Innovation activities in a university of applied sciences: redefining applied research

Liubov Vetoshkina
Department of Education, University of Helsinki, Helsinki, Finland
Laura Lamberg, Essi Ryymin and Heta Rintala
Häme University of Applied Sciences (HAMK), Hämeenlinna, Finland, and
Sami Paavola
Department of Education, University of Helsinki, Helsinki, Finland

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Abstract

Purpose – This study analyses development of research-related innovation activities in a University of Applied Sciences (UAS) in Finland. Focus on production of innovations in relation to academization challenges the traditions of applied research in UAS, which has always relied on collaboration with local stakeholders.

Design/methodology/approach – Drawing on the approach of cultural-historical activity theory, the study conceptualizes development of innovation activities as a movement across multiple intertwined developmental lines. The authors ground these conceptualizations in the data, coming from interviews with key researchers in a multidisciplinary research project on smart bioeconomy at a Finnish UAS.

Findings – Development of research-related innovation activities in the UAS happened along six lines: development of researcher's expertise, development of project, development of organization, development of research, development of field and development of funding models and policies. The developmental tensions between the lines were essential for promotion of innovation activities.

Originality/value – The study reveals the complex multilayered nature of research-related innovation activities in the specific context of UAS, where it creates challenges and opportunities for developing the traditions of applied research. The results encourage UAS to critically evaluate their changing role as research institutions in regional, national and international innovation systems.

Keywords Innovation activity, Applied research, University of Applied Sciences, Cultural-historical activity theory, Multidisciplinary research

Paper type Research paper

1. Introduction

In innovation models, research organizations are traditionally considered an essential part of innovations. Linear models, both "technology push" and "market pull" models, understand the source of innovation to be in basic research, followed by applied research and development (R&D), which eventually lead to production and diffusion (Godin, 2006). In contrast, non-linear models, for example the triple helix model, focus more on the dynamics of innovation, highlighting unstable and changing nature of university-industry-government interactions (Etzkowitz and Leydesdorff, 2000; Cai and Etzkowitz, 2020). This model stresses the enhanced role of the university in production of innovations in the knowledge-based society.

These innovation models primarily focus on academic and research universities emphasizing basic research, while less is known on the innovation contribution of

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universities of applied sciences (UAS) (Mäkimattila *et al.*, 2015; Schlegel *et al.*, 2022). The university sector shows shortcomings in what is typical for research in UAS, namely, application of research results and collaboration with industry (De Weert, 2011). Recently, this focus on applied research is challenged due to increased academization of UAS and increase of the importance of their research mission. These transformations erode the traditional boundaries between basic and applied research (Carvalho and Diogo, 2020; Tight, 2015).

Among Nordic countries, Finland has been regarded as a forerunner in innovation policies and development of innovation systems (Miettinen, 2013b). In Finland, in light of recent policy changes, including new funding models, UAS, in addition to a variety of existing R&D activities, is also expected to produce basic or fundamental research and transform their research, development and innovation (RDI) activities (Maassen *et al.*, 2012; Ministry of Education and Culture, 2019; Ministry of Education and Culture Finland, 2020; Heikkinen and Kukkonen, 2019). This is a challenge to the dual or binary systems, with a strict division between the research universities and UAS (Carvalho and Diogo, 2020; Heikkinen and Kukkonen, 2019). In practice, the changing role of UAS often means that researchers and research organizations are expected to engage into so-called "innovation activities" – activities that are deliberately aimed at development and implementation of innovations and new knowledge (OECD/Eurostat, 2018). In studies on involvement of researchers in RDI activities, analysis is often focused on opposite processes of how academics manage the pressure on conducting applied research (Lam, 2010).

The aim of the article is to study development of research-related innovation activities in UAS. The data for the study come from interviews with key researchers in a multidisciplinary research project on smart bioeconomy in a Finnish UAS. The aim of the studied project was creation of cross-disciplinary data-driven knowledge and application of this knowledge in practice. The project combines expertise of four research units of the UAS.

To conceptualize and analyse the notion of innovation activity, we utilize a framework of cultural-historical activity theory (CHAT) (Engeström, 2015; Miettinen, 1999). This framework allows focusing on procedural and developmental dimension of innovation, considering contradictory interactions and co-evolution of various layers within concrete innovation activities (Toikka *et al.*, 2016). Historical development of activity is conceptualized as a tension-laden movement across multiple intertwined developmental lines in activity, connecting past, present and future (Vetoshkina, 2018).

Based on this understanding, we develop an analytical framework for identification of developmental lines in innovation activities. Our study was guided by two theory-driven research questions:

RQ1. What kind of developmental lines can be identified in innovation activities in the project?

RQ2. What kind of tensions between the developmental lines were crucial for development of innovation activities?

We start our inquiry with a background on the current transformation of UAS research and innovation activities in Finland. After that we provide a description of the theoretical and conceptual framework to innovation activities and their development. We continue with reporting details on our research case and the data and introduce our analytical framework. The results of the analysis consist of descriptions of developmental lines and tensions between them. We end our paper with a discussion of the findings in light of changes of UAS research profile and its role in production of innovation.

2. Research context: UAS in Finland

In European countries, the organization of higher vocational and professional education has different historical, economic and cultural characteristics. In Finland, UAS emerged in the beginning of 1990s rather rapidly and became firmly established as a part of the national education system. A relatively strict division has existed between the roles and the tasks of so-called research universities and those of UAS, also known as dual or binary system (Heikkinen and Kukkonen, 2019). UAS focused on professional education, regional development and applied research (Universities of Applied Sciences Act, 932/2014). The tasks of UAS have gradually expanded over time: R&D activities have been formally introduced since 2003, and innovation activities since 2015. Recently, basic and fundamental research started appearing in strategies of UAS, and they are expected to attract more external funding (Maassen *et al.*, 2012; Ammattikorkeakoulujen rehtorineuvosto/Arene ry, 2017). Traditionally, goals of RDI activities in UAS were to produce knowledge and solutions based on applied research for public and private companies and organizations regionally, and to serve educational activities (Maassen *et al.*, 2012).

Since the introduction of research mission, UAS is regarded as central actor in regional innovation systems (Välimaa and Neuvonen-Rauhala, 2010). R&D projects in UAS in Finland have often aimed at development of regional and sectoral ecosystems, and a significant part of projects include external funding from various sources. UAS provides testing services, operating environments and workforce to support RDI activities of project partners (Ammattikorkeakoulujen rehtorineuvosto/Arene ry, 2017).

In the recent years, expectations towards research and educational activities in UAS in Finland have changed as they are expected to develop their RDI activities by attracting more external research funding, becoming internationally competitive and engaging in new kinds of partnerships with higher education institutions, including research universities, other UAS and businesses (Carvalho and Diogo, 2020; Heikkinen and Kukkonen, 2019; Ministry of Education and Culture, 2019; Ministry of Education and Culture Finland, 2020).

The dual system with relatively clear distinction of tasks between research universities and universities of applied sciences is shattering due to influence of the knowledge society, massification of the educational sector and educational restructuring (Carvalho and Diogo, 2020). UAS are undergoing the process of academization or academic drift (Tight, 2015). Research universities are undergoing a professional drift and becoming "entrepreneurial universities" with focus on practical implications of research results and their commercialization (Carvalho and Diogo, 2020; Klofsten *et al.*, 2019). This creates a potential threat to traditions and practices of applied research in UAS, as the produced knowledge loses ties to practice and becomes integrated into scientific knowledge (Harwood, 2010).

3. Conceptual framework: innovation activities and their development

There are different concepts and terms used to describe and analyse innovations and various processes around them (Kotsemir *et al.*, 2013). When discussing concepts specifically for measuring innovation in business, the Oslo Manual (OECD/Eurostat, 2018) uses the notion of "innovation activities", referring to process, while limiting the word "innovation" to outcomes. Innovation activities are understood as "all developmental, financial and commercial activities undertaken by a firm that are intended to result in an innovation for the firm" (OECD/Eurostat, 2018, p. 68). In this interpretation, some activities are novel, while others are not themselves novel, but necessary for the development or implementation of innovations. Innovation activities do not necessarily result in innovations.

The notion of innovation activity is, however, rarely substantially defined and theoretically conceptualized. The term is used primarily in business-oriented literature: sometimes it appears almost as a synonym for innovations (e.g. Casali *et al.*, 2016) or for R&D

activities and innovations together (e.g. Kyriakopolous *et al.*, 2016). The concept of innovation activities and its theoretical basis can be further developed specifically regarding the scientific use of this concept to expand its application to understanding of innovation processes in different contexts.

We use CHAT to conceptualize the notion of innovation activities and develop an analytical framework to study their development. This approach allows focus on procedural dimensions of innovations by considering contradictory interactions and co-evolution of various layers within concrete innovation activities, influencing development of innovations, including product development, researcher and user communities and larger networks of society (Miettinen, 1999; Toikka *et al.*, 2016).

Engeström (2015) has developed an understanding of human activities as object-oriented activity systems, where various tools are employed to work on an object collectively with a division of labour, to obtain a certain outcome. The object of activity means raw material and a purpose or motive of the activity in question. In previous studies of innovation within this framework, the central focus of understanding has been defined as an objectual network of innovation (Miettinen, 1999; Toikka *et al.*, 2016). They are understood as constantly developing heterogeneous networks of multiple activity systems with multiple actors (including end-users), who are involved in development and implementation of innovation, jointly working on a certain object of activity. This requires often long-term development and various kinds of expertise (Toikka *et al.*, 2016). Sustainable innovations are created across a longer period in the process of object construction (Vetoshkina and Toiviainen, 2022).

The principle of historicity in CHAT means analysing history and development of a given activity system or a network of activities. Concrete historical analysis of activities may happen on multiple levels. For instance, Vetoshkina (2018) conceptualized historical development of activities as a movement across heterogeneous and intertwined lines of history across the past, present and future: (1) line of personal history, (2) line of community history, (3) line of general history and (4) line of the object history. Movement across the lines was depicted as happening by resolving conflicts, tensions and contradictions, specific for each line.

Focus on history makes it possible to understand current problems and contradictions, as well as to sketch developmental potential of an activity system (Engeström, 2015; Engeström and Sannino, 2011). The concept of contradiction as simultaneous existence of incompatible or opposite things is essential in this framework, as development is conceptualized as constant creation and resolution of the contradictions (Engeström and Sannino, 2011). For Miettinen (2013a), developmental contradictions in human activities comprise a foundation for innovation, as defining a productive problem itself contains directions for solving it. Contradictions in activity are usually systemic and aggravate in activity across a significant period, and in everyday actions they are manifested as various conflicts and tensions. Contradictions are difficult to access directly from empirical data, but they can be approached through their manifestations in activity (Engeström and Sannino, 2011).

Drawing on these ideas, we aim at analysing development of innovation activities as movement along developmental lines across past, present and future. These lines are not fixed, but are specific to activities under scrutiny and need to be identified in each concrete case.

4. Data and method

4.1 Case and data

The methodological framework of the study draws on the CHAT, where it is understood as building a bridge between theory and data in their constant interaction and co-evolution (Vetoshkina and Paavola, 2021). This does not mean application of specific techniques, but implementation of certain methodological principles of CHAT, including, among others, focus on activity systems, historicity and multi-voicedness (Engeström, 2015).

Our data come from a multidisciplinary research project concerning smart bioeconomy in a Finnish UAS. The project aims at creating cross-disciplinary innovations through data-driven knowledge creation. The first strand of the project focuses on the utilization of data analysis and interpretation in value chains of food production and uses methods of IoT (Internet of things) and machine learning in analysing, monitoring and optimizing the production chains of, for example, dairy products, vertical farming and algae cultivation. The second develops digitalized measurements as well as IoT-based data collection, analysis and interpretation in the context of carbon and nutrient dynamics. The project combines competences and research interests of four research areas in the UAS, including biological, digital, technological and educational. Educational and organizational researchers inside and outside of the organization have been brought together to investigate knowledge creation processes related to the project.

The key data consist of 11 semi-structured interviews with key researchers involved with the research project. The aim of the analysed interviews was to map the project, its focus and goals, history, expectations and involved stakeholders. The overall length of the interviews varied from 37 to 97 min. The interviews constituted the focal data for this article, but we also used auxiliary ethnographic data, collected by the educational researchers. This data included observations of project meetings, interviews, workshop data, field visits, project documentation, descriptions and other text artefacts. The supporting data are not analysed in this article but were used to make sense of the focal interview data.

4.2 Ethical considerations

The interviewees have signed a consent form. To ensure the anonymity of the research participants, in the presentation of results we use excerpts referring only to an assigned number for each interview (with numbers allocated randomly), without giving other details (such as a title or role in the project). The projects are public, and without the omission or paraphrasing of certain revealing details, participants could be identified (removed and paraphrased text is in brackets). Nevertheless, we have tried to ensure the diversity of voices and consistency of their presentation by referring to the randomized interview numbers in the excerpts. The previously mentioned points also affected our choice of excerpts for the article. The UAS has also granted permission for the research, and the writers of this article have signed a data usage agreement.

4.3 Analytical framework and procedure

Our analysis was both theory- and data-driven. We have applied a modification of thematic analysis (Braun and Clarke, 2006). The interviews were transcribed by an external service. The preliminary reading of the data showed a long and complex history behind the projects, unfolding on multiple levels. We decided to apply the analytical framework of lines of history in activity and their potential intersections (Vetoshkina, 2018). We drafted potential developmental lines, with which three researchers coded the data set independently to ensure the triangulation of the analyses (Denzin and Lincoln, 2011). In the process of analysis, lines were modified and specified. The unit of analysis was a thematic episode – a part of an interview, constructed around a certain theme or topic, which could be a part of a speaking turn, a speaking turn or several turns. Each thematic episode could contain from one to several lines of history. Overall, we identified 365 thematic episodes.

We defined a developmental line as a trajectory following evolution around a certain significant topic or phenomenon in activity. We identified the following developmental lines in the data:

(1) Development of researcher's expertise (139 instances);

(2) Development of project (200);

(3) Development of organization (164);

(4) Development of research (245);

(5) Development of field (190);

(6) Development of funding models and policies (65).

Thematic episodes also contained intersections of the lines. There were following types of intersections:

(1) Simple mentioning without explicit connection.

(2) Mutual support when the development on one line clearly supports the development on another.

(3) Conflicts or tensions, when the development on one line clearly disturbs or prevents the development on another line.

(4) Developmental tensions, where a certain tensions or conflicts between the developmental lines led to development or creation of something new.

In this article we are specifically focusing only on the developmental tensions and their roles in the development of innovation activities (159 instances), when focusing on all the possible overlaps would be excessive for one article. The focus on tensions is determined mainly by the theoretical framework of CHAT, where various tensions and conflicts are central for understanding the development of activity (Engeström, 2015).

5. Results

The results are presented with the help of the excerpts from the data in accordance with the research questions: first, we focus on RQ1 and describe the developmental lines identified in the research-related innovation activity in the project. Then, we focus on the RQ2 and describe the developmental tensions between the lines and their role in the development of innovation activities.

5.1 Developmental lines in innovation activities

Line 1: development of researcher's expertise. This line reflects the development of researcher's expertise, career and research interests. Although the process of building expertise appeared as a long-term work in a specific field, expanding to different fields was an important element in performing the tasks and strengthening researcher's profile (Ex. 1).

> *Excerpt 1.* I'm mainly involved with research on [research field A], but of course since I have this [research field B] background, I'm also involved with these [field B] things in a role of some kind. Mostly I guess as a kind of specialist. But when you write these research proposals [. . .], then it's for sure this larger group. I'm not completely fixated on [field A], rather I get to use my own expertise in many other things too. *(Interview 9)*

Interviewees talked about the development of their core competences and their development in connection with and through the projects they are involved in. Flexible and expanding expertise was important, especially in the project-based work across disciplines, where collaboration plays the key role.

Line 2: development of a project. The second line focuses on life cycles of specific research projects. Explaining the history and distinguishing different projects from one another was not a simple task for researchers – it was sometimes difficult to define which actions belonged

under which specific project. Different projects supported each other to provide continuation and development of a broader research programme (Ex. 2), as the timeline of a single project itself was not always enough to conduct longitudinal research (Ex. 3).

Excerpt 2. The next proposals, so what happens is that one is now being written and another being planned, so of course it's like this needs continuation [. . .] so it's like, whichever elements from this happen to become the next biggest thing in this field of smart bioeconomy, well, there'll be that continuation. *(Interview 6)*

Excerpt 3. [. . .] the time we have isn't enough to collect the kind of data where the effects in [research field] could be discovered. So we won't be getting an article like that but hopefully something, from the point of view of how exactly [a researched phenomenon] can be followed. So that's what we've now set as our goal and we're hoping the time is sufficient. *(Interview 2).*

The project-based way of conducting research provided a way of focusing on a specific research issue and acquire funding, and the combination of different projects brought forth certain research focuses, in this case smart bioeconomy.

Line 3: development of organization. The third line focuses on the development of the organization where projects took place, the UAS. The researchers reflected on development of teaching and structural changes in the UAS, namely, division of degree programmes and research units. The emergence of research units meant new recruitments with stronger emphasis on research merits (Ex. 4). The goal of strengthening the organization's research profile was also underlined with the change of a title "*yliopettaja*" (principal lecturer) to "*tutkijayliopettaja*" (principal research scientist) and basic requirements to the position.

Excerpt 4. We have a constant debate here about why we publish, since we're not a research university, but the thing is that [our organization] has invested a great deal in research. We have a lot of principal research scientists, post doc researcher level people coming to work here, [. . .] we can't succeed in international grant applications, if our researchers don't have publication portfolios. We'll be dropped out already in the initial phase, nobody will even consider us for their applications [. . .] So there's a clear reason why we publish, it's that we won't be a believable research partner, or a believable actor internationally if we don't produce high-quality publications. *(Interview 4)*

When interviewees discussed development of UAS and mentioned "research", they often meant "fundamental science" and basic research which results in scientific publications. At the same time, there was a long tradition of small-scale applied research in collaboration with business partners before the establishment of the research units as a part of the organization. In this case, scientific publications were not a primarily goal. Students were also involved into research in various ways, for example, internships, theses and student projects.

Line 4: development of research. The fourth line focuses on the development of research in a certain scientific field or a discipline – changes in how research is done. In this multidisciplinary project, the researchers were talking about challenges and benefits of multidisciplinary research, for instance, contributions of smart services and technology researchers allowed planning new equipment, bringing different possibilities to biological research (Ex. 5).

Excerpt 5. Yeah, so our starting point has been that we need a new [piece of equipment]. We have [it], but it's more or less held together with adhesive tape right now [laughing], some kind of this. So we needed a completely new one, and now we

started building a proper one from scratch and we'll think about the [features of the equipment], so we can get more accurate measurements and better control of [research field A]. *(Interview 11)*

Excerpt 6. I don't see, the difference comes from me working with [research sub-field A], and right now I work with [research sub-field B]. We're talking about pretty much the same thing. [. . .] The application possibilities are similar to a great extent. The only thing that is the [research material] that has changed, and it also offers different possibilities in some ways. *(Interview 9)*

Different fields often had similar ways of conducting research, which also made multidisciplinary research possible (Ex. 6). The development of research rarely took place within one discipline independently.

Line 5: development of field. The fifth line focuses on the development of a practical field where research is conducted and research results are applied (e.g. dairy production, farming). Development in a field often has a strong economic emphasis, while academically oriented research does not always bring instant and economically feasible solutions (Ex. 7). The idea of development solutions with and for end users was really strong (Ex. 8). Research does not always bring instant solutions (Ex. 7, 8).

Excerpt 7. If it does not matter, that these products are expensive. If the value is that [they are locally produced]. If this has value, for example that [this product] costs twice as more as in a store, than it can be [used]. It is not financially viable. *(Interview 10)*

Excerpt 8. But then if this experiment succeeds, that [anchor][. . .] It could then become a monitoring tool for the [practitioner], and, like this, it would be an innovation here as a result. [. . .] That we are not here in our own clouds making world a better place, that if a [practitioner] bumps into me in the street and asks: "What's new you have there in [the UAS]?" We can say that next month there will be an event, and it is worth coming [there], that there is a direct application, like that . . .. *(Interview 8)*

The UAS had a long history of collaboration with different stakeholders from the field, aimed at creating direct applications. With the new funding schemes and goals of scientific publishing, the created knowledge does not always have direct applications to practice.

Line 6: development of funding models and policies. The sixth line focuses on the changes in funding models and policies around UAS. The interviewees mentioned that the changing funding model of UAS is bringing in a type of research more common to research universities. The organization used to rely on smaller scale projects with direct funding from companies, while now a greater share of funding started to come from public sources and the collaboration models with companies are also changing (Ex. 9).

Excerpt 9. Well, we are, by definition, a university of applied science. Since research universities do scientific research, we do applied research. We, kind of, we have to balance between this situation that, on the other hand our funding is constantly shifting towards [. . .] that competitive international funding, EU funding, Horizon programmes and what else is out there. *(Interview 4)*

In the new funding model, UAS has to compete for the same funding as research universities. These changes called for stronger rethinking of both strategy and practices of the UAS to develop the research profile.

5.2 Developmental tensions

In the interviews, the developmental lines seemed to be integrated in the development of innovation activities potentially supporting and reinforcing each other or causing tensions between them. Already in the description of the lines above, the tension-laden nature of movement along the lines became evident (e.g. Ex. 4, 6).

The new funding policies and schemes were considered to change the profile of the UAS, especially research-wise. In the development of organization (Ex. 10, Ex. 4 earlier), the interviewees experienced that the strong tradition of applied research (Line 3), conducted in collaboration with companies (Line 4), was gradually changing, due to new expectations towards the tasks of UAS in scientific research production (Line 6). To execute new strategy and new type of projects (Line 2), the organization had to recruit more workers with strong research merits (Line 1), who are able to foster new ways of doing research (Line 4) and a stronger research profile for the UAS (Line 3).

Excerpt 10. But there's no like, or actually there's been more talk about how [our organization] doesn't have a research tradition in a sense, I mean, we've done experiments and such, we've gotten ourselves familiar with the subject, but we don't have that kind of scientific research tradition, which is now the main idea of [person A] that we're creating it now. *(Interview 7)*

New ways of doing research were also emerging through overcoming boundaries (Ex. 11). The lack of specific research infrastructure inside the organization (Line 3) made it difficult to directly compete with research organizations with established research infrastructures (Line 4). This challenge pushed to find new competitive and innovative research solutions building on the available perspective inside the organization (Line 3), for example, by applying smart and digital solutions in an unconventional way (Line 4).

Excerpt 11. Well our problem is that this organization doesn't have [specific research infrastructure], so we can't really do anything in house, and then there are many things you can't outsource either, so that is something we have to think about, and what I'm also trying to say here is that we can't compete with this [specific research infrastructure] because we don't have that, that we need to find our own approach to it which would come exactly from this kind of continuous measurement and sensor technology, which then differs from traditional ways of working within [the research field in question]. But it's kind of a challenge and an opportunity. *(Interview 2)*

At the individual level, the interviewees felt that the development of innovation activities challenged them and their expertise. Several researchers mentioned the idea of "going out of one's comfort zone" (Ex. 12). Participation in multidisciplinary projects (Line 2) required contribution of own skills and knowledge, both from individual researchers and from separate disciplines. A need to compromise put researchers outside of "comfort" of their own expertise (Line 1), as well as was breaking disciplinary boundaries (Line 4). This tension pushes researcher's expertise to expand and develop (Line 1), and results in actual success of the project (Line 2), where new scientific knowledge is created (Line 4).

Excerpt 12. This is sort of outside the comfort zone as to how far that collaboration can be taken within the frame of this project, at least the comparison and implementation well they will be left over for the next grant. [. . .] *(Interview 3)*

This UAS has had a strong tradition of applied research, conducted in collaboration with companies, where results have been transferred directly to practice, rarely shared through publications in scientific journals. The new funding models and the changes in the role of UAS have pushed to conduct more what interviewees themselves called "university

research". Even with new recruitments and new projects, the competences of doing basic research and publishing require time and focus to be developed inside the organization. Focusing resources on learning novel ways of research can be actually a boundary for innovation activity within an organization, as time and resources are allocated to familiarization with these new research and working practices. This boundary can be developmental in a long run – it can potentially bring new types of knowledge, partnership and funding to boost innovation activity in the UAS.

6. Discussion

In this article, we aimed at studying the development of research-related innovation activities in a university of applied sciences to reflect the changes in UAS applied research. We focused on a novel multidisciplinary research project in a Finnish UAS, aimed at the creation and application of new knowledge in the field of smart bioeconomy.

To answer RQ1, we have identified six developmental lines in the innovation activity. In the studied research project on bioeconomy, the development of innovation activities was grounded in the development of researcher's expertise, project, organization, research, field or practice, and policies and funding models. Most classical theories of innovation (e. g. Etzkowitz and Leydesdorff, 2000; Godin, 2006; Miettinen, 2013b) focus on innovations, their elements and dynamics of innovation at institutional or policy level. While it is essential for policymaking, research-related innovations also heavily rely on collaboration and expertise of individuals and collectives in networks, engaged into innovation activities (Miettinen, 2013b). The studied bioeconomy project heavily relied on interaction of different disciplines to find new solutions. The focus on interactions of individuals and collectives does not mean going back to the formerly prevalent focus on highlighting the importance of individual inventors (Kotsemir *et al.*, 2013). In our case of UAS, the success of innovation activities required a constant interaction between individual, organizational and policy levels. Simply hiring more research staff will not result in the transformation of the research profile of the UAS; this required that the researchers in the UAS were engaged in the novel types of projects, encouraged by the organization.

The analytical framework of the developmental lines is not meant to constitute a universal model of development of innovation, where elements are predetermined, for instance, between university-industry-government (Cai and Etzkowitz, 2020). The analytical framework of the developmental lines allows to bring forth a complex background of innovation, not at a prescribed trajectory or a clear path from invention or new solution to actual use as in linear models (Godin, 2006). Novel and creative solutions to problems often require a long process of building expertise, knowledge and experimenting around the problem (Miettinen, 2013a). In the studied case in the UAS, one research problem was studied in several consecutive and parallel research projects. Innovation activities appeared in our data as complex, prolonged and multilayered phenomena.

For answering the RQ2, we have focused on developmental tensions between the developmental lines. Development on one line could support the development of another line, for instance, a new funding model could bring funding to support novel types of research projects and strengthen the UAS research profile and national and international competitiveness. Tensions and conflicts between the lines were also common, and they could either disturb development or be a source of a new solution to a problem. Tensions in innovation activity, which are primarily source of inventive activities (Miettinen, 2013a), aggravated during long-term work around a problem on different levels, including individual, collective and organizational issues and policies. In the studied UAS, lack of certain research infrastructures, which are common for research universities, in a sense

forced researchers to find their own unique approaches in order to be competitive. The pressure to do new types of research in UAS and publish results in peer-reviewed journals could potentially shake the strong tradition of applied research with local partners. It could also bring novel ways of collaboration with new partners, like universities, and provide a larger audience for the results through international publications.

The previous evaluations of RDI activities in Finnish UAS mentioned that many aspects of RDI activities needed to be strengthened (Kajaste, 2018; Maassen *et al.*, 2012). The evaluations also stressed that often RDI has been an end in itself, while far less attention was directed towards the impact of these activities. In our case, the goal of RDI activities was contradictory in nature. Researchers reflected on a need to develop novel types of research as a goal in itself to be competitive (see Ex. 4). At the same time, they had a clear aim at applying their research results and producing impact with innovations (see Ex. 8).

Our study focuses on a research project in one UAS with a limited amount of focal data, which includes 11 interviews. This is the main limitation, which makes argument about the innovation in UAS in general restricted. We addressed this issue with a collection of auxiliary data around the project and the UAS. Focus on one research project is also justified, as academic work becomes more projectified, which reshapes research practices (Ylijoki, 2016). Focusing on innovation activities in research projects may address the ongoing fragmentation of research work especially in the case of UAS research, but at the same time reveals the longitudinal and complex nature of innovation activities, as different developmental lines were present in one project.

7. Conclusions

Our article focused on the transformation of research-related innovation activities in Finnish UAS in the effort to transform its research profile by producing basic research in addition to applied research. A report of the Finnish Ministry of Education and Culture on the evaluation of RDI activities in UAS (Maassen *et al.*, 2012) stated that many issues are related to the lack of a generally accepted definition of what RDI activities are in UAS. That holds true, as UAS have to engage in innovation activities to become competitive in regional, national and international innovation systems. This engagement is about finding balance between supporting the tradition of applied research with practical implications, and creating new practices of conducting basic research which contribute to the body of scientific knowledge. The movement between these two creates practical challenges, but also provides UAS with grounds to contribute into production of innovation with unique knowledge.

Academic and professional drifts are making UAS and research universities more alike questioning their specific and complementary roles. The issue is the direction in which both are changing (Carvalho and Diogo, 2020). Our study can hardly provide answers to this question, but the results show that the transformation of UAS should be addressed more in innovation models and innovation policies. The consequences and possibilities of this development require attention and debate of both researchers and policymakers updating expectations and potentialities of different kinds of research and innovation projects. One potential way for public research institutions is to engage into open innovation processes, which assumes innovation processes as distributed interorganizational collaboration structures that may involve multiple stakeholders, including, among others, industrial and academic partners (Van Lancker *et al.*, 2019). UAS should redefine their role in heterogenous innovation systems, not only by envisioning future directions through strategies, but also by focusing on different

historically unfolding lines in their research-related innovation activities: mapping existing research expertise and projects, profile of organization, strong and potentially growing research fields, demands and development of practice, businesses and policies. This can provide sufficient ground for development of research-based collaborative networks with research universities and other public and business partners, which are crucial for fostering innovation processes.

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Corresponding author
Liubov Vetoshkina can be contacted at: liubov.vetoshkina@helsinki.fi