evaluate which collaborative research projects and UI partnerships should be funded. The results of this study show that there are challenges from the viewpoints of university project managers and financier representatives in the performance measurement of these activities at all three stages explored: before, during, and after the projects. The methods or individual measurements used to evaluate these collaborations are based primarily on the project applications, which are obviously established before the project. The current methods and measurements used to steer projects and to make the results visible do not assess either increased learning or innovation capabilities of the participating organizations.

The results of the study further indicate that, at the moment, no commonly implemented performance measurement systems exist among universities, financier representatives, and industrial organizations to help steer collaborative projects as part of the Triple Helix operations. Some individual measurements are used to follow specific aspects, such as the resources used or workshops arranged, but they are mainly applied from the project applications and evaluation instructions and implications given by the funding agencies, and comprehensive performance measurement systems are lacking. Even though some tools and frameworks to evaluate the collaborative projects in the context of university–industry–government relations have been suggested, both university project managers and financier representatives of the collaborative research and development projects are unfamiliar with them and do not know how to implement them. There does not exist a culture where performance measurement activities would have been commonly deigned and adopted with university project managers, industry organizations and financier representatives. The results of this study also indicate that as part of their Triple Helix-related operations, universities are presently more interested in measuring the issues that they

report to financiers and the academic world than in evaluating their intra-organizational learning and increasing their own innovation capabilities. While in the short term this approach may support the evaluation of the societal effectiveness of UI collaborations, in the long term, these partnerships should generate new knowledge and increase the innovation capabilities of the participating organizations to support long-term economic growth at a broad societal level.

The financier representatives in the collaborative research and development projects conducted between universities and other societal organizations are currently using evaluation criteria provided by the funding calls, as well as the aims and goals promised in the project applications, while evaluating the performance of UI research projects. The biggest challenges they seem to face in these actions are related to cross-project evaluation. They struggle to find successful projects that could be used as benchmarks for other projects, and the comparison of different projects poses challenges. The lack of continuity of the university project managers' work contracts poses performance measurement challenges for both project managers and financier representatives. When project managers cannot be sure of the continuity of their work, they do not see it meaningful to evaluate the long-term aspects of these collaborations. As many of the advantages gained from these projects are only realized long after the projects, financier delegates find it difficult to evaluate the projects if the project managers have moved to other positions and organizations and are unavailable. The challenge is that the performance measurement of the UI research projects relies too heavily on the project managers; therefore, these activities should be disseminated more widely.

To support the operational-level management and evaluation of university–industry–government relations and to develop the future performance evaluation practices of the UI research projects, the creation of a collaborative design and implementation culture for performance measurement processes is needed to implement the theoretical tools and frameworks. This culture should involve all the participating stakeholders, including the financier representatives, in designing, building, and implementing the measurement frameworks for UI collaborations, and support evaluation and management throughout entire projects. This would enhance the measurement effectiveness of such collaborations at both the operational and societal levels.

One theoretical implication of this study is the increase in the understanding of the current performance measurement activities that university project managers and financier representatives pursue in UI projects as part of managing university–industry–government relations. In addition, the study increased the empirical understanding of the current challenges related to the performance measurement of these projects. Because operational-level activities of Triple Helix operations UI projects seem to be of growing interest to both academics and industry representatives, the results of this study can be utilized to develop better performance measurement tools and frameworks that could be more easily adopted in such contexts. While developing these frameworks, the academics should also pay attention to the viewpoints, practices, and challenges of the financier representatives, not focus only on universities' and industry organizations' perspectives.

As managerial implications, this study increases the university project managers' and financier representatives' understandings of each other's performance measurement practices and challenges. As it seems to be quite common that university project managers and financier

representatives do not design performance measurement tools for these collaborative projects, the results of this study can support their understanding of each other's viewpoints and increase the interplay between them. Only following the instructions provided by the funding calls or only following the research plans causes challenges in performance measurement. To be aware of these challenges and of the performance measurement activities of the others, more comprehensive and suitable evaluation methods can be developed to support the management of UI projects.

The limitation of this study is that the empirical evidence was gathered from Finland, and some cultural aspects that are country specific might exist. For that reason, it may be important and valuable to execute comparative studies in other countries. Further, as the UI research and development projects seem to be growing, it would be reasonable to investigate how a culture of PE design and implementation could be fostered and supported in these collaborations. It is also important to find performance measurement practices for financier representatives to support their cross-project evaluations. Finally, though the lack of continuity among the university project managers' working conditions cannot be directly solved by performance measurement activities, it is important to explore how these challenges could be met for long-term performance evaluation.

REFERENCES

Agrawal, A., 2001. University-to-Industry knowledge transfer: Literature review and unanswered questions. International Journal of Management Reviews, 3, 285–302.

Al-Ashaab, A., Flores, M., Doultsinou, A., Magyar, A., 2011. A Balanced Scorecard for measuring the impact of Industry-University collaboration. Production Planning & Control: The Management of Operations, 22(5–6), 554–70.

Albats, E., Fiegenbaum, I., Cunninghma, J.A., 2017. A micro level study of university industry collaborative lifecycle key performance indicators. Journal of Technology Transfer, 1-43

Anderson, T.R., Daim, T.U., Lavoie, F.F., 2007. Measuring the efficiency of university technology transfer. Technovation,, 27(5), 306-318.

Barfod, M.B., 2012. An MCDA approach for the selection of bike projects based on structuring and appraising activities. European Journal of Operational Research, 218, 810–818.

Bark, R.H., Kragt, M.E. and Robson, B.J., 2016. Evaluating and interdisciplinary research project: Lessons learned for organisations, researchers and funders. International Journal of Project Management, 34, 1449-1459.

Bititci, U., Carengo, P., Dörfler, V., Nudurupati, S., 2012. Performance measurement: Challenges for tomorrow. International Journal of Management Reviews, 14, 305–27.

Bititci, U. S., Martinez, M., Albores, P., Parung, J., 2004. Creating and managing value in collaborative network. International Journal of Physical Distribution & Logistics Management, 34(3), 251–68.

Bogers, M., Zobel, A.-K., Afuah, A., Almirall, E., Brunswicker, S., Dahlander, L., … Ter Wal, A. L. J. (2017). The open innovation research landscape: established perspectives and emerging themes across different levels of analysis. *Industry and Innovation*, *24*(1), 8–40. https://doi.org/10.1080/13662716.2016.1240068

Busi, M., Bititci, U., (2006. Collaborative performance measurement: a state of the art and future research. International Journal of Performance and Productivity Management, 55, 7-25.

Calderini, M., Franzoni, C., Vezzulli, A., 2007. If star scientists do not patent: The effect of productivity, basicness and impact on the decision to patent in the academic world. Research Policy, 36(3), 303–19.

Caniëls, M.C.J., Bakens, R.J.J.M., 2012. The effects of Project Management Information Systems on decision making in a multi project environment. International Journal of Project Management, 30, 162-175.

Cao, Q., Hoffman, J.J., 2011. A case study approach for developing a project performance evaluation system. International Journal of Project Management, 29, 155-164.

Champenois, C., & Etzkowitz, H., 2018. From boundary line to boundary space: The creation of hybrid organizations as a Triple Helix micro-foundation. Technovation, 76–77, 28–39

Clark, B.,2001. The entrepreneurial university: New foundations for collegiality, autonomy, and achievement. Higher Education Management, 13(2), 9–24.

Cohen, W., Nelson, R., Walsh, J., 2002. Links and impacts: The influence of public research on industrial R&D. Management Science, 48(1), 1–23.

Croce, A., Grilli, L., Murtinu, S., 2014. Venture capital enters academia: an analysis of university- managed funds. Journal of Technology Transfer 39(5), 688–715

D´Este, P., Patel, P., 2007. University-industry linkages in the UK: What are the factors underlying the variety of interactions with industry?. Research Policy, 36(9), 1295-1313.

D´Este, P, Guy, F., Iammarino, S., 2012. Shaping the information of university-industry research collaborations: What type of proximity does really matter?. Journal of Economic Geography, 13(4), 537-558.

Etzkowitz, H., 2008. The Triple Helix: University-Industry-Government Innovation in Action. Routledge, London.

Etzkowitz, H, Leydesdorff, L., 1995. The Triple Helix University-industry-government relations: A laboratory for knowledge based economic development. EASST Review, 14 (1), 14–19.

Geuna, A., 2001. The changing rationale for European university research funding: Are there negative unintended consequences?. Journal of Economic Issues, 35, 607–32.

Gulbrandsen, M., Slipersaeter, S., 2007. The third mission and the entrepreneurial university model. In: Bonaccorsi A. and Daraio C. (eds.), Universities and strategic knowledge creation: Specialization and performance in Europe, 112–43. Edward Elgar Cheltenham.

Harrison, F., Lock, D., 2004. Advanced Project Management: a Structured Approach. Gower Publishing, Ltd.. p. 34.

Immonen, S., Cooksy, L., 2014. Using performance measurement to assess research: Lessons learned from the international agricultural research centres. Evaluation, 20(1), 96-114.

Iqbal, A. M., Khan, A. S, Iqbal, S., Senin, A. A., 2011. Designing of success criteria-based evaluation model for assessing the research collaboration between university and industry. International Journal of Business Research and Management, 2(2), 59–73.

Kauppila, O., Mursula, A., Harkonen, J., Kujala, J., 2015. Evaluating university-industry collaboration: the European Foundation of Quality Management excellence model-based evaluation of university-industry collaboration. Tertiary Education and Management, 21(3), 229-244.

Kerssens-van Drongelen, I.C., Cooke, A., 1997. Design principles for the development of measurement systems for research and development processes. R&D Management, 27, 345-357.

Korhonen, P., 1992. Multiple criteria decision support—a review. European Journal of Operational Research, 63, 361–375.

Lauras, M., Marques, G., Gourc, D., 2010. Towards a multi-dimensional project Performance Measurement System. Decision Support Systems, 48, 342-353.

Lewis, J.P., 2000).The Project Manager's Desk Reference. McGraw-Hill, New York.

Ling, F., Low, S., Wang, S., Lim, H., 2009. Key project management practices affecting Singaporean firms' project performance in China. International Journal of Project Management, 27(1), 59–71.

Lundberg, H., Andersen, E., 2012. Cooperation among companies, universities and local government in a Swedish context. Industrial Marketing Management 41, 429-437.

Marques, G., Gourc, D., Lauras, M. 2011, Multi-criteria performance analysis for decision making in project management. International Journal of Project Management, (29), 1057–1069.

Mäkimattila, M., Junell, T., Rantala, T., 2015. Developing Collaboration Structures for University-Industry Interaction and Innovations. European Journal of Innovation Management, 18(4), 451-470.

Miller, K., McAdam, R., & McAdam, M., 2016. A systematic literature review of university technology transfer from a quadruple helix perspective: toward a research agenda. R&D Management, 48(1), 7-24.

Mora-Valentin, E.M., Montoro-Sanchez,A., Guerras-Martin, L.A., 2004. Determining factors in the success of R&D cooperative agreements between firms and research organizations. Research Policy, 33, 17-40.

O'Shea, R., Chugh, H., Allen, T., 2008. Determinants and consequences of university spinoff activity: A conceptual framework. Journal of Technology Transfer, 33, 653–66.

Park, H. W., 2014. An interview with Loet Leydesdorff: the past, present, and future of the triple helix in the age of big data. Scientometrics, *99*(1), 199–202.

Peças, P., Henriques, E., 2006. Best practices of collaboration between university and industrial SMEs. Benchmarking: An International Journal, 13(1), 54–67.

Perkmann, M., et al., 2013. Academic engagement and commercialization: A review of the literature on University–Industry relations. Research Policy, 42, 423–42.

Perkmann, M., Neely, A., Walsh, K., 2011. How should firms evaluate success in University–Industry alliances? A performance measurement system. R&D Management 41(2), 202-16.

Perkmann, M., Walsh, K., 2009). The two faces of collaboration: Impacts of University-Industry relations on public research. Industrial and Corporate Change, 18(6), 1033–65.

Perkmann, M., Walsh, K., 2007. University–Industry relationships and open innovation: Towards a research agenda. International Journal of Management Reviews, 9(4), 259–80.

Pillai, A.S., Joshi, A., Rao, K.S., 2002. Performance measurement of R&D projects in a multi-project, concurrent engineering environment. International Journal of Project Management, 20, 165-177.

Pinheiro, M.L., Serôdio, P., Pinho, J.C., Lucas, C., 2016. The role of social capital towards resource sharing in collaborative R&D projects: Evidences from 7th Framework Programme. International Journal of Project Management, 34 (8), 1519-1536.

Piva, E., Rossi-Lamastra, C., 2013. Systems of indicators to evaluate the performance of University–Industry alliances: A Review of the literature and directions for future research. Measuring Business Excellence, 17(3), 40–54.

Plewa, C., Korff, N., Johnson, C., Macpherson, G., Baaken, T., Rampersad, G.C., 2013. The evolution of university-industry linkages – A framework. Journal of Engineering and Technology Management, 30(1), 21-44.

Rantala, T., Ukko, J., 2019. Performance evaluation to support European regional development – university-industry perspective. European Planning Studies, 27 (5), 974-994.

Rantala, T., Ukko, J., 2018. Performance measurement in university–industry innovation networks: implementation practices and challenges of industrial organisations. Journal of Education and Work, 31 (3), 247-261.

Salter, A., Martin, B., 2001. The economic benefits of publicly funded basic research: A critical review. Research Policy, 30(3), 509–32.

Saunila, M., Ukko, J., 2013. Facilitating innovation capability through performance measurement: A study of Finnish SMEs. Management Research Review, 36(10), 991–1010.

Saunila, M., Ukko, J., 2012. A conceptual framework for the measurement of innovation capability and its effects. Baltic Journal of Management, 7(4), 355-75.

Schartinger, D., Schibany, A., Gassler, H., 2001. Interactive relations between universities and firms: Empirical evidence for Austria. Journal of Technology Transfer, 2 (3), 255-268.

Thomas, G., Fernandez, W. (2008) 'Success in IT projects: a matter of definition? ', *International Journal of Project Management*, 26 (7), pp. 733–742.

Ukko, J., Pekkola, S., Saunila, M., Rantala, T. 2015. Performance measurement approach to show the value for the customer in an industrial service network. International Journal of Business Performance Management, 16(2/3), 214 - 229.

Urbano, D., Guerrero, M., 2013. Entrepreneurial Universities: Socioeconomic Impacts of Academic Entrepreneurship in a European Region. Economic Development Quarterly, *27*(1), 40–55

Voytek, K.P., Lellock, K.L., Schmit, M.A. 2004. Developing performance metrics for science and technology programs: the case of the manufacturing extensions partnership program. Economic Development Quarterly, 18, 174-185.

Xu, Y., Yeh, C-H., 2014. A performance-based approach to project assignment and performance evaluation. International Journal of Project Management, 32, 218-228.

Publication III

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DEVELOPING COLLABORATION STRUCTURES FOR UNIVERSITY–INDUSTRY INTERACTION AND INNOVATIONS

ABSTRACT

Purpose *– This paper examines the doing, using, and interacting (DUI) of Universities of Applied Sciences (UAS) while developing intra- and inter-collaboration with industry. It also reviews recent literature related to the roles of absorptive capacity (AC) and social capital (SC) in interaction.*

Design/methodology/approach *– A qualitative case research on developing collaborations between UAS and small and medium-sized enterprises (SMEs) for innovation activities.*

Findings *– Prior knowledge and contacts vary in organisations, and interaction should be supported while aiming to maximize benefits of internal and external resources available for innovation. This paper contributes by pointing out the importance of the interconnection of DUI, AC, and SC while developing collaboration.*

Originality/value *– This paper describes issues challenging the collaborative innovation activities and directions to focus on structural development to support interaction with parties having different backgrounds, goals, and strengths. The study highlights the importance of knowledge exchange with several universities and firms, and the different learning modes related to innovation.*

Keywords: *Innovation, DUI, Absorptive capacity, Social capital, University-industry*

1. INTRODUCTION

This paper examines learning through doing, using, and interacting (DUI) in Universities of Applied Sciences (UAS) for developing structures for small and medium-sized enterprise (SME) collaboration. It also reviews recent literature related to the roles of absorptive capacity (AC) and social capital (SC) in DUI. The paper focuses on the interconnection of DUI, AC and SC in development of innovation activities. Findings of the study can be used to enhance UAS as organisations transferring knowledge and technology among SMEs – assuring a close link between education and innovation. By better understanding the roles of AC and SC in unidirectional knowledge exchange the University City-Region actors can further develop their interaction.

Universities (science and applied sciences) are seen as important parts of knowledge exchange activities for innovation, and they have their own interests in networking with firms (Perkmann et al., 2011; Perkmann & Walsh, 2007; Peças & Henriques, 2006). Firms are forced to participate in new alliances and use open-innovation tools to gain knowledge due to the increasing complexity and pace of technological change – this to respond to the business dynamics and to compete (Rothwell, 1994; Chesbrough, 2003).

Jensen et al. (2007) presented two different modes of learning in innovation activities: the science, technology, and innovation (STI) mode based on the production and use of codified scientific and technical knowledge, and an experienced-based mode of learning based on DUI. Firms combining these modes are more likely to create new products or services than those relying primarily on one mode (Jensen et al., 2007). To enable DUI and STI learning, SC and AC play important roles in the interactions of networked organisations and individuals (Kallio, 2012; Kallio et al., 2010). This is the case especially in the innovation context, where front-end activities often lean on prior informal networks of actors and knowledge gained in earlier activities (Lehenkari, 2006; Cohen & Levinthal, 1990). SC and the theory of AC, describing the ability to recognize, acquire, assimilate, transform, and exploit external knowledge, are linked to DUI and STI modes (Jensen et al., 2007) in the UAS–SME innovation context. The aim of this paper is to examine the DUI learning in UAS when they develop structures for SME collaboration. The research question is: *how are DUI, AC, and SC interconnected within UAS–SME innovation collaboration and structure development?*

The paper is structured as follows. First, the combination of the theories of DUI, SC, and AC are presented concerning University–SME innovation activities. The empirical part of the paper presents the data and its analysis in the context of UAS–SME collaboration structures. The characteristics of UAS and SMEs as well as those of innovation collaboration are discussed. The implications and future research avenues are also presented.

2. LITERATURE REVIEW

2.1 INTERACTION, KNOWLEDGE, AND INNOVATION

The present discussion emphasizes the non-linear nature of the innovation processes, and the importance of interactive learning in organisations. Whereas the linear model focuses on explicit knowledge, the interactive model stresses systemic relations between actors and processes. It is the emphasis on a variety of knowledge types and the links between them, which is regarded as the most valuable resource in the interactive model, and interactive learning is regarded as the most important process (Lundvall, 1992; Johannessen, 2009).

The interactive innovation model highlights the connection between organisational, technological, and environmental factors. The model presupposes that innovation processes vary from organisation to organisation and that the interlinking patterns of these interactive processes are important. In the interactive model, R&D activities are not seen as the primary process generating innovations, but rather as part of systemic relations among various elements: markets, finance, internal and external knowledge, management, company culture, networked activities, and the regional and national innovation system. (Johanessen, 2009; Kautonen, 2012)

Major and Cordey-Hayes (2000) state that effective innovation requires the transfer of knowledge. To combine the information gained through social interaction, the different parties must have some overlap in knowledge or someone must support the transform of knowledge so that it becomes relevant to the others (Dyer & Singh, 1998; Parjanen et al., 2010). Brokers can transfer disconnected pools of information to new contexts and establish necessary ties between actors (Burt 2004; Parjanen et al., 2010; Tura & Harmaakorpi, 2005). They can also bridge and bond the SC needed in these actions (Ibid.). The capability of an actor to benefit the structural holes in social networks is closely linked to SC and overlapping knowledge related to AC. An open communicative environment and a free flow of information are seen to promote innovation processes in and between organisations. The link between theory and practice will be established more easily to support the organisation as a whole, and interaction between several types of expertise have space to transform into innovations (Johanessen, 2009; Fjelstad et al., 2012).

Today complex networks of firms, universities, and government offices are critical features of many industries, especially in technological and environmental industries. Various forms of inter-organisational partnerships and virtual networks are core competencies in the R&D of new technology and business. Networks of sources of knowledge are widely distributed and orchestrated by various actors. Universities and UAS are seen increasingly as important sources of knowledge, innovation, and economic growth, because firms increasingly source innovation by forming alliances with universities and UAS (Powell & Grodal, 2005; Kautonen, 2012; Huston & Sakkab, 2006; Chesbrough, 2003; Isaksen & Karlsen, 2012).

Motivations for firms to engage in alliances with universities and UAS vary. While often SMEs are aiming to solve problem that have occurred in R&D projects, the interests of large corporations are also towards sourcing new ideas and concepts for the future. Although firms' perceptions of benefits in these alliances are different, and vary

according to size and other issues, there exist some main reasons for collaboration with universities and UAS. Firms, for example, seek to leverage their R&D funding (Grimaldi & von Tunzelman, 2002) or want to access novel scientific knowledge or improve their problem-solving capability. In addition, collaboration with universities and UAS provides opportunities for companies to seek potential recruits (e.g. Perkmann et al., 2011). Firms have also started to collaborate with universities in many informal alliances, or in development projects, where the aim is not so clear in the beginning of the project. In these alliances, reasons for firms to participate may be, for example, to gain more SC and to strengthen their AC.

External and novel knowledge can be gained from the universities and UAS in different parts of the world. However, sourcing of knowledge is easier to organise with partners found in the same region than with distant partners (Isaksen & Karlsen, 2010). It is acknowledged that geographical distance has an influence on the sources of knowledge available to firms (Bishop et al., 2011; Isaksen & Karlsen, 2010). Therefore, some firms benefit from being located within a close geographical distance to universities or UAS.

For universities and UAS, reasons to collaborate are based mainly in their given roles and educational tasks. Universities and UAS are challenged to engage more in their regions to underpin collaboratively firm's innovation and development activities to ensure that the knowledge they produce is useful to regional industry. We assume that drivers behind collaboration are often financial and lacking the bi-directional benefits of knowledge co-creation and structures needed. However, this area has not been well studied, previously, and, therefore it is one research gap we are seeking more understanding of in this paper.

2.2 DUI AND STI MODES IN INNOVATION ACTIVITIES

Although the learning processes vary based on the organisation and collaboration structures in innovation activities, there is large amount of research literature on the topic (e.g., Alegre & Chiva, 2008; Jensen et al., 2007; Lampela, 2012; Lane & Lubatkin, 1998). We focus on two ideal model descriptions, DUI and STI, to give the frame for analysis of innovation activities in the UAS–SME context. Jensen et al. (2007) contrast two different modes of learning in innovation, based on different types of knowledge production. Technology and innovation (STI) mode is based on the production and use of codified scientific and technical knowledge. The DUI mode relies on informal processes of learning and experience-based know-how. The formal and informal knowledge elements and processes are discussed in context of 'know-what, know-why, know-how, know-who' previously presented by Lundvall and Johnson (1994). The DUI mode of learning refers to know-how and know-who, which are often tacit. Although such learning may occur as an unintended by-product of the firm's design, production, and marketing activities, Jensen et al emphasize that the DUI mode can be intentionally fostered by building structures and relationships which enhance and utilise learning by doing, using, and interacting (Jensen et al., 2007). Jensen et al. (2007) conclude that firms combining the two modes are more likely to create new products or services than those relying primarily on one mode or the other. They also find that their research results are beneficial to innovations systems and policies (Jensen et al., 2007).

Harmaakorpi and Melkas continue the DUI/STI discussion to support innovation research and analysis from a knowledge perspective in practical contexts, such as DUI-

related intellectual cross-fertilization, e.g., creative sessions where scientific and practical experience are combined for innovation, and issues that often become more visible slowly, such as the heterogeneous development of organisations to support innovation. They also present and describe innovation policy types and modes (in Table 22.1, p. 447). STI are linked to universities, and DUI is linked to UAS, but not excluding each other. Harmaakorpi and Melkas also point out the role of information quality in these activities (Harmaakorpi & Melkas, 2012).

2.3 Absorptive capacity and Social capital in innovation activities

Instead of linear technology related processes, innovations are seen to emerge as nonlinear processes embedded in social and economic activities. Innovation as a process of interactive learning between organisations and their environment highlights the role of AC and SC (Lundvall, 1992; Johannessen, 2009; Cohen & Levinthal, 1990; Tura & Harmaakorpi 2005; Godkin, 2010).

AC is originally defined by Cohen and Levinthal (1990) as *an organisation's ability to value, assimilate, and apply new knowledge*. Zahra and George (2002) developed the concept further by distinguishing between two different types of AC: potential absorptive capacity that is important in acquiring and assimilating external knowledge, and realised absorptive capacity, which refers to the functions of transformation and exploitation of the knowledge. They also suggested that there is a need for special social interaction mechanism between assimilation and transformation processes. Dyer and Singh (1998) see partner-specific AC as a function of '*1) the extent to which partners have developed overlapping knowledge bases and (2) the extent to which partners have developed interaction routines that maximize the frequency and intensity of sociotechnical interactions*'. The AC reification construct presented in Lane et al. (2006, p. 856, Figure 4) is slightly more mechanistic in nature, but they also point out the roles of external and internal drivers related AC. Lichtenthaler (2009) highlights AC-context issues related to exploratory, transformative, and exploitative learning in using external knowledge. Organisations should keep assimilated knowledge alive by maintaining and reactivating it. Sometimes assimilated knowledge has to be maintained for years until it can finally be utilised and applied in new products. The transformative learning has an essential role in this. Exploratory, transformative, and exploitative learning have complementary positive effects on profiting from external knowledge (Lichtenthaler, 2009). Although AC involves individuals, groups, and organisational levels linked to knowledge flows, several mechanisms can influence it, such as internal networks, cross-functional interfaces, and interactive learning (see also Volberda et al., 2010, p. 934, Table 1.) Organisation AC can been seen as being dependant on the links across a mosaic of individual capabilities (Cohen & Levinthal, 1990), formal and informal networks related and influenced strongly by cognitive processes of the managerial levels (Volberda et al., 2010). Cohen and Levinthal (1990, p. 131) see interaction between individuals as relevant antecedents: '*An organization's absorptive capacity will depend on the absorptive capacities of its individual members. To this extent, the development of an organization's absorptive capacity will build on the prior investment in the development of its constituent, individual absorptive capacities.*' Because of the natural changes of actors and inbuilt AC (personal learning and education), AC and SC are assumed to play important roles in this interaction dynamics related to DUI and STI innovation activities.

Characterizing innovation as social, nonlinear, and as an interactive learning process raises the question of the role of sociocultural structures in innovation processes (Tura & Harmaakorpi, 2005). For studying nonlinear innovation processes SC offers a conceptual framework and tool to theoretically handle the importance of networks and strategic alliances in the modern business environment (Tura & Harmaakorpi, 2005; Perez-Luno et al, 2011). According to Tura and Harmaakorpi (2005), SC refers to the possession of social relationships and membership in collectives, and to the resources that derive from these relationships and memberships. Nahapiet and Ghosal (1998, p. 243) see SC as '*the sum of the actual and potential resources embedded within, available through, and derived from the network of relationships*'. Social capital is also seen to inhere in the structure of relationships of human capital and economic capital (Portes, 1998). It is generally agreed that social capital plays an important role while developing organisational and regional innovation capability. The term capability refers to the ability of the innovation networks to exploit and renew existing resource configurations in order to create a sustainable competitive advantage in a dynamic innovation environment. It is seen that through SC, an actor can mobilize other actors and their resources embedded in social structures. SC also supports networks to share information efficiently, by reducing transaction costs and allowing the adaptability of system. It facilitates creative interaction and collective learning processes by encouraging and supporting cooperative behaviour. Building SC is strongly connected to actions. Moreover, the impact of the social, structural, and cultural environment is widely accepted in innovation activities (Tura & Harmaakorpi, 2005; Smedlund, 2008).

SC has been classified in various ways and into subcategories (Alguezaui & Filieri, 2010; Landry et al., 2002; Perez-Luno et al., 2011) to better understand its nature, but we follow three main dimensions presented by Tura and Harmaakorpi (2005): (1) the structural dimension; the impersonal configuration of linkages between actors, such as 'how to reach who'; (2) the relational dimension, the personal relationships between the members of the network, e.g., reputation, respect, and friendship; and (3) the cognitive dimension, referring to the social assets, such as systems of meanings and shared representations, values, and interpretations. All of them are facilitating the actions of individuals within the social innovation structure. Usually, these things are linked to positive aspects in innovation activities, but it is important to remember also the possible negative impacts. Owing to the previously presented issues, SC can also been seen as limiting some actions and possibilities in networks in all three dimension, e.g., bad reputation, missing link, etc. SC can also support some sorts of closure in community, and it restricts its sensitivity to new information and alternative ways of doing things (Nahapiet & Ghosal, 1998; Tura & Harmaakorpi, 2005; Pihkala et al., 2007; Alguezaui & Filieri, 2010).

SC is about the causal action capabilities of the (individual or collective) actors, where trust also has a certain role. It is also important to notice that there are situations where an actor's SC is 'worthless'. This context-dependence is known as the 'field-specificity of social capital'. Tura and Harmaakorpi present a well-fitting example:

> *A simple example of this is a distinguished scholar who has high social capital within the scientific community. This status does not, however, automatically give his/her social capital outside that community, in fields such as the business environment where both the respected actors and the rules of the field differ significantly from those of the university*. (2005, p. 1117)

2.4 SUMMARY OF LITERATURE REVIEW

Organisations create new knowledge and build enabling AC and SC in their context and drivers based on their purposes. Educational and business organisations have their own goals, but those goals are interlinked with each other's. Knowledge exploration and exploitation networks in innovation activities are also different in nature (Smedlund, 2008; Walter et al., 2007; March, 1991). SC and AC are developed based on internal activities and interaction with external parties. DUI and AC play important parts in this internal and external learning related to innovation, and as mentioned in Lane et al. (2006; based on Cohen & Levinthal, 1990), AC also allows traditional firms to learn to do something more and quite different, than 'learning by doing', which allows organisations to get better at what they already do. According to the literature, SMEs are often challenged in STI activities because of their limited resources and capabilities and, therefore, they search for support to R&D from universities. However, literature also occasionally points out that the high-technology based SMEs often spin off from universities, requiring DUI, SC, and AC for developing innovation and for its commercialization.

In our study, we have used the broader interpretation of AC, SC, and DUI in the R&D context found in the literature, and not limited to firms' formal codified R&D activities (AC applicable to the education organisations participating in networked innovation activities). We are also aware of the complex conceptualization of partly overlapping terms and issues, but see it as fruitful starting point for this study focusing in practical development of interaction structures for innovation.

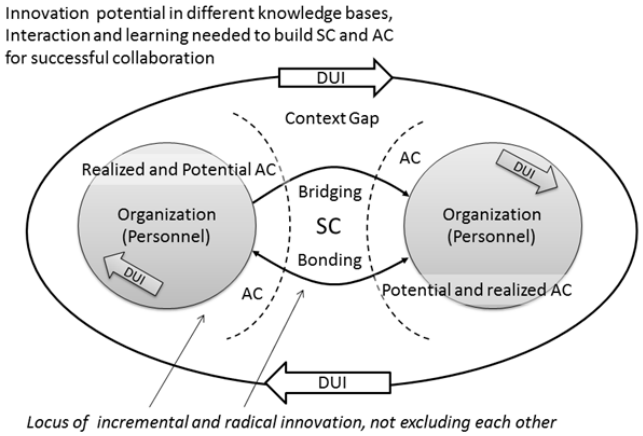

Figure 1. Illustrating synthesis of AC, SC, and DUI interconnection.

3. CASE DESCRIPTION

The research is based on a project in the southern part of Finland financed by the European Union's (EU) European Regional Development Fund. The project was focused on developing collaborative processes and structures in Universities of Applied Sciences for supporting the innovation activities and internalization of Finnish metal industry firms. The project was conducted from 1November 2009 to 30 April 2013, and participants included six UAS, one University of Technology, and 40 SMEs in Southern Finland.

The aim of the project was to create tools and operations models for SME–university collaboration for innovation activities and internalization. Research focuses on developing enabling structures, models, and methods supporting cooperation and interaction in these actions and relationships.

3.1 UNIVERSITIES OF APPLIED SCIENCES, AND THEIR ROLE IN FINLAND

The higher education system of Finland consists of two different levels: Universities of Sciences and Universities of Applied Sciences[1]. The mission of the universities is to conduct scientific research and provide higher education based on the research. UAS educate professionals for the labour market and perform applied R&D, which supports education and promotes regional development (OKM, 2012). Anyhow, compared to the rather old University tradition, UAS became part of the Finnish education system as late as in the 1990s, and only in 2003, research and innovation activities were formally added to their tasks that earlier included only education (Vestala et al., 2010). According to a Finnish evaluation, UAS seem to have had a remarkable role in developing innovation systems (Harmaakorpi et al., 2010; Vestala et al., 2010). Due to the large amount and extended role of UAS, regions are still in the process of developing collaboration structures, and the roles of various actors are evolving. A committee of Ministry of Education (Vestala et al., 2010) noted that in the structure development of the higher education institutions, measures should be taken to consolidate cooperation between UAS, universities, research institutes and other parties so that these form a regionally operating entity. Further research on this field is also vital. As presented above, in education, the tasks of UAS have been described as applied research and R&D services related to that, whereas Universities of Sciences have been directed at basic research and production of scientific knowledge.

3.2 SME IN THE INTERNATIONAL BUSINESS ENVIRONMENT

Multinational enterprises are often thought to dominate businesses, but more than 99% of all European businesses are SMEs. '*They provide two out of three of the private sector jobs and contribute to more than half of the total value-added created by businesses in the EU. Moreover, SMEs are the true back-bone of the European economy, being primarily responsible for wealth and economic growth, next to their key role in*

[1] OKM, Ministry of Education and Culture (2012). Polytechnic education in Finland. Available at http://www.minedu.fi/OPM/Koulutus/ammattikorkeakoulutus/?lang=en

innovation and R&D' (EU)[2] SMEs are a crucial part of the business networks, e.g., large firm's value adding R&D, production, and service networks. They are often seen as a main source of innovations, and this is often linked to entrepreneurial attitude among the skills and expertise of their personnel. However, often SMEs lack the resources and time to look beyond their immediate short-term needs (Major & Gordey-Hayes, 2000; Mäkimattila et al., 2012).

Firms engaged in this project were SMEs with various sizes and backgrounds, and located around Southern Finland. They presented multiple aspects of the networked metal industry. Some firms could be classified as traditional suppliers for larger firms, and some were Science University spin offs presenting high-tech services for industry; therefore, the size, age, and experience in international business were very different, which affects the innovation principles and processes as well as partner networks in these activities.

4. RESEARCH METHODOLOGY AND DATA

An action-oriented R&D project provides the context of this study. The methodology is a combination of action-oriented research and case-study research methods. According to Coughlan and Coghlan (2002), action research uses a scientific approach to study important social or organisational issues together with those who experience these issues directly. Action research always has two goals: making the action happen and reflecting on what happens, in order to contribute to the theory. Action researchers are not just observing change; they are actively working to make it happen (Coughlan & Coghlan 2002).

Case-study research method is usually used to contribute to our knowledge of individual, group, organisational, social, economic, and political phenomena. In Voss et al. (2002, p. 197), the strengths of case research are summarized based on Meredith (1998) and Benbasat et al (1987): '*The phenomenon can be studied in its natural setting and meaningful, relevant theory generated from the understanding gained through observing actual practice. The case method allows the questions of why, what and how, to be answered with a relatively full understanding of the nature and complexity of the complete phenomenon.*' The case-study method has been often misunderstood and criticized, but now it is better accepted as a tool for capturing important findings in complex systems. According to Yin (2009), the rigor of the case study has been one of the greatest concerns among biased views influencing the direction of the findings and conclusions. Case studies typically combine data collection methods, such as archives, interviews, questionnaires, and observations. Using quantitative and qualitative research methods in combination produce the best results in research (Yin, 2009; Eisenhardt, 1989; Voss et al., 2002; Flyvbjerg, 2006).

In order to enhance understanding about the UAS collaboration, an initial questionnaire was developed in 2009; 11 workshops were observed during 2010–2013; 12 semi-structured interviews were conducted during spring 2011; a closing survey was conducted in spring 2012, and finally a concluding workshop was held in 2013. Data were gathered in a collaborative manner, and several researchers participated in these

[2] http://ec.europa.eu/enterprise/policies/sme/files/sme_definition/sme_user_guide_en.pdf http://ec.europa.eu/enterprise/policies/sme/facts-figures-analysis/index_en.htm

activities from different regions. Surveys and interview questions were planned based on innovation theories in the literature. Research was operationalised so that the terms *AC* and *SC* were not used directly. Innovation, AC, and SC literature theory language was converted to practical terms so that they would easily understand in e.g., questionnaires directed to firms and workshop collaboration.

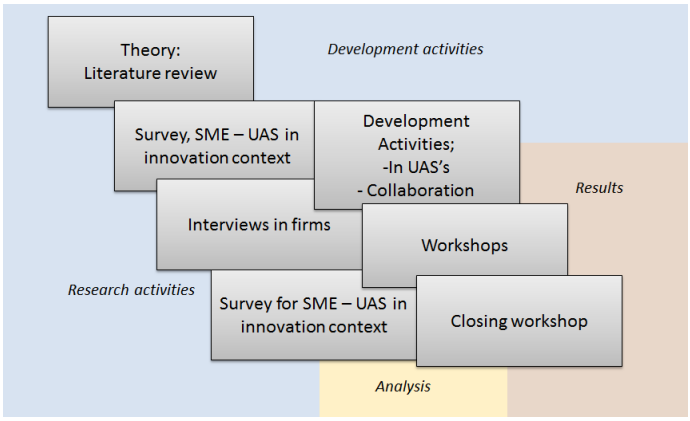

Figure 2. Data collection and analysis: Action-oriented research during development activities.

Table 1. Summary of the data acquisition in this study

Purpose	**Data Acquisition / Method**	**Participators / Organisations**	**Output**
Studying the current state of innovation activities in SMEs.	Survey, an electric questionnaire sent to SMEs	65 persons in all organisational levels in various SMEs in Southern Finland	The questionnaire identified the SMEs' general focus in innovation activities with UAS
Studying the current state of innovation processes in SMEs and interaction related with UAS	Interviews, structured questions about innovation topics based on innovation literature	12 managers in different SMEs having some prior contact with UAS of various regions	Very different capability levels of SME–UAS network activities, indications of SC, and AC challenges
Further developing the output of the questionnaire and interviews	Diagnosis workshop; presentations and memos	6 researchers and 3 project managers from UAS and Science Universities	Development targets of networked innovation structures and related activities in UAS
Developing activities, while benchmarking others, and discussing ongoing development actions	10 workshops; presentations and memos	Total of 14 researchers from UAS and science universities	Development targets, ongoing actions, and focused research topics
Fulfilling development and research needs Understanding the cap between felt importance of topics and realised outcomes of UAS as seen from both UAS and SME aspects	Survey, based on innovation literature and prior studies Electric questionnaire with background questions and similar question sets for UAS and SME in two-dimensional squares: felt importance and realised outcome under 9 main topics related to innovation and internalization, with free text space given to feedback included about the topics and in general	110 persons answered, in all organisational levels, from SMEs (35) and UAS (75) Each of the 6 UAS was asked to send this survey at least to: *10 persons in a UAS* *10 SMEs with which they are collaborating* *10 SMEs that have not started / rejected UAS cooperation in some form earlier*	Complementary information for research and future development
Clarifying the results and benefits of the process done and current activities going on to carry outcomes further in practice	Closing workshop, summary table, and memo	8 researchers from UAS and science universities	Research and development targets for the future, and implementation of developed solutions

Researcher triangulation was used to validate the interpretations made out of data gathered with various methods. Three researchers analysed data and workshop observations, and made interpretations. Then, the researchers discussed their findings and searched for mutual understanding and differences in interpretations. Outcomes were reflected and combined with those of other researchers participating UAS. The analysis results were compared to the literature presented in the theory section.

5. Analysis and Findings

Based on workshops in different premises, we identified three different main combinations affecting the interaction structures between technology-oriented universities and industry: Areas having (1) only UAS; (2) UAS and regional units from science universities; and (3) UAS and the main campus of Science University. In the end of the observation period, one of the UAS and one science university were located in same premises, but they were not merged in an administrative manner. Moreover, it was noted that politically established regional technology centres had important impact on roles and structural constructions of actions. Interaction between the parties was formulated through those constructions, activities and the personal relationships of the actors.

Based on our second survey, the main reasons to start UAS–SME collaboration were (1) personal relationships; (2) contacts; and (3) projects (often related to funding). In the UAS workshop, it was said that often the relational SC forces to participate and possible funding are often seen as the driver. It was also noted that it really matters is who you know, when alliances are formed and participants are chosen. Free comments (SME) in the second survey highlighted the same issues, e.g., *'We have not been working with UAS while we have no known contacts there, we would like to, but as a small actor, we do not have time to search possible routes and structures to collaboration . . .'* or *'. . . we have only worked with science universities (Technology)'*. It was seen that especially with limited resources, focus and partners are chosen with SC in different forms thus playing an important role, not only in SMEs but also in UAS. It was also mentioned that regional aspects and possible future projects are guiding convention formation (also the probability of future project funding), especially in UAS and universities. Limited resources as well as internalization aims were mentioned as the reasons why SMEs search for partners for R&D activities. In the second survey, the reasons why SMEs quit collaboration were identified as follows: (1) nothing or natural project ending; (2) schedules and bureaucracy; (3) business/economic cycle. Interviews and workshops had similar implications, pointing out that collaboration is natural when the benefits are probable and a time fit exists.

Table 2. Main findings in different stages of study

FINDINGS	DUI	SC	AC
Survey 1	SME DUI orientation with customers and suppliers – as main innovation source UAS should better share projects with other research institutes (other UAS, universities, etc. – also the STI connection)	SMEs' prior contacts build on student training periods and final thesis – in addition, research collaboration and prior personal contacts mentioned Because of the SMEs' internalization aims, contact networks are valued as important Defined/allocated collaboration conventions and contact persons required	Research partner should understand well the goals and context-related information SMEs' difficulties in understanding and valuing research outcomes (transformation among acquisition)
Interviews	SMEs have practical aims in interaction Limited resources and time in both (SMEs and UAS) SMEs wish that universities would specialize with certain profiles in university networks	How to reach who, clear contacts (bridging) Flexibility to avoid bureaucracy (bonding) Dynamic nature of SC SC important to source future oriented information	Regional roles of actors and cumulative AC related to role Development conventions and common understanding through collaborative doing – building overlapping knowledge base Future orientation and knowledge-transformation challenge
Diagnosis workshop	Interaction structures vs. UAS service offering Open-innovation dimension Variety of SMEs, all individual and strongly related personnel	Field-specificity of social capital – e.g., enterprises and universities, UAS, and science universities Entirety of student, personnel, and organisation SC – internal SC among external dimensions	AC is based on interest and prior knowledge, in UAS and SME. Dynamic nature of AC
Workshops (development)	How to enable DUI, bi/multidirectional platforms needed DUI in networks of universities and firms among other actors and knowledge sources DUI in 'formal' and informal conventions and networks Action needed to build SC and AC, both needed to start action => DUI	UAS challenged to reach SMEs, often based on prior personal contacts The role of students, bridging SC, also international dimensions University and firm labour personal contacts (work and free time as well as prior contacts in both)	Importance of education for long-term AC development in SMEs Acquisition; how-to-reach information needed How to know what is available – loop to SC How-to-value knowledge with limited resources. AC in different fields in universities
Survey 2	The role of UAS for SMEs – participants and roles, DUI and STI. Interconnection of DUI and STI	Difficulties in finding the right contacts and activities rather with previously known parties especially in risky cases	Very different level of prior AC in SMEs – context–related SMEs are unique in skills and learning orientation
Closing workshop	Different needs, different platforms – DUI development can be done when SC and AC roles are identified	SC: bridging and bonding – focus on entirety and all network resources	AC: acquisition, assimilation, transformation, and exploitation – focused development activities

UAS saw their capabilities and structures, as well as action challenges, rather similarly, based on our surveys and interviews. In the questionnaire directed to the UAS and the SMEs, both were asked similarly about the felt importance of interaction-related topics and realised outcomes. UAS and SMEs had similar interpretations of the importance of those issues, but UAS saw their impact slightly more positively. Only in regards to intellectual property and normative topics did SMEs indicate that the UAS performed better in support than the UAS saw themselves having performed.

Internal UAS development of structures was seen natural and important in enabling the interactions with external 'business' partners. UAS are often focusing on developing laboratory and offering related services (e.g., rapid prototyping), and communication and IT tools and updated courses for students to achieve the necessary levels of skills and complementary education for firm personnel. UAS have also further developed and applied collaborative DUI-supporting frameworks, such as LCCE (Learning and Competence Creating Ecosystem), LbD (Learning by Developing), and CDIO (Conceive-Design-Implement-Operate) for interaction with firms. AC and SC aspects were often embedded and not directly focused in structure development in the mentioned topics.

Common challenges were the temporal fit of combining educational and business schedules, and the slightly different drivers behind the collaboration in UAS–SME alliances. It was seen that SC and AC are built through actions. In addition, it was mentioned that this could sometimes happen in organisation slots and levels, where it is not directly benefitting innovation activities. A noticed issue was that mostly firms are purposely sourcing precise information or service where it is available, and they are not willing to allocate their limited resources for long-term relationships, 'running idle'. UAS might sometimes aim to long-term collaboration mostly for political reasons and strategic decisions. In firms, communication channels are opened when needed, and closed after accomplishment of an objective. Sometimes there is a SME demand that is not visible outside, but activated because of suitable offer from the UAS. There was indication that the UAS would like to collaborate mainly in terms of course tasks, but available resources limited the possibilities of guiding individual student works in firms. Moreover, firms are waiting for real results out of the works because of the time used and other transaction costs. SC had an important role in all of the three dimensions.

Prior personal contacts were seen as a major issue for firms seeking collaboration and other universities for cooperation in networked projects. There was no major difference in how firms and UAS themselves saw the UAS as an innovation partner for SMEs. However, finding the 'right persons' with the 'right knowledge' was mentioned, in both directions, in early phases of collaboration activities. There is clear demand of projects such as this case to develop personal and organisational networks (SC) between UAS, science universities and firms. There has been much discussion on the field of UAS–SME networks, but practical UAS–UAS innovation network activities could be reinforced to utilise the different strengths of the UAS and to connect suitable science universities to UAS–SME networks thru UAS. EU and Finnish funds (such as the European Regional Development Fund, ERDF) can support the interaction needed, as in this project, to build AC and SC for DUI activities nationally and internationally.

In the analysis, we recognized that there is cooperation between UAS in several fields, but often, the SC is built on different levels than directly benefitting practical innovation collaboration with other universities and SMEs. In large organisations, internal SC also

plays important role in networked innovation activities with external parties. We have indications that SC is more important if the other party's AC is limited. Brokering and SC are then needed to link actors over structural holes, but also to cover AC problems.

An internalization-related finding was that while building DUI, it is important to notice that in different countries organisations might have slightly different roles. It was said in the workshop: '*To start to do anything in China, you have to go there and be active. Prior contacts are important, as well as the combination of the university, firm, and political actors participating – like sister cities used in the Mayer model*'. Universities, UAS, public intermediate organisations, cities, and firms might have different positions in activities – this might also influence the AC and SC that are supposed to be present in parties' activities. In addition, the personal connections and SC-related issues might have different value in different countries. In China and Russia, SC-related issues seem to be important for successful innovation activities to take place.

6. DISCUSSION

In this paper, our goal was to integrate learning approaches and innovation by testing established theoretical concepts of DUI/STI (Jensen et al., 2007), AC (Cohen & Levinthal, 1990), and SC, with empirical findings in a UAS context. Issues found are linked to a very practical approach of SMEs, aiming to do straightforward business with universities having simultaneously diverse goals.

Although innovation now has an increasingly systemic nature, the complex combination of technological and market knowledge challenges innovation networks (Johannessen, 2009). This highlights that AC, SC, and interaction are used to combine firms' knowledge with available information. We see that this information transformation occurs when SMEs, UAS, and science universities together process available information. In these activities, some overlapping knowledge base is necessary. Speeding up information transition processes is not enough; intervention to add and combine complementary information is crucial, as is the linking of these processes in different organisations. In knowledge transfer, integration, and collaborative knowledge creation, formal and informal governance are also important (Hong & Olander, 2010). Personal relationships and trust among formal contracts have significant roles, especially if the university and industry in alliance are in the same field of research and have deep prior core knowledge (Hong & Olander, 2010). The fear of later rising competition, instead of successful collaboration or cooperation might limit the DUI and STI activities, and this has been mentioned earlier in other studies (Lehenkari, 2006). SC is a key issue while information is being shared in the early phases of innovation.

It is widely agreed that social interactions enhance the innovation performance, and the optimal structures of social networks that support innovation have also been widely studied and the outcomes have been presented (Alguezaui & Filieri, 2010; Smedlund, 2008). In structures there seems to be development possibilities for UAS to use each other's networks and to specialize in certain areas of services for firms. Often UAS are seen to serve local firms regionally, but seldom as working as collaborative channels for regional SMEs to combining resources from other UAS and science universities. Moreover, the brokering in such activities (Burt, 2004; Parjanen et al., 2010, 2011) as well as long-term development to support information transformation to knowledge collaboration with firms could be enforced. SMEs are easily trapped in exploitation

(Mäkimattila et al., 2012) and those existing contacts, to explore information from the same sources. Shared information transformation platforms and new contacts could support innovation activities and renewal of firms and UAS.

AC of the organisations enables technology-transfer between universities and the firms, and allows intermediaries to work for that purpose. Both the intermediary function and the AC are important to facilitate the transfer of tacit knowledge for innovations (Kodama, 2008). Long-term R&D collaboration and personal education builds AC in both organisations. We also would like to highlight the collaborative knowledge creation including the AC and SC combination in this – although interactive innovation is largely based on DUI (Jensen et al., 2007), but not forgetting the important role of the STI mode and the interplay of both of these modes as competitive edge.

As pointed out by Gray (2006), policy makers should reappraise the role of technical and vocational education to support the development of AC in SMEs. AC needs both general and very specific knowledge on the field, and cannot be built only on 'basic general codified knowledge' to enable DUI innovation. Certain prior-knowledge bases support firm–university interaction, and geographical proximity facilitates the exchange of tacit and context-specific knowledge; Bishop et al. (2011) support this finding. However, UAS could also focus on internal AC to enable knowledge acquisition and transformation from science universities and firms, and from other UAS.

Firms and UAS should focus on the diversity of their contacts in the current complex world demanding external collaboration for innovation activities. SC, especially relational, makes tacit knowledge more valuable for radical innovations (Perez-Luno et al., 2011). Tight structural and relational SC in organisations might limit firms and UAS by narrowing the networks of innovation and creative solutions. As also discussed earlier, inter-firm linkages and university–industry linkages lead to different outcomes (Kodama, 2008).

SC is giving fast access to the right arenas for sharing information and participating in DUI. Especially, if the profiting potential is not directly visible, SC supports brokers in their actions. AC instead could be linked to important long-term development and learning, to overlap prior knowledge to create new combinations of meaningful information. This brings the combination of AC and SC into the core of innovation activities. We see the interactive DUI loop sourcing from rather linear STI processes, with crucial support of SC and AC. Often the DUI loop triggers new a STI path, having a systemic interplay with the innovation and the related actors. STI can be a rather linear analytic process requiring AC, but the early stage and end are strongly linked to DUI processes leaning on SC. However, SC and AC are also built thru DUI, requiring time and action.

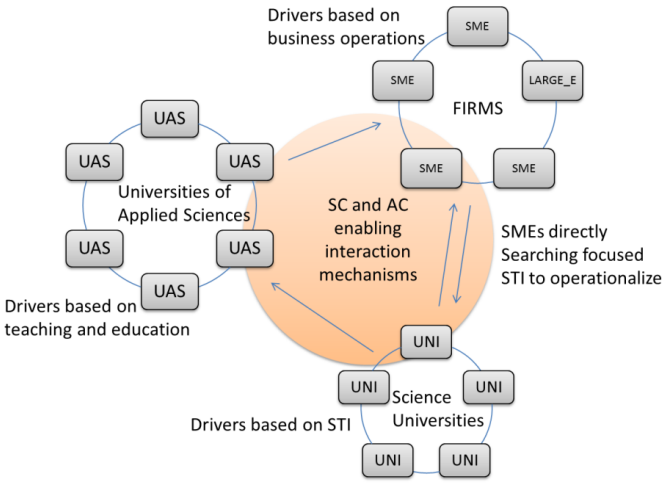

Figure 3. DUI and STI sourcing from different contexts.

UAS are often supposed to transfer science university STI knowledge to the organisations, and firms are seen as knowledge users (Figure 3, left side). In practice, there seems to be some challenges (Figure 3, right side). The knowledge producers and users should be seen as simultaneous actors in the collaborative work of interpreting the information based on their context (Figure 3, SC and AC). Currently, the practical mechanism needs development to interlink DUI and STI activities –Figure 3 illustrates university and firm actors and their DUI and STI drivers. Focus should be in structural, relational and cognitive dimensions in SC as well as in potential and realised AC with different types of information and networks (see also Smedlund, 2008). However, we would like to remind that networks are dynamic in nature – developing based on actions and related SC elements (individuals, network structure, norms, beliefs, and trust) and have different natures in different phases of innovation proceeding. Moreover, the size of the organisation affects the roles of structural, relational, and cognitive SC dimensions in intra- and interorganisational networks.

We agree with Tidd (Tidd, 2001, p. 173; Tidd & Bodley, 2002, p. 128): '*Much research on the management of innovation attempts to identify some 'best-practice'. . . However, there is unlikely to be 'one best way' to manage and organise product development as industries differ in terms of sources of innovation and the technological and market opportunity, and organisation-specific characteristics are likely to undermine the notion of universal formula for successful innovation.*' Besides the mentioned industry dynamics, we would also like to point out the differences in collaboration based on regional combination of existing science universities and UAS, and the combination of these with other intermediates such as technology centres and those related to dynamics. Based on our study, it seems that best practises and innovation processes are linked to deeper structures of regional entities. However, UAS could fill the important role of sharing best practises and innovation-related knowledge, building AC and SC to enable learning to utilise DUI and STI modes with firms.

We also see DUI, AC, and SC as having important roles in radical innovations in the future. Radical innovation requires deep knowledge of the respective technological domains, and it develops within a trusting context since it involves more risky investments. Developing radical innovation needs shared frames of reference with partners, and common repertoires of communication to solve various problems (Alguezaui & Filieri, 2010). Instead of linking DUI only to incremental innovations (Isaksen & Karlsen, 2010 and many others), we see the role as merging actors and STI processes in systemic contexts. When different knowledge bases of different firms (SMEs and large multinational corporations) and universities (Science and UAS) are combined with well-covering individual networks, the radical systemic innovations have the power to appear and reach markets.

The findings of the study advance the prior wide range of research related to AC, SC, DUI and STI, by making their roles and interconnections visible in the UAS context (Table 2). Organisations can develop their collaboration structures better when the different theories discussed above are paid attention to. The theories support practical work by focusing on AC and SC as innovation enablers, but also recognizing the inertial forces related, as well as by understanding the different aspects of DUI and STI. In their interaction, UAS, Universities and firms can develop their internal focus and contribute to active regions, where developed structures truly support collaboration and coopetition instead of pure competition. As such, strengths of different universities and firms, like knowledge and networks, can be utilized both regionally and globally. In the era of globalization actors in regions should harness each other's networks and different knowledge production modes to compete with, access and produce value for other University City-regions having different strengths. Implications presented in this paper might also benefit current studies related to regional industrial changes and new business ecosystems rising in certain fields. This is a hot topic also in many other areas than the Finnish forest and telecom industry regions that are undergoing tremendous change that has impacts on the whole society.

7. LIMITATIONS AND FUTURE RESEARCH

This study focuses on extending the understanding of issues related UAS–SME innovation collaboration, linking it to the DUI theory. The aspect was to connect theory and practice by combining questionnaires, interviews, and workshop observations in Southern Finland, following the educational actors and structures involved in this area.

Future research should examine in more depth, the tools helping networked UAS together with science universities to integrate available information for innovation activities with SMEs. Further, research should include deeper analysis of the practical mechanisms linking UAS, science universities, and firms. The roles are rather clear in the normative approach, but during the research it became rather obvious that practical routes are not polished between different universities, knowledge transfer methods, and firms searching available information from different sources. Although recently shared strategy work for specialization of different Universities has begun, this opens the window for observing the change and implementation results, also from a smart-specialization perspective. Moreover, the different drivers behind DUI activities and the roles of different intra- and inter-organisational loops should be analysed in the practical context of knowledge co-creation.

8. CONCLUSIONS

In this paper, we examined learning approaches and innovation by testing the established theoretical concepts of DUI/STI (Jensen et al., 2007), AC (Cohen & Levinthal, 1990), and SC, with empirical findings in a UAS context. The paper makes a contribution by pointing out the interconnection of DUI, STI, AC and SC in innovation activities. The study highlights the importance of knowledge exchange with different types of universities and firms, and the different learning modes related to innovation. Prior knowledge and contacts vary in organisations, and interaction should be supported to utilize external resources of different organisational and individual backgrounds. The issues found are linked to a very practical approach of SMEs aiming to do straightforward business with universities having simultaneously diverse goals, and this brings also the AC and SC into the core of today's networked innovation.

UAS are focusing to fulfil the politically given task of education and regional supportive actions to serve firms with other public organisations. The education actions and publicly financed projects are often measured on criteria other than those directly linked to innovation collaboration with other UAS, science universities, and SMEs. Activities might have been on a level where the where gained SC is not directly promoting actual innovation activities between different universities and firms. Hence, SC and AC are rooted in individuals. Moreover, innovation structures to support DUI and STI are linked to organisations' capabilities to utilise both individual and organisational dimensions. Formal and informal interaction support building SC and AC, and all of them are needed in the current complex, interlinked innovation activities with other parties. Interaction is needed to build overlapping knowledge bases and for brokerage to bridge actors from different contexts. Current DUI loops are rather homogenous and local, including some STI connections, instead of utilising larger heterogeneous resources and idea pools for a longer-term perspective of combining both modes. This study pointed out that UAS should also focus on SC and AC while enhancing structures and networks with other actors. Easily, the regional focus is on the in individual UAS offerings, such as education and laboratory services for SMEs, instead of enabling the larger heterogeneous resource-pool usage needed in current global competition. In particular, the SMEs emphasised the idea that UAS and universities should focus on internal network development, and clarify the roles and focus they aim to offer to SMEs: This covers the international dimensions to access abroad. In addition, the diversity of SMEs, their needs and capabilities are significant – there is likely not one recipe or process that could fit for everyone's needs. Therefore, the access to participatory activities is strongly related to prior SC and AC, as well as to the future collaboration in parallel development of these achieved during interaction. During this study, both the UAS and SMEs highlighted the importance of concrete doing and interacting in target-oriented collaboration projects.

REFERENCES

Alegre, J. & Chiva, R. (2008). Assessing the impact of organizational learning capability on product innovation performance: An empirical test. *Technovation* 28(6): 315–326.

Alguezaui, S. & Filieri, R. (2010). Investigating the role of social capital in innovation: sparse versus dense network. *Journal of Knowledge Management* 14(6): 891–909.

Benbasat, I., Goldstein, D. K., & Mead, M. (1987). The case research strategy in studies of information systems., *MIS Quarterly* 11(3):369–386.

Bishop, K., D'Este, P. & Neely, A. (2011). Gaining from interactions with universities: Multiple methods for nurturing absorptive capacity. *Research Policy* 40: 30–40.

Burt, R. (2004). Structural holes and good ideas. *American Journal of Sociology* 110(2): 349–399.

Chesbrough, H. (2003). *Open Innovation: The New Imperative for Creating and Profiting from Technology*. Boston: Harvard Business School Press. 227 p.

Cohen, W. and Levinthal, D. (1990). Absorptive capacity: A new perspective on learning and innovation. *Administrative Science Quarterly* 35: 128–152.

Coughlan, P. & Coghlan, D. (2002) Action research for operations management. *International Journal of Operations & Production Management*, 22 (2), 220-240.

Dyer, J. H., & Singh, H. (1998). The relational view: Cooperative strategy and sources of interorganizational competitive advantage. *Academy of Management Review* 23: 660– 679.

Eisenhard, K. M. (1989). Building theories from case study research. *The Academy of Management Review* 14(4): 532–550.

Fjeldstad, Ø. D., Snow, C. C., Miles, R. E., & Lettl, C. (2012). The architecture of collaboration. *Strategic Management Journal*, 33(6): 734–750.

Flyvbjerg B. (2006). Five misunderstandings about case-study research. *Qualitative Inquiry* 12(2): 219–245.

Godkin, L. (2010). The zone of inertia: Absorptive capacity and organizational change. *The Learning Organization* 17(3): 196–207.

Gray, C. (2006). Absorptive capacity, knowledge management, and innovation in entrepreneurial small firms. *International Journal of Entrepreneurial Behaviour & Research* 12(6): 345–360.

Grimaldi, R. and von Tunzelmann, N. (2002). Assessing collaborative, pre-competitive R&D projects: The case of the UK LINK scheme. *R&D Management* 32: 165–173.

Harmaakorpi, V. and Melkas, H. (2012) Epilogue: Two modes of practice-based innovation. In Melkas, H and Harmaakorpi, V. (eds.) *Practice-based innovation: Insights, applications and policy implications*, Springer.

Harmaakorpi, V., Myllykangas, P., & Rauhala, P. (2010). Tutkimus-, kehittämis- ja innovaatiotoiminnan arviointiraportti. *Seinäjoen ammattikorkeakoulun julkaisusarja* B 43.

Hong, J. Z. & Olander, H. (2010). University-industry knowledge interaction: Case studies from Finland and China. *International Journal of Healthcare Technology and Management: Special Issue on Academic Knowledge and Industrial Development* 11(5): 356–372.

Huston, L., & Sakkab, N. (2006). Connect and develop: Inside Procter & Gamble's new model for Innovation. *Harvard Business Review*, 84(3), 58-66.

Isaksen, A. & Karlsen, J. (2010). Different modes of innovation and the challenge of connecting universities and industry: Case studies of two regional industries in Norway. *European Planning Studies* 18(12): 1993-2008

Jensen, M., Johnson B., Lorenz, E., & Lundvall, B. (2007). Forms of knowledge and modes of innovation. *Research Policy* 36: 680–693.

Johannessen, Jon-Arild (2009). A systemic approach to innovation: The interactive innovation model. *Kybernetes* 38(1/2): 158–176.

Kallio A. (2012). Enhancing absorptive capacity in A Non-Research and Development Context – An Action Research Approach to Converting Individual Observations into Organisational Awareness. *Dissertation, Acta Universitatis Lappeenrantaensis 477.*

Kallio, A., Harmaakorpi, V., & Pihkala, T. (2010). Absorptive capacity and social capital in regional innovation systems: The case of the Lahti Region in Finland. *Urban Studies* 47(2): 303–319.

Kautonen, M. (2012). Balancing competitiveness and cohesion in regional innovation policy: The case of Finland. *European Planning Studies* 20(12): 1925–1943.

Kodama, T. (2008). The role of intermediation and absorptive capacity in facilitating university–industry linkages: An empirical study of TAMA in Japan. Research Policy 37: 1224–1240.

Lampela, H. (2012) Dynamics of development in innovation collaboration – relationships, learning and end products. *International Journal of Entrepreneurship and Innovation Management* 15 (½): 47-58.

Landry, R., Amara, N., & Lamari, M. (2002). Does social capital determine innovation? To what extent? Technological *Forecasting & Social Change* 69: 681–701.

Lane, P., Koka, B., & Pathak, S. (2006). The reification of absorptive capacity: A critical review and rejuvenation of the construct. *Academy Of Management Review* 31(4): 833–863.

Lane, P. & Lubatkin, M. (1998). Relative absorptive capacity and interorganizational learning. *Strategic Management Journa*l 19: 461–477.

Lehenkari, J. (2006). *The Networks of Learning in Technological Innovation: The Emergence of Collaboration Across Fields of Expertise*. Doctoral dissertation, December 2006. University of Helsinki.

Lichtenthaler, U. (2009). Absorptive Capacity, Environmental Turbulence, and the Complementarity of Organizational Learning Processes. *Journal the Academy of Management* 52(4): 822–846.

Lundvall, B.-Å. (ed.) (1992) National Systems of Innovation: Towards a Theory of Innovation and Interactive Learning. London: Pinter.

Lundvall, B.-Å. & Johnson, B. (1994). The learning economy. *Journal of Industry Studies* 1: 23–42.

Major, E. J. & Cordey-Hayes, M. (2000). Engaging the business support network to give SMEs the benefit of foresight. *Technovation* 20: 589–602.

March, J. G. (1991). Exploration and exploitation in organizational learning. *Organization Science* 2(1): 71–87.

Meredith, J. (1998). Building operations management theory through case and field research. Journal *of Operations Management* 16: 441–454.

Mäkimattila, M., Kallio, A., & Salminen, J. (2012). Issues in absorbing foresight knowledge for innovation in SMEs. *13th International CINet Conference*. 16–18 Sept. 2012, Rome, Italy.

Nahapiet, J. & Ghoshal, S. (1998) Social capital, intellectual capital, and the organizational advantage, *Academy of Management Review* 23: 242–266.

OKM, Ministry of Education and Culture (2012). Polytechnic education in Finland. Available at: http://www.minedu.fi/OPM/Koulutus/ammattikorkeakoulutus/?lang=en

Parjanen, S., Melkas, H., & Uotila, T. (2011). Distances, knowledge brokerage and absorptive capacity in enhancing regional innovativeness: A qualitative case study of Lahti region, Finland. *European Planning Studies* 19(6): 921–948.

Parjanen S., Harmaakorpi, V., & Frantsi, T. (2010). Collective creativity and brokerage functions in heavily cross-disciplined innovation processes. *Interdisciplinary Journal of Information, Knowledge, and Management* 5:1-21

Peças, P. & Henriques, E. (2006). Best practices of collaboration between university and industrial SMEs. *Benchmarking: An International Journal* 13(1): 54–67.

Perkmann, M & Walsh, K. (2007). University–industry relationships and open innovation: Towards a research agenda. *International Journal of Management Reviews* 9(4): 259-280

Perkmann, M., Neely, A., & Walsh, K. (2011). How should firms evaluate success in university–industry alliances? A performance measurement system. *R&D Management* 41(2): 202-216

Perez-Luno, A., Cabello Medina, C., Carmona Lavado, A., & Cuevas Rodrigues, G. (2011). How social capital and knowledge affect innovation. *Journal of Business Research* 64: 1369–1376.

Pihkala, T., Harmaakorpi, V., & Pekkarinen, S. (2007). The role of dynamic capabilities and social capital in breaking socio-institutional inertia in regional development. *International Journal of Urban and Regional Research* 31: 836–852.

Portes, A. (1998). Social capital: Its origins and applications in modern sociology. *Annual Review of Sociology* 24: 1–24.

Powell, W. & Grodal, S. (2005). Networks of innovators. In J. Fagerberg, D. Mowery, & R. Nelson (Eds.) *The Oxford Handbook of Innovation* (pp. 56–85). Oxford: Oxford University Press.

Rothwell, R. (1994). Towards the Fifth-generation Innovation Process. *International Marketing Review, 11(1): 7-31.*

Smedlund, A. (2008). The knowledge system of a firm: Social capital for explicit, tacit, and potential knowledge. *Journal of Knowledge Management* 12(1): 63–77.

Tidd, J. (2001). Innovation management in context: Environment, organization, and performance. *International Journal of Management Reviews* 3(3): 169–183.

Tidd, J. & Bodley, K. (2002). The influence of project novelty on the new product development process. *R&D Management* 32(2): 127–138.

Todorova, G. & Durisin, B. (2007). Absorptive capacity: Valuing a reconceptualization. *Academy of Management Review* 32(3): 774–786.

Tura T. & Harmaakorpi, V. (2005). Social capital in building regional innovative capability. *Regional Studies* 39(8): 1111–1125.

Vestala, L., Kaunismaa, E. & Jaroma, A. (2010). Ammattikorkeakoulujen tutkimus-, kehittämis- ja innovaatiotoiminnan työryhmä. Ammattikorkeakoulujen tutkimus-, kehittämis- ja innovaatiotoiminta innovaatiojärjestelmässä. *Opetusministeriön työryhmämuistioita ja selvityksiä 2010:8*. (The Polytechnic Research, Development and Innovation in the Innovation System. *Reports of the Ministry of Education, Finland, 2010:8*)

Volberda, H. W., Foss, N. J., &. Lyles, M. A. (2010). Absorbing the concept of absorptive capacity: How to realize its potential in the organization field. *Organization Science* 21: 931–951.

Voss C., Nikos Tsikriktsis N., & Frohlich, M. (2002). Case research in operations management. *International Journal of Operations & Production Management* 22(2):195-219

Walter, J., Lechner, C., & Kellermanns, F. (2007). Knowledge transfer between and within alliance partners: Private versus collective benefits of social capital. *Journal of Business Research* 60: 698–710.

Yin, R (2009). *Case Study Research*: *Design and Methods.* Thousand Oaks, 4th ed. Sage Publications.

Zahra, S. & George, G. (2002). Absorptive capacity: A review, reconceptualization, and extension. *Academy of Management Review* 27(2): 185–203.

Publication IV

Rantala, T., Ukko, J., and Rantanen, H.
Designing a performance measurement system for university-public-organization collaboration.

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Designing a performance measurement system for university-public organisation collaboration

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Abstract: This study explores designing and building performance measurement systems (PMSs) in the context of university-public organisation collaborations. In the case organisation, using the current literature on university partnerships and public sector performance measurement, we present, empirically test, and elaborate on a process model for designing and building PMSs for university-public organisation collaboration. The empirical section of this study discusses building PMSs to evaluate university-public organisation collaboration with a collaborative research and development project between a university and a public dental healthcare organisation as the empirical case. The study's results reveal that building PMSs for university-public organisation collaboration can support the management of such collaborations with both public and university project managers. The results also reveal that building PMSs can help to overcome the challenges related to measuring performance in the public sector and university partnerships.

Keywords: performance measurement; performance management; university collaborations; public sector.

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1 Introduction

Recent research has demonstrated a growing interest in university-industry partnerships, discovering that collaborative relationships between universities and other organisations play an important role by generating, among other things, new innovations, knowledge, and product development (Lundberg and Andersen, 2012; Perkmann et al., 2013). As private and public organisations develop greater expectations of the research and knowledge generated in universities, universities are more frequently requested to interact with other society to support their research and development activities (Schartinger et al., 2001; Lundberg and Andersen, 2012). Research on university partnerships has traditionally focused on collaboration activities between universities and private sector (industrial) organisations, largely ignoring governmental and public organisational views. Perkmann and Walsh (2007) point out that, despite the differences across industries and scientific disciplines, university-industry relationships are widely practiced. That is why both organisations and academics have developed greater interest in the role played by the research and knowledge generated by universities as a part of the organisation development process (Bishop et al., 2011). Similarly, the collaboration and partnerships between universities and different types of organisations aiming for knowledge exchange and research cooperation has received increasing attention in innovation analysis (Schartinger et al., 2002; Kloet et al., 2013). There has also been some interest in evaluating the effects of research funding; Luukkonen (2014), for instance, developed a methodological approach for studying the European Research Council's potential effects on the European research funding landscape. However, beyond the surge of interest in universities as a partner of collaborative actions with industry organisations, interest is also growing regarding universities' partnerships with public sector organisations. Public and governmental healthcare organisations engaging with universities in collaborative research and development projects in order to improve productivity and service quality represent a typical example of the 21st century university-public organisation partnership.

One reason for universities and public or private sector organisations to form partnerships and collaborative research and development projects is to fulfil the requirements of funding grants and national research program financiers. Different funding grants (e.g., European Regional Development funds, Horizon, 2020) require co-funding from different actors. To gain access to grants from these funding programs, universities must be able to secure co-funding from government authorities, other public organisations, or the private sector (Lundberg and Andersen, 2012). For organisations,

these funds offer opportunities to leverage their research and development funding. That is what recent studies on university-industry partnerships have identified as one of the main reasons for the rising interest in universities as development and innovation activity partners with both public and private organisations (D'Este and Patel, 2007; Lundberg and Andersen, 2012), even though these studies have also suggested that research grants carry some negative influences and challenges as well (Bloch and Sørensen, 2015).

However, while forming these partnerships and collaborations appears attractive to private and public organisations and universities, there are some challenges involved due to organisational and institutional differences. Regarding managing these collaborations, one main challenge involves their evaluation and measurement, for example:

- How should these collaborations' success, outcomes, and effects be evaluated?
- What type of frameworks and measures should be used to evaluate the collaborations?
- How should these frameworks and measurement systems be designed and constructed?

Perkmann et al. (2011) state that organisations are recognising a need for more systematic evaluations and measurement of university-industry partnerships not only to assess their achievements and resulting influence, but also to monitor ongoing collaboration activities so as to make improvements possible. As a result of the increased interest in university-industry partnerships, some frameworks have recently been presented to improve their management and evaluation (e.g., Mora-Valentin et al., 2004; Iqbal et al., 2011; Al-Ashaab et al., 2011; Perkmann et al., 2011). However, these frameworks are developed solely to evaluate the activities between university and industry organisations. Consequently, the literature on university-public organisation partnerships suffer from some limitations due to the lack of proper procedures for designing and building performance measurement systems (PMSs) in the context of university-public organisation collaboration.

Therefore, this study aims to explore designing and building PMSs in the context of university-public organisation collaboration to support the management and evaluation of these collaborations from the perspective of both public organisation managers and university project managers. First, based on the literature regarding performance measurement and university-industry partnership, we construct a conceptual PMS design process for university-public organisation collaboration. Second, we empirically test and complement the conceptual model in a case study representing a collaborative research and development project between a university and a public dental healthcare organisation. In addition to complementing the constructed theoretical model, the case study's objective is to clarify whether a PMS can be designed for university-public organisation collaboration by utilising the conceptual model developed based on the literature, in addition to determining the possible advantages this achieves. The results can be utilised by not only both public sector managers and university researchers and project managers planning to start a collaborative project and form a collaboration, but also the financier delegates of the funding grants and politicians aiming to develop better evaluation frameworks to support the management of university-public organisation collaborations.

2 Performance measurement frameworks

The literature on measuring and managing performance presents frameworks for measuring networks' performance (Busi and Bitici, 2006; Chen et al., 2007; Chang et al., 2010; Pekkola and Ukko, 2016; Saunila et al., 2017), as well as frameworks for measuring the performance of individual private sector organisations (Turner et al., 2005; Garengo and Bitici, 2007; Wiesnet et al., 2007) and public sector organisations (e.g., Williams, 2003; Rantanen et al., 2007; Linna et al., 2010; Moxham, 2010; Newcomer and Caudle, 2011). These frameworks and process models comprise a different number of phases using different methods for designing and building these measurement systems. Some frameworks have also been presented for university-industry partnerships (c.f., Mora-Valentin et al., 2004; Al-Ashaab et al., 2011; Iqbal et al., 2011; Perkmann et al., 2011).

Research on performance measurement recognises that private and public sector organisations differ regarding performance measurement (e.g., Brignall and Modell, 2000; Rantanen et al., 2007; Jääskeläinen and Laihonen, 2014). Concurrently, the literature on public performance measurement often involves the application of certain specific frameworks or tools (Van Helden et al., 2008; Jääskeläinen and Laihonen, 2014). The problems and challenges related to measuring the performance of public organisations are caused, for example, by different stakeholders' conflicting requirements (Lawton et al., 2000; Wisniewski and Stewart, 2004; Mettänen, 2005; Rantanen et al., 2007). Another challenge related to performance measurement in the public context is the definition of 'what public organisations actually produce', the question of efficiency vs. effectiveness or output vs. outcome (Rantanen et al., 2007). At the general level, public sector organisations seem to face more challenges than private sector organisations, and empirical experiences from Finland (Rantanen et al., 2007) indicate that the development and use of PMSs in public sector organisations especially differ from those in the private sector. Therefore, there exists a need for understanding and developing a process to design a PMS – paying attention to specific characteristics of public sector performance measurement – for university-public organisation collaboration to support those collaborations' management and evaluation.

Since the literature on university-industry collaborations and performance measurement in the public sector lacks frameworks and models for designing PMSs in such a context, the following Sections 3.1 to 3 will present and describe a five-phase conceptual process model for evaluating university-public organisation collaboration.

3 A process model for designing and building a PMS for university-public organisation collaboration

Although PMSs are traditionally developed and utilised among private sector organisations, there has been increasing interest in public sector performance measurement. Kloot and Martin (2000), for example, stated that the worldwide drive for public sector reform has focused on the measurement of performance in public sector organisations. Even though performance measurement is not exactly a new concept in public sector organisations, most of the research and development related to performance measurement is still being done among private sector organisations. Because of this, public sector organisations sometimes face challenges that have, in many cases, already

been solved in private sector organisations. This also seems to be the case with performance measurement in university collaborations. These can include several aspects of the challenges presented in different studies, and they can be categorised into three main classes of problems, as presented in Fryer et al. (2009):

1 technical

2 system

3 involvement.

The first – the technical challenges of performance measurement in university-public organisation collaboration – can be related, for example, to the collecting, interpreting, analysing, and reporting of data (c.f., Adcroft and Willis, 2005; Bevan and Hood, 2006; Carvalho et al., 2006). The second – system problems – refers to 'bigger picture' issues (Fryer et al., 2009) involved in university-public organisation collaboration, i.e., integrating the PMS (c.f., Gianakis, 2002) or a lack of strategic focus, which can lead to short-termism of the collaboration activities and measurement (c.f., Neely et al., 1995). The third category – involvement – which is also present in university-public organisation collaboration, relates to intellectual issues in the measurement and a lack of involvement of the part of the organisations and persons involved in the performance measurement (c.f., De Waal, 2007; Verbeeten, 2008), as well as insufficient support from the organisations' managers (c.f., Pollanen, 2005; De Waal, 2007).

The practice of performance measurement often involves the application of pragmatic frameworks and tools, such as balanced scorecards (Al-Ashaab et al., 2011), the European Foundation of Quality Management excellence model (Kauppila et al., 2015), or more technical surveys and indicators (Jääskeläinen and Laihonen, 2014). However, before these tools and frameworks can be applied and utilised, a fundamental question has to be asked: what kind of strategic choices lay behind selecting and implementing measurement practices? (Jääskeläinen and Laihonen, 2014) These strategic choices related to performance measurement are often made without comparing them to alternatives and, in the context of partnerships, without considering other participant's viewpoints. Research is also needed to develop appropriate measures and measurement systems to account for the influence of partnerships at both the organisational and societal level (Bozeman and Dietz, 2001; Perkmann and Walsh, 2007).

Cuthbertson and Piotrowicz (2011) presented a modification of Pettigrew's work, (1985) identifying that the context, process, and content of performance measurement needs to be understood to support designing and building supply chain measurement systems. Ukko et al. (2015) further demonstrated that this particular framework can also be utilised when designing PMSs for networks. The framework of Cuthbertson and Piotrowicz (2011) incorporates the following elements:

- Context: Under what conditions does the measurement take place? This involves the factors influencing collaborative network performance measurement, namely, the organisational context factors – inner-organisational factors and collaborative network context – specific to the collaborative network's environment.

- Process: How is the performance measurement carried out? This involves the tools, methods, and frameworks for measuring collaborative network performance; the way that the data is captured, presented, and used; and the development of the measurement system.
- Content: What is measured? This includes metrics, levels, categories, and dimensions.

As the collaboration between university and public organisations can be executed in the form of a collaborative network including several operators or in the form of partnerships between individual university units and public organisations, the presented framework can also be utilised in university-public organisation contexts.

3.1 Defining the aims of the partnerships and the purposes of the measurement system

While research on university partnerships and collaborations has traditionally focused on the transfer of different intellectual property (e.g., patenting, licensing, commercialisation, etc.), recent studies have revealed that university-industry partnerships are actually much more multi-faced by nature (e.g., Agrawal, 2001; Grossman et al., 2001; Perkmann and Walsh, 2007; Mäkimattila et al., 2015). These studies represent and identify different types of channels and mechanisms that function as informational or social structures through which universities and industries exchange information, knowledge, and other resources (Perkmann and Walsh, 2007).

Bishop et al. (2011) present three different types of advantages in how organisations can develop their exploitative and explorative learning capabilities by interacting and collaborating with universities. First, the research and knowledge generated in universities can be used to improve the organisation's understanding of certain phenomena, thus enhancing its awareness of new research and technological opportunities and contributing to the development of its explorative learning capabilities. Second, interaction and collaboration with universities can also enhance the organisation's capacity for exploiting new or existing knowledge in order to support its business potential by creating new products or enhancing processes, or by achieving cost reductions through developing existing products or processes. Third, interaction and collaboration with university researchers and project managers, as well as public or private organisation personnel, can enhance the organisation's problem-solving capabilities. Because of organisations having different reasons for collaborating with universities, in the beginning of the PMS design process, it is important to understand the form the collaboration takes and the reasons behind it, as well as the goals of the participating organisations. Failing to understand these aims and reasons can cause difficulties or even result in the failure of the collaboration activities. In addition, unfairly distributing benefits and partners' unrealistic objectives can introduce challenges for further development during the collaboration (Ukko et al., 2015). University-public organisation collaborations can be arranged in different ways, and the participants may have different expectations toward them. Therefore, it is important to ensure that all participants understand the vision and goals of the collaboration (Busi and Bitici, 2006; Ukko et al., 2015).

Thus, the aim of the first phase of the design process should be creating a pre-understanding of what the individual organisations (in this context, public organisations and universities) bring with them and share during the collaboration (e.g., Lönnqvist and Laihonen, 2012; Ukko et al., 2015). Ukko et al. (2015) presented the following questions that can be utilised when analysing the form and aims of collaborations between universities and public organisations:

- What are the goals and joint vision of the collaboration?
- What are the individual partners' goals?
- What is the structure of the collaboration (i.e., what are the participants' roles)?
- What information is commonly shared by the participating organisations?
- What are the identified shared resources and processes at the partnership-level?

3.2 Defining the dimensions and success factors to be measured

After the first phase, the focus of PMS design for university-public organisation collaboration should be defining the form, joint vision, and goals for the collaboration. Following this, the focus should be on defining the dimensions and success factors to be evaluated. Clarifying the common understanding of the collaboration will assist in defining the dimensions and success factors. Instead of focusing solely on the dimensions and success factors of the individual organisations, the collaborations' common dimensions and success factors should also be determined (e.g., Al-Ashaab et al., 2011; Perkmann et al., 2011; Grazia et al., 2016).

Perkmann et al. (2011) presented a success map of university-industry alliances articulating just how these partnerships succeeded and identifying the cause and effect relationships underpinning that success. Following Brown (2007) and Perkmann et al. (2011) identified four stages in an alliance: inputs, in-process activities, outputs, and outcomes. These presented process stages can also be utilised for evaluating the performance of university-public organisation collaborations. Perkmann et al. (2011) also presented metrics in their success map that can be utilised when defining the success factors for the PMS under construction:

- Input: Access to resources, motivated researchers, and high-quality researchers.
- In-process: Relevant research, high-quality research, and training and learning opportunities.
- Output: New technologies, new scientific knowledge, and skilled and trained staff.
- Impact: New ideas, solution concepts, innovation, and human capital.

Al-Ashaab et al. (2011) designed a new collaborative balanced scorecard (CBSC) integrating the collaborative aspect with universities and other external partners. Their CBSC accounts for the aspects of open innovation as a part of the development activities between universities and industries. The CBSC has different key performance indicators in six perspectives, some of which can also be utilised as dimensions when designing a PMS for university-public organisation collaboration, including competitiveness, sustainable development, innovation, strategic knowledge partnership, human capital, and

internal business processes. These dimensions and success factors can be utilised by both participating organisations, namely, universities and public organisations. The presented dimensions and success factors cover aspects that are specific to university-industry collaborations and public sector organisations. These dimensions and success factors form examples that both universities and public sector organisations may choose to integrate with the range of factors used to measure the performance of their other daily operations.

3.3 Constructing the PMS

Bourne et al. (2000) argued that recent academic literature and practitioner activities have focused on the early stages of PMS development, or the conceptual frameworks and processes for designing the actual measures. Currently, the developed and demonstrated performance measurement frameworks are typically developed exclusively in either private or public sector organisations, but we believe that some of these frameworks could be utilised among both. This is important for more effectively using public recourses and avoiding unnecessary overlapping work.

During the measurement system's construction phase, some of the existing PMS design frameworks (c.f., Simons, 2000; De Toni and Tonchia, 2001; Ukko et al., 2015) can also be utilised in university-public organisation collaboration. Additionally, some frameworks intended for evaluating performance in university-industry alliances can also be utilised during this phase (c.f., Perkmann et al., 2011; Al-Ashaab et al., 2011; Kauppila et al., 2015). Also, if possible, involving all necessary participants of the collaborations (e.g., public organisations managers and employees, university project managers and researchers, and financier delegates) should be considered during the determining phase of the individual measures. Involving the personnel at an early stage when building a PMS has been shown to have some positive effects (e.g., Ukko et al., 2007, 2008). For instance, this makes it possible to ensure that the constructed measurement system pays attention to the goals and wishes of all participants, not just a select few. It is also important at this phase to ensure that measurement is executed in such a way that accounts for the value generation of all participants.

The process of determining and selecting the measures for the PMS under construction can also focus on, for example, the level at which the measurement system is used (c.f., Ukko et al., 2015). The measures should account for various dimensions and success factors, and both quantitative experimental measures and qualitative collaboration success measures should be used (Butcher and Jeffrey, 2007; Thune, 2011; Kauppila et al., 2015). As presented above, the study of Bishop et al. (2011) provides evidence of the multiple types of benefits that firms gain from partnerships with universities. Due to the intellectual nature of some elements to be measured, it is acceptable that some of the measures chosen for the PMS may be more subjective. When these more subjective measures relate to the success factors determined in the previous phase of the process, it is better to have subjective measures than to have no measures at all. The aim of this phase of the process should be on finding a proper number of measures to generate the information on the university-public organisation collaboration. Public organisations are often knowledge intensive systems, and evaluating and managing intellectual capital plays an important role in their value creation (Veltri et al., 2011). Nevertheless, the issues related to measuring and developing intellectual capital in public organisations seem to be under investigated compared to literature

focusing on the private sector (Massaro et al., 2015; Grazia et al., 2016). Grazia et al. (2016) proposed a conceptual model for integrating PMSs with intellectual capital measurement functions. This model provides a holistic representation of healthcare organisations and could be used to more effectively manage and strategically control organisations.

3.4 Creating procedures for data collection and utilisation

After a proper number of applicable measures have been determined and selected for the PMS, the selected measures should be critically reviewed one more time (Ukko et al., 2015). There might be, for example, overlapping measures that measure the same issues, producing exactly the same information, or there might be measures for which it is difficult or even impossible to gather data. These measures should be removed from the final PMS. The PMS can also include measures that examine only the operations of university or public sector organisations, failing to monitor the whole collaboration. While it might be reasonable in some cases to include a few measures studying solely the operations of individual organisations, in order to increase understanding of the other partners' operations and activities, these defined measures and objectives need to be distributed to make both universities and public organisations aware of them.

After reviewing the measures, the design process should focus on using the measurement system in the university-public organisation collaboration as defined in the first phase of the process. This phase of the design process should include reviews of the measurement system's purpose, data gathering, reporting, and target setting. Regarding the target setting, it should be noted that targets can reflect the ongoing activities' future aims in short- or long-term periods (Al-Ashaab et al., 2011). Operations and activities in university-public organisation collaborations tend to vary, which is why the target setting and planning should include both qualitative and quantitative goals. Grazia et al. (2016) also argue that a long period of time can elapse between output delivery and the end outcome. For this reason, it is important to take care of the data gathering, utilisation, and reporting in the long-term. Additionally, to allow for careful measurement selection and target setting, it is necessary for all measures to define the following issues (c.f., Ukko et al., 2015):

- *Who will utilise the information gathered from the measures?* When the operations and actions in the university-public organisation collaboration are measured and evaluated, the gathered information must be utilised. Measuring the operations and actions of university-industry collaborations is not meaningful if the gathered data is not utilised. Therefore, if the gathered data is utilised, it should be concerned with each measure. If no one can utilise the data gathered from the measure, one must consider whether that particular measure should be excluded from the measurement system (Ukko et al., 2015).
- *Where is the data for the measures gathered?* In addition to utilising the data, it is important to determine where and how the data for the measures is gathered. As the accountability of public sector operations becomes more and more important, new technology and IT-driven tools are developed to support measurement processes. However, most of the technology used for measuring and improving processes was developed to enhance control and accountability rather than to support the evaluation

of learning, creativity, and dynamic capabilities (c.f., Gayialis et al., 2016). For this reason, it is important to define the ways in which the data is gathered for the qualitative evaluation of university-public organisation collaborations. Even though the current technology-driven tools make it possible to gather more and more data than ever before, it is still difficult to gather relevant information for measures (Ukko et al., 2015). The measures for which it is difficult or even impossible to gather data should be reviewed and possibly removed from the measurement system.

- *How often and to whom should the results be reported?* The results gathered from the performance measurement of university-public organisation collaborations are usually reported during the collaboration to the management team or the steering group. These groups usually consist of members of the participating organisations, university members, members of the financiers, and in some cases, members from other stakeholder groups. The results of the collaborations, however, can be important and interesting for many other groups – e.g., for the personnel of the public organisation, for the researchers not participating in the partnership, for the financier delegates, and for the politicians. For that reason, it is important to report the results during the collaboration to all who may find them interesting and to whom they are relevant. The context, frequency, and methods of the reporting should be carefully defined in this phase.

3.5 Implementing and updating the measurement system

Given the literature's growing interest in performance measurement and the propositions of its benefits, a movement toward its universal acceptance in support of better management practices can be expected (c.f., Julnes and Holzer, 2002). However, PMSs are still not being actively used in many public organisations or university-industry partnerships. Even though PMSs are carefully designed and built, implementing and using them as part of management can be a challenging task. For this reason, after constructing the PMS, the focus should shift toward implementing the system.

It has been suggested (e.g., Bourne et al., 2000) that the task of implementing and utilising PMSs is far from complete at the conclusion of the design phase. It has also been stated that implementing PMSs in public organisations can be complicated and quite slow (e.g., Wisniewski and Olafsson, 2004; Olafsson, 2006). Lundberg and Andersen (2012) present that it may take time, probably longer than expected, to establish cooperative partnerships and interactions between actors from universities, governmental organisations, and industrial organisations due to the cultural gaps between organisations. They highlight that understanding the time that might be necessary for such collaborations will make it easier to define targets and goals that support the management of them. Bititci et al. (2006) also present that a PMS is not static, but rather it matures as the management and organisational culture evolves. As university-public organisation collaborations evolve and change their forms and goals over time, the PMS should regularly be reviewed and updated. Updating the measurement system can be executed through the gathered feedback and by learning from challenges during the partnership.

The constructed and presented process model for designing and building PMSs for university-public organisation collaboration is composed of five phases, namely:

1 defining the aims of the collaboration

2 defining the dimensions and success factors of the PMS

3 constructing the measurement system

4 specifying the measures and their use

5 implementing and updating the measurement system.

The summary of the performance measurement design process for university-public organisation collaboration is presented in Table 1.

Table 1 PMS design process for university-public organisation collaboration

Viewpoint of the public organisation	*Content and design phase of the PMS*	*Viewpoint of the university*
(Factors related to the performance measurement of public organisations)		• (Factors related to the performance measurement of universities)
• *Aims:* e.g., increasing productivity, increasing service quality, solving problems, and generating innovations	*Defining the aims of the collaboration (context)* A common view and understanding of the aims, strategies, and evaluation of the university-public organisation collaboration	• *Aims:* e.g., commercialisation of technologies, increasing research productivity, and transferring knowledge
• *Evaluation:* e.g., inputs, in-process activities, outputs, and outcomes (Perkmann et al., 2011)		• *Evaluation:* e.g., inputs, in-process activities, outputs, and outcomes (Perkmann et al., 2011)
• *Challenges related to evaluation:* e.g., difficulties in solving the needs of different stakeholders (c.f., Lemieux-Charles et al., 2003; Rantanen et al., 2007; Grazia et al., 2016)		• *Challenges related to evaluation:* e.g., intangible aspects, multiple objectives, long-term nature, and measurement norms (c.f., Perkmann et al., 2011)
• *Dimensions:* e.g., human capital, economic capital, and external development (c.f., Fryer et al., 2009; Newcomer and Caudle, 2011)	*Defining the dimensions and success factors of the PMS (Content)* A balanced set of dimensions and success factors concerning the measurement of both participants and the partnership as a whole	• *Dimensions:* e.g., sustainable development, innovation, strategic knowledge partnerships, human capital, and internal development processes (Al-Ashaab et al., 2011)
• *Success factors:* e.g., leadership, policy and strategy, people management, partnership and resources, and processes (Grazia et al., 2016)		• *Success factors:* e.g., relevant research, new scientific knowledge, training and learning opportunities, solution concepts, innovations, and human capital (Perkmann et al., 2011)

Table 1 PMS design process for university-public organisation collaboration (continued)

Viewpoint of the public organisation	*Content and design phase of the PMS*	*Viewpoint of the university*
• *Ideating measures:* e.g., qualitative/quantitative long- and short-term measures	*Constructing the measurement system (Process)* A suitable number of short- and long-term measures, including data collection, data utilisation, reporting channels, and the frequency for each measure	• *Ideating measures:* e.g., qualitative/quantitative long- and short-term measures
• *Challenges related to developing measures* (c.f., van Peursem et al., 1995; Sheldon, 1998)		• Challenges related to developing measures (c.f., Kauppila et al., 2015)
• *Creating procedures for collecting and reporting data* (c.f., Kelman and Smith, 2000; Brown, 2002)		• Creating procedures collecting and reporting data (c.f., Kelman and Smith, 2000; Brown, 2002)
• *Reviewing the purpose of utilising the measurement system*		• Reviewing of purpose of utilising the measurement system
• Setting the target levels for the final PMS	*Specifying measures and their use (process)* Remove any overlapping or unnecessary measures	• Setting the target levels for the final PMS
• Defining the data utilisation (c.f., Neely et al., 1995; Neely, 1999)		• Defining the data utilisation (c.f., Neely et al., 1995; Neely, 1999)
• Reviewing the measures	Implementing and updating the measurement system	• Reviewing the measures
• Implementing the PMS	The measurement system's use for managing the university-public organisation partnership	• Implementing the PMS
• Updating the measurement system (c.f., Grazia et al., 2016)		• Updating the measurement system

4 Methodology (case example)

The feasibility of the PMS building process that we developed based on the literature is empirically tested and elaborated in the following case example. We use the case study method as it can be utilised when the researcher seeks to answers to how and why questions and a more in-depth understanding of the phenomenon under discussion (Yin, 2003). In this case study, the research approach is action oriented, wherein the researcher has access to the design process as a facilitator. The key benefit of this is that action-oriented research offers in-depth information on the process (Gummesson, 2000). The case study method should also be recognised as a research approach that can apply various qualitative and quantitative research methods, such as analysing archives, conducting interviews, or using questionnaires (Gummesson, 2000). The results of this

case study are based on the collaborative research and development project between a public dental healthcare organisation and a university research unit in Finland.

The public organisation in question provides dental healthcare services for people of all ages. During the last few years, however, there has been an increased number of un-cancelled withdrawals from dentists among teenage customers. This was the main reason behind starting the research-based development project with the local university unit as a solution was sought for this problem. The other issue involved during the research and development process was how to make the dental healthcare service package more attractive to teenager customers and the target organisation's personnel. The collaborative research project between the dental healthcare organisation and a university research unit was launched in order to find answers for these problems. As part of the project, a PMS was designed and built to evaluate and monitor the ongoing development process and collaboration.

Table 2 Data gathering in the empirical case

Method of collection	*Participants*	*Number of participants*	*Data analysis method*
Group interviews	There were 5–8 members from the dental healthcare organisation and 3–5 members from the university A total of four semi-structured group interviews lasting approximately 2.5 hours were executed	8–10	Qualitative content analysis
Workshop observation	This gathered data based on the observations, discussions, and feedback of two workshops where the PMS was designed and built	21 participants from the dental healthcare organisation 3–5 participants from the university (researchers, project managers)	Qualitative content analysis
Survey	The survey was arranged after the workshops for all participants from the public dental healthcare organisation	21 participants	Quantitative analysis

4.1 Data gathering

The results for this case example were gathered during the research and development project whereby the PMS for the university-public organisation collaboration was collaboratively designed. During the project, two collaborative development workshops were arranged to design and build the PMS. The results are based on interviews with the management team (including both public organisation and university members), workshop observations, and a survey that was arranged after the second workshop. A total of four semi-structured group interviews were conducted with the project's management team. Each of the interviews lasted 2.5 hours on average, and all of the meetings and interviews were recorded. Participants of the group meetings consisted of

organisation representatives, university researchers, and project managers. The literature on performance measurement and the design process presented in Table 1 was used to design the interview protocol. Afterwards, all of the group meetings were discussed with the observers in order to share the observations gathered during the meetings. Additional data was gathered from the survey, which consisted of nine questions and was answered by a total of 21 participants. The researchers made observations throughout the entire process. Researcher triangulation was used to validate the interpretations made from data gathered by various methods. Researchers analysed both data and workshop observations to make their interpretations. The researchers then discussed their findings with each other and searched for mutual understanding, as well as any differences in interpretations. Table 2 summarises the data gathering.

4.2 Estimated PMS design process

The PMS in the case study was designed and built to involve personnel from the public sector organisation, university researchers, and project managers in the actual development process at an early stage. The design process highlighted cooperation between participants. Before defining the dimensions and success factors of the PMS, the collaboration project's management team carefully defined the purpose of utilising the measurement system. One such purpose was to evaluate project's effects and outputs while it is still running, as well as to make visible the outcomes following the project's conclusion.

4.2.1 Defining the dimensions and success factors of the PMS

After we defined the purpose for utilising the PMS for university-public organisation collaboration, and in the beginning of the design phase of the performance measurement development process (and before the first actual development session), the collaboration project's management team was interviewed and asked to define the dimensions and success factors for the PMS to be developed. The responses were made based on the issues handled during the earlier phases of the development project and on the opinions of interviewed persons.

A total of five dimensions were selected for a final PMS to manage and evaluate the ongoing research and development project between the university and the dental healthcare organisation. For each dimension, between two and three success factors were found to be critical for the project's success.

4.2.2 First development session

After the purpose for utilising the measurement system under construction was defined and the dimensions and success factors were identified, the next phase of the process was executed in two collaborative development sessions. The personnel of the dental healthcare organisation participated in conjunction with university researchers in the first development session, the objective of which was to ideate and select the PMS measures using different types of group work methods. During the working phase of this development session, participants were divided into five groups, and each group worked on one dimension of the PMS. In the first phase of this session, the participants were asked to produce and ideate measures for each previously identified PMS success factor.

At first, the issue was to ideate a large number of measures without concern for characteristics, such as usability. After the participants ideated as many measures as they could, the most important measures for each dimension were chosen.

In the second phase of the first development session, the selected measures were introduced and discussed to the other participants. Each of the chosen measures was discussed with the participants, after which the final measures for the PMS were chosen. In this development session, the participants realised that they were genuinely participating in the design process and that they actually had a chance to develop measures for a PMS that was going to be used to evaluate their own work.

4.2.3 Second development session

The main objective of the second development session was to create procedures for collecting and reporting data. The following questions were discussed by the participants: Where should the data for the measure be gathered? Who is responsible for the reporting? How often should the results be reported? This session primarily intended to develop practices for using and exploiting the measurement system by involving all of the dental healthcare organisation's personnel in the development, along with the university researchers and project managers. The result of this second development session was a shared vision of how the measurement results should be reported and how often, as well as who is responsible for informing others about them. The participants commonly believed that analysing the results and putting the development objects into practice was primarily the responsibility of the collaboration's management team. However, there was also a common consensus among participants that the results of the measurement should be more widely informed than just among the management team.

4.2.4 Third development session

After two development sessions, the final version of the PMS was complete. The objective of the third development session was to set target levels for the PMS. This phase of the process involved only the management team (consisting of eight persons from the dental healthcare organisation and four researchers from the university). After the third development session, the PMS was complete and its implementation could begin. Table 3 presents the design process of the case example's PMS.

Table 3 The performance measurement development process

Step 1	*Step 2*	*Step 3*	*Step 4*
Initial interviews	1 Development session	2 Development session	3 Development session
Defining the dimensions and success factors of the PMS	Ideating and producing measures Selecting measures	Creating procedures for collecting and reporting data	Setting the target levels for the final PMS

4.3 Findings of the case example

The case study results reveal that the explored model is well-suited for designing and building a PMS for university-public organisation collaboration. The executive team and personnel of the dental healthcare organisation, as well as the university researchers and project managers that participated in the PMS design process, similarly thought that the method used in the process was both well-suited and sensible. This is an interesting result because, in many cases, performance measurement has been regarded as an unfamiliar issue, which has caused resistance to change. These results, however, show that the participants in the collaborative design process understood well what was done and why. This is good with regard to this system's use in the future, as it indicates that the staff understands the purpose of the performance measurement and its connection to their own work. Exploiting the collaborative process model increased the participants' interest in the measurement, which can be seen an essential point for future implementation and utilisation of the measurement system. The participants even hoped that they would receive more information about the measurement results in the future.

5 Discussion

Based on the current literature, building a PMS for university-public organisation collaboration should begin by determining the purpose for utilising the measurement system (e.g., Bourne et al., 2005). The results of this study reveal that, as presented by Pettigrew (1985), the performance measurement context of university-public organisation collaboration seems to be unclear to both public sector managers and university managers/researchers, and there seems to be confusion about the conditions under which the measurement should take place. Therefore, it is important to pay attention and carefully determine the purpose for utilising the PMS in such a context: e.g., is the measurement system's purpose to intensify and guide the processes, to analyse and make visible the effects, or to enhance and support learning? Our results suggest that carefully determining the purpose of the PMS can aid in overcoming possible challenges related to unfairly distributed benefits and partners' unrealistic objectives, as presented by Ukko et al. (2015).

Utilising a PMS design process for university-public organisation collaboration can reduce and even overcome some of the challenges related to performance measurement in such a context. The results of this case example indicate that some of the challenges presented in the earlier literature on performance measurement in the public sector can be solved by utilising this process model. For example, some of these challenges (Rantanen et al. 2007) that were addressed by this process include the participants' understanding of what was done and why, as well as the connection between their own work and the measurement. This is a very important challenge to overcome, as doing so supports the further use and implementation of the measurement system. Utilising the presented performance measurement design process allowed the participants to better understand the data gathering and IT-processes, which can help in overcoming challenges related to collecting, interpreting, analysing, and reporting data (c.f., Adcroft and Willis, 2005; Bevan and Hood, 2006; Carvalho et al., 2006).

In addition to increasing understanding of the measurement, the case study's findings revealed a significant lack of resistance to change against the measurement and its development. Additionally, the people responsible for the measurement were founded and named during the process. This is another very important aspect for future measurement, as Fryer et al. (2009) argue that it is essential to create a culture in which measurement is seen as a way of improving and identifying good performance rather than as a burden that is used to chastise poor performers.

We found many reasons to explain these positive influences. The first was the participation and collaboration among the employees of the public sector organisation and the university researchers, which is in line with the results of Ukko et al. (2008) indicating that involving personnel at an early stage when building a PMS positively affects the process. The second reason for the positive influence was found to be the deep commitment to the process among the management of the public sector organisation and the university project managers, which supports the findings of Pollanen (2005) and De Waal (2007) indicating that insufficient support from the organisations' managers creates challenges for performance measurement. Our findings also support their results indicating that challenges in university partnerships relate to a lack of involvement on the part of the organisations and people involved in the performance measurement (c.f., De Waal, 2007; Verbeeten, 2008)

The results and findings gathered from the case study were added to the process model that was constructed from the literature. The findings and process phases that require careful attention are presented in red. Table 4 summarises the findings of the study and presents a comprehensive process model to design a PMS for university-public organisation collaboration.

Table 4 A process model to design a PMS for university-public organisation partnership (see online version for colours)

Viewpoint of the public organisation	*Content/design phase of the PMS*	*Viewpoint of the university*
(Factors related to the performance measurement of public organisations)		(Factors related to the performance measurement of universities)
Aims: e.g., increasing productivity, increasing service quality, solving problems, generating innovations, and increasing absorptive capacities and innovation capabilities.	*Defining the aims of the partnership and the purposes for utilising the measurement system (context)*	*Aims:* e.g., commercialisation of technologies, increasing research productivity, transferring knowledge, and supporting problem-solving and innovation activities
Evaluation: e.g., inputs, in-process activities, outputs, and outcomes (Perkmann et al., 2011)	A common view and understanding of the aims, strategies, and evaluation of the university-public organisation collaboration	*Evaluation:* e.g., inputs, in-process activities, outputs, and outcomes (Perkmann et al., 2011)
Purpose for utilisation: e.g., guiding the processes, analysing and making visible the effects, and enhancing and supporting learning		*Purpose for utilisation:* e.g., guiding the processes, analysing and making visible the effects, and enhancing and supporting learning

Table 4 A process model to design a PMS for university-public organisation partnership (see online version for colours) (continued)

Viewpoint of the public organisation	*Content/design phase of the PMS*	*Viewpoint of the university*
Challenges related to evaluation: e.g., difficulties in solving the needs of different stakeholders (c.f., Lemieux-Charles et al., 2003; Rantanen et al., 2007; Grazia et al., 2016)		Challenges related to evaluation: e.g., intangible aspects, multiple objectives, long-term nature, and measurement norms (c.f., Perkmann et al., 2011)
Dimensions: e.g., human capital, economic capital, and external development (c.f., Fryer et al., 2009; Newcomer and Caudle, 2011)	*Defining the dimensions and success factors of the PMS (content)*	Dimensions: e.g., sustainable development, innovation, strategic knowledge partnerships, human capital, and internal development processes (Al-Ashaab et al., 2011)
Success factors: e.g., leadership, policy and strategy, people management, partnership and resources, and processes (Grazia et al., 2016)	A balanced set of dimensions and success factors concerning the measurement of both the participants and the partnership as a whole	Success factors: e.g., relevant research, new scientific knowledge, training and learning opportunities, solution concepts, innovations, human capital (Perkmann et al., 2011), and an increase in one's own innovation capabilities
Ideating measures: e.g., qualitative/quantitative long- and short-term measures	*Constructing the measurement system (process)*	*Ideating measures:* e.g., qualitative/quantitative long- and short-term measures
Challenges related to developing measures (c.f., van Peursem et al., 1995; Sheldon, 1998)	A suitable number of short- and long-term measures, including data collection, utilisation, reporting channels, and the frequency for each measure	Challenges related to developing measures (c.f., Kauppila et al., 2015)
Creating procedures for collecting and reporting data (c.f., Kelman and Smith, 2000; Brown, 2002)		Creating procedures for collecting and reporting data (c.f., Kelman and Smith, 2000; Brown, 2002)
Reviewing of purpose for utilising the measurement system		Reviewing of purpose for utilising the measurement system
Setting the target levels for the final PMS	*Specifying measures and their use (Process)*	Setting the target levels for the final PMS

Table 4 A process model to design a PMS for university-public organisation partnership (see online version for colours) (continued)

Viewpoint of the public organisation	*Content/design phase of the PMS*	*Viewpoint of the university*
Defining the data utilisation (c.f., Neely et al., 1995; Neely, 1999)	Remove any overlapping or unnecessary measures	Defining the data utilisation (c.f., Neely et al., 1995; Neely, 1999)
Reviewing the measures		Reviewing the measures
Implementing the PMS	Implementing and updating the measurement system	Implementing the PMS
Updating the measurement system (c.f., Grazia et al., 2016)	Use the measurement system as a part of managing the university-public organisation partnership	Updating the measurement system (c.f., Grazia et al., 2016)
Evaluating the influence of university-public organisation partnerships		Evaluating the influence of university-public organisation partnerships
Evaluating the goals of the public organisation as a part of the collaboration		Evaluating the goals of the university as a part of the collaboration

6 Conclusions

Collaborations between universities and public sector organisations form settings for transferring the research and knowledge produced in the universities to the rest of society. They can also increase the problem-solving and absorptive capabilities of public organisations. Currently, the literature on this subject presents numerous frameworks for successful performance measurement building in both public and private sector individual organisations. Although some PMSs and tools for university-industry partnerships have also proposed, university-public organisation partnerships lack a proper procedure for PMS design in such a context. This study contributes to the literature by presenting a conceptual process model for designing and building a PMS for university-public organisation collaboration. We present a five-phase model combining the special characteristics of performance measurement related to performance measurement in the public sector and in university partnerships. Not many studies have examined the field of university-public organisation collaborations, but this study indicates that it is possible to use performance measurement design processes when creating evaluation tools for these alliances. The presented framework can be utilised by both universities and public organisations when designing or actively participating in these partnerships, as well as by financier delegates and politicians.

As a managerial implication, the presented model is empirically tested in a collaborative project between a university and a public dental healthcare organisation. The presented case example demonstrates that, in spite of the differences and challenges recognised regarding performance measurement in the public sector and in university partnerships, the actual measurement systems can be designed and built in circumstances where the design process utilises the participants' collaboration. Even though the context

of the performance measurement of the university-public organisation collaboration seems to be unclear to both public sector managers and university managers/researchers, and there seems to be confusion about the conditions under which the measurement should take place, the results of this study indicate that some of the challenges recognised in the field of performance measurement can be solved by utilising the presented process model. The participants understood what was done and why, and they understood the connection between their own work and the measurement, which, in the future, can create and support the measurement culture in university-public organisation collaboration.

However, as this study focused solely on the designing and building phase of the PMS, more evidence needs to be collected regarding the implementation processes and the utilisation of the measurement systems in university-public organisation collaboration. It is also essential for future research to explore how the ex-post evaluation (executed after the collaborations are finished), of university-public organisation partnerships can be supported by utilising PMSs. Finally, the empirical findings of this study's case example are based on evidence from one public dental healthcare organisation in Finland. More evidence is needed from other public sector organisations to estimate whether the presented process model suits them as well, as well as to confirm the success elements of the utilised method and to find and create other processes and frameworks for designing PMSs in other such contexts.

References

Adcroft, A. and Willis, R. (2005) 'The (un)intended outcome of public sector performance measurement', *International Journal of Public Sector Management*, Vol. 18, No. 5, pp.386–400.

Al-Ashaab, A., Flores, M., Doultsinou, A. and Magyar, A. (2011) 'A balanced scorecard for measuring the impact of industry-university collaboration', *Production Planning and Control: The Management of Operations*, Vol. 22, Nos. 5–6, pp.554–570.

Bevan, G. and Hood, C. (2006) 'What's measured is what matters: targets and gaming in the English public health care system', *Public Administration*, Vol. 84, No. 3, pp.517–538.

Bishop, K, D'Este, P. and Neely, A. (2011) 'Gaining from interactions with universities: multiple methods for nurturing absorptive capacity', *Research Policy*, Vol. 40, No. 1, pp.30–40.

Bititci, U., Mendibil, K., Nudurupati, S., Garengo, P. and Turner, T. (2006) 'Dynamics of performance measurement and organizational culture', *International Journal of Operations and Production Management*, Vol. 26, No. 12, pp.1325–1350.

Bloch, C. and Sørensen, M.P. (2015) 'The size of research funding: trends and implications', *Science and Public Policy*, Vol. 42, No. 1, pp.30–43.

Bourne, M., Franco-Santos, M., Kennerley, M. and Martinez, V. (2005) 'Reflections on the role, use and benefits of corporate performance measurement in the UK', *Measuring Business Excellence*, Vol. 9, No. 3, pp.36–40.

Bourne, M., Mills, J., Wilcox, M., Neely, A. and Platts, K. (2000) 'Designing, implementing and updating performance measurement systems', *International Journal of Operations and Production Management*, Vol. 20, No. 7, pp.754–771.

Bozeman, B. and Dietz, J.S. (2001) 'Strategic research partnerships: constructing policy-relevant indicators', *The Journal of Technology Transfer*, Vol. 26, No. 4, pp.385–393.

Brignall, S. and Modell, S. (2000) 'An institutional perspective on performance measurement and management in the new public sector', *Management Accounting Research*, Vol. 11, No. 3, pp.281–306.

Brown, M. (2002) 'Change and stability in the Canadian healthcare system', *Expert Reviews of Pharmacoeconomics Outcomes Research*, Vol. 2, No. 4, pp.309–312.

Busi, M. and Bitici, U. (2006) 'Collaborative performance measurement: a state of the art and future research', *International Journal of Productivity and Performance Management*, Vol. 55, No. 1, pp.7–25.

Butcher, J. and Jeffrey, P. (2007) 'A view from the coal face: UK research student perceptions of successful and unsuccessful collaborative projects', *Research Policy*, Vol. 36, No. 8, pp.1239–1250.

Carvalho, J., Fernandes, M., Lambert, V. and Lapsley, I. (2006) 'Measuring fire service performance: a comparative study', *International Journal of Public Sector Management*, Vol. 19, No. 2, pp.165–179.

Chang, H., Wang, H. and Kao, T. (2010) 'The determinants of long-term relationship on inter-organizational systems performance', *Journal of Business and Industrial Marketing*, Vol. 25, No. 2, pp.106–118.

Chen, M., Yang, T. and Li., H. (2007) 'Evaluating the supply chain performance of IT-based inter-enterprise collaboration', *Information and Management*, Vol. 44, No. 6, pp.524–534.

Cuthbertson, R. and Piotrowicz, W. (2011) 'Performance measurement systems in supply chains: a framework for contextual analysis', *International Journal of Productivity and Performance Management*, Vol. 60, No. 6, pp.583–602.

D'Este, P. and Patel, P. (2007) 'University-industry linkages in the UK: what are the factors underlying the variety of interactions with industry', *Research Policy*, Vol. 36, No. 9, pp.1295–1313.

De Toni, A. and Tonchia, S. (2001) 'Performance measurement systems – models, characteristics and measures', *International Journal of Operations & Production Management*, Vol. 21, Nos. 1/2, pp.46–71.

de Waal, A.A. (2007) 'Successful performance management? Apply the strategic performance management development cycle!', *Measuring Business Excellence*, Vol. 11, No. 2, pp.4–11.

Folan, P. and Browne, J. (2005) 'A review of performance measurement: towards performance management', *Computers in Industry*, Vol. 56, No. 7, pp.663–680.

Fryer, K., Antony, J. and Ogden, S. (2009) 'Performance management in the public sector', *International Journal of Public Sector Management*, Vol. 22, No. 6, pp.478–489.

Garengo, P. and Bitici, U. (2007) 'Towards a contingency approach to performance measurement: an empirical study in Scottish SMEs', *International Journal of Operations and Production Management*, Vol. 27, No. 8, pp.802–825.

Gayialis, S.P., Papadopoulos, G.A., Ponis, S.T., Vassilakopoulou, P. and Tatsiopoulos, I.P. (2016) 'Integrating process modeling and simulation with benchmarking using a business process management system for local government', *International Journal of Computer Theory and Engineering*, Vol. 8, No. 6, pp.482–489.

Gianikis, G.A. (2002) 'The promise of public sector performance measurement: anodyne or placebo?', *Public Administration Quarterly*, Vol. 26, No. 1, pp.34–64.

Grazia, M., Giuseppe, P. and Ferulano, M. (2016) 'Intellectual capital and performance measurement in healthcare organizations: an integrated new model', *Journal of Intellectual Capital*, Vol. 17, No. 2, pp.320–350.

Gummesson, E. (2000) *Qualitative Methods in Management Research*, Sage publications, Inc., Thousand Oaks.

Iqbal, A., Shahid Khan, A., Iqbal, S. and Aslan Amat, S. (2011) 'Designing of success criteria-based evaluation model for assessing the research collaboration between university and industry', *International Journal of Business Research and Management*, Vol. 2, No. 2, pp.59–73.

Jääskeläinen, A. and Laihonen, H. (2014) 'A strategy framework for performance measurement in the public sector', *Public Money and Management*, Vol. 34, No. 5, pp.355–362.

Julnes, P. and Holzer, M. (2002) 'Promoting the utilization of performance measures in public organizations: An empirical study of factors affecting adoption and implementation', *Public Administration Review*, Vol. 61, No. 6, pp.693–708.

Kauppila, O., Mursula, A., Harkonen, J. and Kujala, J. (2015) 'Evaluating university-industry collaboration: the European Foundation of Quality Management excellence model-based evaluation of university-industry collaboration', *Tertiary Education and Management*, Vol. 21, No. 3, pp.229–244.

Kelman, C. and Smith, L. (2000) 'It's time: record-linkage – the vision and the reality', *Australian and New Zealand Journal of Public Health*, Vol. 24, No. 1, pp.100–101.

Kloet, R., Hessels, L., Zweekhorst, M., Broerse, J. and Buning, T. (2013) 'Understanding constraints in the dynamics of a research programme intended as niche innovation', *Science and Public Policy*, Vol. 40, No. 2, pp.206–218.

Kloot, L. and Martin, J. (2000) 'Strategic performance management: a balanced approach to performance management issues in local government', *Management Accounting Research*, Vol. 11, No. 2, pp.231–251.

Lawton, A., McKevitt, D. and Millar, M. (2000) 'Coping with ambiguity: reconciling external legitimacy and organizational implementation in performance measurement', *Public Money and Management*, Vol. 20, No. 3, pp.13–19.

Lemieux-Charles, L., McGuire, W., Champagne, F. and Barnsley, J. (2003) 'The use of multilevel performance indicators in managing performance in health care organizations', *Management Decisions*, Vol. 41, No. 8, pp.760–770.

Linna, P., Pekkola, S., Ukko, J. and Melkas, H. (2010) 'Defining and measuring productivity in the public sector: managerial perceptions', *International Journal of Public Sector Management*, Vol. 23, No. 5, pp.479–499.

Lönnqvist, A. and Laihonen, H. (2012) 'Welfare service system productivity: the concept and its application', *International Journal of Productivity and Performance Management*, Vol. 61, No. 2, pp.128–141.

Lundberg, H. and Andersen, E. (2012) 'Cooperation among companies, universities and local government in a Swedish context', *Industrial Marketing Management*, Vol. 41, No. 3, pp.429–437.

Luukkonen, T. (2014) 'The European Research Council and the European research funding landscape', *Science and Public Policy*, Vol. 41, No. 1, pp.29–43.

Mäkimattila, M., Junell, T. and Rantala, T. (2015) 'Developing collaboration structures for university-industry interaction and innovations', *European Journal of Innovation Management*, Vol. 18, No. 4, pp.451–470.

Massaro, M., Dumay, J. and Garlatti, A. (2015) 'Public sector knowledge management: a structured literature review', *Journal of Knowledge Management*, Vol. 19, No. 3, pp.530–558.

Mettänen, P. (2005) 'Design and implementation of a performance measurement system for a research organization', *Production Planning and Control*, Vol. 16, No. 2, pp.178–188.

Mora-Valentin, E.M., Montoro-Sanchez,A., and Guerras-Martin, L.A. (2004) 'Determining factors in the success of R&D cooperative agreements between firms and research organizations. *Research Policy*, Vol. 33, No. 1, pp.17–40.

Moxham, C. (2010) 'Help or hindrance? Examining the role of performance measurement in UK nonprofit organizations', *Public Performance and Management Review*, Vol. 33, No. 3, pp.342–354.

Neely, A. (1999) 'The performance measurement revolution: why now and what next?', *International Journal of Operations and Production Management*, Vol. 19, No. 2, pp.205–228.

Neely, A., Gregory, M. and Platts, K. (1995) 'Performance measurement system design – a literature review and research agenda', *International Journal of Operations and Production Management*, Vol. 15, No. 4, pp.80–116.

Neely, A., Mills, J., Platts, K., Richards, H., Gregory, M., Bourne, M. and Kennerley, M. (2000) 'Performance measurement system design: developing and testing a process-based approach', *International Journal of Operations and Production Management*, Vol. 20, No. 10, pp.1119–1145.

Newcomer, K. and Caudle, S. (2011) 'Public performance management systems', *Public Performance and Management Review*, Vol. 35, No. 1, pp.108–132.

Olafsson, S. (2006) 'The experience of implementing the balance scorecard in the city of Reykjavik', in Neely, A., Kennerly, M. and Walters, A. (Eds.): *Performance Measurement and Management: Public and Private*, pp.1071–1078, London, UK.

Pekkola, S. and Ukko, J. (2016) 'Designing a performance measurement system for collaborative network', *International Journal of Operations and Production Management*, Vol. 36, No. 11, pp.1410–1434.

Perkmann, M (2015) 'University-industry relations', in Audretsch, D.B., Hayter, C.S. and Link, A.N. (Eds.): *Concise Guide to Entrepreneurship, Technology and Innovation*, Edward Elgar, Cheltenham.

Perkmann, M., Neely, A. and Walsh, K. (2011) 'How should firms evaluate success in university-industry alliances? A performance measurement system', *R&D Management*, Vol. 41, No. 2, pp.202–216.

Perkmann, M., Tartari, V., McKelvey, M., Autio, E., Broström, A., D'Este, P., Fini, R., Geuna, A., Grimaldi, R., Hughes, A., Krabel, S., Kitson, M., Llerena, P., Lissoni, F., Salter, A. and Sobrero, M. (2013) 'Academic engagement and commercialisation: a review of the literature on university-industry relations', *Research Policy*, Vol. 42, No. 2, pp.423–442.

Pollanen, R.M. (2005) 'Performance measurement in municipalities. Empirical evidence in Canadian context', *Journal of Public Sector Management*, Vol. 18, No. 1, pp.4–24.

Rantanen, H., Kulmala H., Lönnqvist, A. and Kujansivu, P. (2007) 'Performance measurement systems in the Finnish public sector', *International journal of Public Sector Management*, Vol. 20, No. 5, pp.415–433.

Saunila, M., Rantala, T., Ukko, J. and Pekkola, S. (2017) 'Gaining insights into the measurement of value in industrial service network', *International Journal of Quality and Reliability Management*, Vol. 34, No. 4, pp.478–493.

Schartinger, D., Rammer, C., Fischer, M.M. and Fröhlich, J. (2002) 'Knowledge interactions between universities and industry in Austria: sectoral patterns and determinants', *Research Policy*, Vol. 31, No. 3, pp.303–328.

Schartinger, D., Schibany, A. and Gassler, H. (2001) 'Interactive relations between universities and firms: empirical evidence for Austria', *Journal of Technology Transfer*, Vol. 26, No. 3, pp.255–268.

Simons, R. (2000) *Performance Measurement and Control Systems for Implementing Strategy*, Prentice Hall, Englewood Cliffs, NJ.

Thune, T. (2011) 'Success factors in higher education-industry collaboration: a case study of collaboration in the engineering field', *Tertiary Education and Management*, Vol. 17, No. 1, pp.31–50.

Turner, T., Bitici, U. and Nudurupati, S. (2005) 'Implementation and impact of performance measures in two SMEs in central Scotland', *Production Planning and Control*, Vol. 16, No. 2, pp.135–151.

Ukko, J., Pekkola, S., Saunila, M. and Rantala, T. (2015) 'Performance measurement approach to show the value for the customer in an industrial service network', *International Journal of Business Performance Management*, Vol. 16, Nos. 2/3, pp.214–229.

Ukko, J., Tenhunen, J. and Rantanen, H. (2007) 'Performance measurement impacts on management and leadership: perspectives of management and employees', *International Journal of Production Economics*, Vol. 110, No. 1, pp.39–51.

Ukko, J., Tenhunen, J. and Rantanen, H. (2008) 'The impacts of performance measurement on the quality of working life', *International Journal of Business Performance Management*, Vol. 10, No. 1, pp.86–98.

van Helden, G.J., Johnsen, Å. and Vakkuri, J. (2008) 'Distinctive research patterns on public sector performance measurement of public administration and accounting disciplines', *Public Management Review*, Vol. 10, No. 5, pp.641–651.

van Peursem, K., Pratt, M. and Lawrence, S. (1995) 'Health management performance: a review of measures and indicators', *Accounting, Auditing and Accountability Journal*, Vol. 8, No. 5, pp.34–70.

Veltri, S., Bronzetti, G. and Sicoli, G. (2011) 'Reporting intellectual capital in healthcare organizations: specifics, lessons learned, and future research perspectives', *Journal of Health Care Finance*, Vol. 38, No. 2, pp.79–96.

Verbeeten, F.H.M. (2008) 'Performance management practices in public sector organizations: impact on performance', *Accounting, Auditing & Accountability Journal*, Vol. 21, No. 3, pp.427–454.

Williams, D.W. (2003) 'Measurement government in the early twentieth century', *Public Administration Review*, Vol. 63, No. 6, pp.643–659.

Wisniewski, M. and Olafsson, S. (2004) 'Balanced scorecards: a comparison of experience in local authorities in Scotland and Iceland', in Neely, A., Kennerly, M. and Walters, A. (Eds.): *Performance Measurement and Management: Public and Private sector Management*, Vol. 17, No. 3, pp.222–233.

Wisniewski, M. and Stewart, D. (2004) 'Performance measurement for stakeholders: the case of Scottish local authorities', *International Journal of Public Sector Management*, Vol. 17, No. 3, pp.222–233.

Yin, R.K. (2003) *Case Study Research, Design and Methods, Applied Social Research Methods Series*, 3rd ed., Vol. 5, Sage Publications, Thousands Oaks.

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Performance evaluation to support European regional development – A university–industry perspective

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ABSTRACT

Regional-level innovation policies and development activities, which are not only technology oriented but that also address intellectual issues, knowledge and absorptive capacity enhancement as sources of innovation and economic growth, are posing challenges regarding their management. One of the main challenges that arises with these new types of regional-level development activities relates to their evaluation because insufficient attention is paid to the design and building of the current evaluation frameworks suggested for the context of regional development. This study presents a framework to design and build a performance evaluation system to support the performance measurement of regional development activities. Utilizing operational-level development activities as an empirical example, this study aims to improve the understanding of performance evaluation in university–industry collaborations in the context of regional development. The presented framework highlights the role of evaluation as part of the learning process in regional development activities between universities and industrial and public-sector organizations. The results of the study show that it is also possible to use the evaluation system to increase understanding of the interplay between operational level development activities and regional development programmes.

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Regional development; performance management; performance evaluation; university–industry collaboration

1. Introduction

The role, development and importance of the region as a territory of reference is rapidly changing and constantly evolving within the European Union (EU) area (Zabala-Iturriagagoitia, Jiménez-Sáez, & Castro-Martínez, 2008). During recent decades, the pursuit of a knowledge-based economy has become an important goal for economic development among European countries, and different types of knowledge-based regional development strategies have been widely adopted to achieve these goals (Laasonen & Kolehmainen, 2017). Within the context of increasing globalization and international competitiveness, the development of information and communication technologies, and the growing role of the economy and innovation, differences between regions and regional development are becoming more apparent; the future goal of marginal regions is to narrow the gap with more developed regions (Stec & Grzebyk, 2018; Zabala-Iturriagagoitia, Voigt,

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Gutiérrez-Gracia, & Jiménez-Sáez, 2007). Governments, funding agencies, and policymakers at the European level have high expectations of research, development and innovation infrastructures in the context of scientific and innovative policies aimed at sustaining long-term economic growth (Florio, Forte, Pancotti, Sirtori, & Vignetti, 2016). As interest in innovation and development activities from the public- and private-sector and science organizations increases, the infrastructures supporting these activities are facing increased scrutiny (Lundberg & Andersen, 2012).

Collaborative relationships and partnerships in research, development and innovation activities have been identified as an important factor explaining the differences in innovation performance, not only between the individual organizations but also between regions (Fritsch, 2004; Lundberg & Andersen, 2012). As part of the regional development activities, the importance of knowledge and academic support for organizational development and innovation activities has been identified, and public resources are now being directed through different regional-level funding mechanisms towards university–industry interaction to generate innovation and economic growth.

New types of regional policies are posing challenges for the management of regional level innovation and development activities. Regional-level development and innovation activities may involve partners from private and public organizations and from research institutions, which might all have different management and organizational cultures (Bishop, D'Este, & Neely, 2011; Pecas & Henriques, 2006; Perkmann & Walsh, 2009; Rantala & Ukko, 2018). One of the main challenges for new types of regional-level development activities relates to their evaluation. Evaluation of the regional-level policies and of the innovation and development activities is not a novel issue among academics and policymakers; however, ongoing changes have left some open questions about evaluation. An important weakness of the current evaluation frameworks presented to support the evaluation and management of the regional-level innovation activities is that they pay insufficient attention to the design and building of mechanisms for these activities (Diez, 2001). The design and building of the evaluation frameworks should therefore be guided by the participation of all actors involved in generating new regional policies, and the evaluation must become an open process of collective learning (Diez, 2001).

This study presents a framework for designing and building a performance evaluation system to support the performance evaluation of regional development. In this study, the performance evaluation reflects the measurement and evaluation of the outputs and outcomes of the development activities in university–industry collaborations. As such, the performance evaluation reflects the evaluation of the participating organizations' aims and goals compared to the original operational level development plans, and the evaluation of the outcomes compared to regional level development programmes. Utilizing operational-level development activities as an empirical example, this study aims to improve the understanding of performance measurement of university–industry collaborations in the context of regional development. The presented performance evaluation framework supports the evaluation of regional development activities at the operational level but also connects the activities of industrial organizations and universities to the 'big picture' of the regional development activities.

Even though universities are currently collaborating with other societal organizations in innovation and development activities in the context of regional development, all participating organizations have specific interests and expectations towards the collaboration

(Rantala & Ukko, 2018). In some cases, the personal interests of the organizations are main motivational drivers towards the collaboration activities and the participants are not interested in the development activities at the regional level. However, from the societal viewpoint, the regional level innovation and development activities should produce and generate outcomes for other society, not only the participating organizations. The presented evaluation framework highlights the role of evaluation in the learning processes and aims to increase the understanding and interests of the participating organizations in regional development activities at the regional level. Empirical and practical evidence to support the presented framework was gathered from two European Regional Development Fund-based projects in Finland. The originality of the study lies in defining the evaluation system in a way that considers the viewpoint of universities and industrial organizations as participants of regional development and requires the organizations to collaborate with universities at an early stage in the evaluation design. The results of the study can be utilized by policymakers, corporate financiers, enterprises and academics to support, improve and evaluate regional development activities.

2. Regional development

Since the 1980s, theories and studies of regional policies and development have evolved, and the focus of regional development has moved to new arenas (Diez, 2001). Policies and development infrastructures (e.g. university–industry collaborations) have been established which highlight that innovation activities and networks of all existing institutions in the region (e.g. industrial organizations, public- and third-sector organizations, and universities) are strong elements that must integrate actions and operations undertaken by regional administration and governments (Cooke et al., 2000; Diez, 2001). These policies and mechanisms to turn the policies in practice are not only technology oriented but also address intellectual issues, such as new knowledge and absorptive capacity, as sources of innovation and economic growth at the regional level (Bishop et al., 2011). According to Laasonen and Kolehmainen (2017), scholarly debate originates from different innovation models, especially from regional innovation systems, which have been major conceptual frameworks for understanding innovation-driven and knowledge-based regional development. In addition, for innovation activities and networks, which are sources for regional development, cluster policies have been extended across the world since Porter (2003) began to promote the role of clusters or related organizations and other agents in enhancing regional or territorial competitiveness (Aragon, Aranguren, Diez, Iturrioz, & Wilson, 2014). These cluster policies are aimed towards creating collaborative relationships of a systemic nature, bringing together different social, institutional and economic resources (Aragon et al., 2014).

Most recently, the focus of regional innovation policies has shifted towards putting entrepreneurship and its importance in innovation generation at the forefront of the regional development policies and activities, and has brought SMEs to the centre-stage in EU development policy thinking (Foray & Rainoldi, 2013; McCann & Ortega-Argiles, 2016; McCann, Ortega-Argiles, & Foray, 2015). This shift and policy approach towards creating and sustaining local competitiveness and economic growth and sustainability is called the Smart Specialization Policy approach (Foray, 2014). Kroll (2015) claimed that one idea behind establishing the Smart Specialization approach is to draw

attention and raise a political level of support for 'general purpose technologies' (e.g. Foray, 2012). Those technologies refer to solutions that could be used to increase organizations' sustainable development activities and their absorptive capacity (e.g. McCann & Ortega-Argiles, 2014).

Related to challenges in evaluating contemporary regional development activities and policies, Stec and Grzebyk (2018) claimed that existing literature does not offer precise methods or frameworks that could be used to evaluate the progress of implementing the Europe 2020 goals. Secundo, Perez, Martinaitis, and Leitner (2017) added that the call for performance evaluation, frameworks, tools and individual performance measures is driven by the European policy framework, which highlight the role of universities in the context of regional development. Even though different kinds of approaches and frameworks have been used to evaluate cluster policies (Zabala-Iturriagagoitia et al., 2008), challenges related to evaluating and measuring the impacts of such policies and infrastructures on the competitiveness of firms and territories exist (Aragon et al., 2014; Aranguren, De la Maza, Parrilli, Vendrell, & Wilson, 2012). The importance of intangible learning effects (e.g. trust, cooperation, knowledge transfer, and absorptive capacity) also present difficulties in evaluating the effectiveness of cluster policies (Aragon et al., 2014). Therefore, Aragon et al. (2014) claimed that it is particularly important to find evaluation frameworks that are not only suitable but also contribute to the cooperative basis of the policy itself. They added that a common acceptance exists within evaluation theory and within policy-making and practitioner communities that involving the stakeholders in the evaluation process offers the potential to generate useful information and facilitate an increase in capacity and capital (Dobbs & Moore, 2002).

The regional development and new types of regional and innovation policies have highlighted the partnerships and collaboration activities between universities and private and public-sector organizations (e.g. Acosta, Azagra-Caro, & Coronado, 2016). These collaborations are becoming increasingly important because, according to Muscio (2010), they create benefits for all parties involved and for the regional areas and society in general. For that reason, government initiatives and changes in the institutional framework have facilitated these collaborations (Franco & Haase, 2015; Guenther & Wagner, 2008; Mäkimattila, Junell, & Rantala, 2015; Messeni Petruzzelli, 2011; Rasmussen, 2008; van Looy, Debackere, & Andries, 2003). The vital research and knowledge that universities produce are supposed to be transformed to support the innovation and development activities of the other regional organizations. In the long run, meaningful knowledge and economic welfare are important for the development of a whole region.

Even though university–industry collaboration has been argued to have many positive impacts on participating organizations and on regions and society as a whole, the collaboration activities also face some challenges (Bruneel, D´Este, & Salter, 2010). Universities and private and public sector organizations represent different logics and they all may have different operational cultures, organizational structures and goals for operations (Tartari, Salter, & D´Este2012; Villaini, Rasmussen, & Grimaldi, 2017). While the academic orientation and logic of universities strives for openness and the creation of knowledge, private and public sector organizations are more directed towards secrecy and finding solutions that could create them competitive advantages (Bruneel, D´Este, & Salter, 2010; Villani, Rasmussen, & Grimaldi 2017). All participating organizations may therefore have individual expectations towards the collaboration and development activities. In addition to

securing their salaries, university researchers and project managers' interests might relate to possibilities of joint publications or publications containing industrial cases, which might boost and sustain their careers. However, the interests of participating organizations, both private and public, in these collaboration activities relate, for example, to receiving some governmental funding support to their innovation and development activities. In other words, participating organizations and individual persons might have different expectations towards university–industry collaborations; they are not interested in the role of the development activities at the regional level. However, the aim of the regional level innovation and development activities and policies is to provide wellbeing and economic growth to the whole region, not only to the individual organizations. Therefore, the individual development activities, such as university–industry collaboration projects, should generate positive outcomes for the whole region, despite the participants' individual interests towards them.

Even though universities and industrial organizations are showing greater interest in the collaborations, and firms are increasingly engaging in formal partnerships with universities, frameworks to evaluate these collaborations are lacking (Perkmann, Neely, & Walsh, 2011). This lack presents challenges not only for universities and industrial and public organizations in evaluating their operational roles but also for the whole collaboration as a part of the region's development. However, despite the challenges in evaluating these collaborations, the evaluation of public policies and regional development activities has garnered increasing attention over recent years. According to Magro and Wilson (2015), this interest stems from the paucity of governmental and public funding resources of many countries which has increased the interests of public administrations and policymakers to evaluate the impacts of their policies. Smits and Kuhlmann (2004) claimed that policymakers (and other stakeholders) learn from their interventions by evaluating the results and outcomes of their efforts; at the same time, these insights gathered by the evaluation can be turned into new development and policy concepts and interventions.

3. Performance evaluation of regional development activities

Within the context of new types of regional policies and development activities some attention has been paid to the development of new types of evaluation methods and frameworks to support the management of regional development activities. According to Aranguren, Magro, and Wilson (2017), a growing need remains for performance evaluation because the complexity of contemporary policies highlights the challenges in existing evaluation frameworks and processes. One of their main findings is that explicit demand for evaluation and the existence of surroundings where politicians, other societal stakeholder members and researchers can meet frequently are important elements if evaluation is to be transformative (Aranguren et al., 2017). In her 2001 study, Diez explored the value of the traditional, objective and quantitative models and methods of evaluation when applied to regional innovation and cluster policies. In her study, the opinion was that classical evaluation models, based on the quantitative analyses and/or value of money studies, did not adapt to the specific characteristics of this new generation of regional policies and proved to be of little use for evaluating these policies. Diez (2001) also examined regional innovation and cluster policies, their characteristics and their evaluation, and identified the following most problematic elements that must be overcome

when seeking and developing new frameworks and methods to evaluate regional development activities:

- Intangible objectives, the complexity of cause–effect relationships and systemic nature;
- At a horizontal and vertical level, embeddedness, dynamic and flexible processes and the region as an active subject.

Table 1 presents the challenges, characteristics and evaluating proposals of the study of Diez (2001). The dashed line box highlights the focus of the performance evaluation framework presented in this study.

From the different viewpoints and according to other scholars related to evaluation (for example, among the researchers of performance measurement) the role of the participatory evaluation and involvement of the stakeholders and personnel of the target organizations have been recognized (e.g. Ukko, Tenhunen, & Rantanen, 2008). Participatory evaluation and involvement of the stakeholder groups start out by recognizing that designing the evaluation frameworks and methods develops within multidimensional contexts and society, and allows the frameworks to be built upon the aims, values and goals of all the participants at all phases and throughout the entire evaluation process (Diez, 2001). The approach of the participatory evaluation in the context of designing and building the evaluation frameworks and methods has not been actively used to support the evaluation of regional innovation and development activities. Diez (2001) argued that important weaknesses related to evaluation are that the new types of regional policies pay insufficient attention to designing mechanisms and structures that allow later evaluation of these policies.

Table 1. Matching regional policies to evaluation approaches (Diez, 2001).

Characteristics	Challenges	Evaluating proposals
Innovation is a complex interactive process where continuous feedback is produced	There is no linear causal relationship between resources, activities, results, effects and regional impact	What is needed is a holistic approach and application of naturalistic, qualitative and interrogative techniques
The objectives of the policy are the creation of knowledge, learning and capacity building	Well-defined objectives do not exist and there are numerous difficulties in quantifying effects and identifying	Qualitative information is the most suitable and useful tool for estimating the effects of individual and institutional learning
Systemic nature: at a vertical and horizontal level	Complex interactions are produced between the different regional subsystems and effects at different levels: companies, institutions, regional community	Case studies as a method of observation and analysis
The policies are firmly rooted in their context and embedded in their socio-economic framework	It is necessary to know and understand the cultural and political context	Social, cultural and political elements are an integral component of the evaluation. Evaluation is a socio-political process
Innovation policies are dynamic processes where continuous interactions are produced	Evaluation must be an active-reactive-adaptive process in relation to changes in conditions (context) and the needs of stakeholders	Evaluation design must be dynamic and flexible
Policies are designed via a bottom-up approach and with the active participation of all the regional actors	Evaluation must be opened up to the different actors involved and must recognize the existence of a pluralist society	The participation of the actors involved must guide the evaluating design. Evaluation is a collective learning process

The performance evaluation framework and design process presented in this study highlights the participation of the actors involved in the regional development processes between university, industry and public-sector organizations. The designing and building of the performance measurement system is seen as a collective learning process between participating organizations, which is suggested as an element for the evaluation proposals presented in Table 1. Kuhlmann (2003) stated that the use of a performance evaluation as a mediation tool, which does not hinder the different perspectives and viewpoint of organizations, but makes the different interests visible, can provide new perspectives to policy planning. Kuhlmann (2003) added that conducting performance evaluations to mediate stakeholders' viewpoints will not generate radical changes to innovation and research policies; however, the practical level implementation of radical changes can be supported by mediation underpinning the learning capabilities of the participating organizations. The involvement of the participants to the performance measurement design process also provides possibilities and surroundings for interactions between participants, which is seen a part of innovation policies and their dynamic processes. Further, the involvement of the participants in the performance measurement design process opens the evaluation for all actors and stakeholder groups.

The literature on performance measurement recognizes the trends towards inter-organizational work and regularly calls for research on performance measurements in collaborative organizations (Bitici, Garengo, Dörfler, & Nudurupati, 2012). The regional development and innovation activities are a collaborative infrastructure that performance measurements can be used to support on the one hand, and ask for more empirical evidence and understanding on the other hand. Bitici et al. (2012) presented a question related to the evaluation of challenges, theoretical and practical, associated with systems of collaborative organizations, where the act of collaboration creates an additional dimension of complexity: How do we concurrently manage the performance of the collaborative organization while also managing the performance of the participating organizations as a complete system? Their review (Bitici et al., 2012) identified three principle challenges that the performance measurement research community needs to address:

- understanding performance measurement as a social system,
- understanding performance measurement as a learning system, and
- understanding performance measurement in autopoietic networks.

In summary, evaluation is becoming an important and integral part of regional development and regional policies. Because evaluation serves as an additional policy element in its design, build, implementation and development (Diez, 2001), it is important to create conditions between academics, politicians and other regional stakeholders that enable the development of mechanisms for participative, qualitative and contextual evaluation.

4. Research design and methodology

Since existing literature on the evaluation of regional policies lacks models for the design process, this study presents a framework for designing and building of a performance evaluation system to support the management of such infrastructures using university–industry collaborations as an example of regional development activities. The conceptual

framework has been developed by establishing an understanding of the key concepts (e.g. stakeholder involvement and defining the aims of regional development programmes) to define how to design a performance evaluation system that can support the management and evaluation of regional development activities at the operational level.

This paper provides insights from two Finnish case studies from European regional development activities established between university research units and private and public-sector organizations operating in the same regional area. The Finnish strategy for regional development is linked to the Europe 2020 programme, which is a long-term programme for achieving socioeconomic growth, the main objective of which is to strengthen and develop the economies of all member states (Stec & Grzebyk, 2018). In terms of the big picture, the regional development priorities in Finland are as follows: (1) growth through renewal, (2) vitality through regional networks, and (3) wellbeing through partnerships (Ministry of Economic Affairs and Employment of Finland, 2018). Southern Finland will use the structural funds to diversify its economic structure and increase the number of growing, innovative and internationalizing organizations located in the region. For example, SMEs are supported in developing their growth potential and new business, in specialization and increasing their network-like cooperation (Structuralfunds.fi, 2018). More precisely, the empirical part of the study is executed in the Päijät-Häme region, which is recognized as a regional eco-innovation cluster, having variety of educational institutions, local innovation centres and business parks in the region (Cooke, 2008; Pananpanaan, Uotila, & Jalkala, 2014). A main part of Finland's future competitive advantage is suggested to be high level knowledge, research and development skills (Structuralfunds.fi, 2018). As such, university–industry collaborations are under high societal expectations, also in the context of regional development. Finland thus provides an interesting context for this study.

As a methodological framework, this study builds on two longitudinal, qualitative case studies. According to Yin (2003) and Meredith (1998), case studies can be utilized to explore and understand emerging and contemporary phenomena in real-life contexts. The researchers were motivated to utilize case studies as a background for this study to gain an empirical, real-life understanding of the performance measurements of operational-level regional development activities. Voss, Tsikriktsis, and Frohlich (2002) stated that case studies can be utilized to generate an in-depth understanding and to capture the context of the explored phenomenon in much more detail.

The case study method can also be considered an approach that enables researchers to apply various quantitative and qualitative methods, such as conducting interviews or using questionnaires to explore different phenomena (Gummesson, 2000). When developing the performance evaluation framework presented in this study, the researchers were able to gather empirical data from the two large longitudinal cases presented below.

Case 1

The aim of the regional development and research project in Case 1 was to develop and support the competitiveness and innovativeness of regional organizations by transferring the knowledge and know-how produced in the university setting to participating organizations. Twenty researchers participated in 13 different cases during the project which took place from 1 January 2011 through 30 June 2014. During that time, 227 organizations

participated in projects in different cases and work packages. The data gathered from Case 1 is based on different workshop observations, individual and group interviews conducted during the project, feedback and surveys gathered, and the researcher's personal observations. Table 2 presents details of the most important cases and work packages for the data collection.

The data and empirical evidence from the project for this study were gathered and analysed from the viewpoint of the evaluation and measurement of the project. For example, what are the challenges related to the evaluation of such activities and how could the evaluation frameworks be designed and built to support the management of the project? The data were analysed through the cooperation of three researchers. Qualitative content analysis and quantitative analysis were conducted to analyse the data gathered from the different cases. Qualitative content analysis was performed to analyse the individual and group interviews, workshop observations, field notes, memos and drawings. Quantitative analysis was conducted to analyse the results gathered from surveys arranged in the different cases. From these analyses, the researchers made patterns related to the current challenges of performance evaluation and measurement of university–industry collaboration in the context of regional development. During the analysis phase, research triangulation and data triangulation were used to validate the findings. Data triangulation, based on data from different cases, was used to increase the understating of the explored phenomenon from different viewpoints. Research triangulation was used to increase the

Table 2. Main sources for data gathering from Case 1.

Case/Work package	Target of development	Data gathering
Establishment of regional innovation network including 30 SMEs	Innovation network was established to support long-term innovation activities of participating organizations and establish the innovativeness of the whole region Industrial organizations' contemporary performance measurement practices and challenges were explored as a part of the collaboration activities (for more information, see Rantala & Ukko, 2018).	– Interviews with participating members from industry organizations in the building phase of innovation networks – Workshop observations during 10 workshops – Feedback gathered after each workshop – Interviews with the participants during the evaluation phase of the collaboration
Development project with public dental healthcare organization	The results were gathered during the research and development project with a public dental health care organization whereby the performance measurement system for the university–public organization collaboration was collaboratively designed (for more information, see Rantala, Ukko, & Rantanen, 2018).	– Group interviews with the steering group/ management team; four semi-structured interviews, which lasted 2.5 h on average. – Workshop observations during three workshops with the mangers and personnel of the public sector organization – Survey arranged after the workshops for all participants from the public dental healthcare organization (21 persons)
Development project of city centre area	The development of a local city centre area. Because of changes in shopping and trading behaviours, the city centre area suffered from the loss of customers and people. Therefore, area entrepreneurs, property owners and event organizers worked in a participatory process with public servants to design the future of the city centre (for more information, see Konsti-Laakso & Rantala, 2018).	– Field notes from individual meetings with the management team of the process during the working phase of three workshops – Group discussions, notes, drawings, photos, videos, recorded interviews, feedback after the workshop (3 workshops, 43–65 participating organizations)

number of experts to analyse and interpret the findings and to avoid possible biases related to single-observer analysation.

Figure 1 presents the challenges related to performance evaluation and measurement in university–industry collaboration in the context of regional development, which is discussed in the following chapter.

The regional development and research project in Case 2, which was conducted from 1 December 2014–31 May 2018, was established to continue the regional innovation and development support activities started in Case 1 between the university and other regional organizations. The structure of the development project was divided into three different work packages: the first focused on concretizing and facilitating regional development/experimental platforms, the second focused on the systematic development of new types of value networks, and the third focused on supporting and facilitating start-up and student entrepreneurships. As a part of the whole development project, a performance evaluation system was designed and built to not only support the management of the whole collaboration but also evaluate the performance of participating organizations as part of the project. By utilizing the evidence and experiences gathered during the regional development project in Case 1, members from the participating organizations and university (project manager, case managers, individual researchers) designed and built the performance evaluation system in three collaborative workshops. The empirical level evidence to support the presented framework in chapter five was gathered during these workshops and later during the whole development project. Table 3 presents the data gathered from Case 2 in more detail.

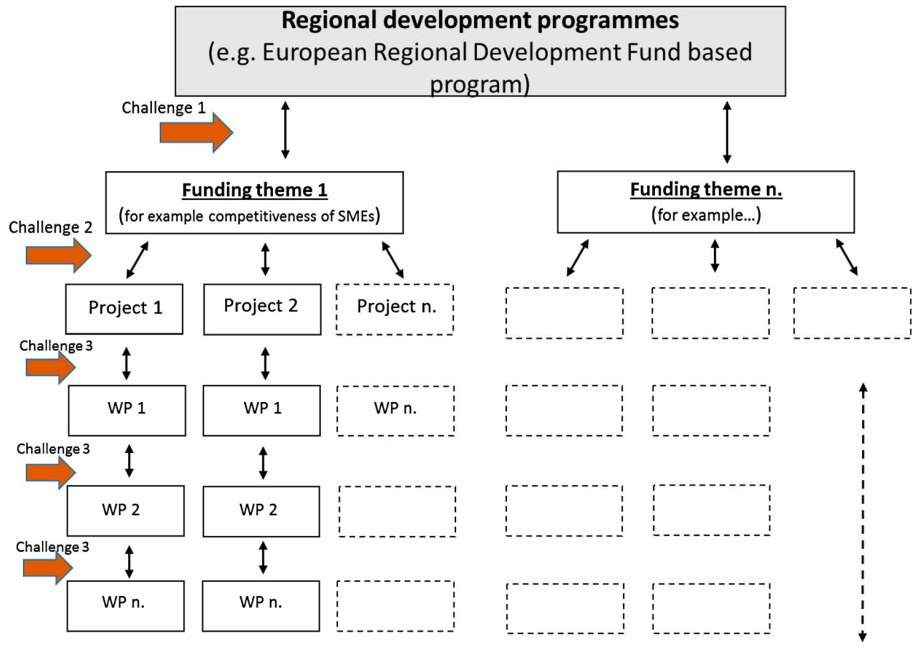

Figure 1. Challenges related to evaluation of the regional development programmes.

Table 3. Process of data gathering from Case 2.

Phase of the performance evaluation system building	Aim of the phase	Data gathering
First phase (first workshop)	In the first phase of the performance measurement design process, development perspectives and development targets were defined to each work package and each organization: • What are the objects, processes, structures, etc. that the project seeks to influence and which, if successfully reached, will lead to the desired results for work packages and the whole project? • The perspectives and measures through which the goals of the project are achieved.	– Workshop observations (around 15 participants) – Feedback gathered after the workshop
Second phase (second workshop)	In the second phase of the performance measurement design process, the methods used to evaluate the selected perspectives and development targets were defined for each perspective: • How can the selected perspectives and development targets be evaluated and measured? – Indicators – Surveys – Quantitative and qualitative assessment – Ex: Number of events, number of participating companies, increased turnover, increased co-operation, increased learning, increased occupational wellbeing	– Workshop observations (around 15 participants) – Feedback gathered after the workshop
Third phase (third workshop)	The third phase of the performance measurement design process defined the collector of data, the information to collect, to whom the information is reported and who will benefit from it for each evaluated item: • Who collects the information? – Named person – How is the information reported? • Where and when is the information collected?	– Workshop observations (around 10 participants) – Feedback gathered after the workshop

Qualitative content analysis was conducted to analyse the data gathered from three workshops. Workshop observations and feedback gathered after each workshop from university members and participating organizations were used in the analyses which focused on the design and building of the performance measurement system in the explored context. From these analyses, the researchers explored how the involvement of the members of participating organizations in the performance measurement affected their understanding and interest in the development project at different levels (i.e. individual, organizational and regional). As in Case 1, research triangulation and data triangulation were used to validate the findings. Data triangulation, based on data from three workshops, was used to improve the understating of the explored phenomenon from different viewpoints, and research triangulation was used to increase the number of experts to analyse and interpret the findings and to avoid possible biases related to single-observer analysation.

5. Performance evaluation framework to support regional development at the operational level

The evaluation of regional development and innovation activities should form the basis not only for the support but also for the evaluation purposes of the individual

organizations and their roles in regional development. As presented earlier in this study, when universities and industrial, public and third-sector organizations participate in regional development activities, they each have specific goals and wishes related to those activities. The organizations typically pursue regional development activities for different projects and working packages (Figure 1). Even though this kind operationalization of regional development programmes is attractive to the organizations because it allows them to execute activities related to their interests, it creates barriers to their understanding of regional development at the 'big picture' level. The empirical evidence gathered from three cases during Case 1 (presented in Table 2) reveals that university members and participating organizations were both predominantly unaware of the connections between the different funding streams and regional development programmes (see Challenge 1 in Figure 1). The results gathered from Case 1 also reveal that university members operating in these regional development activities seemed to be more aware of the aims and goals of the different funding streams, while other participating organizations seemed less aware (see Challenge 2). Finally, the empirical results from Case 1 reveal that organizations participating with universities in these regional development activities were also unaware of the actions pursued in other work packages.

The presented framework and process model for designing and building performance evaluation systems for regional development activities between university and public and private sector organizations involves participants from the universities and other participating organizations. In addition to the empirical evidence gathered during the two case studies, the presented framework is developed based on previous literature regarding performance measurements, university–industry partnerships and evaluations of regional policies and development (Albats, Fiegenbaum, & Cunninghmam, 2017; Bishop et al., 2011; Bitici et al., 2012; Diez, 2001; Pecas & Henriques, 2006; Perkmann et al., 2011; Perkmann & Walsh, 2009; Ukko et al., 2008; Zabala-Iturriagagoitia et al., 2008).

5.1. Defining the aims and roles of the regional development project

At the big picture level, and in general, regional policies are divided into smaller pieces, i.e. regional development programmes that are executing the policies in practice. Regional development projects are usually funded from different sources or funding calls through which the regional development programmes are executed. Universities and industrial and public-sector organizations usually participate in regional development activities through these development and innovation projects. Each of these projects has its own goals and aims that are linked to the funding stream. In addition, each of these funding streams have their own goals that are linked to the aims and goals of the regional development programmes with the aim of executing regional policy.

The empirical evidence from Case 1 (presented in Table 2) and Case 2 (presented in Table 3) reveals that both university members and participating organizations face challenges (Challenge 1) in understanding how the aims and goals of the funding sources are linked to the regional development programme. The results gathered in Case 1 suggest that the university members seem to be aware of the aims and goals of the different funding streams that fund their projects, but the participants from the industry and public sector organizations miss the connections between operational-level activities, themes and aims, and their funding themes. Therefore, the first phase of the performance

evaluation system design process should define and clarify, together with the participating organizations, how the regional development activities at the operational level connect to the funding source and to the regional development programme. Defining the links between these infrastructures increases the participants' understanding of the development activities, thus overcoming Challenge 1.

To outline a project's connection to other funding themes and regional development programmes, the aims, wishes, roles and responsibilities of the participating organizations should be carefully defined during the first phase of the process. All participating organizations have specific expectations towards the project that should be defined in this phase to make sure that they align with the aims and goals of the entire project. The empirical evidence gathered in Case 1 indicated that the participating industrial and public-sector organizations were unfamiliar with the goals and aims of the funding themes and the development project's connections to the funding theme (Challenge 2). This evidence also suggested that the university researchers are more aware of the aims and goals of the funding stream; thus, defining this connection increases the understanding and learning of the participating industrial and public-sector organizations.

In this phase, the aims and goals of the industrial and public-sector organizations, as well as university members participating in individual work packages, should be precisely defined and clarified. The empirical evidence gathered from Case 1 (first and second cases in Table 2) shows that even though industrial and public-sector organizations are participating with universities in these regional-level research and development projects, they are pursuing these activities as individual work packages or tasks. For that reason, they seem to be aware of the aims and goals of the work package in which they are participating, but they are unaware of the operations, aims and tasks that are pursued in other work packages. For that reason, clarifying and presenting the aims and goals of the other work packages can increase the regional-level understanding of participating organizations and support, thus overcoming Challenge 3.

5.2. Construction of the measurement system

After defining and clarifying the aims and roles of the participants and the aims of the entire project, the next step involves determining the purpose and construction of the evaluation system. The performance evaluation system in university–industry regional development collaborations can be used for several different purposes, which include steering the actions of the development project, evaluating the ongoing processes, making the results visible and supporting learning among participants.

As presented above, regional development and innovation projects are often divided into individual work packages or tasks. In university–industry collaborations, these projects are usually managed by the universities (participating organizations are not interested in handling bureaucracy) and the industrial and public-sector organizations are the participants. During the first phase of constructing the measurement system, critical success factors and measures for each work package should be defined and should reflect the aims and goals of the university members and participating organizations. As each organization has its specific interest towards the regional development activities, these interests should be noted and evaluated. After each organization has defined and clarified their motivations for participating and determined measures for evaluating such activities, the success

factors and selected measures should be introduced to other participants to increase understanding of the other work packages and other participants' goals and actions. This supports cross-learning between participating organizations and helps to overcome challenges in understanding the operations pursued in regional development projects (Challenge 3, Figure 1).

After designing the measures for each work package and for the whole development project, the defined and selected measures should be connected to the aims and goals, as well as to the measures of the funding streams and regional development programmes. Even though individual projects and work packages may (and should) have their own goals and measures, the development operations and measurement activities pursued in these projects should accord with the aims and goals and with the measurement of the regional-level funding and development programmes. In other words, the achievement of the operational level aims and goals should also fulfil the achievement of the regional level aims and goals. When regional level policies and development activities are executed in individual research and development projects, the achievement of the projects goals should also lead to a situation in which the regional level aims and goals are achieved, meaning that the operational-level measures and measurement activities should accord with the 'upper-level' aims, goals and evaluation.

After a suitable number of measures have been selected for the evaluation system, the next phase of the construction involves defining the data gathering and the person or team responsible for the measurement. For each measure, there should be meaningful tools or channels to gather data and information, and there should be someone interested in the gathered information. All participants should together define how the data are gathered for the selected measures and who is responsible for gathering the data. The empirical results gathered from Case 1 (presented in Table 2) revealed that the operational-level performance evaluation of the regional development projects between university and public and private sector organizations are mainly pursued by university members (usually by the university project manager). These gathered results are usually reported to other participants in steering group meetings that often include participants from other organizations. However, to support the learning and understanding of regional-level development activities, the performance evaluation activities should involve more than only one or two people, and should thus include members from all participating organizations (university, industrial and public organizations, and financier delegates).

5.3. Implementing and updating the measurement system

After constructing the performance evaluation system, the next phase of the process is the implementation. The system can support the management and learning purposes of the regional development project only if it is in active use. Implementation can be defined as a phase in which the constructed systems and frameworks are transferred into practice. Some refining of the constructed evaluation system can also be done during the implementation phase. As the forms of regional development evolve naturally during the projects, this may lead the performance evaluation system to diverge from its original purpose. It is therefore necessary to update the evaluation system during the project. Selected measures should be regularly revised, and measures that have turned out to be insignificant should be removed.

Figure 2 summarizes the process for designing and building a performance evaluation framework to support the regional development between universities and other regional organizations.

As a summary of the empirical evidence gathered from the performance measurement challenges in Case 1 (i.e. the university–industry innovation networks, the performance measurement design in university–public organization collaboration, and the evaluation of community engagement in urban development) and from the performance measurement system design process in Case 2, the university members and participating organizations have difficulties understanding not only the connections between individual operational level research and development activities but also their connection to development at the regional level. The empirical evidence gathered in Case 2, however, shows that the involvement of the members by all participating organizations in the performance evaluation design and building improves the participants' understanding of the interplay between the development project and the regional level development goals. The results gathered from the three different workshops, where the performance measurement system was collaboratively designed and built, also shows that an increased understanding of the aims and goals of the development activities at the regional level increases the participants motivation towards developing and achieving the projects' goals at the regional level. As such, the empirical results gathered from the two cases indicate that involving participants in the design and building of performance measurement and evaluation systems in university–industry collaboration in the context of regional development, increases participants' understanding of the connections between the following context specified challenges:

1. Challenges in understanding the connection between different funding streams and regional development programmes;
2. Challenges in understanding the connection between operational-level development projects and funding streams;

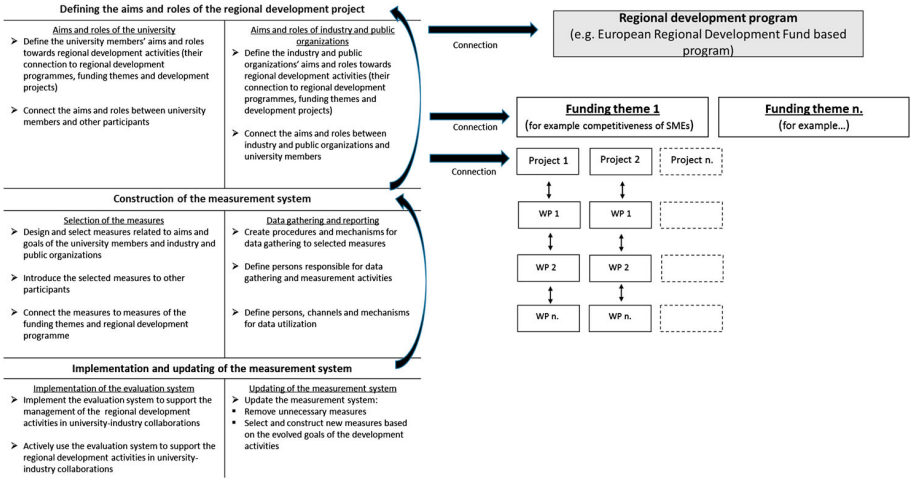

Figure 2. Performance evaluation framework to support regional development activities.

3. Challenges in understanding the connection between individual, operational-level work packages.

The increased understanding of the interplay between individual development activities and regional level development, in turn, increases the participants' motivation and interest in the regional level development.

6. Discussion

This study presents a framework for the design and building of a performance evaluation system to support regional development. The phenomenon was explored through operational-level regional development activities pursued between a university and private- and public-sector organizations. The results of this study reveal that even though different approaches have been suggested to evaluate regional development (e.g. Aragon et al., 2014; Aranguren et al., 2012; Zabala-Iturriagagoitia et al., 2008), a lack of understanding remains among the university members and the private- and public-sector organizations about the connection between operational-level development activities and regional-level policies. It seems that both participating sides are more interested in their own aims and goals and in the collaboration between the participants than in the development at the regional level. As such, it seems that, currently, universities and public organizations are pursuing development activities at the operational level, and the vital research and knowledge produced by universities are transformed to support the innovation and development activities of the participating organizations. For that reason, the organizations' activities are evaluated mainly at the operational level. However, because meaningful knowledge and economic welfare are important aspects for the development of the whole region in the long run, the operational-level development activities should support and execute the aims and goals of regional-level development programmes and policies (Smits & Kuhlmann, 2004), and the university and industry participants' interests should meet the development goals at the regional level. The results of this study indicate that by connecting the operational-level research and development activities to regional level development programmes and policies, and by increasing the understanding of the interplay and links between them, the performance evaluation framework presented herein increases participants' motivation and interest in the development at the regional level. As such, the design, building and use of the performance measurement system increases the dialogue between participants and provides surroundings in which the stakeholders have possibilities to meet frequently, interact verbally and form an understanding of the development activities, which have been suggested Aranguren et al. (2017) as important elements for the evaluation to be transformative. Thus, the presented framework also supports the findings of Kuhlmann (1998) and Diez (2001), which showed that the common learning process makes it possible to create an environment in which the evaluation process can be used to build trust among participating organizations and other stakeholder groups.

The empirical results of this study, and the presented performance evaluation framework, support Diez's (2001) idea that new regional policies must be jointly designed by all regional stakeholders and should be extended to the evaluation process. The results of the study are also in line with Kuhlmann (2003), who presented that the evaluation

processes in the context of regional development can be used as a mediation tool that does not hinder the different perspectives and viewpoints of participating organizations, but rather deliberately makes different goals and viewpoints visible, thus providing new perspectives to policy planning. Even though the empirical results of the study show that universities and private and public-sector organizations are mainly interested in operational-level regional development, rather than development of the policy's 'big picture', the suggested performance evaluation framework connects the operational-level activities to upper-level development tasks and goals. Thus, the suggested performance evaluation framework can be considered as an option to Aragon et al.'s (2014) findings which suggested that it is particularly important to find evaluation frameworks that are not only suitable but also contribute to the cooperative basis of the policy itself.

Finally, as performance evaluation is becoming an increasingly important and integral part of regional policies and development, and it will form a part of the policy as one more element in the design, build, implementation and development process (Diez, 2001), operational-level feedback gathered from performance evaluation activities could be more effectively used for planning long-term development programmes. The results of this study accords with Kuhlmann (2003), who presented that mediating stakeholders' perspectives by conducting evaluations will not bring revolutionary changes in research and innovation policies, but the practical implementation of radical changes can be greatly supported by mediation underpinning the learning capabilities of the participating organizations. The evaluation of operational targets and goals could be seen as upper-level design mechanisms, as presented in Figure 3.

As this study focused on the performance measurement activities at the operational level, and the results indicate that the involvement of the participants in the performance measurement processes increases their interests and motivation towards development at the regional level, further studies could develop and provide more insights regarding the surroundings in which financier delegates and decision makers have involvement in these evaluation processes. It is not only operational level developers that can learn from the evaluation activities; policymakers can also learn from their interventions by evaluating the results and outcomes of their efforts. At the same time, the insights gathered by the evaluation can be turned into new development and policy concepts and interventions (Smits & Kuhlmann, 2004).

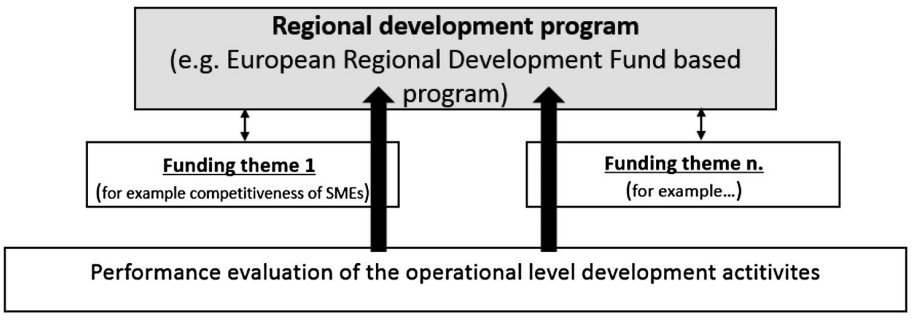

Figure 3. Connection between operational level evaluation and regional level development.

7. Conclusions

The evaluation of new types of regional policies and regional-level development activities pose challenges for such infrastructures. Although existing literature highlights the need for new evaluation methods to support the management of such collaborative actions, procedures for the design of evaluation frameworks in such contexts are lacking. This study presents a framework for the design of a performance evaluation system for regional development projects using university–industry collaboration as an example. The presented framework highlights involving the organizations participating in regional development activities in the evaluation activities. The involvement of the organizations in the design and construction of the performance evaluation systems can increase the understanding related to the performance evaluation of regional development, making it possible to use the evaluation system to support the learning and understanding of the participating organizations.

Instead of focusing on feasibility or introducing individual measures, the presented framework aims to connect the operational level development activities to larger regional level development programmes. As such, the process model can be utilized as a framework by the participating stakeholder groups in designing and building a performance measurement system, or as a complementary tool to traditional quantitative evaluation techniques that external evaluators are utilizing.

The results of the study show that university–industry collaborations are pursuing regional development programmes and policies mainly at the operational level. For that reason, the performance evaluation activities of the participating organizations relate mainly to operational-level development activities. However, involving the participating organizations, both university and industrial, in the performance measurement process could help to overcome the participants' understanding of the connections between the following three challenges, which are characteristics in university-industry collaboration:

1. Challenges in understanding the connection between different funding streams and regional development programmes;
2. Challenges in understanding the connection between operational-level development projects and funding streams;
3. Challenges in understanding the connection between individual, operational-level work packages.

Overcoming these challenges and increasing the participants' understanding of the development at the regional level increased their interests and motivation to achieve the development goals at the regional level. As such, the performance measurement process in university–industry collaboration in the context of regional development can generate surroundings in which operational level participants are more deeply involved in regional level development.

As this study focused mainly on involving the participants of university–industry collaboration in the performance measurement process, and improving the understanding of the links and interplay between the operational level development programmes and regional level development, future research should explore what actual effects can be achieved by increasing the participants' understanding. Further, as this study focused

on a performance measurement design process between university and industry organizations, future research should determine how financier delegates and decision makers and/or politicians could be involved in these operational level performance measurement processes, in which cases this might be reasonable, and what might be the positive and negative sides of the involvement. Finally, even though universities usually act as facilitators or brokers in the collaboration activities between universities and other societal organizations, the results of the study indicate that they are motivated by their own interests and are not particularly aware of the development at the regional level. Thus, further research should examine how operational-level feedback gathered from performance evaluation activities could be used more effectively for planning long-term development programmes, and investigate how universities should develop their policies and incentives to promote regional development.

Disclosure Statement

No potential conflict of interest was reported by the authors.

References

Acosta, M., Azagra-Caro, J., & Coronado, D. (2016). Access to universities' public knowledge: Who is more regionalist? *Regional Studies*, *50*(3), 446–459. doi:10.1080/00343404.2014.923094

Albats, E., Fiegenbaum, I., & Cunninghmam, J. A. (2017). A micro level study of university industry collaborative lifecycle key performance indicators. *Journal of Technology Transfer*, *43*(2), 1–43.

Aragon, C., Aranguren, M., Diez, M.-A., Iturrioz, C., & Wilson, J. (2014). Participatory evaluation: A useful tool for contextualizing cluster policy? *Policy Studies*, *35*(1), 1–21. doi:10.1080/01442872.2013.803532

Aranguren, M., De la Maza, X., Parrilli, D., Vendrell, F., & Wilson, J. R. (2012). Nested methodological approaches for cluster policy evaluation: An application to the Basque Country. *Regional Studies*, *48*, 1547–1562. doi:10.1080/00343404.2012.750423

Aranguren, M. J., Magro, E., & Wilson, J. R. (2017). Regional competitiveness policy evaluation as a transformative process: From theory to practice. *Environment and Planning C: Politics and Space*, *35*(4), 703–720. doi:10.1177/0263774X16662469

Bishop, K., D'Este, P., & Neely, A. (2011). Gaining from interactions with universities: Multiple methods for nurturing absorptive capacity. *Research Policy*, *40*, 30–40. doi:10.1016/j.respol.2010.09.009

Bitici, U., Garengo, P., Döfler, V., & Nudurupati, S. (2012). Performance measurement: Challenges for tomorrow. *International Journal of Management Reviews*, *14*, 305–327. doi:10.1111/j.1468-2370.2011.00318.x

Bruneel, J., D´Este, P., & Salter, A. (2010). Investigating the factors that diminish the barriers to university-industry collaboration. *Research Policy*, *39*(7), 858–868. doi:10.1016/j.respol.2010.03.006

Cooke, P., et al. (2000). *The Governance of innovation in Europe*. London: Pinter.

Cooke, P. (2008). Regional innovation systems, clean technology and Jacobian cluster-platform policies. *Regional Science Policy and Practice*, *1*(1), 23–45. doi:10.1111/j.1757-7802.2008.00002.x

Diez, M. A. (2001). The evaluation of regional innovation and cluster policies: Towards a participatory approach. *European Planning Studies*, *9*(7), 907–923. doi:10.1080/09654310120079832

Dobbs, L., & Moore, C. (2002). Engaging communities in area-based regeneration: The role of participatory evaluation. *Policy Studies*, *23*(3/4), 157–171. doi:10.1080/0144287022000045966

Florio, M., Forte, S., Pancotti, C., Sirtori, E., & Vignetti, S. (2016). *Exploring cost-benefit analysis of research, development and innovation infrastructures: An evaluation framework* (Working Paper Series, 01/2016). Milano: CSIL Centre For Industrial Studies. p. 86.

Foray, D. (2012). Smart Specialisation and the New Industrial Policy Agenda, Innovation for Growth, i4 g Policy Brief N8 8 (Brussels: European Commission).
Foray, D. (2014). *Smart Specialisation, Opportunities and challenges for regional Innovations policy*. London: Routledge.
Foray, D., & Rainoldi, A. (2013). Smart specialization programmes and implementation. S3 Policy Brief Series, No. 02/2013.
Franco, M., & Haase, H. (2015). University-industry cooperation: Researchers' motivations and interaction channels. *Journal of Engineering and Technology Management*, *36*, 41–51. doi:10.1016/j.jengtecman.2015.05.002
Fritsch, M. (2004). Cooperation and the efficiency of regional R&D activities. *Cambridge Journal of Economics*, *28*(6), 829–846. doi:10.1093/cje/beh039
Guenther, J., & Wagner, K. (2008). Getting out of the ivory tower – New perspectives on the entrepreneurial university. *European Journal of International Management*, *2*(4), 400–417.
Gummesson, E. (2000). *Qualitative methods in management research*. London: Sage Publications.
Konsti-Laakso, S., & Rantala, T. (2018). Managing community engagement: A process model for urban planning. *European Journal of Operational Research*, *268*, 1040–1049. doi:10.1016/j.ejor.2017.12.002
Kroll, H. (2015). Efforts to implement Smart Specialization in practice – Leading unlike horses to the water. *European Planning Studies*, *23*(10), 2079–2098. doi:10.1080/09654313.2014.1003036
Kuhlmann, S. (1998). Moderation of policy making? Science and technology policy evaluation beyond impact measurement – The case of Germany. *Evaluation*, *4*(2), 130–148. doi:10.1177/13563899822208491
Kuhlmann, S. (2003). Evaluation of research and innovation policies: A discussion of trends with examples from Germany. *International Journal of Technology Management*, *26*(2/3/4), 131–149. doi:10.1504/IJTM.2003.003366
Laasonen, V., & Kolehmainen, J. (2017). Capabilities in knowledge-based regional development – towards a dynamic framework. *European Planning Studies*, *25*(10), 1673–1692. doi:10.1080/09654313.2017.1337727
Lundberg, H., & Andersen, E. (2012). Cooperation among companies, universities and local government in a Swedish context. *Industrial Marketing Management*, *41*, 429–437. doi:10.1016/j.indmarman.2011.06.017
Magro, E., & Wilson, J. R. (2015). Evaluating territorial strategies. In J. M. Valdaliso & J. R. Wilson (Eds.), *Strategies for Shaping territorial competitiveness* (pp. 94–111). London: Routledge.
Mäkimattila, M., Junell, T., & Rantala, T. (2015). Developing collaboration structures for university-industry interaction and innovations. *European Journal of Innovation Management*, *18*, 451–470. doi:10.1108/EJIM-05-2013-0044
McCann, P., & Ortega-Argiles, R. (2014). Smart specialisation, regional growth and applications to EU cohesion policy. *Regional Studies*, *49*(8), 1291–1302. doi:10.1080/00343404.2013.799769
McCann, P., & Ortega-Argiles, R. (2016). Smart specialization, entrepreneurships and SMEs: Issues and challenges for a result-oriented EU regional policy. *Small Business Economics*, *46*(4), 537–552. doi:10.1007/s11187-016-9707-z
McCann, P., Ortega-Argiles, R., & Foray, D. (2015). Smart specialization and European regional development policy. In D. D. Audretsch, A. N. Links, & M. Walshok (Eds.), *The Oxford Handbook of local competitiveness* (pp. 458–480). New York: Oxford University Press.
Meredith, J. R. (1998). Building operations management theory through case and field research. *Journal of Operations Management*, *16*, 439–452. doi:10.1016/S0272-6963(98)00023-0
Messeni Petruzzelli, A. (2011). The impact of technological relatedness, priorities, and geographical distance on university–industry collaborations: A joint-patent analysis. *Technovation*, *31*(7), 309–319. doi:10.1016/j.technovation.2011.01.008
Ministry of Economic Affairs and Employment of Finland. (2018). Available at: https://tem.fi/en/regional-development-priorities-2016-2019
Muscio, A. (2010). What drives the university use of technology transfer offices? Evidence from Italy. *Journal of Technology Transfer*, *35*(2), 181–202. doi:10.1007/s10961-009-9121-7

Pananpanaan, V., Uotila, T., & Jalkala, A. (2014). Creation and Alignment of the Eco-innovation strategy model to regional innovation strategy: A Case from Lahti (päijät-häme region), Finland. *European Planning Studies*, *22*(6), 1212–1234. doi:10.1080/09654313.2013.774322

Pecas, P., & Henriques, E. (2006). Best practices of collaboration between university and industrial SMEs. *Benchmarking: An International Journal*, *13*(1), 54–67. doi:10.1108/14635770610644574

Perkmann, M., Neely, A., & Walsh, K. (2011). How should firms evaluate success in university-industry alliances? A performance measurement system. *R&D Management*, *41*(2), 202–216. doi:10.1111/j.1467-9310.2011.00637.x

Perkmann, M., & Walsh, K. (2009). The two faces of collaboration: Impacts of university-industry relations on public research. *Industrial and Corporate Change*, *18*, 1033–1065. doi:10.1093/icc/dtp015

Porter, M. (2003). The performance of regions. *Regional Studies*, *37*(6/7), 549–578. doi:10.1080/0034340032000108688

Rantala, T., & Ukko, J. (2018). Performance measurement in university–industry innovation networks: Implementation practices and challenges of industrial organisations. *Journal of Education and Work*, *31*(3), 247–261. doi:10.1080/13639080.2018.1460655

Rantala, T., Ukko, J., & Rantanen, H. (2018). Designing a performance measurement system for university-public-organization collaboration. *International Journal of Public Sector Performance Management*, *4*(3), 349–372. doi:10.1504/IJPSPM.2018.093467

Rasmussen, E. (2008). Government instruments to support the commercialization of university research: Lessons from Canada. *Technovation*, *28*(8), 506–517. doi:10.1016/j.technovation.2007.12.002

Secundo, G., Perez, S. E., Martinaitis, Z., & Leitner, K. H. (2017). An intellectual capital framework to measure universitieś third mission activities. *Technological Forecasting & Social Change*, *123*, 229–239. doi:10.1016/j.techfore.2016.12.013

Smits, R., & Kuhlmann, S. (2004). The rise of systemic instruments in innovation policy. *International Journal of Foresight and Innovation Policy*, *1*(1/2), 4–32. doi:10.1504/IJFIP.2004.004621

Stec, M., & Grzebyk, M. (2018). The implementation of the strategy Europe 2020 objectives in European Union countries: The concept analysis and statistical evaluation. *Quality & Quantity*, *52*(1), 19–133. doi:10.1007/s11135-016-0454-7

Structuralfunds.fi. (2018). Available at: http://www.rakennerahastot.fi/web/en/southern-finland

Tartari, V., Salter, A., & D'Este, P. (2012). Crossing the Rubicon: Exploring the factors that shape academics' perceptions of the barriers to working with industry. *Cambridge Journal of Economics*, *36*(3), 655–677. doi:10.1093/cje/bes007

Ukko, J., Tenhunen, J., & Rantanen, H. (2008). The impacts of performance measurement on the quality of working life. *International Journal of Business Performance Management*, *10*(1), 86–98. doi:10.1504/IJBPM.2008.015922

van Looy, B., Debackere, K., & Andries, P. (2003). Policies to stimulate regional innovation capabilities via university–industry collaboration: An analysis and an assessment. *R&D Management*, *33*(2), 209–229. doi:10.1111/1467-9310.00293

Villaini, E., Rasmussen, E., & Grimaldi, R. (2017). How intermediary organizations facilitate university-industry technology transfer: A proximity approach. *Technological Forecasting and Social Change*, *114*, 86–102. doi:10.1016/j.techfore.2016.06.004

Voss, C. A., Tsikriktsis, N., & Frohlich, M. (2002). Case research in operations management. *International Journal of Operations and Production Management*, *22*, 195–219. doi:10.1108/01443570210414329

Yin, R. K. (2003). *Case study research: Design and methods* (applied social research methods series, Vol. 5) (3rd ed.). London: Sage Publications.

Zabala-Iturriagagoitia, J. M., Jiménez-Sáez, F., & Castro-Martínez, E. (2008). Evaluating European regional innovation strategies. *European Planning Studies*, *16*(8), 1145–1160. doi:10.1080/09654310802315849

Zabala-Iturriagagoitia, J. M., Voigt, P., Gutiérrez-Gracia, A., & Jiménez-Sáez, F. (2007). Regional innovation systems: How to assess performance. *Regional Studies*, *41*(5), 661–672. doi:10.1080/00343400601120270

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