Discovering the effect metrics for innovation projects

Laura-Maija Hero, Marianne Pitkäjärvi and Kaija Matinheikki

Working life-integrated innovation projects have become a common part of education. An innovation project is a social phenomenon of learning that brings the competence of several individuals together in a social process through which a novel idea is turned into practical reality to convey value to its users. University–industry innovation collaboration research has mainly understood the role of the university as a partner responsible for research. However, these projects are often based on student teamwork, an open challenge from real working life and a predefined intention to produce a concrete, novel, and innovative product, service, or new operating model into use. The outcomes are meant to be taken into use to convey value for business and society. A paucity of empirical research exists on the development and assessment of these innovation education programs based on their effects on the surrounding society. The variables that are important in studying the effects of innovation education projects on surrounding society, participating companies, and organisations must be identified. In this study, a set of effect measurement scale variables were discovered through a document analysis and focus group interviews. The findings imply the importance of recognising the effects of the project both on the clients' and their organisations' goals (project output, benefits of participation, and what survives) and the wider impact of the projects on the surrounding society (impacts on the daily lives of citizens; well-being and health; economy, ecology, digitalisation; and social matters). Thus, a preliminary impact assessment model is suggested.

Keywords: Innovation project, university-industry collaboration, impact, higher education, innovation pedagogy, document analysis, focus group

Introduction

Working life-integrated authentic innovation projects have become a common part of education. There is an increasingly growing societal pressure on higher education institutions (HEIs) to act as operators for innovations and provide economic growth for society (OECD/EU, 2019). University-industry collaboration (UIC) has been widely perceived as a promising tool for enhancing organisational capacity in open innovation, where an organisation employs external networks in developing innovation and knowledge (Ankrah & AL-Tabbaa, 2015; Blumenthal, 2003; Philbin, 2008). This paper focusses on the evaluation of the UIC in the sector of universities of applied sciences (UAS), including the effects of innovation projects on working life and the surrounding society. Innovation projects, as a social phenomenon, bring together the competence of several individuals through social processes in which a novel idea is turned into practical reality (Taatila et al., 2006). UIC refers to the interaction between any parts of the higher educational system and industry that mainly aims to encourage knowledge and technology exchange (Ankrah & AL-Tabbaa, 2015). Here, industry refers broadly to any professional branch not limited to the manufacturing of goods (cf. e.g. 'creative industries', and 'service industries').

In Finland, research, development, and innovation (RDI) activities that promote working life and regional development are the basic tasks of UAS in addition to education. A special feature of the RDI work of UAS is the significant participation of students in projects. Innovation projects with companies, associations, and public organisations are a mandatory part of curricula in many UAS today (Heikkinen & Isomöttönen, 2015; Hero & Lindfors, 2019; Keinänen & Oksanen, 2017; Muukkonen et al., 2013). The opportunities of networked innovation development programmes and the need to investigate them further to make them into a widely used educational practise has been recognised (Biffi et al., 2017;

O'Brien et al., 2003). The empirical knowledge of the assessment of the implementation practises and challenges has been called for (Rantala & Ukko, 2018). The impact assessment of innovation and entrepreneurship activities in HEIs remains underdeveloped (OECD/EU, 2019). This is partly due to the fact that the currently available metrics typically focus on the number of spin-offs, the volume and quality of the intellectual property, and the commercialisation of research results. Such metrics do not take into account important factors such as teaching and learning outcomes, sustainability effects, the contribution to local economic development, and social and cultural dimensions. The consequence of the lack of an effective measurement of the impacts of these activities is that even in advanced innovation-intensive countries, no consensus has been reached as to what metrics to use in the assessment of educational innovation activities outside universities (OECD/EU, 2019). Therefore, we suggest that understanding the effects of these projects on working life and the surrounding society in the local area would promote better understanding of pedagogical opportunities. UAS are much dependent on the policies of the area and surrounding society. The UAS teachers and management staff have experiences in innovation project programs and have been given the mandate to further develop the existing pedagogies.

The aim of this research project was to discover the effect metrics for innovation projects in HEIs for a well-focussed assessment. This aim was delimited to the effects of innovation projects on the surrounding society, not on students' learning. The effects of innovation education programs on student learning and competence development have been studied quite extensively, with promising results (Brazee & Lopp, 2012; Hero & Lindfors, 2019; Keinänen & Oksanen, 2017; Lindfors & Hilmola, 2016). As the learning experience seems to be meaningful and effective, wider implications in society can be expected. This study was delimited to the UAS context. UAS have been given the mandate and requirement to participate in the development of their surrounding areas (Ministry of Justice, 2014; see also Etzkowitz, 2003; Lepori & Kyvik, 2010). The main research question was 'What variables are important when studying the effects of innovation education projects of UAS in the surrounding society, participating companies, and organisations?' To answer the main research question, we set two sub-questions: 1) What metric variables are relevant on the basis of the policy documents guiding UAS? 2) What effect metric variables do teachers and management staff members consider relevant?

The results can be applied in innovation project effect assessment (e.g. client interviews and surveys) as part of the innovation management operations and to reform curricula and pedagogies. It is important to identify the meaningful effect metrics to continuously collect insights into the effects on collaborating companies and organisations, even on the customers and end users of their products and services. These insights can then be used to make innovation projects more transparent for decision makers in HEIs, external funding bodies, management groups, curricula designers, teachers, and students. In addition, these insights are important when selecting partners as clients for student teams. This strategy provides an opportunity to renew and develop pedagogies further and unfold their local impacts on the innovation and education metrics of HEIs.

Building a common and shared understanding of what an impactful HEI means for a specific area within a given socio-economic context and policy framework is the main starting point in understanding the effects of pedagogy outside HEIs. This will be a progressive and reflective process relating to the particular focus of the aims of HEIs in quest. The views of the effects are considerably influenced by the local needs and policies giving direction to the RDI in the area (Kohler & Huber, 2006). Also, there are different case-specific and HEI internal needs for insights. Different countries also have different imperatives, cultures, traditions, frameworks, and public policy influences, which influence their views of the meaningful effect metrics. No single model is considered effective, but a magnitude of unique responses promote effect measurement of pedagogy on the surrounding society. Amidst all the diversity, we trust that key themes would guide material collection to make the effects transparent in the Finnish UAS context. UAS have the mandate and requirement to participate in the development of the surrounding area (Ministry of Justice, 2014; see also Etzkowitz, 2003; Lepori & Kyvik, 2010).

Background

University-industry innovation collaboration

The qualitative effect metrics are important in the triple helix framework, which aims at understanding the relationships between university, industry, and government in the regional innovation system (Etzkowitz, 2003). The different research and teaching orientations distinguish two kinds of HEIs in Finland. UAS represent a practical and professionally oriented form of higher education whose existence is based on their ability to educate a skilled workforce and provide services to the needs of a knowledge-based society (Ministry of Justice, 2014). Accordingly, one of the main goals of establishing, developing, and reforming the Finnish UAS system has been to bring the UAS, companies, and businesses closer to each other. According to the Ministry of Justice (2014), the mission of the UAS is to provide higher education for professional expert jobs based on the requirements of working life and its development, research, artistic, and cultural premises and to support professional growth. In addition, the task of the UAS is to conduct applied research, development, and innovation, which are aimed at promoting UAS teaching, supporting the world of work, promoting regional development, and rebuilding the industrial structure of the region (Ministry of Justice, 2014). Thus, research, development, and innovation are especially integrated into the role of UAS as regional knowledge providers (see Etzkowitz, 2003; Lepori & Kyvik, 2010).

The reasons for the industrial organisations' participation in collaborations and innovation networks with universities are linked to intellectual capital and knowledge acquisition, although they miss the clear connection between the advantages gained from the development activities and actual business performance (Rantala & Ukko, 2018). According to Ankrah and AL-Tabbaa (2015), the most common forms of UIC are alliances, networks, joint ventures, and consortia. In UIC, organisations are typically involved in long-term development and collaboration, but today, they are also involved in an increasing number of projects focussed on specific challenges or creating commercial products (Rantala & Ukko, 2018). Thus, for students, working life-integrated innovation projects have become a common part of education (Maritz et al., 2014).

Innovation education is generally considered part of entrepreneurship education in HEIs in Europe (Maritz et al., 2014), but it is also an important part of craft, design, and technology education (e.g. Lindfors & Hilmola, 2016). An innovation project is a social phenomenon of learning that brings together the competence of several individuals in a social process through which a novel idea is turned into practical reality to convey value to its users (Taatila et al., 2006). The purpose of innovation projects as educational programmes is not only to enhance the innovative performance of individuals and organisations (Donovan et al., 2013; Maritz et al., 2014) but also to produce novel products and services to the working-life partner organisation. Innovation project activities in higher education are designed and facilitated by teachers, firms, and other organisations as problem- or project-based development activities (e.g. Hero & Lindfors, 2019).

Impact of innovation projects

In her framework for measuring innovation impact based on the suggestion from an extensive meta-analysis of the literature, Cheah (2016) presents the counts of innovative processes or products and their sales, productivity, and profitability, as measures that should be addressed when evaluating the outcomes of innovations. The focus of Sillanpää's (2013) study was on the impact of welfare service innovations. The impact measurement for social innovations has traditionally been conducted using different types of economic evaluations, such as cost-benefit or cost-effectiveness analysis, or social return on investment, where the costs are based on service consumption. Sillanpää (2013) stipulates that such an approach is insufficient and presents an alternative model. In this model, the impacts on the service system level are evaluated by quantifying the service use, and the effects on individual level are evaluated through quality-of-life indicators. On the other hand, the UNESCO Institute of Statistics

(2008) claims that measuring the impact of innovation depends on whether it is a new product, process, marketing method, or organisation. At the company level, the impact can be measured through sales, market share, and productivity. Furthermore, impact can be measured by observing the amount of knowledge flowing through networks.

The assessment of UIC projects has been complex. Studies on UIC have been too exclusively orientated towards outputs (Rossi & Rosli, 2015). There is a wealth of research on the effects of entrepreneurship education programmes on the creation of student entrepreneurship (e.g. Black & Mischel, 2020; Mukesh et al., 2020; Turner & Gianiodis, 2018). Abundant research has also investigated the effects of innovation education programmes on student learning (Brazee & Lopp, 2012; Hero & Lindfors, 2019; Keinänen & Oksanen, 2017), even in the context of comprehensive education (Lindfors & Hilmola, 2016). In the context of UAS, students' learning experiences appear to be multi-dimensional and versatile, and students can recognise their competence development and agency in the process (Hero & Lindfors, 2019).

Albats et al. (2018) studied the common and context-specific key performance indicators of UIC and identified the following indicators at a micro level: the amount of resources allocated by partners to collaboration; the efficiency of collaboration management and clearly defined roles; a number of company innovations resulting from collaboration with a university and new strategic partnerships; a number of young researchers involved, fit between collaboration and organisational strategy; a number of joint publications; and enterprise image improvements (Albats et al., 2018). Perkmann et al. (2011) proposed a performance measurement system for UIC alliances and distinguished different process stages: inputs, in-process activities, outputs, and impacts resulting in both prospective and retrospective measures and subjective and objective measures. There seems to be a lack of holistic understanding of the performance measures and assessment opportunities associated with such collaborative project networks of organisations. According to Bititci et al. (2012), the challenge is on how the performance of the organisation in the UIC should be managed as a complete system but assessed according to the interests of all parties.

Maritz et al. (2014) provided a framework by which innovation education facilitators may develop and evaluate their innovation education programmes. According to Maritz et al. (2014), the assessment of the effects of the collaborative projects should capture both the process and outcome. Apart from the learning assessment, which is an integral part of pedagogy, the assessment should focus on the process, outcomes, impact, student behaviours, financial resources, innovation intentions, knowledge gained, and return on investment and skills. In addition, the parameters of the funding authorities should be assessed if the projects are externally funded (Maritz et al., 2014). However, little research exists on the effects of these programmes outside educational institutions, namely the industry partner companies and organisations participating in the action learning programmes. Knowledge is lacking on the benefits that partners experience right after and several years after these projects. Organisations that collaborate in research and development projects with universities have recognised the need for systematic evaluation and measurement of the projects (Rantala & Ukko, 2018). These organisations participate in, for example, action learning projects as ‘clients’ offering open challenges for student innovation development. Students work collaboratively to address their client's real-world challenge through concurrent team collaboration learning (see e.g. Brazee & Lopp, 2012). When these projects are also mandatory for students and are primarily conducted by ‘student innovators’, the systematic evaluation and measurement of the benefits for the organisations outside the HEI become even more challenging, as the HEI is generally responsible for the research activities and student learning. In conclusion, there is a wealth of research on innovation pedagogy from the learning point of view, but a paucity of research exists on the effects outside educational institutions. Research on the development and assessment of innovation education programmes based on their effects on society is also lacking.

Materials and Methods

Educational leaders must be knowledgeable of policies because in educational organisations, especially those dependent on state funding, almost all functions of the organisation are dictated by policies that have both national and local ramifications (Cardno, 2018). In this study, a set of effect measurement variables was developed through document analysis and focus group interviews to create metrics to discover the effects of innovation projects (Table 1). The document material consisted of 13 policy documents that seek to give direction to RDI work in the regional context. Parallel to the document analysis, two focus group workshop interviews of multidisciplinary innovation project teachers and management staff members were conducted. In total, 13 subjects participated in the focus group workshops, which were organised online via Zoom because of the coronavirus disease pandemic.

Table 1. Materials and methods

Research question	***Method***	***Participants, data***
What metrics variables are relevant based on policy documents guiding UASs?	Document analysis	N=13 Policy documents
What effect metrics variables teachers and management staff members consider relevant?	Focus group 1	N = 8 Multidisciplinary innovation project teachers
What effect metrics variables innovation management staff members consider relevant?	Focus group 2	N = 5 Innovation manager-coordinators

Document materials

Research that focusses on educational problems can make use of policy documents not only to understand the nature and sources of problems that are complex but also as a basis for further empirical studies. As a research tool, policy document analysis is a method for investigating the nature and content of a policy document to examine what lies behind and within it. Policy documents are produced in the arenas of politics and policy to direct management operations (Cardno, 2018). For example, Goldstein and Reiboldt (2004) conducted a document analysis to help generate new interview questions for their longitudinal ethnographic study. It is also necessary to determine the authenticity, credibility, accuracy, and representativeness of the selected documents (Bowen, 2009). We chose our material on the basis of the policies that guide the RDI strategies and actions of the HEI in question as a UAS responsible for regional development (Ministry of Justice, 2014; see also Etzkowitz, 2003; Lepori & Kyvik, 2010). We identified the themes of the strategy actions in the policy documents that guide the improvement of the innovation capability in the surrounding area of the case UAS. The documents provide guidance on different levels (broad global, national, and regional policy strategies) and in different areas (RDI, HEI, and working life). The documents were chosen to inform of the strategies on global, European, national, regional (county), city, and HEI levels. The documents included global sustainable development goals (United Nations, 2021), the strategies for achieving the priorities and recovery plan of the European Commission (2021a, 2021b) and G20 contribution, the 2020 strategic orientation and Pisa 2020 strategic vision and direction (OECD/EU, 2020a, 2020b; OECD/UNDP, 2019), the Nordic action plan (Nordic Co-operation, 2021), the programme of the local prime minister (Finnish Government, 2021), the programme of the regional council (Helsinki-Uusimaa Regional Council, 2021), the strategies of the cities where the UAS is located (Espoo, 2021; Helsinki City, 2021; Vantaa, 2021), and the strategy of the UAS (Metropolia University for Applied Sciences, 2021). The material consisted of strategy documents that directed the UAS innovation project education as part of the mandatory studies and aerial RDI responsibilities of the UAS (Ministry of Justice, 2014; see also Etzkowitz, 2003; Lepori and Kyvik, 2010).

Document analysis

Like other analytical methods in qualitative research, document analysis requires data examination and interpretation to gain understanding and develop empirical knowledge (Corbin & Strauss, 2008; Gibbs, 2012). Our document analysis was a systematic procedure of reviewing or evaluating documents, mainly electronic materials. The document analysis yielded data, including excerpts, quotations, or entire passages, that were then organised into categories, sub-categories, and representative quotations specifically through content analysis (cf. Bowen, 2009). The analytical procedure entailed finding, selecting, making sense of, and synthesising data contained in the documents. Our document analysis involved skimming (superficial examination), reading (thorough examination), and interpretation based on the recommendation of Bowen (2009). A thematic analysis was performed for pattern recognition within the data, using the emerging themes as categories for the thematic inductive analysis (Krippendorff, 2019). The analysis was conducted by first reading the documents twice and then inductively thematising the content piece by piece into sub-categories identified according to content. One reference unit was a sentence, group of sentences, or a part of a sentence discussing the same topic. First, the identified variation in meanings was categorised by description. These preliminary categories were not predetermined but were constituted on the basis of the collected text data. The first phase of the analysis focussed on understanding the phenomenon in general terms by reading and re-reading the data. Repeated readings afforded greater familiarisation with the text data. By focussing on the similarities and the differences in the expressed meanings, cases of variation were identified and themed accordingly. The initial description categories were further elaborated, adjusted, and defined according to the most characteristic features of each category. In the second phase, the second and third authors acted as the 'devil's advocates', poking on the preliminary categories (Bowen, 2009) to avoid subjectivity bias and blind spots. Finally, the variables were categorised according to qualitatively distinct descriptions and interpreted in a potential question format by the three authors (see Table 2).

Focus group workshops

Document analysis is often used in combination with other qualitative research methods as a means of triangulation. The qualitative researcher is expected to draw upon multiple (at least two) sources of evidence, that is, to seek convergence and corroboration through the use of different data sources and methods. Apart from documents, such sources include interviews, participant, or non-participant observation (Bowen, 2009). We decided to seek for further empirical materials from the responsible teachers and managers, as they work with external partners constantly. By involving teachers and innovation management staff, we ensured that the effect metrics were derived from UIC expertise in HEIs and in turn benefit pedagogy, the choice of partners, and development of the UIC. Regional communities such as non-governmental organisations were also considered, but we decided to delimit the sample to educational professionals to ensure fit with curricula and their larger societal aims. After all, the document analysis would offer wider societal views. Conducting focus groups offers a method for collecting material through an in-depth exploration of a topic to gain understanding without interfering, to determine the range without generalising, and to provide insights into how people perceive the matter without making statements about the population (Krueger & Casey, 2014; Shamdasani & Stewart, 2014).

We decided to conduct the first focus group for teachers and the second focus group for management staff. This way, we could ensure that the discussions were understood by all and that all participants felt safe to express their insights and opinions. Initially, of the 29 potential multidisciplinary innovation project teachers invited, eight participated in the first online focus group workshop (focus group 1). The participants had tutored 7–120 innovation project student teams in 1–40 project course implementations (approximately 7 weeks). In total, the participants had tutored 297 teams of 4–6 students in each team, that is, a total of approximately 1500 students. One teacher participated only as a theory lecturer and organiser of the education in innovation projects for several years.

Group interview, when organised as a facilitated workshop and data collection method, has the advantage of making use of interpersonal dynamics (Atkinson et al., 2013; Freilich et al., 2020). Such collaborative method promotes discussion, sharing of insights, and generation of ideas in a way that other methods cannot (Gameiro et al., 2018; Wilson et al., 2016). Focus group material collection allows for social interaction: the sharing of thinking, perspectives, and ideas with participants able to explore each other's responses verbally, adding to these and clarifying them, or developing them in line with their own beliefs and concepts (Gibbs, 2012). This promotes the synthesis and validation of ideas and concepts. It is important to apply a method that allows for collaborative idea development, as a common understanding of the pedagogy exists, although joint understanding of what is important knowledge is lacking.

During focus group workshop 1, the participants were divided into pairs and asked to generate questions to identify the immediate and delayed effects of innovation projects at the industry partner organisations. Each pair placed their ideas on sticky notes on the Google Jamboard online platform. The raw material data from the Google Jamboard contained 47 drafts for the questions. Upon removing duplicates, 45 were left (focus group 1). After that, 10 innovation management members were invited on the basis of their responsibilities in the multidisciplinary innovation project coordination. Five of the invited manager-coordinators attended (focus group 2). This group was chosen to assess the preliminary results, as they were considered to play a key role in assessing how UAS strategies are reflected by innovation projects. First, the participants evaluated the suggested sub-categories and their exemplary questions using the following scale: 1) 'I consider this theme of paramount importance to ask'; 2) 'This topic is worth asking'; and 3) 'This theme can be asked if it fits in the question set.' Second, a discussion was facilitated, and the participants were asked to improve the format of the questions and suggest new questions that fit the sub-category.

Focus group material analysis

A qualitative content analysis provides a means to gather both latent and manifest contents from raw materials (Elo & Kyngäs, 2008; Graneheim et al., 2017). The focus group 1 data consisted of questions formulated by the participants. The material was analysed using a data-driven, thematic inductive analysis (Krippendorff, 2019). The analysis was conducted by first reading the literary material twice and then inductively thematising the content piece by piece into theme sub-categories identified according to content. We encoded the reference units and tracked the stages of the analysis to ensure the rigor of the process. One reference unit was a variable that appeared in a question format, that is, as a sentence, group of sentences, or part of a sentence discussing the same topic. The first phase of the analysis focussed on identifying and describing the potential themes of the questions, that is, the effect metrics variables, by reading and rereading the data. Repeated readings afforded greater familiarisation with the data and allowed for thematising the data to categories by focussing on the similarities and differences in cases of variation in the text. Owing to the focussed and condensed nature of the raw material, abstraction and interpretation remained at very low levels. Instead, we stayed close to the text and simply categorised the material, as suggested by Tuomi and Sarajärvi (2018). The document and focus group data were kept separate, as this allowed for later assessment of the importance of the variables in focus group 2. The focus group 2 material was matched with the focus group 1 material by collecting numerical estimates of the participants into tables (see Tables 2 and 3). The wording of the sub-categories were combined, rephrased, and improved in focus group 2.

Results

In this study, we aspired to discover the effect metrics for UIC innovation projects in HEIs. The main research question was 'What variables are important when studying the effects of innovation education projects of UAS in the surrounding society, participating companies, and organisations?' The aim was delimited to the assessment of the project outside educational institutions. The results of the document analysis after the content-driven thematisation and proposed questions from focus group 1 and their assessment by focus group 2 are presented in Table 2.

Table 2. Results of the document analysis: categories and sub-categories from the document analysis and simplified phrases of representative citations, and proposed questions based on the document analysis by focus group 1 and assessment by focus group 2. Assessment criteria: I = important; WA = worth asking; LI = less important; NA = no answer.

Category	***Sub-category***	***Simplified phrases***	***Proposed question***	***Assessment****
Social sustainability	Citizen well-being	Ensure healthy lives and promote well-being (United Nations)	Did the project relate to well-being and health issues or promotion? Did the project increase well-being and/or health of people? How?	I = 60% WA = 40%
		Well-being and health promotion (Vantaa 2021)		
	Social responsibility	Social responsibility (Finnish Government 2021)	Did the project relate to and/ or promote social responsibilities like youth inclusion, ageing of the population or gender equity? How?	I = 100%
		Youth inclusion (Finnish Government 2021; Helsinki City 2021); Aging (Finnish Government 2021); Gender equality (United Nations; European Commission 2021b)		
Everyday life	A functional and experiential everyday life	Hassle-free and comfortable urban life (Helsinki City 2021)	Did the project relate and/or promote a functional and experiential everyday life of people? Did it involve active participation of citizens? Did it produce experiential, creative or cultural outcomes for vibrant and attractive city/ local community? What?	I = 80% WA = 20%
		Smooth everyday life (Espoo 2021)		
		Active participation of residents (Espoo 2021)		
		A vibrant and attractive city (Vantaa 2021)		
	Creativity and culture	Open-mindedness and creativity, openness, questioning the present and the courage to do things in a new way (Espoo 2021)		
Ecological sustainability	Climate wisdom	Ecologically sustainable Finland, mitigating climate change and protecting biodiversity, responsible and decreasing use of natural resources (Finnish Government 2021)	Did the project contribute to ecological sustainability? Did it mitigate climate change? Did it relate to experiences and care for nature ? How?	I = 80% WA = 20%
	Nature	Experiences and care for nature (Helsinki-Uusimaa Regional Council 2021)		
Employment and economic growth	Employment	Economic growth, full and productive employment and decent work (United Nations)	Did the project enhance employment or mitigate unemployment? Did it contribute to economic growth? How?	I = 60% WA = 40%
		Vitality from startups and SMEs (Helsinki-Uusimaa Regional Council 2021)		
	Economic growth	Economic growth by high rate of employment (Finnish Government 2021)		
Technologies and innovations	Digitalization and technological development	Technological development (Finnish Government 2021; Helsinki-Uusimaa Regional Council 2021)	Did the project produce technological improvements or/ and new technological solutions? How and what?	I = 80% WA = 20%
		Artificial Intelligence and Robotics (Metropolia University for Applied Sciences 2021; European Commission 2021a)		
Competence and learning	Competence development	Quality education and promote lifelong learning (United Nations)	Did the project improve your or your company's competence? Did you get new networks? Did you learn during the project? What?	I = 100%
		High expertise (Finnish Government 2021); Expertise for the future (Metropolia University for Applied Sciences 2021)		

		Digital skills (European Commission 2021a; Metropolia University for Applied Sciences 2021)
	Networking and partnerships	Internationality (European Commission 2021a)
		Interactivity (Metropolia University for Applied Sciences 2021)

**Assessment criteria: I = important; WA = worth asking; LI = less important; NA = no answer.*

The results of the document analysis consisted of 6 categories and their 11 sub-categories and the question proposals from the focus group 2 material (Table 2). The proposed effect metrics variables (i.e. themes) for the impact assessment of UIC innovation projects related to the 1) social sustainability effects, such as citizen health and well-being, and social responsibility, such as inclusion, equality, and aging; 2) everyday lives of the residents and their functional, experiential, creative, and functional forms in a vibrant area; 3) ecological sustainability such as mitigating climate change and care for nature; 4) employment and economic growth by promoting employment and the vitality of local firms; 5) technologies and innovations in the form of RDI and promoting new technical applications; and 6) competence development such as lifelong learning, high expertise, digital skills, and new networks.

Table 3. Results from focus group 1: categories, sub-categories and simplified phrases of representative citations of the proposed questions and assessment from focus group 2. Assessment criteria: I = important; WA = worth asking; LI = less important; NA = no answer.

Category	***Sub-category***	***Representative citations***	***Assessment****
Added value of the project	Sustainability value	Has it promoted ecology? Has it contributed to your other sustainability goals? How in practice? (Teacher A)	I = 80% LI = 20%
	Value for clients own targets	Which of your own strategic goals were positively impacted? (Teacher B)	WA = 40% LI = 40% NA = 20%
		Has the project outcomes been a financial benefit to the company? (Teacher E)	I = 100%
		Has the output been useful? (Teacher A)	I = 80% LI = 20%
	Learning of client	Did you learn something on a personal level, what? (Teacher H)	I = 20% WA =80%
		What has the organization learned from the project process? (Teacher B)	I = 80% WA = 20%
Outcome of the student teams	Outcome implementation	Did the product go on sale or otherwise to concrete use? How much did it require for your own further development work? (Teacher F)	I = 80% WA = 20%
		In what form is the output implemented? The whole outcome, a part of it, or just an idea? (Teacher B)	I = 80% NA = 20%
	Outcome further development	Do you currently have a product, service, or business model based on an idea from the project? (Teacher H)	I = 100%
		Has there been further development ideas based on the project? (Teacher H)	I = 80% NA = 20%
		How did you apply the outcome? (Teacher D)	I = 80% WA = 20%
Participation in the project	Being a client	Did you keep in close contact with the student team? (Teacher E)	I = 40% WA = 20% NA = 40%

	Did you get value for your time / resources you dedicated to the project?	WA = 60% LI = 20% NA = 20%
	Could you recommend this project to other companies / organizations? On what basis, why?	I = 80% WA = 20%
Organizing of the project course	Would you like to be more involved in the guidance?	I = 20% WA = 20% LI = 20% NA = 40%
	How would you like the project process to be further developed? (Teacher G)	I = 40% WA = 40% NA = 20%
	How did multidiscliplinarity of the teams add value? (Teacher A)	I = 60% LI = 20% NA = 20%

**Assessment criteria: I = important; WA = worth asking; LI = less important; NA = no answer.*

The proposed variables related to 1) the added value of the innovation project included three sub-categories: sustainability value, values for the client's own targets, and the learning and organisation of the client. Those related to 2) the outcome of the student teams promoted focussing on the outcome implementation such as product sales or usage, and the product's journey after the project (further development or application by the client). The variables related to 3) the client's participation in the innovation project included acting as a client, such as keeping contact with the students and the return of the invested resources (Table 3).

Both materials emphasised the importance of asking about the sustainability effects: ecological, economic, and social value of the projects to the clients and the surrounding society. Only the document material brought up the following cultural values explicitly on this superficial level of analysis: 'education and culture' (Finnish Government, 2021), 'live events' (Helsinki City, 2021), and 'creativity' (Metropolia University for Applied Sciences, 2021). Both materials emphasised the meaning of learning and competence development of the client and the organisation the client represents ('Did you learn something on a personal level? What?' [Teacher H]; 'What has the organisation learned from the project process?' [Teacher B]; quality education and promote lifelong learning [United Nations, 2021]; high expertise [Finnish Government, 2021]; expertise for the future [Metropolia University for Applied Sciences, 2021]; digital skills [European Commission, 2021a; Metropolia University for Applied Sciences, 2021]).

On the basis of the results presented in Tables 2 and 3, most sub-categories were combined, rephrased, and improved in focus group 2. The respondents in focus group 2 considered the following four themes to be of paramount importance in the questions they were to formulate: 1) social responsibility (e.g. Finnish Government, 2021); 2) the financial benefit of the project outcomes to the company (Teacher E, focus group 1); 3) if the client has a product, service, or business model based on an idea from the project (Teacher H, focus group 1); and 4) whether the organisation learned from the project. These were based on the variables identified in the document analysis, such as 'Quality education and promote lifelong learning' (United Nations, 2021), 'High expertise' (Finnish Government, 2021), 'Digital skills' (European Commission, 2021a; Metropolia University for Applied Sciences, 2021), and 'Internationality' (European Commission, 2021a). The less important themes were the impact of the project on the client's own strategic goals (Teacher B, focus group 1) and the client's own learning (Teacher H, focus group 1).

Figure 1. Suggested impact assessment model for innovation projects based on the results from the document analysis and focus groups.

Finally, the results of the document analysis and focus groups were integrated to form one entity by first removing duplicate variables and then thematising the sub-categories. On the basis of the findings and focus group 2 assessment, a total of 9 sub-categories were chosen for the final categorisation. The proposed effect measurement variables for the impact assessment of UIC innovation projects were divided into two categories: 1) Impact on the organisation's goals that is comprised of the concrete output (e.g. product, service, and operating model) of the project, the experienced benefits of the industry partner, and the trajectory of the student output after the project, and 2) wider impact on society that is comprised of the effects on daily lives, health, and well-being of the citizens in the area and the wider economic, ecological, social, and digital effects (cf. effects on digitalisation) that the projects may have (Figure 1).

Discussion and conclusions

UAS have the mandate and requirement to participate in the development of their surrounding area (Ministry of Justice, 2014; see also Etzkowitz, 2003; Lepori & Kyvik, 2010). Even students participate in this development, such as via UIC innovation projects (Heikkinen & Isomöttönen, 2015; Hero & Lindfors, 2019; Keinänen & Oksanen, 2017), but these projects lack external assessment criteria for understanding their effects on society. The aim of this study was to identify the effect metrics for determining the impact of the UIC innovation projects. The main research question was 'What variables are important when studying the effects of innovation education projects of UAS in the surrounding society, participating companies, and organisations?' Student learning and competence development were delimited from the study. It was important to identify the meaningful effect measurement variables to continuously collect insights that teachers and coordinators of these projects can use in selecting partners as clients for student teams and in making UIC innovation projects more transparent for all parties involved: the decision makers in HEIs, external stakeholders such as funding bodies, HEI management groups, teachers, and students. Unfolding the impact outside the UAS would provide an opportunity to renew and develop innovation pedagogy.

The data consisted of policy documents and written focus group materials. The research data were studied by two researchers, and the preliminary results of the document analysis and focus group 1 were evaluated robustly by experts in focus group 2. As a practical implication and on the basis of the results, we suggest an impact assessment model (Figure 1). The important variables based on this study are related to project output; experienced benefits of participating in UIC innovation projects as a client; what happened to the student outputs after the project and what survived in some form; how the project impacted the daily functional, cultural, and experiential lives of citizens and their well-being and health;

and whether it had economical, ecological, and social sustainability effects or promoted digitalisation. (Figure 1.)

Our findings largely support those of Perkmann et al. (2011), who distinguished between different process stages: inputs (cf. 'Benefits of participating' [focus group 1]; 'Project output' [focus group 1]; and in-process activities, outputs, and impacts (cf. wider impact on society, such as 'Ecological impact', 'Health and well-being', 'Digitalisation' [document material]). However, our study focussed on the effects of UIC as retrospective subjective and objective measures and not as prospective measures (Perkmann et al., 2011). Maritz et al. (2014) postulated that the assessment of the effects of UIC projects should capture both the process and outcome, impact, student behaviours, financial resources, innovation intentions, knowledge gained, and return on investment and skills. The results support mainly these aims, as the findings emphasise the economic impact, learning of the industry partner organisation. However, student learning, student behaviours, and innovation intentions and behaviours were delimited from the study. In addition to the variables identified by Maritz et al. (2014), our results revealed the variables of well-being and health, social, ecological, and effects on digitalisation. Our results suggest that in the UIC context, there should be a wider and more sustainability-oriented impact assessment than the economic impact measures suggested by, for example, Cheah (2016).

Even though the data were gathered and analysed rigorously, it is not possible to generalise from the results of this qualitative study with only 13 documents and 13 focus group subjects, as the context is delimited to one area (Finland, capital area) and one UAS. The model can act as a basis for practical assessment tools such as an interview guide that would help HEIs discover the opinions and experience of client partners and their views on the effects of innovation projects. However, future research is needed, as these results may only be applicable in one area. However, the method of gathering the aerial document data can also be applied to other areas. Further research is recommended to determine the actual effects of UIC innovation projects on the basis of the suggested model. The methods of gathering data may vary, but the findings suggest that qualitative data (e.g. industry partner interviews) would be a suitable option. Semi-structured interviews may provide an opportunity to stick in sub-category themes but still help the interviewee to dig deeper by asking further deepening questions.

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*Document analysis material is marked with *.*

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PhD. Laura-Maija Hero acts a senior lecturer (cultural management) and a researcher in Metropolia University for applied sciences in Finland. She holds a phd in craft, design and technology education. Her post-doc research concerns innovation pedagogy and digitalization, extended reality and metaverse related educational topics. She leads a research team and is active in local and international RDI networks. She has a long experience in international technology business in different marketing management positions.

PhD. Marianne Pitkäjärvi acts as a principal lecturer and a researcher at the School of Health Care in Metropolia University for applied sciences in Finland. She has experience in the education of and research regarding healthcare professionals; supervisory role in numerous Master Thesis and service design projects with themes relating to health & wellbeing and pedagogy; participatory and managerial roles in several national and international research and development projects focusing on internationalization of higher education as well as on health and wellbeing and digitalization and productization of higher education.

PhD. Kaija Matinheikki acts as a principal lecturer responsible for the research and development work in the faculty of welfare, Metropolia University of Applied Sciences in Finland. She is an adjunct professor of University of Jyväskylä in Multicultural Education and Career Counselling. She has professional experience in the field of research and development focusing on intercultural learning and counselling, integration policies and welfare issues, human resources and capacity building within the national and international context.