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Collaborative Innovation in Healthcare: A Case Study of Hospitals as Innovation Platforms

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Abstract: Rising healthcare costs and vast business opportunities in health markets

have resulted in a great demand to enhance innovation creation. However, innovation development in healthcare is challenging because of the fragmented and complicated context. Potential means to tackle the challenges include utilizing the concepts of open innovation and co-creation, which require organisations to develop new roles and relationships with multiple stakeholders. This paper analyses a 12-month co-creation project where a new collaboration model for healthcare innovations was developed by a hospital, research partners, and companies. We demonstrate how organisations experiment with collaborative innovation in the healthcare context, and what was learned from this experimentation. The study utilizes an action research approach and a case study strategy. The co-creation model applied can produce innovations that meet the end-users' needs, but successful implementation requires careful planning, creating separate development paths for idea-type and more mature solutions, and the commitment of project participants.

Keywords: co-creation, collaboration, healthcare, hospital, innovation, open innovation

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Lotta Haukipuro is a Coordinator of the GenZ (Generation Z and beyond: Co-evolution of human capabilities and intelligent technologies in the 21st century) project at the University of Oulu, Faculty of Humanities. She received her doctoral degree in 2019 from Oulu Business School. Her research has focused on user-centric development of products and services and user involvement through living lab approach in different contexts. She has worked in several national and international living lab and user involvement related RDI projects since 2011.

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Anna Sachinopoulou has been a researcher for 25 years, in the Netherlands and Finland. She has covered topics in Optoelectronics, Knowledge Engineering and Information Technology. Since 2014 she is studying the impact that technological achievements have on people and their health. As a coordinator at the Centre for Health and Technology, Oulu, Finland (2012-2017), she supported the transfer of research in health technology to real world services and products, through collaboration of all relevant stakeholders.

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1 Introduction

Cost increases, demographic changes, and opportunities to create benefits for the healthcare industry through rapid technological evolution have increased interest in deepening cooperation among the healthcare, life sciences, and information and communication technology sectors. Recent years have provided many examples of this convergence, such as the foundation of the European Connected Health Alliance and Wireless-Life Sciences Alliance (European Connected Health Alliance, 2018; Wireless-Life Sciences Alliance, 2018). Rising costs in particular are a major push factor for healthcare organisations to identify new and innovative ways to provide better services more efficiently. For instance, EU healthcare spending ranges from 5% to 11% of regional GDP, and spending in the USA is around 16% (Blank et al., 2013; Herzlinger, 2006). Moreover, novel health technologies enable people to obtain care outside of hospitals and to control and share their personal health information and user-generated content for improved personalized care (Gaskell, 2017). Information technology is a key innovation driver in healthcare (Omachonu and Einspruch, 2010), and has contributed to opening up the healthcare sector (Kalis, 2016). In healthcare, "technologies as diverse as robotics and the Internet of Things, big data and machine learning are having as big an impact as bioinformatics and biology" (Gaskell, 2017). Technology contributes to changing the dynamics of value creation and capture, requiring different actors to collaborate in developing joint healthcare services (Gabriel et al., 2017).

The concept of open innovation (OI) emerged as a paradigm to explain and tackle the challenges of innovating in the modern context, and it has been extended to various industries and units of analysis (West and Bogers, 2017) following the seminal work of Henry Chesbrough (2003). Open innovation represents an imperative paradigm shift in innovation management as it relies on a distributed innovation process where knowledge flows purposefully across organisational boundaries (Chesbrough and Bogers, 2014). However, OI in healthcare is in its infancy (Reinhardt et al., 2015; Wass and Vimarlund, 2016). In OI, both economical and non-economical mechanisms are aligned with the organisation's business model (Chesbrough and Bogers, 2014), which is a major problem for the traditionally closed healthcare sector. Thus, it is challenged in healthcare by "the things it has become famous for, including tight control of intellectual property rights and a certain amount of scepticism voiced by doctors and scientists who feel that their problems are so specialised that no one outside of their field could solve them" (Silvi, 2015). Meanwhile, OI requires new ways of thinking, which is a challenge for organisational culture (Boscherini et al., 2013) and organizing (Ollila and Yström, 2016). Organisations involved in innovation, whether public or private, need to develop new roles and relationships in order to succeed in a dynamic and changing environment (Collins, 2006).

Innovations have been acknowledged as crucial in healthcare organisations (Länsisalmi et al., 2006), bridging the gap between possibilities and actually delivering healthcare (Edenius et al., 2010; Wass and Vimarlund, 2016). However, there are several challenges (e.g. Herzlinger, 2006). First, unlike many commercial sectors, health systems as main innovation customers often differ from the actual innovation users (i.e. the patients and citizens) (Gabriel et al., 2017; Wass and Vimarlund, 2016). Second, the nature of innovation itself is complex. In addition to medical (devices) and pharmaceutical innovations (Ciani and Armeni et al., 2016), novel approaches to patient care, illness prevention, and the general wellbeing of people (Gabriel et al., 2017; Gomes and Moqaddamerad, 2016) are considered innovations in healthcare. According to Blank et al. (2013), a paradigm shift has taken place; healthcare should no longer be viewed only as a financial burden, but also as a driver for economic growth by creating new products and services that can be sold in global markets. Third, although knowledge management, trust building, communication, and focus on the user are key mechanisms in innovation in hospitals (Dias and Escoval, 2012), how do healthcare organisations collaborate with other actors in practice? How is the process of collaboration managed? This study seeks to contribute to academic literature on OI via empirically grounded research by addressing two research questions:

RQ1) How do organisations experiment with collaborative innovation in the context of healthcare?
RQ2) How do organisations learn from such experimentation?

2 Theoretical framework

2.1. Innovating in the context of healthcare

In the field of management, knowledge (or access to it) is understood as a strategic asset, whereas healthcare literature refers to knowledge as evidence or research (Ferlie et al., 2012). The healthcare sector is distinguished by the unique status of biomedical knowledge and the role of experts in mastering this knowledge (Gabriel et al., 2017; Silvi, 2015), another reason why healthcare, as an innovation context, is highly fragmented and complicated (Gabriel et al., 2017) and poses specific challenges to knowledge sharing and innovating (Herzlinger, 2006). The more we look to advance wellbeing and aim at proactive prevention rather than reactive treatment, the more external, rapidly changing economic, social, political, and technological determinants play a role (Pikkarainen et al., 2017; Ordanini and Parasuraman, 2011). These factors force the health sector to focus on the development and exploitation of innovations (Ordanini and Parasuraman, 2011).

Controlling healthcare expenses, for example, is critical, but they must be handled along with other long-term societal needs (Diaz and Escoval, 2012). Diaz and Escoval (2012) claim that the challenge not only relates to balancing the allocation of resources across sectors according to national priorities, "but also to improving performance so that investments in health systems demonstrate good value in terms of improved health, access, equity and responsiveness" (Diaz and Escoval, 2012, p. 181). Health systems can no longer afford to have fragmentation and a low innovation capacity (Dias and Escoval, 2012; Ordanini and Parasuraman, 2011) push them towards collaboration, as innovators need to take into account various other players within the healthcare (eco)system (Herzlinger, 2006; Gomes et al., 2018).

Although innovation has been studied extensively (e.g. Krishnamoorthy and Damle, 2017), there is little knowledge of it in the healthcare context (Moreira et al., 2017), and healthcare organisations' knowledge and experience of innovation activity is limited (Labitzke et al., 2014).

Innovation processes typically follow certain phases, such as initiation, ideation, integration, and implementation with either linear or iterative phase arrangements (e.g. Cooper, 1990; Rothwell, 1994; Frankenberger et al., 2013). Research evidence suggests the innovation process is becoming increasingly open, requiring access and a combination of knowledge from different departments and sectors (Diaz and Escoval, 2012). In healthcare organisations, innovation occurs through interaction and co-creation across hospitals and a number of partners (Dias and Escoval, 2012). The sources of these innovations are often in the private sector, meaning there is a need for new innovation collaboration methods, while funding innovation development is more than simply "figuring out who will pay how much for the product or service it yields" (Herzlinger, 2006).

The OI literature relies on the view that collaborating and sharing knowledge with other organisations leads to better innovations (Chesbrough et al., 2014). According to Gabriel et al. (2017) and Bullinger et al. (2012), OI initiatives in the healthcare sector would contribute to the more efficient use of resources and enable the faster adoption and diffusion of healthcare innovations. However, as Wass and Vimarlund (2016) reveal, the sector is lagging behind, with a need for empirically grounded research on OI. Hence, the health sector as an innovation system would benefit from deeper collaboration with other sectors overall, but especially from engaging different actors in the experimentation with and development of innovations via distributed processes (Chesbrough and Bogers, 2014).

2.2. Co-creation as a collaborative innovation practice

Co-creation as a means of creating value (Lusch et al., 2007) through distributed innovation practices (Bogers and West, 2012) could address the systemic challenges of healthcare through a practice-driven approach to innovation collaboration. Co-creation can be referred to as an "outcome of the convergent work of end users with other industrial and non-industrial stakeholders in a common prototyping environment" (Alcotra Innovation, 2013, p. 6), and thus refers to collaborative development between two or more stakeholders that involves knowledge inflows and outflows between complementary partners (Bogers and West, 2012).

Co-creating products and services by harnessing ideas and collaborating with customers is an acknowledged example of an inbound OI practice (Bogers and West, 2012), also referred to as user innovation (von Hippel and von Krogh, 2006; Bogers and West, 2012). Literature acknowledges that in healthcare, the customer (e.g. a hospital, regional healthcare district, or national health system) may differ from the user (e.g. a patient) (Gabriel et al., 2017). The users may equally be healthcare professionals (e.g. nurses, doctors, the IT department, or other support staff). Therefore, the logic of innovation collaboration and co-creation in healthcare is highly multifaceted; who collaborates with whom, and how and why?

Thus, OI should also be viewed as an organisational change process that touches both internal and external structures and processes (Boscherini et al., 2013). The knowledge needed in the development of innovations is increasingly located outside one's organisational boundaries, which highlights the importance of engaging in different forms of collaboration with various actors, in addition to customers or users, such as research organisations, technological partners, suppliers, and even competitors (Chesbrough et al., 2006; Cesaroni and Duque, 2013). Often, even complete ecosystems catalyse innovations. In healthcare, these ecosystems include various public and private actors that contribute to human health, including private companies in fields such as biotechnology, biomedicine, diagnostics, pharmaceuticals, medical devices, healthcare provision, support services, and IT. Besides universities and research institutions, various intermediaries, such as innovation accelerators, incubators, trade organisations, angel investors,

venture capital firms, and governmental actors, may also belong to the ecosystem (Majava et al., 2016).

However, most studies to explore co-creation in the context of healthcare have researched it from the patient co-creation perspective (Zhang, et al., 2015) (e.g. in cases where the patient role has changed from passive to active contributor) (Badcott, 2005) or are based on doctor-patient value outcomes during a care process (Osei-Frimpong, 2017). Rantala and Karjaluoto (2016) provide an interesting study on the role of digitalization in healthcare service development, but also see patients as the end customers.

Considering both individuals and organisations as parties in co-creation contributes to the value that healthcare organisations would gain from innovation collaboration and allows a focus on the providers and developers of those innovations – the private sector companies, especially small and medium-sized enterprises, that aim to solve the practical problems of healthcare professionals for economic gain. How organisations co-develop their capabilities in a context based on deep collaboration and mutually beneficial relationships is a relevant question (Gomes et al., 2018). Therefore, the reciprocal service provisioning perspective (Lusch et al., 2007) rooted in service-dominant logic could "enrich the OI paradigm of theoretical and practical content" (Cesaroni and Duque, 2013, p. 18) by addressing the challenges and opportunities of innovation collaboration. When delving deeper into the dynamics of innovation collaboration in healthcare, we must acknowledge the collaborative creation of value at the organisational level (Dias and Escoval, 2012).

3 Research process

3.1. Research approach

Considering the development process carried out and the real-life context, action research was deemed the most appropriate study approach, as the researchers facilitated and contributed to the research context. Action research emphasizes the interplay between theory and practice, the generation of action or intervention combined with research that aims to create knowledge (Reason and Bradbury, 2001).

Within the action research setting, the case study strategy was employed. A case study is an empirical inquiry that studies a phenomenon within its real-life context to gain understanding of it either by learning something about the case itself or by achieving a broader understanding (Yin, 2009). This study was based on a single in-depth case of the University Hospitals as Innovation Platforms project.

Triangulation, which requires data collection from multiple sources, is considered important to enhance the reliability and validity of case study research (Eisenhardt, 1989; Voss et al., 2002). Data for this study were collected using (1) researchers' observations and notes during 12 months of research, (2) workshops and participants' feedback, and (3) semi-structured expert interviews with 28 key informants. These informants included hospital professionals, including doctors, nurses, pharmacists, and ICT staff, and entrepreneurs who participated in the case project; twenty-two interviewees represented the hospital and six companies. The informants and research data are presented in Table 1.

< Insert Table 1 here >

The interviews were recorded and transcribed, with the analysis conducted following a qualitative approach (Eisenhardt, 1989; Denzin and Lincoln, 2017), i.e. reading the interviews

several times, each time going deeper into the data to find connections, patterns, and juxtapositions. The advantage of the applied analytical method, qualitative content analysis, was the ability to manage large volumes of textual data and various text sources (Elo and Kyngäs, 2005). The patterns that emerged were structured into more generic categories corresponding to the project phases described in section 4 in order to formulate the key concepts and issues on collaborative innovation. The key findings are presented in section 4 and discussed in section 5. To minimize bias, data collection and analysis were a joint effort by the research team. It should also be noted that in action research the researcher affects the phenomenon under study and can even change it on purpose, which can influence the objectivity and generalizability of the results. Despite these limitations, a single case study was best suited to the exploratory research directed by our research questions.

3.2. Case description: Hospitals as Innovation Platforms

The objective of the co-creation pilot implemented in a Finnish hospital (hereafter "the pilot") was to improve the innovation culture of the healthcare sector and create new businesses and practices. The one-year pilot (2017) organized by the hospital and the university developed and tested the co-creation model in which companies and healthcare professionals co-created future hospital services. Figure 1 illustrates the phases and activities involved.

< Insert Figure 1 here >

During preparations (phase 0), the hospital top management, in conjunction with a future hospital program, identified two service areas to be developed within the pilot. The areas were chosen according to the strategic planning of the hospital redevelopment, answering to relevant pre-identified needs. The aim of phase 1 was to collect the specific service areas' needs, for which there were no suitable solutions in the market. First, strategically important specific development themes were identified; key experts were then nominated to identify the specific needs of the development themes to be announced in the innovation competition.

The innovation competition (phase 2) was open to companies and individuals; twenty-four applications were received from fourteen companies and three individuals. In phase 3, an evaluation team of sixty professionals from different areas was formed to select the winners, with the applications evaluated based on healthcare and business criteria. The healthcare evaluation was carried out using an online tool provided by the university, and particularly emphasized improving patient experience, care quality, and safety, as well as productivity, efficiency, and effectiveness. The university's business experts conducted the business assessment (i.e. market, scalability, and internationalization potential of the applications). Each application was scored on a scale from 1 to 5 with justifications. Based on the scoring, the five best applications were selected to enter two different development paths in accordance with the proposal's maturity: the paths for ideas (hereafter "idea path") and for concepts and prototypes (hereafter "co-creation path"). The solutions identified as ideas described non-existing technological concepts, while the solutions identified as prototypes were existing technological achievements that needed maturing into a product or service. Ready products were not taken into account, since the needs of the specific service areas were chosen based on the assumption that there were not suitable market products addressing them. Two winning applications were classified as ideas, and three as concepts.

In phase 4, the idea applications of two companies were developed further through the university's market research and business case course. The course included presenting companies

and their ideas to students, lectures, mentoring, feedback collection from healthcare professionals in three workshops, and a final seminar where students presented business cases to companies and external business experts. On the co-creation path, companies and healthcare professionals further developed the concepts towards testable prototypes through co-creation methods and tools provided by the university. All co-creation activities, such as interactive online and onsite workshops and testing sessions, were facilitated by experienced user researchers. Additionally, hospital innovation ambassadors (healthcare professionals) played an important role in planning the activities. First, a kick-off event was organized where the co-creation process, the detailed needs of the hospital, and the companies' concepts were presented. Subsequently, an interactive workshop was organized to collect the first feedback on the concepts from healthcare and IT professionals. Next, feedback on each concept was gathered using an online tool, with individual testing sessions carried out at the end of the co-creation path. In the final evaluation (phase 5), each company presented their solutions to the evaluation group.

4 Results

The results of the pilot are discussed in this section, with the analysis divided into sub-sections according to the phasing and activities of the co-creation model (Figure 1).

4.1. Preparation and needs finding

Based on the findings, hospital management and professionals believe that development must always be based on real, carefully described needs that emerge directly from the healthcare sector (a criterion for managers to deploy their units' personnel in development work). Both managers and professionals saw involving relevant key experts and managers in the needs description and evaluation as important (supporting the selection and prioritization of the needs presented by key specialists, based on the strategy). According to the hospital staff, professionals from various occupational groups and the necessary range of hospital areas should be involved in describing the needs. If required, outside experts, for example from other healthcare organisations, should be involved.

The personnel of the pre-defined strategic development areas within the hospital participated actively and enthusiastically in describing the development needs. They felt their expertise was appreciated, and they were pleased with the opportunity to advance development needs through co-creation and with the chance to work with companies. The innovation ambassadors were important as they helped other professionals and personnel in describing needs and acting as "interpreters" between stakeholders.

The companies viewed the genuine needs to emerge from the healthcare sector as a priority and a necessary basis for co-creation, because this supports focusing resources on the development. They felt the thorough evaluation and careful description of needs by the healthcare experts made it easier for companies to lead development in the desired direction. A hospital manager stated: *"Hospital personnel know the practical processes and present the needs related to operational activities while the top management and middle management outline what matters strategically to be taken forward."*

Involving experts started during the communication of phase 1, which helped in maintaining their involvement in later phases. The main lesson learnt from the pilot concerning the participation of key experts was to ensure their commitment to the process and the knowledge that the key experts raising the need would participate in the development work, guaranteeing

sufficient expertise and support for the companies involved. In addition, there must be sufficient time to describe and evaluate needs with the required precision, and to ensure that the needs to be developed are transformed into a comprehensible form for companies before they are published as challenges or through an innovation competition.

4.2. Innovation competition and application selection

In creating a bridge between companies and care, enough time should be allowed for those who propose ideas and solutions to ask questions and understand the need they will address. Time is also important for the evaluators, who will need to understand the proposed technology. Previously explored existing solutions can support the common understanding. In addition, the possibility for interaction between the care professionals and the system, and with the companies offering technology, not necessarily directly but perhaps through a well-organized help desk, should be considered. According to a hospital manager "*it must be a regular cross-section of the organisation's functions, which considers the solutions proposed - those responsible for all aspects of the field must be involved in the top-level review."*

The required maturity of the solutions and the co-creation processes should be communicated clearly in the innovation competition call, along with the expected benefits, the necessary commitments, and the rules that apply to the process (e.g. how contact with the care professionals will happen). The different paths, and the evaluation and selection for these paths, should also be described well.

A user-friendly submission tool should contain questions to link the proposed solutions to the needs and to promote clear evaluation criteria that will support the experts' decision. Required answers should also make the innovation potential clear, in order to avoid unsuitable proposals and efforts to just "sell" products through the innovation competition.

4.3. The idea path

Overall, the feedback from the idea path was positive. For example, the CEO of a participating company stated: "*I think all the meetings were excellent and they provided a lot of benefits, because there was an opportunity to discuss with doctors and nurses as well as other parties like IT department.*"

However, several possible improvements were identified. First, there was a four-month gap between the innovation competition and the start of the market research and business case course, which created frustration among the companies and increased the risk that some would leave the idea path. The students' market research during the course would have been most valuable immediately after the innovation competition, when companies began to design their solutions. Second, the idea path and co-creation path were seen as alternatives by the companies, and some were confused regarding which path would fit their needs best. Thus, the content of each path must be communicated clearly to the companies. The third main lesson related to the expert workshops in the hospital; although the companies and students prepared for these workshops, the preparations were partly inadequate. Examples included overlapping questions to the experts and the varying quality of the companies' presentations. The workshops objective to collect feedback on the solutions from the hospital experts was met, but their potential was not fully exploited. To collect expert feedback, companies should create prototypes or demonstrations. Additionally, the workshop participants should be selected carefully to ensure the right focus and efficient time use. Many student participants were foreigners, which created a language barrier during interviews and workshops. Although several hospital staff representatives spoke English, some expert feedback was missed due to language issues. Nevertheless, international students

and experts can provide novel insights and viewpoints in co-creation projects, and this potential should be exploited.

The companies had high expectations for the idea path, and they hoped for a letter-of-intent type of commitment from the hospital and more joint events. According to the CEO of a participating company "*there are big risks involved. In the future it would be good to get a letter of intent or something alike to reduce the risks.*" The project's schedule was identified as problematic given the long summer break and the tight schedule for market research and the business case course. These issues resulted in students and companies conducting overlapping market research. The first idea evaluation was held too early from the companies' perspective; nevertheless, they felt that joint development was mostly useful. Thanks to the expert feedback, the companies could modify the idea before investing heavily in the development; however, the cooperation could have been greater; for example, during the concept creation phase, feedback sessions could have occurred bi-weekly. Furthermore, the companies would have benefitted from having more in-depth information on the hospital requirements, standards, and required approvals.

From the course teacher's perspective, the students' cooperation with the companies worked well and the hospital workshops were valuable. The course was intensive; it included two lecture sessions per week, individual tasks, and team work. External business advisors were also utilized, which was considered good practice. The students were highly satisfied with the course and results, although some did not have prior knowledge on the course topics.

Considering the learnings from the process perspective, the number of cases (three ideas) was considered appropriate for the pilot, while integrating several stakeholders (hospital experts and business experts) was seen as valuable. It was found that collaborative development requires self-intrinsic motivation, as the student and expert participants were volunteers, and that sufficient resources should exist. For example, the individuals whose ideas were selected to the idea path did not participate due to having inadequate resources. Finally, development processes must entail the documenting and sharing of cooperation rules to ensure smooth communication between stakeholders.

4.4. The co-creation path

Overall, the feedback on the co-creation path from the companies, professionals, and management was positive. The companies saw the path as valuable and well organized; multiple co-creation methods and the right type of participants provided direct and rich feedback for the development of the products. This accelerated and steered product development to meet the needs of the stakeholders. At least two companies reported their product had drastically changed from the initial plan due to the knowledge obtained from the professionals. A company CEO stated that during the co-creation their solution changed completely thanks to the feedback from professionals: *"If I had done it alone in the garage, without the client beside me, it would have failed. It is now really a different type of solution."*

The healthcare managers considered the co-creation path as an appropriate approach to develop healthcare services, and they hoped similar action would be continued. The managers saw the path as enabling the development of solutions based on prevailing needs in the healthcare sector, while its intrinsic value was increased due to the broad expertise of health professionals and other experts. As a healthcare manager states *"co-creation has broad effects when involving diverse professionals in the development process. Feedback from the professionals guides the development into right direction and accelerates the process making it cost-effective. Solution will be usable, and quality will be improved."*

Co-creation activities, facilitated by experienced user researchers, were regarded as an opportunity to influence the hospital innovation processes and the products to be used in the daily work of healthcare professionals. The professionals and managers considered the co-creation events as well-organized, effective, and inspiring ways to express their opinions. A novel co-creation approach within the hospital motivated the professionals to participate on a voluntary basis, proof of their positive attitude and commitment towards co-creation.

Crucially, the hospital innovation ambassadors participated in the planning of the activities with the user researchers and identified the right healthcare professionals for each event (e.g. in the testing sessions using the pair-testing method). The ambassadors also helped organize and facilitate the events and increased the exchange of information between the hospital's work units and innovation personnel.

The companies' knowledge of the healthcare sector varied, which affected the support they received. For example, at the beginning of the pilot, four companies were identified as belonging to the co-creation path. However, the maturity and context relevance of one product were perceived as insufficient during the online concept evaluation activities. The company then moved to the idea path to ensure it received the right kind of support. On the other hand, some companies had knowledge of user-centred methods and needed more practical help (e.g. in event arrangement and professionals' recruitment).

Personnel involved in co-creation must be able to concentrate on the activity, meaning there should be no other demanding processes ongoing concurrently. According to the managers, the co-creation should be intense and face-to-face, and the solution being co-created should be periodically reflected back to the original need to ensure development follows the right track.

4.5. Final evaluation

According to the hospital participants, the final evaluation was a valuable experience. Hospital professionals and managers saw the involvement of a sufficient number of experts as important in similar events. Managers with the relevant decision-making power should decide on further development, for example resource allocation and reflecting on strategic considerations. The top management was aware of solutions in all development phases to maintain a sufficiently accurate picture of the solutions and their suitability for practice. A hospital professional stated: *"Talking with them in advance, and only then, the assessment by the managers, could be the way to make decisions."*

Both the healthcare professionals and managers stated that the most effective evaluation method would be to provide a two-phase assessment, where key experts would evaluate the solutions first. The management would then make the final decisions based on experts' suggestions. The commitment and awareness of hospital top management were also considered important.

5 Discussion and conclusions

This empirically grounded research on innovation collaboration in healthcare contributes to the literature dealing with innovation co-creation and collaboration in healthcare and on relational views of hospitals' innovation management. The aim, as guided by the research questions, was to explore how organisations in the healthcare context experiment with and learn from collaborative innovation.

A great need and potential exist for developing innovations in healthcare, but the characteristics of the sector, such as its complexity and separation of actors, create challenges

(Gabriel et al. 2017). The importance of collaboration and OI is undeniable (Chesbrough et al., 2014), but little empirical knowledge exists about appropriate ways to implement them in healthcare (Labitzke et al., 2014; Wass and Vimarlund, 2016). This study developed, piloted, and analysed a co-creation process during a year-long project; the result is a co-creation model that directs healthcare organisations in collaborating with companies and other stakeholders to co-create new, needs-based healthcare innovations. Success in implementing the process, however, requires careful preparation, sector-specific knowledge, and active efforts throughout the whole process.

From a healthcare organisation's perspective, the model analysed can be seen as a way to direct its innovation activities appropriately and to innovate specifically for the healthcare professionals' needs, by allowing them to influence the development of solutions used in their work; that means, from the organisation point of view, the more complete utilization of employees' expertise and tacit knowledge. Healthcare professionals' knowledge of the sector and solutions on the market grows as they cooperate with companies and other stakeholders. Co-creation allows different professions to work on the same goals, which strengthens multi-professional cooperation and collaboration within the organisation. In addition, a uniform approach to innovation development will improve organisations' internal practices.

From a business perspective, co-creation increases companies' knowledge of the healthcare industry and helps in developing new solutions. Through this, companies become aware of development needs in healthcare, which is a valuable basis for their solution development. It also enables them to modify their solutions at the development phase before they reach the market, and thus saves them resources and cuts down on unnecessary work.

5.1. Implications

Based on the feedback analysis, the developed model is suitable for carrying out innovation collaboration between the healthcare organisation and the stakeholders involved in the healthcare service ecosystem. Additionally, three practical implications relate in particular to the lessons learned from innovation collaboration and to what organisations should be aware of when planning to conduct extensive innovation co-creation projects.

First, designing the process requires great care. It is important to communicate clearly and adequately with all parties involved regarding how the process will be implemented and what is expected of them. Second, there is a need to have the capability and competence to tailor the process to the degree of maturity of the solutions developed and to the needs of the parties in a reasonable manner. Third, there must be sufficient knowledge to engage and commit the parties in the process. As the goal of co-creation is to involve all key stakeholders at various stages of development, it is important that the process is planned and implemented under the guidance of user experts to involve the right people in the proper way.

Companies' knowledge and expertise in co-design, the related methods, and the health industry may vary, meaning some need more support to execute co-creation than others. Therefore, those who are responsible for co-creation facilitation should be well prepared to ensure the desired impact. Moreover, success requires close collaboration with the hospital innovation personnel, given their tacit knowledge of the hospital processes, which is valuable in, for instance, finding the right professionals to suit the needs of the companies. Recruitment through hospital innovation personnel is an effective way to gather a sufficient range of professionals from across the hospital and the hierarchy levels. The method for recruiting patients requires careful planning, as they can only be approached through patient organisations or campaigns, for example.

Summarizing, successful collaboration requires extensive expertise, such as deep knowledge of healthcare processes, the management of methods, and working methods of co-creation, of bringing together business and technology, and of procurement in some cases. In addition, contractual issues must be acknowledged before starting the actual co-creation phase, and all stakeholders must allocate sufficient resources. In particular, the organisation facilitating the process, such as a hospital as an innovation platform, must invest in effective, group-specific communication with stakeholders, and in other support these participating groups require.

Engaging healthcare management and professionals in the co-creation process requires a deep understanding of the activities and culture of their organisations, and ensuring the organisation's staff feel they are heard and appreciated. Respondents who enable and maintain the innovation process must be reachable. It is therefore useful for healthcare organisations to consider allocating these responsibilities to specific actors who can manage the process and maintain innovation activities in different organisational areas (Moreira et al., 2017). Commitment by the top management (Boscherini et al., 2013) and other management levels of the healthcare organisation is vital in enabling and maintaining the process, and there should be clear objectives and clear evaluation of success (Labitzke et al., 2014).

The theoretical contribution of this study relates to co-creation as a collaborative innovation practice (Bogers and West, 2012), particularly in addressing the dynamics of innovation collaboration that involves public and private organisations (Majava et al., 2016) and how to organize co-creation (Ollila and Yström, 2016). At the organisational level, knowledge management, communication, and trust building are key to innovation collaboration (Dias and Escoval, 2012). A second contribution relates to collaborative innovation and OI research in the public context (Wass and Vimarlund, 2016), especially at the innovation system level (Gabriel et al., 2017), as how the innovation system functions in healthcare has direct implications on the collaborative innovation practices that can be explored and realized. This domain-specific knowledge is particularly relevant for any private organisation wishing to engage in innovation collaboration with healthcare organisations. Despite the organisational focus of this research, the organisational culture-related aspects (Boscherini et al., 2013) means it also feeds into discussions on the prerequisites and antecedents of individual-level innovation collaboration by addressing the important role of expert knowledge and healthcare professionals in the co-creation process.

5.2. Limitations and future research directions

Action research and case studies have natural limitations regarding the generalizability of results. However, the purpose of the study was to identify key learning points on how co-creation can be conducted in practice. Thus, the study presents suggestions for how organisations such as hospitals, companies, and research institute partners may collaborate to foster healthcare innovations, and what kind of innovation process relates to innovation collaboration in healthcare.

This study illustrates how innovation collaboration was executed through a co-creation process at the organisational level. We identified several interesting topics that relate to other units and levels of analysis, such as, on the individual level, how to motivate healthcare professionals to participate in specialized innovation collaboration projects. Suitable for further consideration is how to effectively commit and motivate managers and experts in co-creation processes. From an organisational learning perspective, how the results are incorporated with the general innovation processes of healthcare organisations calls for further research, as OI research in the public context is in its infancy. In addition, more research is needed to provide information

regarding how to organize innovation activities in healthcare organisations. New methods and models of a bottom-up approach of innovation should also be developed. In such an approach, ideas and needs coming from professionals who are in everyday contact with patients will be collected regularly and processed for further development through the described methodology. We hope that further research will adopt our suggested future research directions.

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Table 1. Summary of research data, data collection phases (see Figure 1), and informants.

Type of research data	When collected	n	Positions of informants
Semi-structured interviews of key personnel (companies)	Phase 5	6	Top management, n = 3 Middle management, n = 3
Semi-structured interviews of key personnel (hospital professionals)	Phase 5	9	Nurses, n=3 Doctors, n=2 Other experts, n=4
Semi-structured interviews of key personnel (hospital managers)	Phase 5	13	Top management, n=2 Middle management, n=3 Front-line-management, n=8
Feedback surveys from the Pilot's workshops	Phase 3, 4	41	Key informants: hospital personnel and students
Lessons learnt document	Phase 4, 5	1	Report provided by the project team

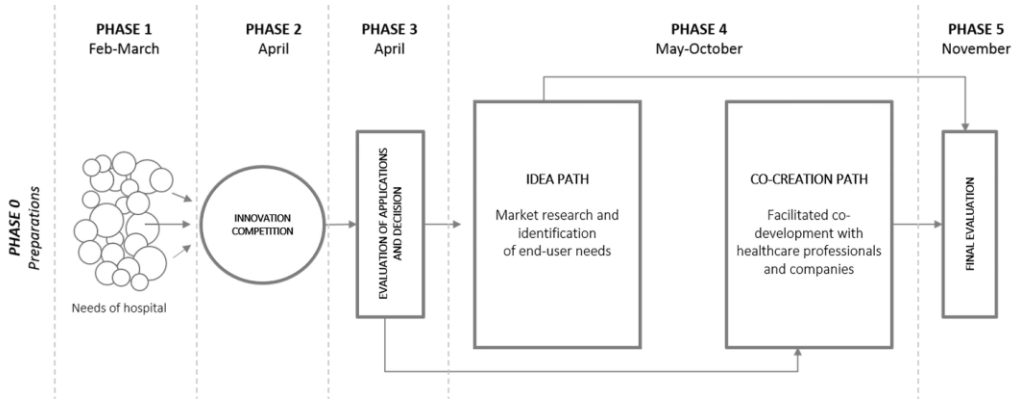

Figure 1. The phasing and activities of the co-creation model