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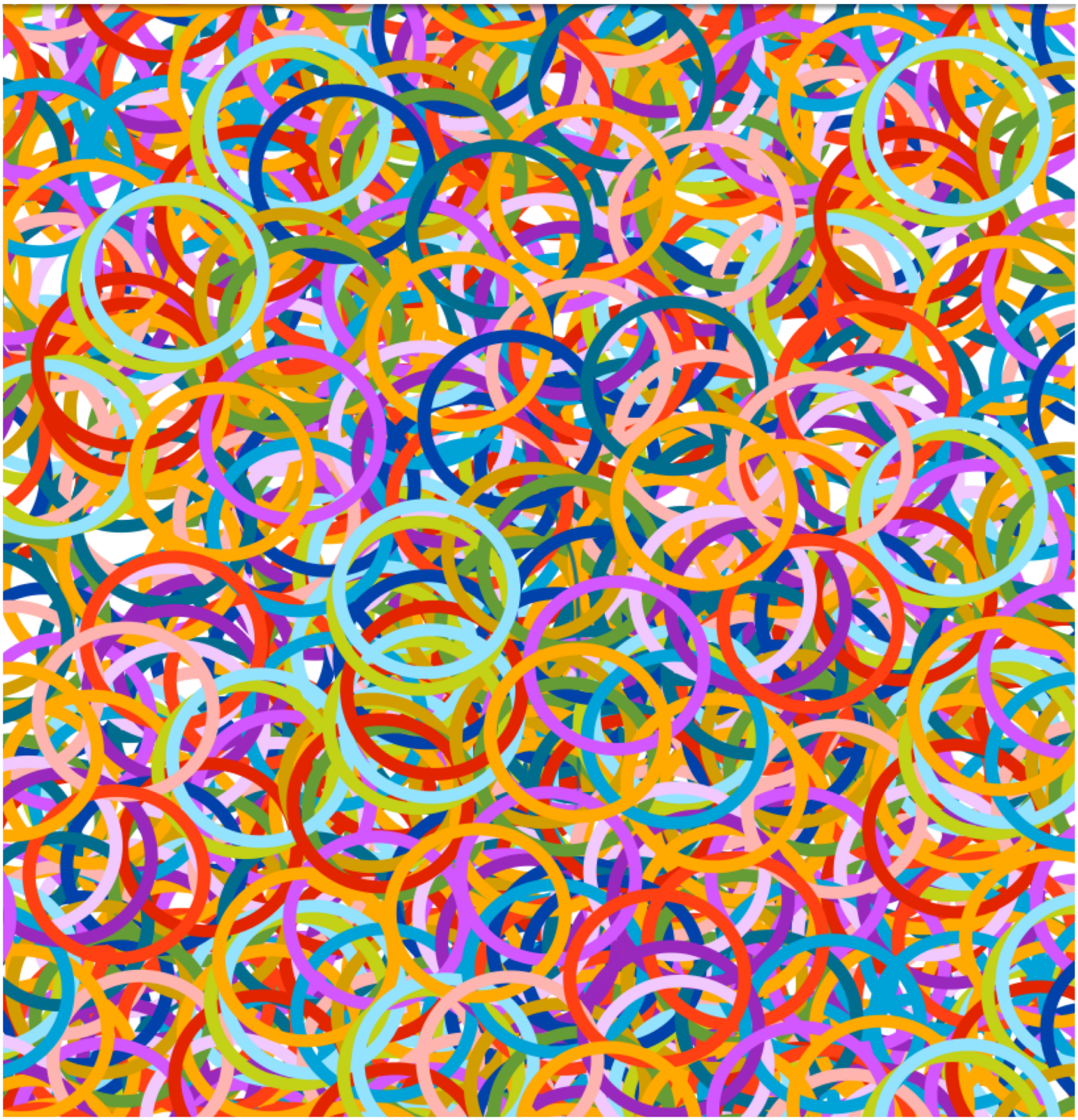

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Societal progress: A tale of two brothers

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Editorial

The story of societal progress has long been acknowledged to involve two brothers - management research and management practice (Beyer, 1982). Although, reared by the same knowledge core (Poole and Van de Ven, 1989; Wallin and von Krogh, 2010), the brothers in a display of their contrasting lives behave independently, often disparately. Their distinct behaviour has prompted scholars to report that 'most of what management researchers do utterly fails to resonate with management practice' (Bansal et al., 2012, p. 73). Those observing the relationship unfold have been concerned of this disconnect for decades (Banks et al., 2016; Hambrick, 1994; Shapiro, Kirkman and Courtney, 2007). Gordon and Howell (1959) posited that universities and business schools need to be 'better informed and more scholarly faculties that are capable of carrying on more significant research, and with greater appreciation of the contributions to be made to the development of business competence' (p.425). Fast forward nearly 60 years and not much seems to have changed. Banks et al. (2016) in a survey conducted with 1700 academics and practitioners found that information asymmetry and goal incongruence has continued to widen the research-practice gap. This resonates with those who have described management research as 'arcane' (Walsh et al., 2007) with its relationship to practice as mostly 'ceremonial' (Bartunek and Rynes, 2010), where others have called the brewing brotherhood a harmful coalition (Ghosal, 2005). Their relational disparity and discontent has also become a media sensation with leading sources such as the Financial Times and the Economist calling on business school administrators (Schiller, 2011) who are seen to favour one brother (i.e. research) and paying little attention to the other (i.e. practice). Yet, much of the focus (and blame) has been on how research does not apply judicious methods and materials to engage with practice with little commentary on practice's intention to engage and adopt research's outputs (Dunbar and Bresser, 2014; Walsh et al., 2007). Once again, the attention is on nurture rather than nature. Where did the nurturing

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go wrong and how can we get the two seemingly important members of societal progress behave in-sync again has been the question of many virtuous scholars attempting to identify and bridge the so-called "gap" (Austin & Bartunek, 2012; Banks et al., 2016; Bansal et al., 2012; Cascio & Aguinis, 2008; Dipboye, 2007; Empson, 2013). Yet, the disconnect seems to be increasing (Tsui, 2013).

So for a moment, let's think differently. Could it be that there is no problem with the nurturing, rather the perspective by which we are evaluating the brothers? Tell me if you have ever seen two brothers who continuously thrive to behave in-sync. While the recognition that the brothers are intertwined is useful, it is even more important to treat them independently. The focus then need not be on who is being favoured and who is getting less attention, rather the debate rests in understanding that both brothers are unique in their functions and personalities, destined to behave differently and achieve mostly differing goals in life. With such a purview, joyous Christmas homecomings (i.e. research translation to practice) can be best enacted by understanding the tensions between them and new knowledge worthy of conversations that these vary tensions create - unlocking the paradoxes of their relationship (Bartunek and Rynes, 2014).

In reality, the ambitious vision of research begins to take form at the point of design and follows through data collection to findings of the organisational world. The scientific process of repetition and re-testing eventually leads to new knowledge and perspectives of seeing the world. This new knowledge when shared becomes the basis of intervention and action for societal change and progress. Change and progress then produce new sets of data and, the cycle continues. However, at some points in this scientific lifecycle there emerges disconnect and dilemmas (Dipboye, 2007). Dilemmas are different from disconnect. Disconnect tends to focus on the "gap", that is they refer to what ought to be and what actual is. Dilemmas on the other hand involve trade-offs between alternatives but none of the alternatives is assumed to be superior to the other and where one is expected to behave in a certain way but there is an incentive to not to (Keeney and Raiffa, 1993). The research scientist is expected to embrace the real-world uncertainties but is incentivised to deliver simplified, controlled and methodologically rigorous outputs to explain the phenomenon under assumptions. The practitioners on the other hand have to operate and enact amongst uncertainties and complexities of the real-world where leverage of assumptions can result in disastrous outcomes. Arguably, a research scientist has the tools and time to subscribe to the view that knowledge is objective, often factual and carries dispassionate truth (Geelan and Hirschkom, 2008). Whereas the mindsets of the practitioners reflect the view that knowledge is often biased, incomplete, influenced by self-serving tendencies and potentially compromised to attain a competitive advantage (Geelan and Hirschkom, 2008). Where specialised terminology and definitions seem to interest the research scholars, the practitioners tend to rely on past experience, heuristics and gut-feeling to advance society (Dipboye, 2007). Clearly, research and practice have unique characteristics and apply a different frame of reference to make sense of the world (Johns, 1993). Is it not better than to harness the effectiveness of two? And an even more provoking thought is - should we ever consider research without a clear focus on practice or practice without a definitive understanding of research in the discourse? - We say research and practice must go hand-in-hand if societal progress is to be realised.

The scientific approach of a researcher can help generate predictive models and solutions to explore and explain the relationships and effects of various conditions on the factor of concern. The practice view embedded in a discursive, conversational and dialectic approach can high-

light the contradictions and complexities of the real world. Collectively, the two can unlock the probabilities of success in choosing (or deviating) between one dilemma or the other, taking into account the fuzzy basis and theoretical grounding for action. More than 20 years ago, Hammond (1996) posited that 'common-sense will bring imperfect reasoning, inconsistency, conflict, and inevitably, error, with its attendant injustices', yet 'quasi-rationality emerges as a valuable form of cognition because it tries to avoid the irresponsibility of intuition as well as the fragility of analysis' (p. 353). Our argument is in the same vein, knowledge creation, process and development involves a social process and societal progress requires some common understanding of the knowledge paradigms. However, we may differ from others in the view that evolutionary process of knowledge management requires one to occasionally depart from the norms and sanctions bounded by accepted forms of rigour and standards to then make a contribution towards creative outputs and innovation. Only through a collective approach which embraces research and practice can there be sufficient monogamy and fuzzy thinking to paint the current societal picture and there-in unveil ways to improve without creating despair.

So how to do we do that? We believe there are at least four actionable items to improve the brotherhood:

1. Champion insights - this involves building a culture within the universities and industrial organisations of openness and acceptance of knowledge flows across boundaries. For practitioners this many involve - (a) better access to research outputs in the language understandable by them, (b) better skills in interpreting the implications of research findings to their practice and, (c) better skills in harnessing the opportunities to improve or change based on the leading research concerning factors which may affect sustainability of the firm. For research scientist this may involve development of - (a) better skills and opportunities to explain specificities and complexities of the research design and findings in a simpler manner in outlets read by those outside academia, (b) better skills, technologies and avenues to collate research in a discipline, decipher it to make sense in particular contexts and convey the research message in an educational setting.
2. Foster leadership - this requires a focus on developing current and emerging leaders in terms of their capabilities to engage with research and practice simultaneously through contemporary means (i.e. micro credentials, summer schools, internal scholar development programs). Importantly, this requires research to be less generalised and be more context rich, sufficiently complex to embrace the challenges and uncertainties of the real-world. It may mean greater emphasis on co-development of multi-disciplinary research projects through university-industry cooperation - the so called 'industrial doctoral programs' rather than the traditional approach fostered within disciplinary silos.
3. Develop a broker - It can be reasonably assumed that research and practice will continue to go about their separate lives, and changing the course of their behaviour will take a long time as it demands a shift in patterns of skills, knowledge, systems, structures, interests and incentives. Thus a role exists for a broker. The broker can act as a match-maker across the quadruple helix (university-industry-government-society), responsible for excellence across all stages of research translation. The broker could be a one or a group of people who have or can adapt to both practitioner and academic behaviours and etymologies and hence are able to effectively process, develop and transfer knowledge across research and practice. The broker's role can be seen as critical for linking industry problems to research

projects, catalysing the dialogue for solving wicked challenges through effective integration of research findings to practice and timely transfer of practitioner challenges and concern to research design.

4. Evoke the brotherhood - and thus spark action. This would involve ways in which research and practice can be challenged but also shown the unique advantages of working in harmony to strengthen the brotherhood. Pragmatically, this means development of shared knowledge, be via unique datasets to facilitate evidence-based decision-making in practice or via road mapping and forecasting to guide research-intensive activities.

To conclude, our call is to avoid a situation in innovation management like what Polkinhorne (1992) claimed of psychological science becoming irrelevant to psychology practice or what led Diboye (2007) to make eight outrageous statements on the state of human resource science and practice and what provoked Bansal and colleagues (2012) to lead a symposium at the Academy of Management after repeated unanswered calls for embracing research and practice as two brothers-in-arms necessary for societal progress.

Yours innovatively,
Anne-Laure Mention, João José Pinto Ferreira, Marko Torkkeli
Editors

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Emotional and Social Intelligence as 'Magic Key' in Innovation: A Designer's call toward inclusivity for all

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Letter From Academia

Abstract. This paper draws attention to the emotional and social intelligence of individuals - encompassing self- and social awareness, empathy and social skills; when applied to innovation, it can boost employee creativity, diversity, risk taking, learning, adapting, and strategic decision making which is deemed as critical in meeting the challenges of the 21st Century. Meanwhile, Design in Business and Innovation have become increasingly synonymous in both meaning (e.g. design and futures thinking) and reach (e.g. products, services, business models, and systems), placing renewed focus on creative human capital as the organizations' greatest asset. Expanding the conversation of Design in business as a strategic role to develop user-centered innovations through 'inclusivity for all', it is proposed that an organization's emotional and social intelligence may well bear the 'magic key' toward competitive resilience and long-term survival.

Keywords. Design; Universal Design; Innovation; Foresight; Inclusivity; Emotional Intelligence.

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1 Introduction

Rapid globalization, increasing competitiveness through technological advances and social impacts are among the driving forces that require new strategic directions and decision-making in modern business. That is, to meet the demands of fast-moving market places, competitive resilience and long-term survival can only be achieved through organizational foresight and creative leadership (Handy, 2011), and the emotional and social intelligence of the organization and its employees, is considered ever more paramount in meeting the challenges of the 21st Century (Bar-On, Tranel, Denburg, & Bechara, 2004; Goleman, 2017; Goleman, Boyatzis, & McKee, 2013).

Meanwhile, the role of Design in business and innovation has gradually expanded over the last two decades. From simply creating and communicating better products, Design is now seen as a set of competencies spanning across innovation, product and portfolio development, market and strategic decision-making, thus enabling interdisciplinary stakeholder teams responsible for creating sustainable value propositions that ensure the organization's future (Bohemia, Rieple, Liedtka, & Cooper, 2014; Buehring & Liedtka, 2018; Heskett, 2001; Lojacono & Zaccai, 2004). Indeed, progressive organizations have noted the favorable use of Design principles applied to problem-solving, sparking the popularity of human-centered design (thinking) processes and applications toward transformative innovations in a global economy (Dunne & Martin, 2006; Liedtka, 2017; Oster, 2008).

Design principles and tools applied in the strategic development of an organization's future-orientation, has positioned Strategic Design in innovation as an organizational competence that looks beyond one-time creative outputs (e.g. products or services), toward Design as an organizational activity that can lead to sustained innovation and competitiveness (Boztepe, 2016; Buhring & Koskinen, 2017; Heskett, 2001; Mozota, 1998). Consequently, Design and Innovation have become increasingly synonymous in both meaning (e.g. design and futures thinking) and reach (e.g. products, services, business models, and systems), placing renewed focus on creative human capital as the organizations' greatest asset (Florida, 2004). In this 'letter from industry', the authors aim, foremost, to expand the conversation of Design in business as a strategic role to develop user-centered innovations based on 'inclusivity for all', in which an organization's emotional and social intelligence may well bear the 'magic key' toward competitive resilience and long-term survival.

2 Emotional and Social Intelligence

It has been suggested that emotional and social intelligence accounts for more than 85% of exceptional achievement within individuals; it encompasses self- and social awareness, empathy and social skills (Goleman, 1995). In aggregate of teams with high emotional and social intelligence, the organization that encourages such qualities to be applied to innovation, are boosting employee creativity, diversity, risk taking, learning, adapting, and strategic decision making (Barczak, Lassk, & Mulki, 2010), which is highly relevant to the development of an organizations' strategic direction and future innovation portfolio. When visionary physicist Stephen Hawking was asked which human failing he would like to correct he answered, "aggression", and which

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traits he would like to see more often, he responded, "kindness and understanding". Which human quality would he like most to magnify? "Empathy."

3 Design inclusivity - for all [A Designer's perspective]

By definition, design inclusivity (or inclusive design) is to extend the innovation focus beyond a narrowly defined target user, and to address the needs of a wider group of users by designing products, services, and experiences that are accessible to as many people as possible (Clarkson, Coleman, Keates, & Lebbon, 2013). Design for all, is "... the intervention into environments, products and services which aims to ensure that anyone, including future generations, regardless of age, gender, capacities or cultural background, can participate in social, economic, cultural and leisure activities with equal opportunities" (Designforall.org, 2018). An example of inclusive design is Sam Farber's OXO Good Grips invention, which initially started with a kitchen utensil (the peeler) as a design challenge to include people with reduced dexterity as well as creating kitchen tools that were more comfortable for everyone. In present day, among a growing list of brands embracing inclusive design in innovation, the OXO brand has developed over 500 products based on its Inclusive Design philosophy, leading to numerous design awards and a profitable business practice.

Indeed, concern for the wider society has been a central theme in Design for generations, and over time, determining the expanding role of the Designer. From the moment that our Cro-Magnon ancestors chipped stones to create cutting tools, we have designed. Creating for our comfort, providing for our existence, responding to the daily challenges that impact our lives is a matter of design. The places and things that make up our individual realms are the results of someone's daring, thinking, and action. Throughout history, Designers have been those people who challenge the norm, rise to the occasion, and seize the opportunity to make a difference for all lives.

Just as the curiosity of DaVinci made way for the first flight of the Wright Brothers, the combustion engine led to the success of rockets capable of launching into space. The invention of the moment gives birth to the products of the future, just as the grandfathers of industrial design in America, Loewy, Teague, Dreyfuss, gave shape to endless products that fill our lives today. Automobiles, airplanes, telephones; all of the things which we, as consumers, have come to expect and require are made possible by the creativity of the art and science that is Design, under the direction of dedicated Designers.

3.1 The dawn of a new era in Design - "Universal"

In the 1960's, product designers found themselves faced by ever-growing challenges. In an exceptional and daring experiment over a period of three years (1979-82), Patricia Moore [author 2] travelled throughout the United States and Canada disguised as women more than eighty years of age. With her body altered to simulate the normal sensory changes associated with aging, she was able to respond to people, products, and environments as an elder [Figure 1].

Fig. 1. Experiencing the Future: Patricia Moore dressed as a woman in her 80s

This experience helped illuminate the missed opportunities in broadening the design and innovation focus, consequently helping to define what is commonly known as Universal Design.

The concerns of poverty, the preservation of the environment, and physical accessibility brought Designers into a new role, as arbiters of the quality of life. Determination of the shape and scope of our cities, protection and support of fragile resources that are our planet, and the independence and autonomy of all persons, throughout the course of their life's entirety catapulted the importance of good Design and the position of the Designer into a role of vital importance.

Just as DaVinci questioned the accepted, the Designer working with interdisciplinary innovation teams of today must re-define what is known. Today's answers must support tomorrow's questions. There has never been a more exciting or vital time for the presence of Design in business foresight and innovation. And, the need for "humanism" in Design has never been more crucial to our future.

3.2 Inclusivity by Design

By focusing our talents on the needs of each individual as equal, Designers have given birth to a new order: "Inclusivity by Design". This 'design for all' philosophic challenge doesn't simply ask "Why?" but rather, "Why not?". Designers don't speak of limitations, instead they tend to focus on possibilities. The emergence of 'inclusivity' in design supports the conviction that where there is a 'deficit', we will present a solution. "Where there is ignorance, we will strive for enlightenment. Where there is a roadblock, we will create a pathway", according to Moore, who is widely recognized as a leading authority on consumer lifespan behaviors.

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With the dawn of the new millennium, the Designer has emerged as the navigator, the translator for what consumers want and wish, their hopes and their desires. Beyond providing for a successful bottom-line for the corporate realm, Design in business and innovation will perpetuate the presence of the companies which address consumer needs. Beyond the confines of the aesthetic, Designers and interdisciplinary innovation team ought to have the capacity to fashion the very quality of life itself. That is, expanding the conversation of Design in business, foresight and innovation, toward 'inclusivity for all', organizations stand to develop and foster their employee's emotional and social intelligence, which may well bear the 'magic key' in their forward-looking and strategic innovations.

4 Conclusion

The human factor has returned to center stage, and the need and opportunity for inclusivity in design and innovation has never been more critical. That is, while rapid globalization, increasing competitiveness through technological advances and social impacts are among the driving forces that require new strategic directions and decision-making, it is the emotional and social intelligence of the Organization and its employees, now considered paramount in meeting the challenges of the 21st Century. Organizations, therefore, should embrace the necessary foundation for meeting consumer wishes, needs, and dreams, by focusing strategic innovation efforts on providing features and aspects which meet the range of everyone's needs. Hence, expanding the conversation of Design in business to include the needs of specific people with other abilities, or younger, weller consumers, interdisciplinary innovation teams will discover new opportunities for innovation by successfully applying their combined emotional and social intelligence. In doing so, they will realize their potential as designers, architects, innovators, and human engineers by practicing 'inclusivity for all'.

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The innovation facilitator: characteristics and importance for innovation teams

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Abstract. This research develops the understanding of the innovation facilitator's (facilitator) role in terms of inexperienced innovation teams in an industrial context. Qualitative data was collected from three X-functional innovation teams' members and their sponsor to identify the requirements for a facilitator. Forty characteristics were identified and charted in an innovation process. Significant findings, contributing to prior research, are that the facilitator's presence and involvement in the innovation teams was crucial in the pre-phase and first phase of the innovation process due to the very high complexity; in these phases, personal characteristics as well as skills in, for example, facilitating, teaching, coaching, and group dynamics were central. The importance of the pre-phase was unexpected, resulting in an extended innovation process, during which an initial preparation phase has been added to the traditional innovation process. This knowledge is applicable, for example, when creating and educating new innovation teams within an organization. Future research is suggested.

Keywords. Innovation Facilitator; Innovation Team; Innovation Management; Product Development; Innovation Process.

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1 Introduction

This research aims to gain knowledge about the innovation facilitator, that is, a person who is in the position of supporting innovation teams to both conduct and learn innovation work from ongoing innovation projects, without driving or managing the work him- or herself. The background to this study is prior research stating that there is a need for increased speed when conducting innovation work to meet shorter product life cycles (Barczak et al., 2009; Chen et al., 2009; Menon et al., 2002). Nowadays it is well known that innovative organisations are built on the empowerment of and trust in the employees; the leadership should be transparent and encourage innovative behaviour to enhance both individual creativity and the teams' ability to evaluate, expand, and refine new knowledge (Mitchell and Boyle, 2008; Schraub et al., 2014). Prior research also claims that high involvement of employees who are not a part of R&D or development is one key to increased innovation (Bessant, 2003; Xu et al., 2006). One practical way to involve employees is to create X-functional innovation teams that can reach out in their networks to involve co-workers or external resources (e.g., McGreevy, 2006a: 2006b; O´Connor and McDermott, 2004; West el al, 2004). At the same time, previous research demonstrates that innovation teams based on inexperienced members have performance problems due to, for example, lack of knowledge and experience regarding innovation work (Karlsson et al., 2010; Kristiansen and Bloch-Poulsen, 2010). This deficiency relates to the complex situation innovation teams need to handle when innovating, as innovation work span from ideation all the way to commercialisation (Johnsson, 2014; Kesting and Ulhöj, 2010; Lee and Sukoco, 2011; Scozzi and Garavelli, 2005).

Previous research on successful teamwork has revealed three approaches. One approach is that successful teams have a mental model that unites the team members' mind-set in, for example, goals and purpose of the project. It is argued that team leaders have a big impact on providing the mental models in which the key factors for success are related to a context in which the team could focus on the "here and now" and the future goal simultaneously (Davison and Blackman, 2005). Another approach is that innovative leadership is the key, in which the team leader handles the sequences of divergent and convergent thinking, deals with the different iterations and loops in the innovation process, works with metaphors and analogies in the search for new ideas by encouraging wild ideas and stimulating out-of-the-box thinking. This approach also requires evaluation, the judgement of new ideas during the convergent stages, and the creation of an environment for social cohesion and work with limited resources (Akbar and Tzokas, 2013; Buijs, 2007; Büschgens et al., 2013). A third approach is to identify innovation champions as enablers of innovation within organisations (Radnor and Robinson, 2000). They have proved to be successful in managing and executing innovation projects when the innovation outcomes are more important than what processes to use or follow (Dulaimi et al., 2004; Gamatese and Hallowell, 2011).

This leads to the problem of teaching innovation teams how to conduct innovation work in practice. Attempts to teach innovation teams through external innovation drivers show positive results in innovation output but not in increased innovation-related knowledge. Hallgren (2009) created innovation steering groups and supported them in their innovation projects. Johnsson et al. (2010) revealed that an external innovation driver should preferably be a person who has experience in practical innovation work in accordance with the uncertain innovation process;

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is socially competent, opportunity driven, and flexible; and has the ability to establish trust. Further, the innovation driver must have a holistic overview of the company's situation; be familiar with innovation strategies, intellectual property rights, product portfolios, and changing management; and be open for project changes. Both Hallgren and Johnsson et al. experienced that there were positive results in terms of innovation output; however, the learning effects were poor, and the innovation activities stopped shortly after that the knowledgeable persons left the organizations. In previous research on factors that enable innovation teams' innovation work (Johnsson, 2016a; 2016b), it was also identified that that the facilitator had an unexpected impact and effect on the teams. Therefore, it is of interest to explore the facilitator to gain knowledge of required characteristics and of when in the innovation projects the facilitator is most needed, if he or she is needed at all. Even though recent research suggests that facilitators for innovation include not only the facilitator him-or herself but also the spatial environment and factors as e.g. culture and policy setting (Brenner and Broekel, 2011), this research focuses on the facilitator as an individual.

2 Literature review and research gap

A literature study was conducted to clarify prior research in the area. This section presents research covering the innovation facilitator, innovation competence, the innovation process, and the identified research gap.

The innovation facilitator (facilitator) is defined as a person who educates, advocates, and advises. He or she is also responsible for raising the organization's awareness of the importance of innovation, standardising and communicating a vocabulary of innovation, providing a set of tools, and developing training activities (Andrew and Sirkin, 2008). In contrast to the innovation champion, who actively and enthusiastically promotes innovations through the crucial organisational stages, converting organisational issues to his or her advantage (Howell et al., 2004), the facilitator's role is to guide the complex and non-linear innovation process with various overlapping circles of individuals, teams, divisions, and departments (Hunter and Cushenbery, 2011).

The facilitator is especially important when an organisation needs to change attitudes and learn new skills or behaviours. Being a facilitator is a long-term commitment that may span several years but eventually becomes unnecessary to the innovation team's work when constant, intensive, companywide education is no longer required (Andrew and Sirkin, 2008). However, the role of the facilitator is complex where operational developer (OD) practitioners are suggested to facilitate innovation (Barnes and Francis, 2006), as the facilitation work includes, for example, economics, sociology, management theory, and systems theory and auditing to develop innovation capability. To this end, the facilitator requires distinctive consulting skills and specialised methodologies, such as data collection, auditing skills, technology visioning, scenario development, change management, and organisational culture development. There are several reasons an OD practitioner becomes a successful facilitator, according to Barnes and Francis. An OD practitioner is usually seen as neutral in terms of the content of ideas being discussed. He or she facilitates meetings in which innovation topics and activities are discussed and is skilful in the use of process tools, able to assist client groups to make their discussions more inclusive and

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productive and to improve their innovation management process, alert to group process issues that can stifle open discussion, and both aware of the strategic direction in the organisation and positioned to raise the issue of how it is being implemented in any group. Further, the OD practitioner is in a position of trust, with the licence to challenge clients' assumptions; broad in perspective; and able to help clients see how they can move their ideas forward. One concept, developed by Kristiansen and Bloch-Poulsen (2010), is EDIT (Employee Driven Innovation in Teams), where employees from all levels in the organisation are encouraged to contribute to innovation work by forming teams. However, problems such as conflict and lack of performance occurred due to lack of innovation-related knowledge. This led to further research which revealed that an innovation facilitator played a significant important role in innovation work by allowing and maintaining space in discussions among the team members, keeping the meetings effective by ensuring that teams avoided endless discussions, and helping the team members see things from the same perspective (Bloch-Poulsen, 2011).

When it comes to practical work, the facilitator should (Heikkinen et al., 2007; Martin, 2011; Knight and Harland, 2005) promote product and process innovation. However, the facilitator should stay outside the actual development processes, providing possibilities for actions to take place without disturbing the process in any way. Nevertheless, the facilitator may influence the work quite radically in that without the position's existence, the work might not be conducted at all or its operations severely hindered (Heikkinen et al., 2007).

As demonstrated above, a facilitator needs to handle a complex context to stimulate innovation output through innovation teams. In this regard, an increased research focus on required competence is emerging, that is, research on the management of social capabilities to increase innovation output (Vincenzo and Mascia, 2011); on characteristics such as strong brokering skills, social competence, and the ability to cope with uncertain situations (Du Chantenier et al., 2010; Han and Hovav, 2012); and on building trust in the innovation project and among team members (Kadefors, 2003; Maurer, 2010; Smyth et al., 2010). A holistic picture of competence is provided by Illeris (2013) by means of the Competence Flower, which demonstrates 20 different factors that all together constitute competence. In this illustration, the context is illustrated as soil in which the flower is planted. The flower's stem is related to capacities, dispositions, and potentials. Then there are two circles of flower petals. The inner circle consists of a personal profile, knowledge, skills, attitudes, judgements and decisions, a holistic perspective, structural understanding, sociability and collaboration, and autonomy. The outer circle of petals consists of creativity, fantasy, combination ability, flexibility, empathy, intuition, critical perspective, and resistance potential. These factors together become actions in specific situations, which also surrounds the flower's receptacle. In brief, the key elements of competence involve not only intellectual but also emotional capacities, dispositions, and potentials. These capacities and potentials are used in practice through actions where immediate judgements, and decision-making also take place. Further, these actions are made in known and unknown situations. Bozic (2016) has developed the understanding of the Competence Flower even further by suggesting a theoretical framework for innovation competence based on relevant literature and research, in which the four areas of innovation practice, content, intra- and interpersonal characteristics are integrated and related to each other. The centre of Bozic's framework is innovation practice, which consists of idea exploration, idea generation, idea championing, and idea implementation. The model's content consists of definitions of innovation, innovation models, good innovation

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practices, and innovation skills such as questioning, observing, networking, experimenting, and associating. The area of intrapersonal characteristics comprises curiosity, autonomy, flexibility, the ability to perceive, motivation, ambitiousness, creativity, self-confidence, entrepreneurship, and intuition. The area of interpersonal characteristics consists of listening, empathy, sharing, dialogue, improvisation, and feedback. In addition to the model described, the learning aspect of developing competence depends on four types of learning: cumulative, assimilative, accommodative, and transformative. The latter is the most complex level of learning (ibid). Transformative learning, when the knowledge becomes one's own, includes creative learning that is created from reflections in unknown situations and is very important for innovation work (Ellström and Nilsen, 2014).

Based on the seven steps when innovating, as suggested by Milton and Rogers (2013), Räsänen et al. (2015) integrated innovation competence to sort out when specific competence is required. They identified competence refers to individual interpersonal and networking aspects and was categorised into five sub-dimensions, namely creative problem-solving skills, systems thinking, goal orientation, team working, and networking skills. When merging the innovation competences with the innovation process, a theoretical framework was suggested. First, idea screening and idea generation include holistic knowledge and the competence regarding abilities to see new possibilities everywhere and to spread new ideas widely. Second, concept development includes the competence to think independently, listen to others, and communicate to transmit and share knowledge and new ideas in the team. The third step, system design, includes the ability to analyse the relationships among systems, work persistently, and interact and share knowledge with others. The fourth step, detail design, includes competence in interacting and sharing knowledge with others and in understanding details. Fifth, building the system includes competent abilities to take group members´ viewpoints and cultural backgrounds into account. The sixth step, testing and validation, includes competent abilities to consider a product from a detailed and holistic perspective. Finally, market launch and delivery include the productive cooperation with professionals and the network from different fields.

The innovation process is usually divided into steps, stages, or phases starting with ideation, in which new ideas are generated, followed by the development of the idea and ending in a market launch. Amabile et al. (1996) divide the process into two parts: a first, creative phase and a second, implementation phase in which the product is developed and launched into the market. Tidd and Bessant (2009) suggest four phases when developing ideas for the market: search for new ideas and innovative opportunities; select ideas to develop and determine what to do further; develop the idea and launch it on the market; and collect the value created. However, the process is not linear, even though the first impression might look that way, but iterative, and loops are taken repeatedly. Besides the innovation processes demonstrated by Milton and Rogers and by Tidd and Bessant, similar innovation processes are suggested by numerous authors (e.g. Baxter, 2002; Farris, 1972; Johnsson, 2009; Trott, 2012). The main differences are how they are more or less practically or theoretically oriented where latter literature suggests an agile approach to innovation work, i.e. to work iterative and flexible to avoid being trapped in gates where valuable time is lost (e.g. Adkins, 2010; Highsmith, 2009; Johnsson, 2009); generally, three phases are common to the innovation processes presented, i.e. an ideation-related phase, execution where the idea is developed and launched on the market, and value harvesting. The practical work when generating ideas is highly abstract and involves many uncertainties, and the

abstract work continues throughout the selection phases of what ideas to prototype and test for market reactions. As the learning increases based on the work conducted, the level of abstractness decreases to become more and more similar to everyday work (Johnsson, 2014).

To conclude, previous research has identified that innovation teams are recommended for agile innovation work and that a facilitator is suggested to be the link to the ability to practice innovation work (e.g., Andrew and Sirkin, 2008; Howell et al., 2004; Heikkinen, et al., 2007). Prior research regarding the personal characteristics of conducting innovation work has been focusing on the individuals conducting practical innovation work (e.g. Bozic, 2016; Kairisto-Mertanen et al., 2011) or on the innovation driver (Johnsson et al., 2010; Hallgren, 2009). Räsänen et al. (2015) have charted the personal characteristics of students in an innovation process to demonstrate when certain characteristics are needed in accordance with an innovation process. The innovation process itself is not standardised. Although there are similarities among the different variations, the work that is supposed to be conducted and guided through by the facilitator is complex (Barnes and Francis, 2006; Hunter and Cushenbery, 2011). This implies that the facilitator must be able to handle all upcoming uncertainties and complexities. Still, prior research has not yet fully explored the facilitator's required characteristics and presence in ongoing, long-term innovation projects conducted by innovation teams in an industrial context, into which this study will provide new insight.

Based on the introduction and literature review, two questions have emerged: Which characteristics, if any, are required of an innovation facilitator when facilitating innovation teams, and when in relation to the innovation process are the innovation facilitator's characteristics most needed?

3 Research design

To gain knowledge about the facilitator's characteristics and presence needed in innovation projects, this study investigated the members of three innovation teams (teams) and their sponsor; Team A consisted of 4 members, Team B of 4 members, and Team C of 7 members. The teams' only restrictions were to deliver innovative concepts that distinctly demonstrated business opportunities and customer value. In this longitudinal ethnographic research, the researcher also participated as facilitator in the innovation projects. However, the researcher was well aware of that participating research might influence the teams and their performance (Gummesson, 2000) and took actions to prevent bias by discussing this matter with the respondents and through continuous reflections throughout the study.

The teams were all systematically created and prepared through five steps to conduct agile innovation work with the support of the facilitator (Johnsson, 2017). First, the sponsor secured top management and the management's commitment. Second, the sponsor and the facilitator identified an innovation team convener (convener) with the purpose of gathering an innovation team. Third, the facilitator prepared the convener with explicit instructions regarding how to manage agile innovation projects (Johnsson, 2009), how to systematically gather team members on a X-functional basis. Fourth, the convener gathered the innovation team members. Fifth was the innovation project's kick-off, that is, the convener planned and executed a kick-off regarding the idea to develop, during which the team members were introduced to agile innovation work

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and group dynamics. To visualise the innovation project's progress, the innovation process demonstrated by Tidd and Bessant (2009) was chosen, consisting of four phases: searching for ideas, selecting an idea to develop, implementing and launching a developed product (e.g., services or processes) on the market, and capturing the value created through the process.

The facilitator was involved with guidance, advice, and explanations of both forthcoming work in the innovation process and expected group dynamic reactions along the projects. All communication regarding the innovation projects was held with the conveners, who then forwarded the information to the other team members.

Similar to Howell et al.'s (2005) study, which identified innovation championing behaviours, this study was conducted stepwise so as not to influence the participants with the pre-defined characteristics of a facilitator. The data were collected from the team members and the sponsor at the point when the innovation projects had reached the early steps in the implementation phase demonstrated by Tidd and Bessant (2009). This was done in three steps: First, an in-depth interview was conducted that focussed on significantly important characteristics a facilitator should possess, the facilitator's effect on the innovation project, and whether the team members had learned to conduct innovation work at a level where they could conduct a new innovation project by themselves. The interviews were audio-recorded and lasted for approximately 40 minutes each. The reason for choosing to interview in this first step is that interviews make it possible to come close to the respondent and are a valid way to understand someone's perspective (Maxwell, 2013); they are recommended for obtaining information that cannot be observed in surveys (Blessing and Chakrabarti, 2009), as interviews make it possible to explore divergences in the respondents' opinions and descriptions of experiences (Yin, 2013). Next, the applicable sections from the interviews were transcribed, reflectively analysed (Schön, 1991, Yin, 2013), and colour-coded to reveal facilitator characteristics. Forty characteristics were identified and evaluated by the team members and the sponsor to see if the facilitator correlated with the identified characteristics. The evaluators were free to adjust the list of characteristics during this phase. After that, all characteristics were rated in five grades: Crucial, Very important, Important, To some degree important and Unwanted. In the final step, the team members and the sponsor plotted all the characteristics in a time chart. The x-axis demonstrated the time from the preparation of the innovation project through the kick-off to the end of the project, illustrated based on the innovation process by Tidd and Bessant (2009). The y-axis demonstrated the importance of the facilitator's characteristics for the team on a scale of 1 to 7, where 1 indicated Not important and 7 indicated Very important.

The collected data were analysed by first photo documenting and charting the data, followed by a thematic analysed in accordance with (Boyatzis, 1998) to identify themes and patterns of the characteristics. All the characteristics were found to be important to some extent. Characteristics were highlighted when; 50% or more of the team members in at least two teams rated characteristics to the same degree and when at least one team member from each team and the sponsor rated one characteristic to the same degree (see Table 1). The plotted characteristics in the time chart were analysed in accordance with the innovation process demonstrated by Tidd and Bessant (2009) to identify in what phase of the innovation process the facilitator's characteristics were most important.

3.1 Examples of coding - Interviews

Quotes from the interviews (below) demonstrate how the questions were asked and the researcher's awareness of his impact on the teams. Significant parts of the answers are highlighted in bold style to visualise examples of the coding, which were used in the first steps of the analyze work. The numbers in brackets indicate the time in the interview where the respondents' start to answer the question asked.

Researcher: "Have you noticed my appearance in the project?"

Sponsor (25.53): "**Yes**. If you'd ask the convener he would say that **it wouldn't be possible to do the work without you because you provide him with confidence in the methodology** "*Yes, you're supposed to feel a bit worried now. No, you need to iterate and reconsider your choices*". That kind of coaching is incredible important together with your e-mails where he can see "*yes*", which strengthens his self-confidence. I mean **the coaching in the methodology and your feedback**. Without that it he couldn't manage according to what he says. So, **in that sense I think you are present**."

Respondent 2 (R2) (46.03): "**Yes**. You were definitely **involved when we had challenges of the commitment aspects**. Very present and visible when we kicked things off. You've been involved in meetings throughout, maybe **not so much leading and championingbut being there as a support mechanism**. So, I would say yes, **visible when needed and I think that has been fine for the team**."

Researcher: "How do I affect your work according to you?"

Sponsor (28.50): "**You represent the methodology they use**. I mean, **they are conducting the work by themselves but you ensure that they don't jump into conclusions**. They think broader than product development only now, which otherwise is the normal way in our company...**You coordinate them to see the bigger picture and to not run too fast**."

R2 (48.48): "You're affecting our work by **providing yourinput when you feel it's needed**. So, if we're missing something my expectation is that were you can contribute. **If we're bearing off path you can bring us back**. If we're not doing something, whatever that may be, my **expectation is that you highlight that and challenge the team**. If we need to be challenged I expect you to challenge the team."

Researcher: "What personal characteristics do I have that affects the project?"

Sponsor (33.13): "**You're good at strengthen the convener's self-confidence, self-esteem and courage by your e-mails for example and your coaching skills. You steer them towards things to do when needed, and you make them believe that it's the right thing to do by encouraging them and strengthen their self-esteem**. I could never do what you do. I'm too inpatient and dominant. Even though I'd read all papers and understood everything I would have taken too much space. **You're a much better listener, patient.** I wonder if they realise **how good you are on this and how much you really know** about this. I don't want to change this, because I believe this is one of the keys to why this works. You're so incredible good, **you let them shine. You're there, tweaking and adjusting small things that lifts them up**."

R2 (55.15): "Yes. **You're knowledge in your expertise which affect the team in a positive way, your feedback whether it's positive or negative is constructive**. That kind of input affect the team. And **feedback**, if we're doing well it's good to know that we are at least heading in the right position and I get that from you. **Sharing what you do, how you do, helping to drive those two X-functional teams helped to build the credibility to the process to the team**. So I think there a lot of positive aspects to who you and what your characteristics are and what you bring to the table."

Researcher: Would you have come this far without my participation?

Sponsor (34.58): "**No**. What do you think after what I just said? **I don't think they would**."

R2 (56.23): "**No, we would not have come this far**."

Researcher: "If I was replaced for somebody else, what would that person need to get the team to perform?"

Sponsor (43.13): "The facilitating role is supposed to be done internally in the future. And they **need the entrepreneurial-management-insight, humbleness to the team, maturity and ability to listen and have patient let it wait for another week. There's a internal need for competence, attitude and leadership regarding this**."

R2 (57.52): "I would say **trust in the team, encouragement for the team, background, communication**. If the team is starting to derail, **being able to highlight that "you're off track, and my job is to steer you back"** having the force in the communication, **expertise to bring the team back around, competence**. I guess I come back to the **knowledge of the process to steer us to ensure us that it's the right direction**. This could easily come off track. So I think **somebody familiar with the process is needed**."

Researcher: "If a new high performing innovation team is created, does it need a facilitator or is written instructions and tools enough?"

Sponsor (36.11): "**No, it won't work**. If you'd quit today I'd try to keep the methodology alive myself. I'd employ a physical person that could observe and coach them. . . "

R2 (59.53): "**I'm going to say initially no**. But, I think through time as more and more people are involved in high performing innovation team projects and understand and learn the process. **Then yes. Maybe**."

Researcher: Something you'd like to add or something you wanted to say that I didn't ask you about?

Sponsor (41.36): No. Nothing that I can think of, except for that I've been bragging so much about our work that we are going to present it at the next coming conference.

R2 (1.08.10): "**I appreciate your feedback, it feels right. I can not compare to anything but we seem to making progress**. We seem to be in line with what we should be doing at this time in the process.

3.2 Examples of coding - Questionnaires

The questionnaires regarding the respondent's and the sponsor's evaluation of the facilitator's characteristics were charted and analysed in three steps; first by importance (Figure 1), followed by evaluating if the facilitator possessed the characteristics (Figure 2), and finally plotted in a time chart (Figure 3). The sponsor's data were systematically compared to the teams' data in average to identify deviation and similarities.

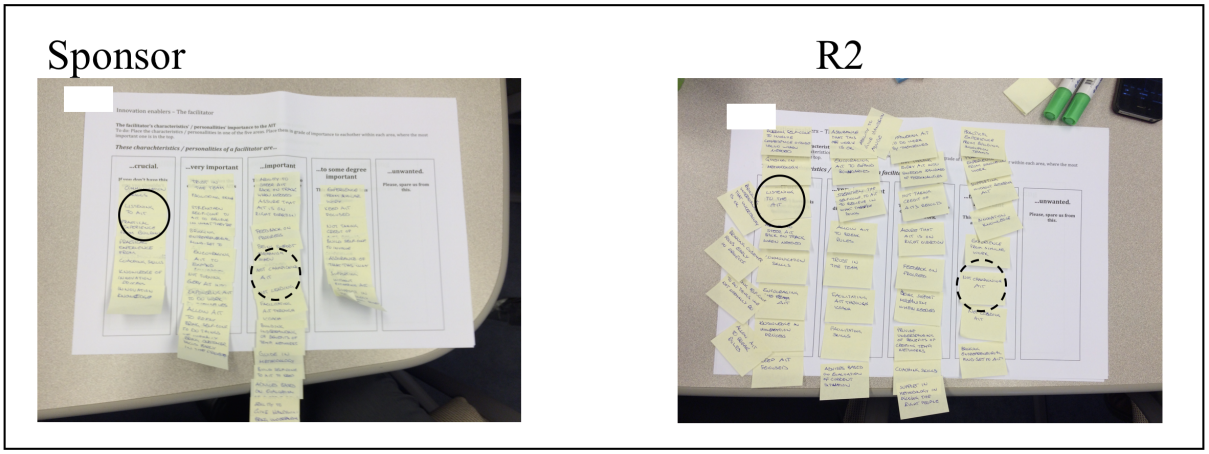

Fig. 1. The figure demonstrates the rated characteristics by the sponsor and Respondent 2

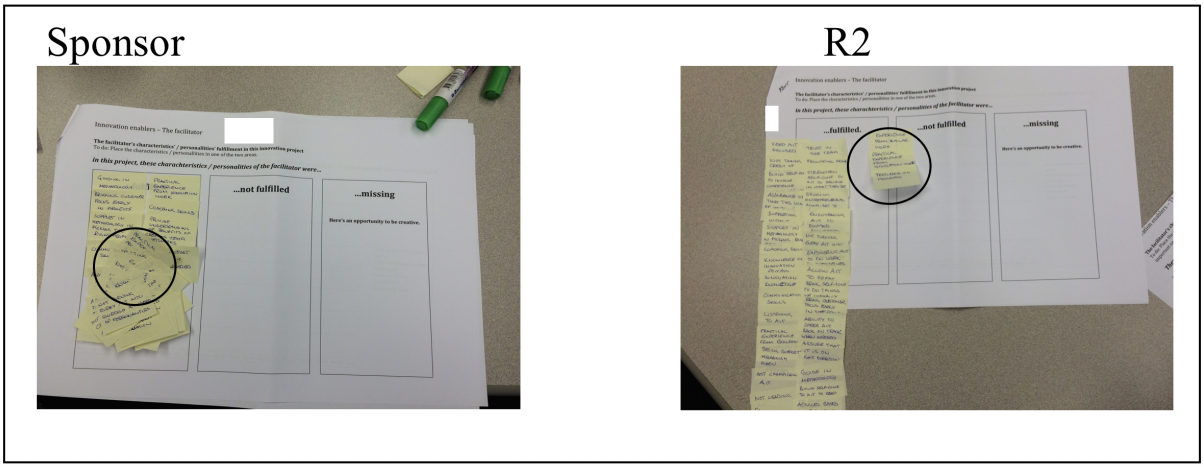

Fig. 2. The figure demonstrates how the facilitator's characteristics correlate to the identified characteristics according to the Respondent and Respondent 2.

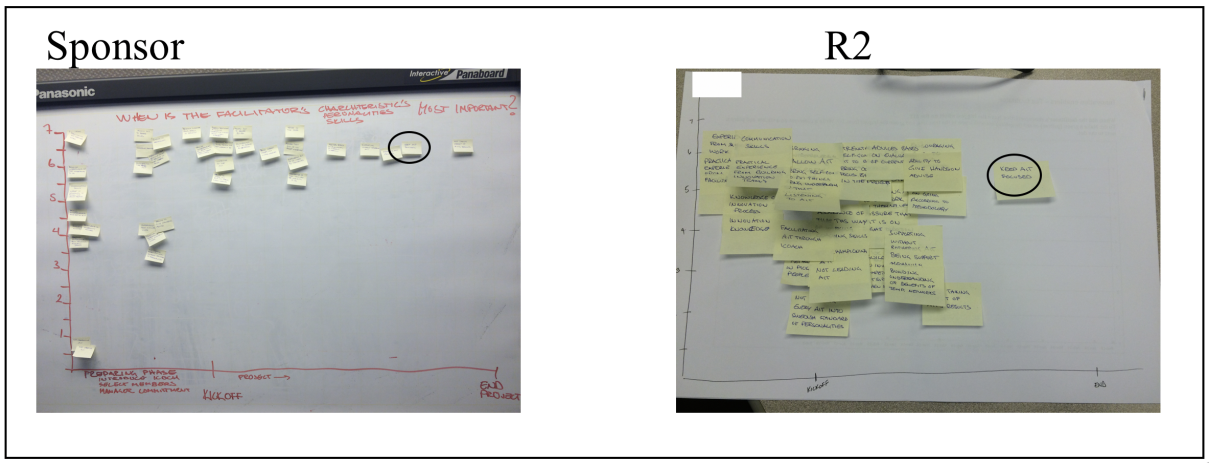

Fig. 3. The figure demonstrates the plotted characteristics in the time chart by the sponsor and Respondent 2.

4 Results

The interviews revealed forty characteristics that a facilitator should possess (see Table 1, column: Characteristic). All respondents found the facilitator's characteristics important to some extent, but the level of importance varied individually. Both similarities and deviations were identified in how the sponsor and the team members assessed the importance of the facilitator's characteristics during an innovation project.

The team members and the sponsor were fully aligned in their assessment of the characteristics' importance in three areas. "Strengthen team's confidence in what they are doing" was considered to be very important; "Advice based on the evaluation of the current situation" and "Feedback on progress" were considered to be important. Also aligned to some degree were the characteristics in the following three areas: "Listening to the team" and "Knowledge of the innovation process" were considered to be crucial by the sponsor and by at least two of the teams' members; "Assure that the team is on the right track" was considered to be important by the sponsor and at least one team member in each team.

Minor deviations were identified regarding ten characteristics. "Trust in the team" was considered to be crucial by the team members and very important by the sponsor; "Develop understanding that uncertainty is OK", "Build self-confidence to do things we do not normally do", and "Allow the team to break rules" were considered to be very important by the team members, and the sponsor considered these characteristics to be crucial. "Supporting without bothering the team", "Coaching skills", and "Challenge the team when needed" were considered to be very important by the team members, and the sponsor considered these characteristics to be important. "Facilitating through convener" and "Ability to give hands-on advice" were considered to be important by the team members, and the sponsor considered these characteristics to be very important. "Build team confidence to continue according to methodology" was considered to be important by the team members and to some degree important by the sponsor.

Significant deviations were identified for five characteristics. "Not championing the team" was

considered to be crucial by at least one respondent in each team and to some degree important by the sponsor. "Encouraging the team to expand boundaries", "Support in methodology of picking the right people", "Innovation knowledge", and "Practical experience from building innovation teams" were considered to be important or very important by the team members and to some degree important by the sponsor. From the teams' perspective, the characteristics relates to the facilitator's ability to build trust in the team by being able to demonstrate his or her competence. The empty boxes in Table 1 do not demonstrate that the characteristics are unimportant but rather indicate that the respondents' assessment of their importance varies significantly.

Regarding whether the facilitator possessed the identified characteristics or not, the sponsor and all team members but four assessed that the facilitator possessed all the identified characteristics (see Table 1). The four team members explained their responses from three perspectives: first, the team already possessed that knowledge; second, they did not know about work that they were not part of; and third, this was an ongoing research project in which these characteristics were tested and evaluated. One of the team members, who also acted as convener felt that the facilitator was disturbing the team's work from time to time.

Table 1 demonstrates the facilitator's characteristics and how the respondents assessed their importance. The table also demonstrates identified themes and characteristics that were not fulfilled according to the respondent(s).

Table 1. The importance of a facilitator's characteristics

No	**Characteristics (In alphabetical order)**	**Team members** (50% or more of team members in at least 50% of the teams)	**team members** (At least one team member in each team.)	**Sponsor**	**Not fulfilled by the facilitator according to team members (Rx) and sponsor (S)**	**Theme**
1	Ability to give hands-on advice.	Important	Important	Very important		Knowledge management
2	Ability to steer the team back on track when needed.	Very important	Very important	Crucial		Knowledge management
3	Advises based on evaluation of current situation.	Very important	Very important	Very important		Knowledge management
4	Allow the team to break rules.	Very important		Crucial		Knowledge management
5	Assurance of that this way of working is OK.			Very important		Knowledge transfer

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No	Characteristics (In alphabetical order)	Team members (50% or more of team members in at least 50% of the teams)	team members (At least one team member in each team.)	Sponsor	Not fulfilled by the facilitator according to team members (Rx) and sponsor (S)	Theme
6	Assure that the team is on right direction.		Important	Important		Knowledge transfer
7	Being support mechanism when needed.			Important		Knowledge management
8	Bring customer focus early in project.	Important		Crucial	R10	Knowledge transfer
9	Bring entrepreneurial mind-set into the team.		Crucial	To some degree important	R10	Knowledge transfer
10	Bring understanding of that uncertainty is OK.	Very important	Very important	Crucial		Knowledge transfer
11	Build self-confidence to involve competence outside the Company when needed.		Important	Crucial	R3, R10	Knowledge transfer
12	Build self-confidence to the team to keep on going according to methodology.	Important	Important	To some degree important		Knowledge transfer
13	Build self-confident to do things we not normally do.	Very important		Crucial		Knowledge transfer
14	Challenge the team when needed.		Very important	Important		Knowledge management
15	Coaching skills.	Very important		Important	R10	Knowledge management
16	Communication skills.			Crucial	R3	Knowledge management

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No	Characteristics (In alphabetical order)	Team members (50% or more of team members in at least 50% of the teams)	team members (At least one team member in each team.)	Sponsor	Not fulfilled by the facilitator according to team members (Rx) and sponsor (S)	Theme
17	Empowering the team to do work by themselves.			Important	R3	Knowledge management
18	Encouraging the team to expand boundaries.	Important	Important, Very important	To some degree important		Knowledge transfer
19	Encouraging the team.			Crucial		Knowledge management
20	Experience from similar work.			To some degree important	R10	Innovation knowledge
21	Facilitating skills.			Very important	R10	Knowledge management
22	Facilitating through convener	Important		Very important		Knowledge management
23	Feedback on progress.	Important	Important	Important	R2	Knowledge management
24	Guiding in methodology.			Crucial		Knowledge transfer
25	Highlight when the team is off track.			Important		Knowledge management
26	Innovation knowledge.	Very important	Very important	To some degree important		Innovation knowledge
27	Keep the team focused.			To some degree important		Knowledge management

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No	Characteristics (In alphabetical order)	Team members (50% or more of team members in at least 50% of the teams)	team members (At least one team member in each team.)	Sponsor	Not fulfilled by the facilitator according to team members (Rx) and sponsor (S)	Theme
28	Knowledge of innovation process.	Important	Crucial	Crucial		Innovation knowledge
29	Listening to the team.	Crucial	Very important	Crucial		Knowledge management
30	Not championing the team.		Crucial	To some degree important		Knowledge management
31	Not leading the team.	Important		To some degree important		Knowledge management
32	Not taking credit of the team's results.	Important	Important	Important		Knowledge management
33	Not turning every team into Swedish standard of personalities.			Important		Knowledge management
34	Practical experience from building innovation teams.		Very important	To some degree important	R2, R10	Innovation knowledge
35	Practical experience from innovation work.	Crucial	Crucial	To some degree important	R2	Innovation knowledge
36	Provide understanding of benefits of creating temporary networks.			Important	R3	Knowledge transfer
37	Strengthen the self-confident to the team to believe in what they're doing.	Very important	Very important	Very important		Knowledge transfer

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No	Characteristics (In alphabetical order)	Team members (50% or more of team members in at least 50% of the teams)	team members (At least one team member in each team.)	Sponsor	Not fulfilled by the facilitator according to team members (Rx) and sponsor (S)	Theme
38	Support in methodology in picking the right people.	Very important		To some degree important	R10	Knowledge transfer
39	Supporting without bothering the team.	Very important		Important	R1	Knowledge management
40	Trust in the team.	Crucial		Very important		Knowledge management

The characteristics were plotted in a time chart by the team members (Figure 4) and the sponsor (Figure 5). The results demonstrate that the facilitator's presence and practical advice were most important in the pre-phase and the first two phases of the innovation process. Later, in the early steps of the implementation phase, it became more important to have access to the facilitator when needed, similar to back-office support. The plotted characteristics in the time chart demonstrate that the teams generally assessed all the identified characteristics as important to some degree except for two characteristics in the first phase: "Not turning every team into Swedish standard personalities" and "Provide understanding of the benefits of creating temporary networks". These findings were explained by the fact that two of the teams were Swedish, which made them biased, and the network-related item was quite obvious, according to the team members. Similarly to the team members, the sponsor also assessed all the identified characteristics as important to some degree except for "Not turning every team into Swedish standard personalities". The difference, however, is that Swedish employees within this global company tend to be less hierarchic and more entrepreneurial, which the sponsor appreciated in this work. The sponsor also assessed "Not leading the team" and "Not championing the team" as not important at all.

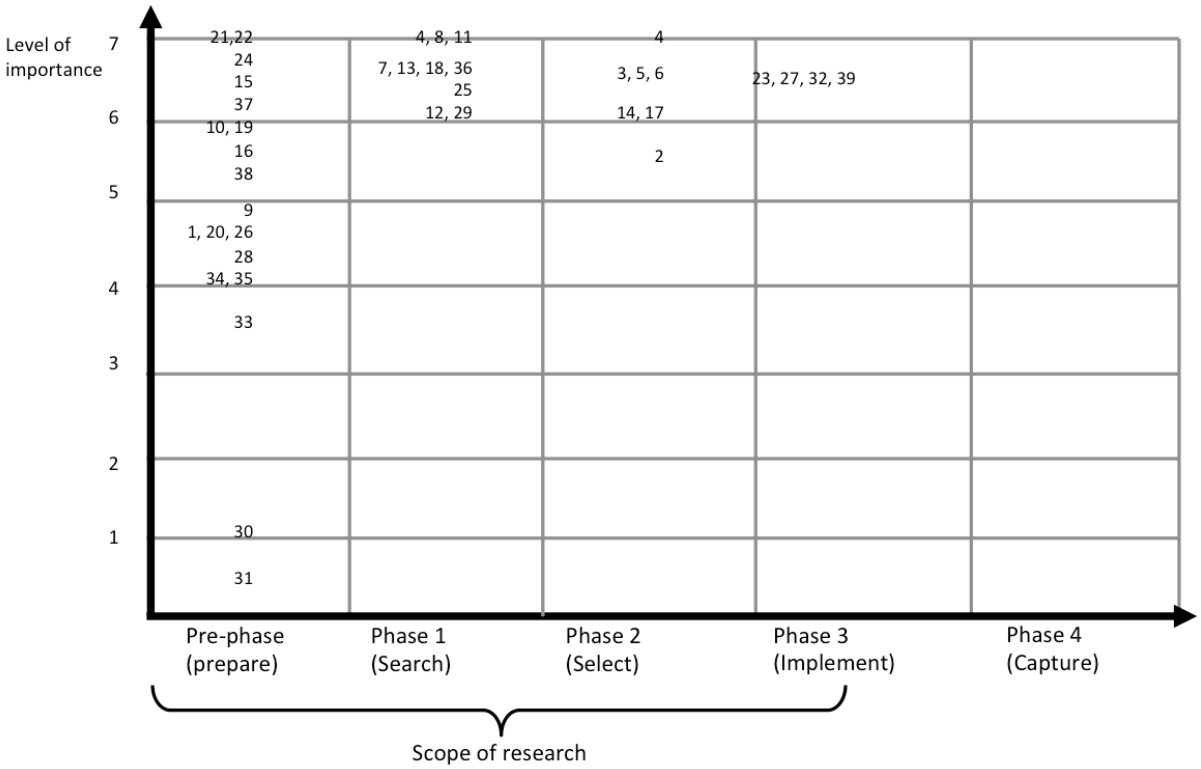

Fig. 4. The figure demonstrates when the facilitator's characteristics are most important in innovation projects, according to the sponsor.

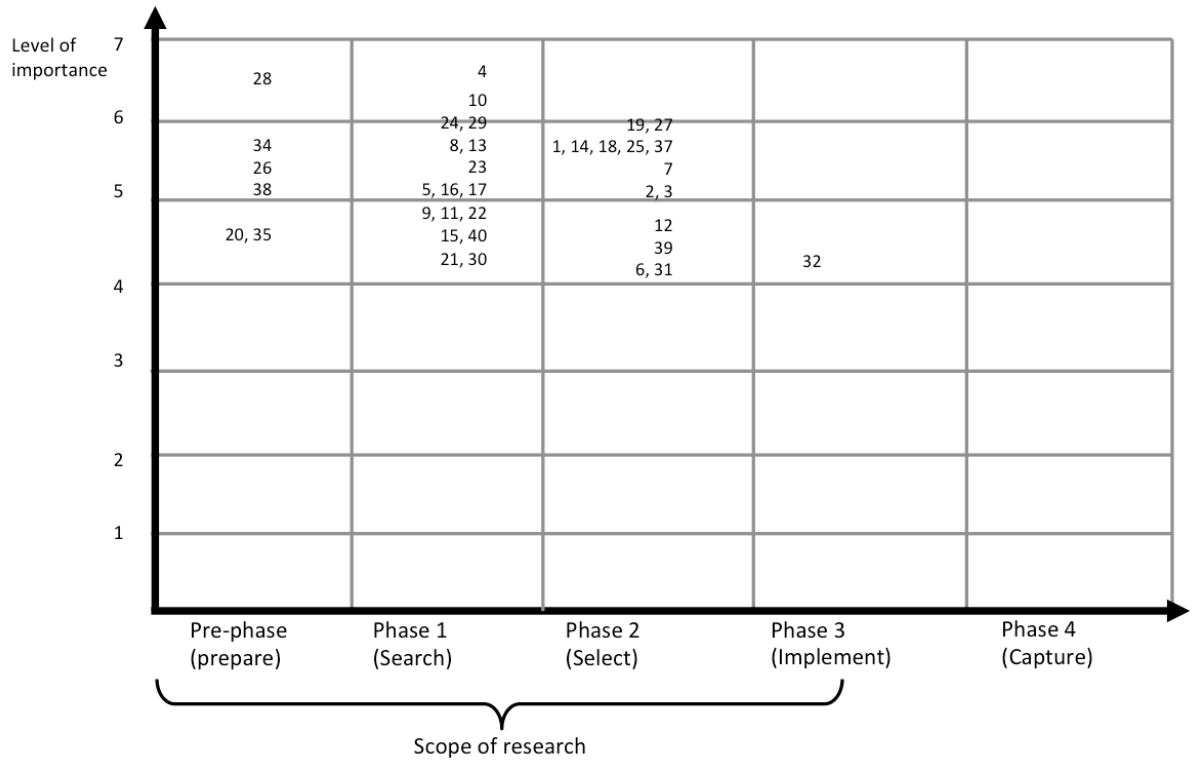

Fig. 5. The figure demonstrates when the facilitator's characteristics are most important in innovation projects, according to the teams on average.

Considering the sponsor's assessments of the characteristics' importance compared to the team members' assessments on average, the deviations are not significant (Table 2). Three of the characteristics were rated the same, with a difference of two decimals: "Develop understanding that uncertainty is OK", "Listen to the team", and "Experience from similar work". The biggest deviation in rating was identified for two characteristics, where the teams rated "Not leading the team" and "Not championing" to be important, but the sponsor rated these characteristics as not important.

The biggest deviations between the sponsor and the teams were related to when in the innovation process the characteristics were important. In general, the sponsor rated the facilitator's characteristics as more important than the teams did (Table 3). The sponsor assessed 21 characteristics, and the teams assessed 6 characteristics as important in the pre-phase. One explanation was identified from the interviews: Team members commented that they did not know what was going on before the kick-off and were unaware of the ongoing communication between the facilitator and the convener between team meetings; they therefore found it difficult to relate to that work. The sponsor, on the other hand, was very well informed regarding the activities in the pre-phase, the teams' work and progress, and the ongoing communication between the convener and the facilitator; in this way, they had a more holistic view than the teams.

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Table 2. The table demonstrates how important the facilitator's characteristics are according to the innovation teams and the sponsor.

		Innovation team members [Average]	Sponsor
No	Characteristics (In alphabetical order)	(Grade of importance 1-7) 1=not imp. 7=very imp. (Low and High indicates the lowest and highest rate)	(Grade of importance 1-7) 1=not imp. 7=very imp.
1	Ability to give hands-on advice.	5.5 (Low: 1.0 - High: 6.5)	4.5
2	Ability to steer the team back on track when needed.	4.9 (Low: 3.0 - High: 7.0)	5.75
3	Advises based on evaluation of current situation.	4.9 (Low: 3.0 - High: 7.0)	6.5
4	Allow the team to break rules.	6.5 (Low: 2.5 - High: 7.0)	7.0
5	Assurance of that this way of working is OK.	5.0 (Low: 3.0 -High: 7.0)	6.5
6	Assure that the team is on right direction.	4.1 (Low: 2.0 - High: 7.0)	6.5
7	Being support mechanism when needed.	5.3 (Low: 3.0 - High: 7.0)	6.25
8	Bring customer focus early in project.	5.5 (Low: 3.5 - High: 7.0)	7.0
9	Bring entrepreneurial mind-set into the team.	4.9 (Low: 1.5 - High: 7.0)	4.75
10	Bring understanding of that uncertainty is OK.	5.9 (Low: 5.5 - High: 6.5)	6.0
11	Build self-confidence to involve competence outside the Company when needed.	4.9 (Low: 2.0 - High: 7.0)	7.0
12	Build self-confidence to the team to keep on going according to methodology.	4.6 (Low: 3.0 - High: 6.0)	6.0
13	Build self-confident to do things we not normally do.	5.3 (Low: 4.5 - High: 6.5)	6.5
14	Challenge the team when needed.	5.5 (Low: 3.5 - High: 7.0)	6.0
15	Coaching skills.	4.7 (Low: 2.0 - High: 7.0)	6.5
16	Communication skills.	5.0 (Low: 3.0 - High: 7.0)	6.5
17	Empowering the team to do work by themselves.	5.1 (Low: 3.5 - High: 7.0)	6.0
18	Encouraging the team to expand boundaries.	5.5 (Low: 4.0 - High: 6.5)	6.5
19	Encouraging the team.	5.8 (Low: 3.5 - High: 7.0)	6.0
20	Experience from similar work.	4.6 (Low: 1.0 - High: 6.0)	4.5
21	Facilitating skills.	4.2 (Low: 2.5 - High: 7.0)	7.0
22	Facilitating through convener	4.8 (Low: 2.0 - High: 6.0)	7.0
23	Feedback on progress.	5.1 (Low: 4.0 - High: 6.0)	6.5
24	Guiding in methodology.	5.8 (Low: 1.5 - High: 7.0)	6.75
25	Highlight when the team is off track.	5.5 (Low: 5.5 - High: 7.0)	6.5

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No	Characteristics (In alphabetical order)	Innovation team members [Average] (Grade of importance 1-7) 1=not imp. 7=very imp. (Low and High indicates the lowest and highest rate)	Sponsor (Grade of importance 1-7) 1=not imp. 7=very imp.
26	Innovation knowledge.	5.3 (Low: 1.5 - High: 7.0)	4.25
27	Keep the team focused.	5.7 (Low: 3.0 - High: 7.0)	6.5
28	Knowledge of innovation process.	6.5 (Low: 2.0 - High: 7.0)	4.25
29	Listening to the team.	5.9 (Low: 4.0 - High: 7.0)	6.0
30	Not championing the team.	4.3 (Low: 2.0 - High: 5.0)	1.0
31	Not leading the team.	4.2 (Low: 1.5 - High: 7.0)	0.5
32	Not taking credit of the team's results.	4.1 (Low: 2.5 - High: 7.0)	6.5
33	Not turning every team into Swedish standard of personalities.	2.8 (Low: 1.5 - High: 6.5)	3.5
34	Practical experience from building innovation teams.	5.4 (Low: 1.0 - High: 7.0)	4.0
35	Practical experience from innovation work.	4.5 (Low: 1.5 - High: 6.5)	4.0
36	Provide understanding of benefits of creating temporary networks.	3.0 (Low: 0.5 - High: 4.5)	6.5
37	Strengthen the self-confident to the team to believe in what they're doing.	5.5 (Low: 3.0 - High: 6.0)	6.25
38	Support in methodology in picking the right people.	5.0 (Low: 3.5 - High: 7.0)	5.5
39	Supporting without bothering the team.	4.3 (Low: 1.0 - High: 7.0)	6.5
40	Trust in the team.	4.6 (Low: 3.0 - High: 7.0)	7.0

Table 3. The table demonstrates when in the Extended Innovation Process the facilitator's characteristics are important.

Phase in the Extended Innovation Process	The importance of an innovation facilitator's characteristics in the different phases of an ongoing innovation project in the Extended Innovation Process according to the innovation teams and the sponsor. *(The numbers below represent the innovation facilitator's characteristics as ordered in Table 1.)*	
	Innovation team	**Sponsor**
Pre-phase	20, 26, 28, 34, 35, 38	1, 8, 9, 10, 15, 16, 17, 19, 20, 21, 22, 24, 26, 28, 30, 31, 33, 34, 35, 36, 37, 38
Search	4, 5, 8, 9, 10, 11, 13, 15, 16, 17, 21, 22, 23, 24, 29, 30, 33, 40	2, 4, 7, 11, 12, 13, 18, 25, 29
Select	1, 2, 3, 6, 7, 12, 14, 18, 19, 25, 27, 31, 36, 37, 29	3, 5, 6, 14, 17, 40
Implement	32	27, 32, 39
Capture	(Out of scope)	(Out of scope)

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The importance of the facilitator's characteristics varied over time in those innovation projects (Figure 6) where the facilitator needed to both be involved in the team and support it by observing activities and advising on forthcoming activities throughout the innovation project. However, activities where the facilitator was expected to be involved in the team decreased during the innovation project, and activities of "back-office" character increased during the innovation project. This was explicitly expressed in terms of, for example, "Supporting without bothering", "Not championing the team", "Not leading the team", "Trust in the team" and "Ability to steer the team back on track when needed". This development was highly connected not only to the teams' learning curve of innovation knowledge but also to the fact that activities in the latter part of the innovation process were less abstract and more similar to what members in an innovation team can relate to in their everyday work; for example, when the innovation project enters the implementation phase, much of the abstract problem identification and problem solving are replaced with practical and hands-on work, such as ordering and assembling physical components. Still, innovation teams have to maintain the innovative mind-set and be ready to radically change plans for upcoming roadblocks or changing market demands.

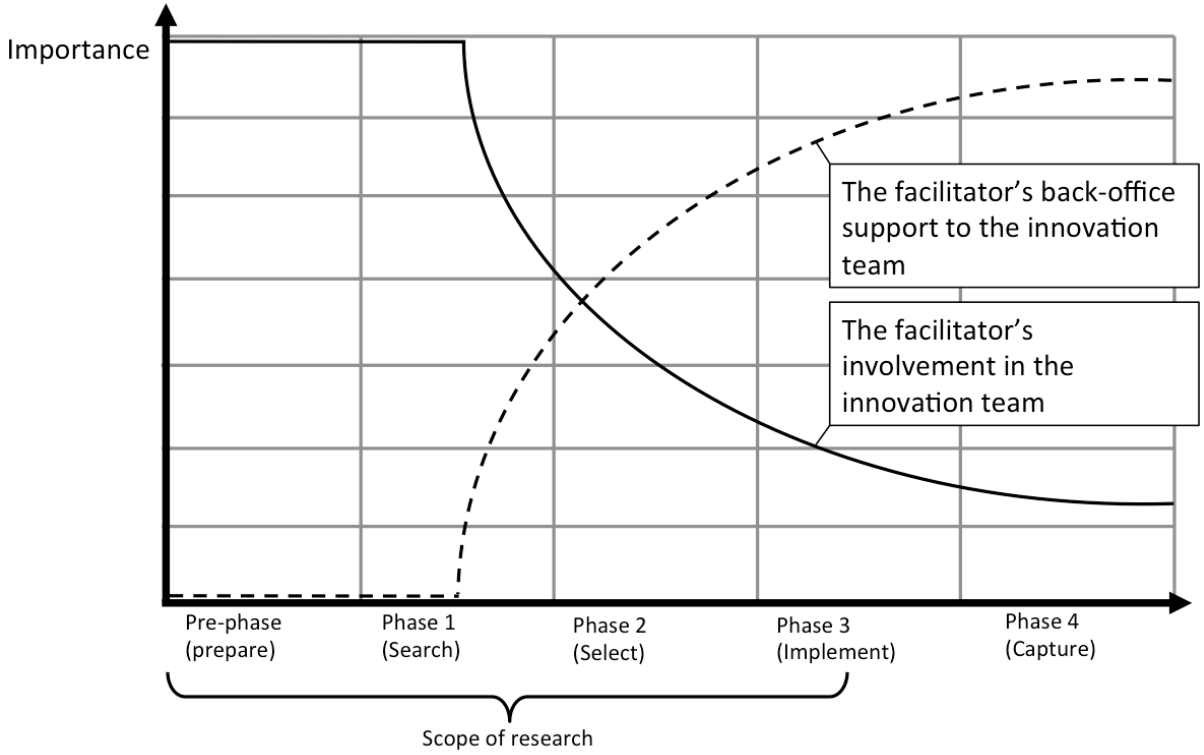

Fig. 6. The figure demonstrates how the facilitator's activities, involvement, and presence in innovation teams change during an ongoing innovation project.

The teams' learning curve from the innovation projects was significant. The interviews revealed that the first (Search) and the second (Select) phase of the innovation projects were very abstract and confusing for the team members, and they responded by arguing that they wasted time on useless work because they were used to being provided with already prepared specifications or

requirements. In the innovation projects within this study, they had to figure out all of these things by themselves by following the innovation process, which includes working on parallel tracks to find out the best solution as the innovation project emerged. In the third phase (Implementation), the team members understood the purpose of previous activities, such as need-finding, and realised that they had saved both time and resources from the work conducted. Other values created were that they had fun while working, their motivation increased, and they explicitly said that they were ready for new innovation projects. In fact, Team B and Team C, who ended their innovation projects before Team A, started new innovation projects in which the facilitator was present as "back-office-support" to the convener.

The facilitator was seen as important or even crucial during the pre-phase and the first two phases of the innovation process, during which the facilitator needs to posses the ability to judge the current situation in order to adjust advice relevant to the given situation, which could vary over time or from project to project. On this basis, four areas of intertwined competences appeared (Figure 7) that the facilitator must be able to handle and educate and advise in: the innovation team creation process, through which the team is created and kicked off; the innovation team model, where the facilitator educates and advises the innovation team on team emergence processes and how they relate to the individuals and the overall organisation; the innovation process, during which the facilitator educates and advises in activities to consider and to plan for, depending on what phase the innovation work is in; and factors that enable innovation work, the facilitator highlighting factors for the innovation team and the sponsor to focus on, which enable the team to conduct the innovation work.

Further, three themes emerged for how the areas of competences were handled by the facilitator when working with the innovation teams: innovation-related knowledge (innovation knowledge), that is, theoretical knowledge of how to conduct innovation work and factors that enable innovation work, innovation management, and practical experience from previous innovation work; innovation-related knowledge management (knowledge management), that is, the ability for the facilitator to transform innovation knowledge into both advice related to innovation work and skills to guide an innovation team according to that advice, all based on the current situation; knowledge transfer, that is, the ability to transfer innovation knowledge and knowledge management to innovation teams through, for example, education, practical advice, and continuous feedback on progress.

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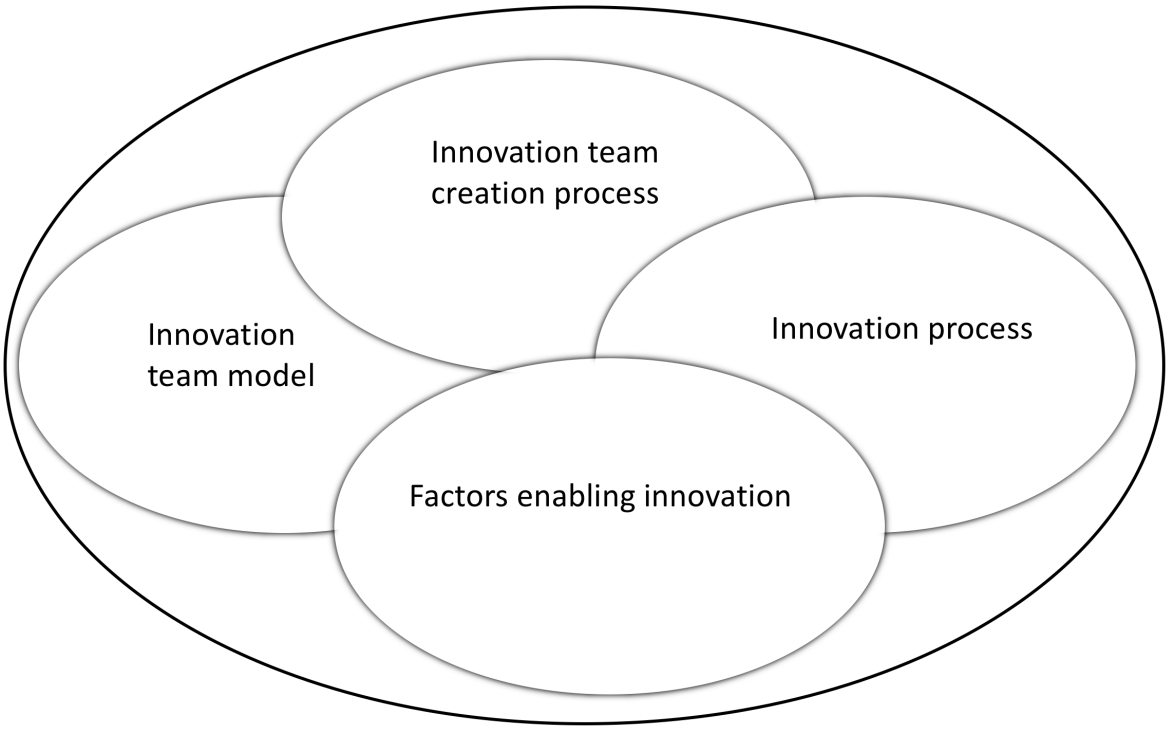

Fig. 7. The figure demonstrates the facilitator's areas of competence.

An unexpected finding was the importance of the pre-phase to the innovation process, in which the facilitator played a significant role when preparing the sponsor and the convener for the forthcoming work and advising the convener which team member to aim for when gathering the innovation team. The time spent in the pre-phase enabled the teams to kick off successfully without any signs of team development problems. The teams handled problems that occurred during the teams' work as a team, not blaming problems on each other but solving them as a team. The pre-phase's purpose was to prepare and allow time for the sponsor, management, and convener to accept the forthcoming work and plan for next steps without being stressed by feelings of unnecessary uncertainty. This resulted in the Extended Innovation Process, demonstrated below (Figure 8; Figure 9).

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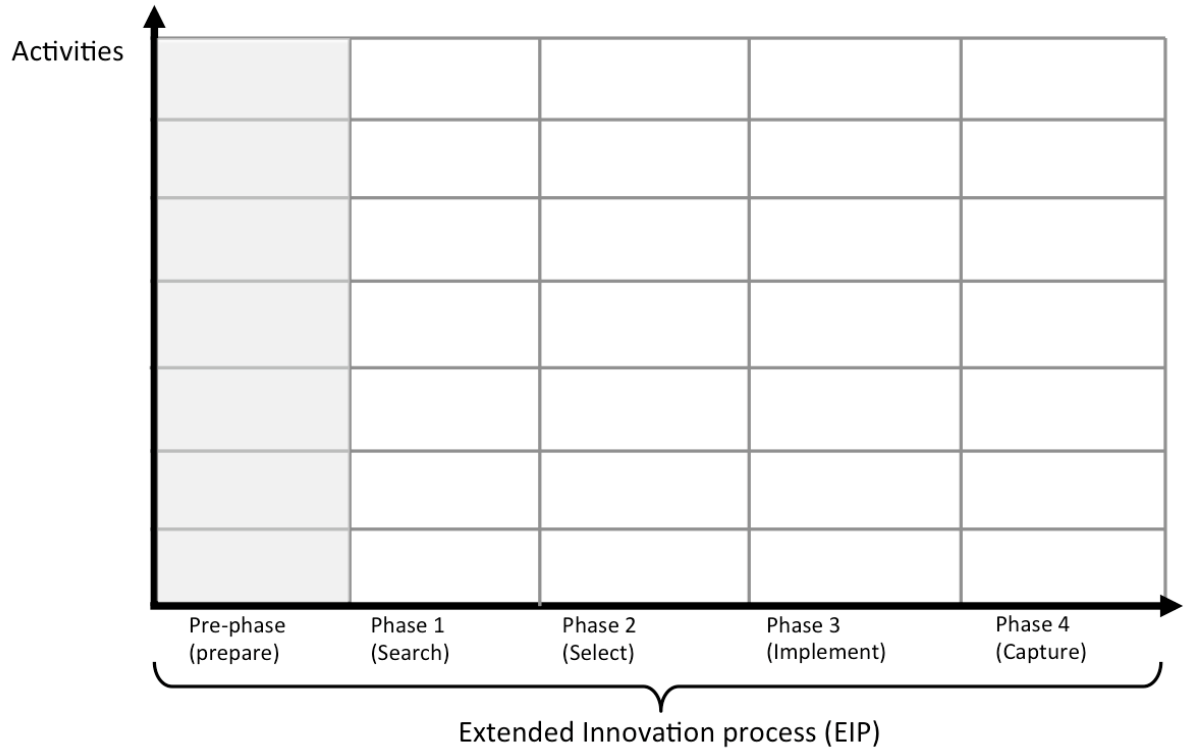

Fig. 8. The figure demonstrates the pre-phase in light grey as an extension of the innovation process illustrated as a work chart, in this case as an extension of the innovation process by Tidd and Bessant (2009) as used within this study.

The Extended Innovation Process (EIP) (Figure 9) is based on the general demonstration of well-established innovation processes and consists of four iterative phases. During the pre-phase, the innovation team is created accordantly in an attempt to avoid group development problems and prepare for forthcoming innovation work. The operational innovation work is begun next, in the ideation phase. This work is characterised by a high level of creativity and abstract work, as ideas are generated and selected based on the overall business strategy. In the execution phase, the practical development work is conducted, comprising work related to design, prototyping, testing, and evaluating the product or service. This phase also involves preparation for production and launch on the market. Last, the value harvesting phase, is where values created from the innovation project are captured. Value is relative and must be defined for each innovation project. Additionally, as the EIP is an iterative process, values must be harvested during each phase of the EIP as the innovation projects emerge towards market launch. However, the first phase regarding preparation is preferably not iterative if not needed due to unexpected circumstances, as illustrated by the densely dashed line and the dashed arrow back from the ideation phase to the preparation phase:

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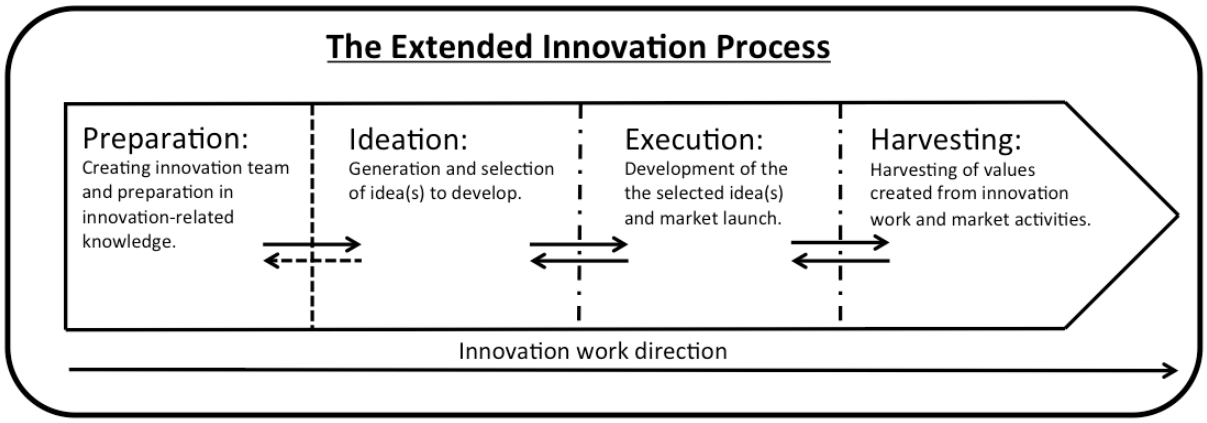

Fig. 9. The Extended Innovation Process (EIP).

5 Discussion and Conclusion

This section discusses four main findings and their contribution to prior research, and it also concludes the research. In the latter part of the section, practical implications are suggested. The four findings are:

- the Extended Innovation Process
- the facilitator's characteristics and importance for innovation teams
- innovation teams' learning effects
- the facilitator's areas of competence.

The Extended Innovation Process

A significant finding and the biggest but also most surprising contribution to prior research is the need for both a preparation phase in the innovation process and a facilitator's presence and involvement in the phases in which this research shows that the facilitator's presence and involvement has the largest impact on the forthcoming work. Both the preparation before the project has begun and the abstract ideation phase are apparently the most complicated for employees inexperienced in innovation management to handle. This has led to the conclusion that the innovation process as established today should be extended with a pre-phase, the Extended Innovation Process (EIP). This research investigated innovation teams conducting real innovation projects, in contrast to Räsänen et al., who suggested a theoretical framework based on Milton and Rogers's (2013) innovation process. This research contributes to prior research in the sense that the facilitator's competence was significantly important before the innovation process originally begins (Amabile et al., 1996; Baxter, 2002; Farris, 1972; Johnsson, 2009; Milton and Rogers, 2013; Tidd and Bessant, 2009; Trott, 2012). In other words, the preparation phase was revealed not only as an important phase for the facilitator to address management, convener, and sponsor about forthcoming innovation work but also as an additional step to the innovation processes presented; it served as a tool to help avoiding the group developing problems which are very common for newly formed teams (Tuckmann and Jensen, 1977; Whelan, 2013).

The facilitator´s characteristics and importance for innovation teams

This research revealed characteristics considered to be important for a facilitator to possess when facilitating innovation teams, which relate to previous research by providing a picture of the facilitator's role for innovation teams in ongoing innovation projects. The identified characteristics of a facilitator are similar to the characteristics to possess when conducting innovation work when it comes to, for example, social skills, handling uncertainty, and building trust (Du Chantenier, 2010; Han and Hovav, 2012; Heikkinen et al., 2007; Kadefors, 2003; Maurer, 2010; Smyth et al., 2010; Vincenzo and Mascia, 2011). The findings also relate to prior research regarding the ability to handle accurate tools, provide training (Andrew and Sirkin, 2008; Barnes and Francis, 2006), and not champion the team (Howell et al., 2004) but guide it in the complex innovation process (Hunter and Cuschenbery, 2011).

However, as the first two phases in the innovation process were assessed to be abstract and sometimes frustrating for the teams, the facilitator must work to avoid team stress, which otherwise will have a negative effect on team performance (Lee and Sukoco, 2011). The same applies to competence (Illeris, 2013) and innovation competence (Bozic, 2016) in the sense that a facilitator needs to possess certain skills and experience and to handle the complex situation of content and inter-and intrapersonal aspects to be successful. The biggest deviations in this research in relation to Illeris and Bozic's suggestions of competences to possess when conducting innovation work is that a facilitator, according to this research, should not be a champion, according to the team members within this study. The sponsor, on the other hand, supported that a facilitator should possess these characteristics, which may be a subject for further research. Additionally, this study revealed that the facilitator has to handle very complex situations, for example, steering the team back on track when needed but not disturbing the team. The research of Räsänen et al. (2015) has suggested a theoretical framework regarding when certain competences are needed in an innovation process. Their results provide a general picture of skills to possess when conducting innovation work in different phases of the innovation process. This research contributes to their research by means of very specific skills and experience regarding the facilitation of innovation teams' work, for which previous research demonstrates clusters of competence areas in general. Barnes and Francis' (2006) research on the OD practitioner suggests, on the other hand, a relatively detailed description of skills and knowledge to possess. However, this research contributes more competence to possess in certain phases of the innovation process; most importantly, this research highlights the need of possessing innovation-related knowledge in theory and practice.

Innovation teams' learning effects

This research demonstrates that the facilitator as a teacher of practical innovation work had positive effects on learning, as two of the teams started new innovation projects in which the facilitators' presence was more of a back-office support. This effect relates to the preparation phase in the EIP, as this is where the teaching begins: by educating not only the management, sponsor, and convener in becoming the innovation team but also the innovation team members, as they are invited to the innovation team and facilitated through the project. This finding contributes to research regarding innovation drivers (Hallgren, 2009; Johnsson et al., 2010) and champions (Dulaimi et al., 2004; Gamatese and Hallowell, 2011; Radnor and Robinson, 2000), in which the learning outcomes have not been satisfying. In this research, the innovation teams were able to start up new innovation projects based on their increased knowledge. However, the

majority of the team members were the same in the new innovation projects, which eased the understanding of tasks to do in complex innovation work. The result would probably not have been the same with completely new innovation teams, or if the majority of the team members were new, due to the new team constellation (Wheelan, 2013) and potential lack of innovation related knowledge.

The facilitator's areas of competence

The characteristics were identified and their importance confirmed by one sponsor and three innovation teams that had been assisted by the same facilitator in a comparable context and set-up. The identified characteristics demonstrate both abilities and tasks for a facilitator to conduct during an ongoing innovation project, which were organised in competence areas covering models and processes related to innovation teams and factors that enable innovation. The areas of competence that a facilitator needs to possess relate to Bozic's (2016) research on innovation competence in the sense that she highlights the need for transitional knowledge for individuals who are going to conduct innovation work. Further, it also relates to Adams and Sirkin's (2008) research, as they demonstrate the need to be able to, for example, educate, be knowledgeable in toolkits, and advise. Further, this research also contributes to Bloch-Poulsen's (2011) research by means of adding innovation-related content to a discussion in order to educate team members if they are inexperienced in the matter. However, this research provides a richer content and adds the perspective of "what to do" and "when to act" to educate and increase the team members' competence for ongoing and future innovation projects.

Additionally, in one aspect, the facilitator him- or herself could be seen as enabling innovation teams, because the presence and involvement by giving advice from time to time to the conveners served as energy to the teams to continue working in times when, for example, they struggled from uncertainty or lack of dedication or resources. According to the team members and the sponsor, the innovation work would not have been able to proceed without the facilitator, especially not in the first two phases of the innovation process. This was highlighted in previous research by Johnsson (2016a; 2016b) but was confirmed in the current research.

This research has identified the required characteristics of an innovation facilitator (facilitator) when supporting innovation teams; it has also identified at which points in an innovation project these characteristics are most important. In this work, it was revealed that the facilitator should not only have a certain attitude, personal skills, and experience from innovation management, he or she should also be knowledgeable in group dynamic process and understand the situation from a holistic system perspective. Further, the research points to the importance of extending the innovation process with a preparation phase to ensure that a new innovation team has a fair chance to do a good job, as it is in the preparation phase that the team members have the opportunity to educate themselves at a stage where they do not waste time and energy.

The deviations between the sponsor's and the teams' opinion as to when the facilitator's characteristics were most needed provided an understanding that the sponsor saw an opportunity to avoid forthcoming problems by planning and preparing an innovation team in advance. The teams, on the other hand, presented a picture of when the facilitator should execute his or her skills relating to the activities in the innovation project. The practical implication of this knowledge is that a facilitator could work closely with the convener on tasks that match the present and forthcoming work in the innovation project. The benefit would be to avoid information

overload and disturbance, which is related to "supporting without bothering the team". On the other hand, a convener must have a holistic view (Bozic, 2016; Illeris, 2013), which means that a facilitator needs to provide the convener with rich information in advance. Therefore, a facilitator must pay careful attention to indications of information overload to avoid setbacks.

When one understands that a facilitator's presence and involvement in the preparation phase and the first phases of the innovation project is of essence, it increases the chances of creating a successful innovation team that does not waste time or resources. This knowledge may be useful when allocating project resources and when planning the start of new innovation teams.

The results from this study show positive learning effects that could be used to develop educating programs for innovation facilitation within companies or consultancy firms. The education could be used to identify appropriate individuals to be educated to become new facilitators who could teach conveners to create innovation teams.

The Extended Innovation Process includes the preparation phase and allows an increased understanding that preparation is needed, but it could also serve as a visual tool for planning activities in forthcoming innovation work.

6 Limitations and future research

This qualitative study has involved three innovation teams in which the researcher has acted as a facilitator to all the teams, which may be a risk due to bias and therefore affect the results negatively. This risk was known in the research design, and actions were taken to avoid bias by carefully planning the research and highlighting this concern in the interviews to strengthen the validity and the reproducibility of the research. The results demonstrate that the facilitator's role was more important and complex than expected, knowledge that may be useful when guiding, advising, and teaching innovation teams in their innovation work. However, overall this research demonstrates a very complex situation for a facilitator to handle, but the innovation teams showed positive learning outcomes within this study. Nevertheless, the findings are based on a limited number of teams and respondents, which calls for attention when generalising the results. Therefore, further research is suggested on the facilitator's characteristics and on how the facilitator could be a teaching tool for new facilitators and conveners. Further, the Extended Innovation Process was unexpectedly identified during this research; therefore, future research is suggested in which its functionality and importance could be studied.

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Does size matter? The effects of enterprise size on the perception of benefits and risks of open innovation projects

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Abstract. This article presents an exploratory study investigating the influence of an enterprise's size on its perception and assessment of the benefits and risks expected from participating in open innovation projects. For this purpose an online survey was conducted in Germany, Austria and Switzerland. The result of this paper is empirical evidence showing how the size of an enterprise affects its perception of potential benefits and risks expected within the context of open innovation project participation. Furthermore, the identified effects are discussed against the theory. Existing theory regarding the benefits and risks of open innovation is expanded by 1) finding that they are perceived mostly independently of enterprise size, 2) confirming their practical relevance, and 3) enabling a finer distinction between their degrees of relevance for small, medium, and large enterprises.

Keywords. Open Innovation; OI Participation; Benefits; Risks; SME.

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1 Introduction

According to conventional understanding, the primary factors in successful enterprises and a high capacity for innovation are their employees, R&D divisions, and a fault-tolerant corporate culture. This kind of innovation refers to the closed innovation paradigm (Chesbrough, 2003a). Due to increasing globalization, new market participants, and shorter product life cycles resulting in increased R&D costs, the closed innovation paradigm was superseded in the last century (Gerybadze and Reger, 1999) by the theory of open innovation (OI), which places much more emphasis on the importance of external resources (Chesbrough, 2003a). OI "is the use of purposive inflows and outflows of knowledge to accelerate internal innovation" (Chesbrough, 2006, p.1). OI is thus an interactive, collaborative, and distributed innovation process involving external partners (Diener and Piller, 2010; Veer et al., 2013) that relies on purposively managed knowledge flows across organizational borders (Chesbrough and Bogers, 2015).

For more than a decade, the specifics of this process have been broadly discussed in innovation management in both academia and the corporate world (e.g. Chesbrough, 2003a; Man and Duysters, 2005; West and Gallagher, 2006; Huizingh, 2011; Tidd, 2013; Huizingh et al., 2015). It is indisputable that enterprises, particularly small and medium-sized enterprises (SMEs), benefit positively from OI collaborations due to their inherently limited capabilities (van de Vrande et al., 2009; Lee et al., 2010). However, they also face manifold challenges in OI practice, leading to uncertainty and even renunciation of OI project participation (Valkokari, 2015). Enterprises thus often face the dilemma of having to cooperate with external partners in order to improve their own innovation capacity, regardless of their ability to cope with the related risks.

The benefits of OI - such as risk diversification across different knowledge sources or cooperation partners - are widely studied (cf. Vanhaverbeke et al., 2008; Dahlander and Gann, 2010; Lee et al., 2010, Denicolai et al., 2016). Comparatively, the risks of OI - such as knowledge spillovers or coordination costs - have not received the same attention thus far. Fewer works have addressed the disadvantages of such collaboration projects (cf. Enkel et al, 2009; Lokshin et al., 2011; Veer et al., 2013). In particular, focusing on process-related, knowledge-related, or legal aspects unveils impactful enterprise challenges, such as the *not-invented-here* (NIH) syndrome (Chesbrough and Crowther, 2006), intellectual property (IP) drain (Chesbrough, 2003b), and the untypical, unstructured character of the legal aspects involved, all of which have not yet been examined in open innovation research (Müller, 2013).

The distinction between the risks and benefits of OI is often context-dependent and is thus a serious challenge for enterprises. Judging whether an aspect is perceived as a benefit or risk is usually highly dependent on the subjective perspective of the individual decision maker (March, 1994) and her bounded rationality (Simon, 1982), as well as limited by the impossibility of either predicting the future or capturing all the necessary environmental information. Thus, supporting entrepreneurial decision processes is beneficial specifically in reducing insecurity (Simon, 1979). Additionally, given the fact that risk awareness is of particular importance for entrepreneurial decision making (Liebenberg and Hoyt, 2003), it is pivotal to provide an understanding that decision makers' "risks are greater if they choose not to innovate" (Valkokari, 2015). Therefore, understanding the importance of the risks and benefits (and their particular implications) of OI project participation is mandatory. However, this is a mere first step towards rational decision-

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making in the context of OI participation. At least as important is a thorough understanding of the underlying situation. Perception and assessment biases caused by framework conditions such as the enterprise size must also be taken into account in order to determine whether a situation has been assessed as objectively as possible.

Although various benefits and several risks have been identified in the OI literature and proven through empirical investigations (e.g. Keupp and Gassmann, 2009; Veer et al., 2013), little is known about the way in which specific benefits or risks of OI collaboration are perceived and how factors such as enterprise size influence their perception and, thus, their assessment. It therefore seems quite worthwhile to take a closer look at the variables influencing perception. There are many indications that the perceived relevance of a specific benefit or risk could be affected by the unique situation of an OI project's framework conditions. As one example, the characteristics of (open) innovation projects may differ depending on the enterprise's size. SMEs, for instance, should put more emphasis on the later stages of the open innovation model (cf. Chesbrough, 2003a) since they benefit more from support at the commercialization stage than from technology, product, or process development (Lee et al., 2010). Large enterprises, on the other hand, are usually relatively good at marketing and commercialization activities. They gain more from leveraging external research as a complement to internal R&D activities or from building strong networks in relevant areas (Chesbrough and Crowther, 2006). Consequently, whether one is employed in a small (<50), medium (50-250) or large enterprise (>250) could influence her perception of the benefits and risks of OI projects. The research question is thus stated as follows:

Does the size of an enterprise affect the perception of the benefits or risks of OI projects?

This article presents an exploratory study investigating the influence of an enterprise's size on the perception and assessment of benefits and risks expected by individuals participating in OI projects. Based on the benefits and risks of OI identified in the literature as well as in ongoing OI processes, an online survey was conducted in Germany, Austria, and Switzerland. Innovation managers, employees and researchers in the field of (open) innovation were asked in the survey to evaluate both the risks and benefits of OI. Afterwards, the collected data set was subjected to an exploratory analysis. The result of this paper is empirical evidence on the effects of the size of an enterprise on the perception of the potential benefits and risks expected in the context of OI project participation. Furthermore, the identified effects are discussed against the background of OI theories.

On the foundation laid by Ullrich et al. (2018) who have conducted initial investigations on practitioners' assessment of the benefits and risks of OI projects and in line with Bogers et al. (2016) who, inter alia, point out that OI research is currently lacking in theory development, this article contributes to the aforementioned question by exploring the relationship between the size of an enterprise and the perception of the benefits and risks of OI projects. The research sheds some light on the inter-organizational comparability of the perception of the benefits and risks of OI collaborations based on an intra-organizational aspect, namely, enterprise size. Addressing the size of the enterprise as an important factor when analyzing company-specific OI processes might also enable the identification of determinants for the assessment of OI projects. Implications can thereby be derived and incorporated into managerial policies on innovation processes. For example, the relevance of specific risks or benefits (might) differ for distinct enterprise sizes. Some

enterprises are thus more prone to (perceive) specific benefits or risks than others of a different size category. Depending on the enterprise in question, then, assessment distortions induced by external conditions can be identified and thus consciously counteracted by the enterprise.

This article elaborates on the existing theory regarding the benefits and risks of OI by 1) finding that the risks and benefits of OI are perceived mostly independent of enterprise size, 2) confirming the benefits and risks as practically relevant, and 3) enabling a finer distinction between their degrees of relevance for small, medium, and large enterprises.

The remainder of this article is organized as follows: The next section reviews the literature on OI focusing on the benefits and risks as well as on the particularities of enterprise size in OI projects. Section 3 describes the methodological approach of this study. The results are presented and analyzed in Section 4 and discussed in Section 5. Finally, a conclusion, the limitations, and an outlook are provided in Section 6.

2 Opening the innovation process

In OI, enterprise boundaries can be viewed as permeable to the external environment, whereby the innovation process includes aspects of strategic cooperative partnerships between enterprises within the same or across different industries, or with suppliers, research institutes, or even competitors (von Hippel, 2005; West and Gallagher, 2006; Chesbrough, 2006; Enkel et al., 2009; West and Bogers, 2013). Some other main issues include the role of intermediaries (Diener, 2014), customers as OI partners (Enkel et al., 2005; Foss et al., 2011; Gatzweiler et al., 2017), and enterprise size and innovation process specifics (Lee et al., 2010; Zeng et al., 2010). Especially the enterprise size and more precisely the special features of SMEs and the impact of OI for SMEs are a matter of concern (see van de Vrande et al., 2009; Lee et al., 2010; Bogers, 2011; Brunswicker and Vanhaverbeke, 2015).

2.1 Open Innovation in SMEs

According to Wynarczyk (2013), the competitiveness of SMEs depends on the cumulative effects and interrelationships between two internal key factors: R&D capacity as well as managerial structure and competencies. Compared to large enterprises, however, SMEs often face various innovation shortcomings due to 1) limited time for innovation, 2) a lack of suitable personnel, infrastructure and financial means, 3) a lack of contact with research partners within the innovation network, and 4) high innovation risk (Jenni and Ziltener, 2008). SMEs are thus expected to particularly gain from collaborations with external partners (Nooteboom, 1994; Rogers, 2004). Moreover, involving external partners potentially reduces the innovation gap between small and large enterprises (Gassmann et al., 2010; Nieto and Santamaria, 2010). According to Bougrain and Haudeville (2002), the benefits of the collaboration especially for SMEs are related to the improvement of internal tacit knowledge and the information base. As a result, SMEs gain important competitive advantages and are much more able to analyze relevant information, whereby their uncertainty regarding their own innovation projects is reduced. OI project participation also reduces risks through error compensation and investment sharing, enables cost advantages

through economies of scale and scope, broadens development potential, increases market penetration, and relieves the application of technologies thus far unused (ibid.).

Against this background, the focus of OI research increasingly (but still insufficiently) shifts from large multinational enterprises to SMEs, which are opening up their innovation processes (cf. Gassmann et al., 2010; Santos, 2015; Vanhaverbeke, 2017). Nevertheless, OI projects in SMEs are still implemented far less frequently than in large enterprises (Santos, 2015). Consequently, the majority of OI research focuses on large enterprises (Santos, 2015) or fails to make distinctions based on size. During the last decade, however, a trend has emerged resulting in a small number of articles focusing on SMEs or on the relationship between SMEs and large enterprises with regard to OI practices and especially on the integration of external knowledge and knowledge absorption (Malecki, 2011; Cheng and Chen, 2013), as well as organizational changes and business incentives for open innovation (Rodriguez and Lorenzo, 2011).

2.2 Structuring the investigation of open innovation's risks and benefits

The positive effects and benefits represent the main research focus of OI (Laursen and Salter, 2006; Lee et al., 2010; Chen et al., 2011). Veer et al. (2013) point out that OI decreases the risk inherent to the innovation process, and simultaneously also the risk and costs related to collaboration activities with different partners. In the context of OI and collaboration, Bogers (2011) identifies many important fields that have yet to be explored. These fields deal with such issues as the complexity of collaborative efforts and the underlying resources and knowledge, the dilemma of knowledge sharing and protection, and the management of innovation when innovating organizations are highly dependent on each other (Vanhaverbeke, 2006).

Braun et al. (2011) distinguish between two levels of analysis (cf. Fig. 1): 1) the operative process level and 2) the strategic level. In addition, 3) the framework conditions affecting the success of the innovation process are also seen as relevant. These three levels form the company arena, which is surrounded by the company's eco-system.

The strategic and operative levels along with the framework conditions form the starting point for the following classification of identified risks and benefits into two main groups: organizational (addressing the strategic level and the framework conditions) and process-related (addressing the sequence of the innovation process - the operative level).

Based on a literature review (from a theoretical perspective) and an analysis of concrete OI projects and ongoing processes (from a practical perspective), a range of benefits and risks of OI projects were identified and structured (cf. Tables 1-4). The benefits and risks identified within these projects and processes through expert interviews (cf. Section 3) are used here to enrich the theoretical foundation. They are marked as statements by the interview partners. The other items identified in the literature are marked with their respective source references as usual.

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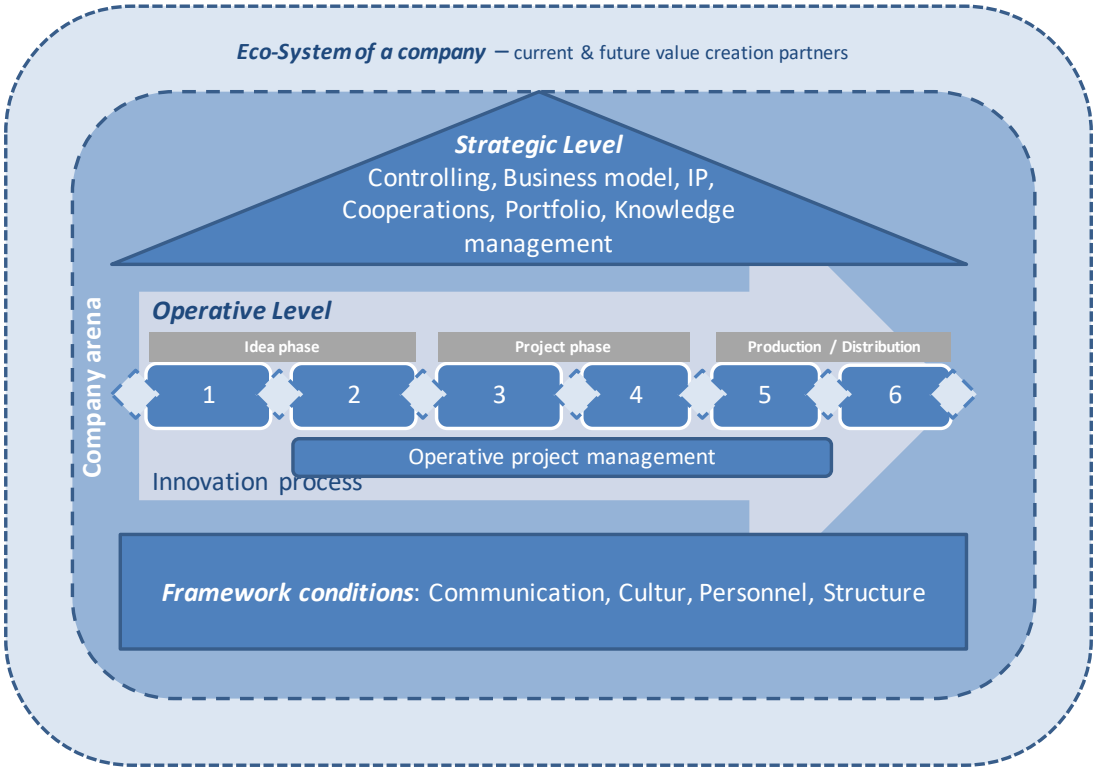

Fig. 1. Open innovation management concept (Braun et al., 2011).

Organizational benefits and risks

As described above, within the innovation process two main levels can be distinguished. The organizational benefits and risks (Tables 1 and 2) have been assigned to the strategic level, which addresses enterprise-specific aspects such as the business concept, knowledge management, intellectual property, product portfolio and controlling. The general conditions as a third main focus, e.g. internal and external communication, corporate culture, and personal development, round out the framework of organizational benefits and risks.

The benefits within this category include the holistic improvement of the enterprise's knowledge basis (e.g. through the inclusion of external experiences), and the improvement of its strategic and competitive power (e.g. benefits from the partner's network, use of the partner's intellectual property) or its internal culture. Taking as an example the filling of internal knowledge gaps, some possible OI benefits for an enterprise might be explained as follows: An enterprise could possess the experiences and potential necessary to develop good and promising ideas for new products. As a consequence of its lack of knowledge in idea development and product distribution, however, the innovating idea could become useless. The benefit of OI in this case is the filling of these knowledge gaps and the successful development of the product.

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Table 1. Organizational benefits of open innovation.

Organizational benefits
Inclusion of external experiences (Lakhani et al., 2006; Laursen and Salter, 2006; Dahlander and Gann, 2010; Chesbrough, 2012; Afuah and Tucci, 2012)
Expansion of the knowledge base (Laursen and Salter, 2006; Lakhani et al., 2006; Chesbrough et al. 2006; Dahlander and Gann, 2010; Afuah and Tucci, 2012; Chesbrough, 2012)
Filling of internal knowledge gaps (Chesbrough, 2006; Laursen and Salter, 2006; Lakhani et al., 2006; Dahlander and Gann, 2010; Afuah and Tucci, 2012; Chesbrough, 2012)
Access to new product and production technologies (Cohen and Levinthal, 1990; Grindley and Teece, 1997; Griffin, 1997; Gassmann and Reepmeyer, 2005; Enkel et al., 2005; Gaso, 2005; Chesbrough and Crowther, 2006; van de Vrande et al., 2006; Page and Schirr, 2008)
Improvement of market knowledge and market requirement detection (Murphy and Kumar, 1997; Enkel et al. 2005; Chesbrough and Crowther, 2006)
Technological synergy effects (Chesbrough and Crowther, 2006; van de Vrande et al., 2006; Vanhaverbeke et al., 2008; Lichtenthaler, 2009)
Extension of the product and service range (van de Vrande et al., 2006)
Benefits from the partner's network (statement interview partners[1])
Synergy gains from patent pooling (van de Vrande et al., 2006; Chesbrough, 2012)
Advantages in technology transfer (Arora and Ceccagnoli, 2006; Chesbrough and Crowther, 2006; Fosfuri, 2006; Nagaoka and Kwon, 2006; Gambardella et al., 2007)
Higher market acceptance via reference effects (Chesbrough and Crowther, 2006)
Use of the partner's intellectual property as a strategic asset (van de Vrande et al.,2006; Chesbrough, 2012)
Improvement of the organizational culture (Rigby and Zook, 2002; Laursen and Foss, 2003; Chesbrough et al., 2006)
Better forecasting of future developments (Chesbrough and Crowther, 2006)
Easy benchmarking of competitors (Rigby and Zook, 2002)
Benefit from foreign cultures (Rigby and Zook, 2002; Laursen and Foss, 2003; Chesbrough et al., 2006)
Risk diversification (Chesbrough and Crowther, 2006; Vanhaverbeke et al., 2008)
Usage of competitive synergies (Gaso, 2005)
Enforcement of standards and designs for new products (Arora et al., 2004; Chesbrough and Crowther, 2006; Lichtenthaler, 2008)
Availability of external experts (Enkel et al., 2005)
Improvement of products or services (Enkel et al., 2005)

Organizational risks (cf. Table 2) on this level could negatively impact the whole enterprise. One example would be selection of the wrong partner. Enterprises often face the challenge of finding the right external project partner, where a partner lacking in complementary knowledge can pose a possible risk. Consequences of this might mean failure of the innovation project or a loss of internal knowledge or confidence.

[1] See Section 3.

Table 2. Organizational risks of open innovation.

Organizational risks
Selection of the wrong partners (Chesbrough and Appleyard, 2007; Enkel et al. 2009)
Unclear communication of OI goals (Chesbrough and Crowther, 2006)
Insecurities over including the external partner (Chesbrough and Crowther, 2006; Chesbrough and Appleyard, 2007; Enkel et al., 2009)
Unintended knowledge drains (Arrow, 1962; Mazzoleni and Nelson, 1998; Rivette and Kline, 2000; Arora et al., 2001; Bogers, 2011; Gatzweiler et al., 2017)
Coordination problems (Ahuja, 2000; Laursen and Salter, 2006; Enkel et al., 2009)
Partner-specific threats (Bogers, 2011; Antorini and Muñiz, 2013)
Lack of cultural values (Chesbrough and Crowther, 2006; Antons et al., 2017)
Integration of security-critical partners (statement interview partners)
Employees' rejection of the process opening (Chesbrough and Crowther, 2006; Laursen and Salter, 2006; Antons et al., 2017)
Inefficient resource allocation (Cohen and Levinthal, 1990; West and Gallagher, 2006)
Submergence of enterprise and OI strategy (statement interview partners)
Opening of enterprise boundaries (Arrow, 1962; Mazzoleni and Nelson, 1998; Rivette and Kline, 2000; Arora et al., 2001; Bogers, 2011; Gatzweiler et al., 2017)
Dependence on external alliances (Veer et al., 2013)
Increase in employees' needs for training and motivation (van de Vrande, 2006)
Monetary inefficiency (Ahuja, 2000; Knudsen and Mortensen, 2011)
Information overload (Laursen and Salter, 2006)
Financial bottlenecks (Enkel et al. 2009; Knudsen and Mortensen, 2011)

Process-related benefits and risks

The process-related benefits and risks (Tables 3 and 4) were assigned to the operational process level, which includes the project management during the stages of a concrete innovation process (cf. Cooper, 1990). This level is more concrete than the organizational one and addresses the management of the process flow, technology use and employees' behavior.

The benefits refer to improvement in the internal innovation process (e.g. process improvement) as well as process outcomes (e.g. faster time to market). One example is the identification of further potentials during the innovation process sequence, addressing the enterprise's ability not only to perform well within one specific process, but also to learn and apply the process-related experience in the future - in other words, to create specific meta-knowledge. Participation in an OI project broadens an enterprise's horizons and increases its access to relevant knowledge and sources of experience.

Table 3. Process-related benefits of open innovation.

Process-related benefits
Increased innovation performance (Rigby and Zook, 2002; Laursen and Foss, 2003; Chesbrough and Crowther, 2006; Foss et al., 2011; Chesbrough, 2012)
Identification of further potentials during the innovation process sequence (statement interview partners)

Process-related benefits
Enrichment of project evaluations with various facets (statement interview partners)
Establishment of a multifaceted decision making process (statement interview partners)
Shorter product development times (Rigby and Zook, 2002; Chesbrough and Crowther, 2006)
Process improvements through process design by the partner (Laursen and Foss, 2003; Chesbrough and Crowther, 2006)
Faster time to market (Rigby and Zook, 2002; Chesbrough and Crowther, 2006; van de Vrande et al., 2006)
Use of the advantages of external IT infrastructures (Chesbrough and Crowther, 2006)

Possible negative process-related effects and therefore risks (cf. Table 4) include, for example, the complication of the internal process flow, especially through the involvement of external resources and structures. One example within this risk category is insecure and inaccurate decision making through more complex decision structures. This risk addresses the coordination of cooperation and collaboration within an OI project. Well-established internal decision-making structures could collide with new external or jointly created structures. Insecurities or complications can therefore arise.

Table 4. Process-related risks of open innovation.

Process-related risks
Delays with effects on the project progress (Knudsen and Mortensen, 2011)
Inefficient integration of internal and external IT systems (statement interview partners)
Insecure and inaccurate decision making through more complex decision structures (statement interview partners)
Unused result potentials (Herzog and Leker, 2010)
Non-consideration of innovation potentials during the process sequence (statement interview partners)
Pursuit and realization of unattractive ideas (statement interview partners)
Slower product development (Lichtenthaler and Ernst, 2006; Knudsen and Mortensen, 2011)
Outflow of employees with expert knowledge to the partner (Chesbrough, 2012)
Deficits in project evaluation due to wasted potential (Barkema and Schijven, 2008; Agrawal et al., 2010; de Burcharth et al., 2014)
Decreased innovation capacity (Herzog and Leker, 2010; Lokshin et al., 2011; Antons et al., 2017)
Inefficiencies in production and distribution (Herzog and Leker, 2010)

3 Methodology

The present exploratory study is part of a project (cf. Vladova and Ullrich, 2015) that aims to enable enterprises, especially SMEs, to weigh up the risks and benefits of OI participation by developing a 1) methodical procedure and 2) guidance application which will structure and support the decision process. To this end, it is necessary to identify and weigh the benefits and risks of OI projects as relevant from a practitioner's perspective. In the course of this identification process, questions arose as to the factors influencing the perception of the benefits

and risks of such projects.

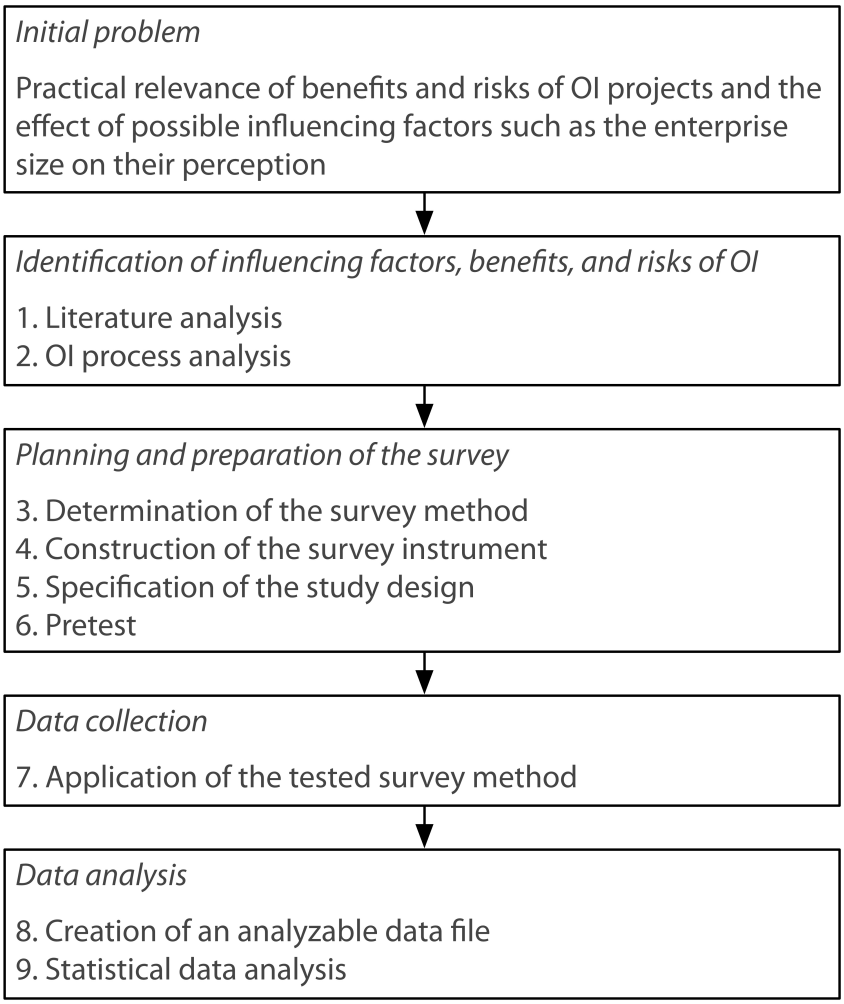

Fig. 2. Methodological approach (following Diekmann, 2012, p. 192f.).

The overall methodological procedure began with a literature review looking at the benefits and risks, influencing factors, phases and evaluation of OI processes, along with the internal and external knowledge interfaces, main actors, and positive and negative aspects of OI in order to establish a solid theoretical background. The procedure identified enterprise size as one potential influencing factor. To enrich this foundation, an analysis was conducted of ongoing OI processes in 15 SMEs on the basis of 35 interviews with decision makers and employees regarding actual benefits and risks. This was followed by planning and preparation of the empirical study (see 3.1), with emphasis on the survey method, construction of the survey, specification of the study design, and a pretest. The data collection (see 3.2) and data analysis (see 3.3) were subsequently examined (Fig. 2).

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3.1 Planning and preparation of the empirical study

Determining the survey method is a particularly necessary starting point for conducting a survey. Widely used methods in empirical studies include (online) surveys and content analysis (cf. Evans and Mathur, 2005; Hsieh and Shannon, 2005). Generally speaking, the advantages of online surveys are the following: avoidance of a bias through anti-sympathetic effects regarding the person conducting the survey, fast feasibility, low costs and no need for data transformation (Wright, 2005; Bryman, 2015, p. 229f.). Potential concerns which should be noted include non-coverage, non-response errors, confidentiality concerns, and technical problems (cf. Sills and Song, 2002). An alternative approach along the lines of content analysis for determining benefits and risks as well as influencing factors would be the concept of stylized facts. Stylized facts are simplified presentations of an empirical finding (Cooley, 1995, p. 3). They can be derived on the basis of empirical data (cf. Kaldor, 1961) or an empirical literature review (cf. Houy et al., 2015). Since the overall survey aims to identify practitioners' perspective towards the benefits and risks, their respective weighting, and especially influencing factors, an online survey was chosen. The choice of a standardized questionnaire in the applied form relied particularly on the respondents' anonymity, sufficient time for response, and the relatively easy opportunities to further process the gathered data (Converse and Presser, 1986).

The survey is structured into five blocks. In accordance with Vladova and Ullrich (2015), benefits and risks were categorized into organizational and process-related aspects. Hence, the five blocks are as follows: demographic information and influencing factors, organizational benefits, innovation process-related benefits, organizational risks and innovation process-related risks of open innovation (cf. Table 5). They were presented exactly in this order. Each block in turn consists of several items in the form of questions pertaining to demographic information and influencing factors (9 items), such as the number of employees in the enterprise or the enterprise's industry sector, and specific benefits and risks (57 items in total, shown in Tables 1-4 in Sec. 2.2). To avoid a potential central tendency bias (Barsalou, 1985), a dichotomous bipolar scale (agree vs. disagree) was applied to measure the respondents' attitude towards each item. Accordingly, the participants stated whether or not they agreed that an item was a benefit or risk.

Table 5. Survey structure.

Classes	**Quantity items (n)**	**Specification**
Demographic information and influencing variables	9	# of enterprise employees, sector, position in the enterprise, decision-making authority in the innovation process, experience in OI participation, initiator of the OI process, intermediary involved in the OI process, location of the company's headquarters, enterprise subject to German jurisdiction
Organizational benefits	19	Listing of the organizational benefits
Process-related benefits	10	Listing of the process-related benefits
Organizational risks	17	Listing of the organizational risks
Process-related risks	11	Listing of the process-related risks

The survey target group consisted of experts from practice and research working in the field of innovation and who were familiar with the OI paradigm. Innovation managers and workers, employees in R&D divisions, owners and managers, as well as academics focusing on innovation research comprised the sample. The regional focus of the sample was set to Austria, Germany and Switzerland.

The pretest aimed to estimate item comprehensibility as well as to check the length of the time period, and was conducted in two subgroups. The first subgroup included two innovation managers with decision-making competence along with two innovation workers, all representing the practitioners' perspective. The second subgroup involved three academics working in the field of innovation management, representing the academic perspective. Their feedback was used for minor revisions to the questionnaire regarding linguistic formulations, as well as the incorporation of explanatory examples of the risks and benefits. The planned survey duration of approximately 20-25 minutes could be verified.

3.2 Data collection

The survey was conducted in order to collect and analyze the practitioners' and academics' perceptions towards the benefits and risks of OI projects, along with possible influencing variables, in the period from June to August 2016. The online survey tool "lime survey" was used to create and host the survey. Through the use of contact databases from research organizations along with a listing of innovation chairs in the above-specified region, the link to the survey was distributed via email to 24,312 target group recipients in total. 348 data sets were answered following two waves of solicitation, which constitute a respondent rate of 1.44%.

Of the total 348 responses, 112 were removed: 110 were blank, one quit part of the way through and one after providing the demographic information. A maximum number of 236 exploitable data sets therefore represent the study's data base. However, a significant number of dropouts (65) occurred after completion of the final demographic information. 16 respondents quit during completion of the survey. The final number of relevant data sets therefore lies between 155 and 171. This steady decrease in exploitable data sets throughout the set of question items is assumed to be explained by the large number of question items (57) and resulting dropouts.

Table 6 visualizes the allocation of the participants into enterprise size categories. 55 of the participants work in enterprises with fewer than 50 employees, 84 in enterprises with more than 250 employees, and 32 belong to the category in between.

Table 6. Sample characteristics.

Variable	**Subclasses**	***N***
Enterprise size (number of employees)	<50	55
	50-250	32
	>250	84

3.3 Data analysis

The data sets captured in the survey were exported to SPSS 23. There, the data was prepared for analysis by removing missing units and incorrect encodings by the program. To find answers to the underlying question, the following procedure was applied: In the first step, a ranking order of the perceptions of all 57 benefits/risks was formed for each enterprise subclass. The rank correlation coefficient *Spearmans rho* was applied to determine whether there were evaluation differences on a general level between small, medium and large enterprises. Scatter plots were also created to identify further information about dependency structures between the enterprise sizes by considering the respective patterns. Cross-tables were then created for every benefit/risk and enterprise size. The *Chi-square test* was used to check which benefits/risks were significantly related to enterprise size. In addition to the significance, the strength of the association was also examined. Therefore, *Cramer's V* was calculated. It is based on the chi-squared statistic and may be used for nominal variables if at least one of them has more than two levels. In the next step, the structure of the associations was specified. This means that differences in the perception of benefits/risks between small, medium and large enterprises were illustrated by comparing the percentages of each. To identify the relevant differences, these percentages were further subjected to a test of significance.

4 Results

In order to gain insight into the possible influence of an enterprise's size on its perception of OI benefits and risks, it was first examined whether there general differences exist between small, medium and large enterprises. After the perceptions of all benefits and risks were placed in a ranking for each enterprise size, it was examined to what extent these rankings differed. Table 7 provides the correlation coefficient according to Spearman. When comparing the ranking for small enterprises with the ranking for medium-sized enterprises, a high degree of agreement (r_s = .861, $p \leq .01$) can be found. Correlations between small and large enterprises (r_s = .867, $p \leq .01$) and between medium and large enterprises are also (r_s = .865, $p \leq .01$) very strong. In summary, the benefits and risks are largely perceived equally regardless of whether an evaluator is employed in a small, medium, or large enterprise.

Table 7. Ranking correlations between the enterprise sizes.

Number of employees		< 50	50-250	> 250
Spearman?s rho (rs)	< 50 employees		.861** (N =57)	.867** (N =57)
	50-250 employees	.861** (N =57)	.865** (N =57)	
	> 250 employees	.867** (N =57)	.865** (N =57)	

** p ≤ .05

Even though the correlations are very strong, the assessments of the benefits/risks according to enterprise size are not identical. The scatter plots (Fig. 3) illustrate the correlations between the company sizes. The perception of the risks is presented along the two axes - small and medium enterprises (left), small and large enterprises (middle), and medium and large enterprises (right).

The spread of the individual benefits/risks is also discernible. The diagonal in each diagram represents perfect correspondence between the enterprise sizes. Many points are located on or close to the diagonal. This means that the perception of these benefits/risks does not differ between enterprise sizes. However, some of the assessed benefits and risks are indeed located some distance away from the diagonal.

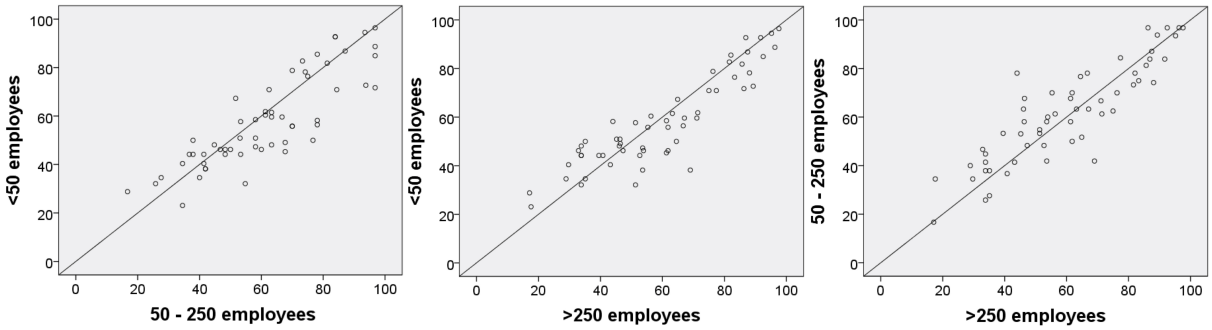

Fig. 3. Distribution of benefits/risks by enterprise size.

According to this general overview of the scatter plots and the apparent general minor deviation in the evaluations according to enterprise size, a detailed consideration of the benefits and risks seems promising. A closer analysis using the chi-square reveals that the perceptions of six benefits and one risk are significantly influenced by enterprise size. The strength of the influence as well as the differences between the enterprise sizes are described for these 7 items below. Table 8 displays the noteworthy associations between the benefits/risks and enterprise size, in which the perception of these benefits/risks is not independent of enterprise size. Here, the strongest association is found for "benefits from foreign cultures." A value of .297, $p \leq .01$ for *Cramer's V* points to a moderately strong correlation. Considering the other benefits, meaningful associations vary from V = .175, p ≤.10 (shorter product development times) to V = .256, p ≤ .01 (easy benchmarking of competitors). With "partner-specific threats", V = .197, p ≤ .05, only one meaningful correlation between risks and enterprise size is found.

Table 8. Correlations between benefits/risks and enterprise size

Benefits/risks		Cramer' s V	N
Benefits	Improvement of market knowledge and market requirement detection	.236***	171
	Benefits from foreign cultures	.297***	170
	Easy benchmarking of competitors	.256***	171
	Identification of further potentials during the innovation process sequence	.244***	164
	Shorter product development times	.175* 164	
	Faster time to market	.191**	164
Risk	Partner-specific threats	.197**	158

p ≤ .10, **$p \leq .05$, ***$p \leq .01$

Based on the correlations, only the strength of the association and the significance can be seen. Table 9 depicts the participants' perception of these significantly different benefits and risks according to enterprise size. Most participants perceive "improvement of market knowledge and

market requirement detection" as a benefit. The lower-case letters in each row illustrate significant ($p \leq .05$) differences between the enterprise sizes (same letter = no difference). Significance can be reported between enterprises having fewer than 50 employees (72.7%) on the one side, and enterprises having 50 to 250 employees (93.8%) as well as enterprises having more than 250 employees on the other side. The same differences are found for "identification of further potentials during the innovation process sequence" (71.7% - 96.8% and 86.3%) and "faster time to market" (32.1% - 54.8% and 51.3%). "Shorter product development times" and "insecurities over including the external partner" reveal a significant difference only between small and medium-sized enterprises (45.3% - 67.7% and 50.0% - 76.7%). A significant difference between medium-sized and large enterprises is found for "easy benchmarking of competitors" (78.1% - 44.0%). Large enterprises estimated the "benefits from foreign cultures" as significantly higher than medium-sized and small enterprises (69.0% - 41.9% and 38.2%).

Table 9. Perception as a benefit/risk according to enterprise size.

	Agreement by enterprise size		
Benefit/risk (*per Number of employees*)	<50	50-250	>250
Improvement of market knowledge and market requirement detection	72.7% $_a$	93.8% $_b$	89.3% $_b$
Benefits from foreign cultures	38.2% $_a$	41.9% $_a$	69.0% $_b$
Easy benchmarking of competitors	58.2% $_{a,b}$	78.1% $_b$	44.0% $_a$
Identification of further potentials during the innovation process sequence	71.7% $_a$	96.8% $_b$	86.3% $_b$
Shorter product development times	45.3% $_a$	67.7% $_b$	61.3% $_{a,b}$
Faster time to market	32.1% $_a$	54.8% $_b$	51.3% $_b$
Partner-specific threats	50.0% $_a$	76.7% $_b$	64.5% $_{a,b}$

Note: Each subscript is a subset of the "size of enterprise," whose column proportions do not differ significantly ($p \leq .05$) from one another.

5 Discussion

In light of the fact that OI in SMEs has its own characteristics and "can scarcely be compared with the existing literature on open innovation" (Vanhaverbeke, 2017, p.7), it is surprising that all subsets (small, medium-sized, large enterprises) are in each case highly correlated ($r \geq .8$) with each other, which implies that there are almost no differences between distinct perspectives regarding the benefits and risks of OI projects. Naturally, design differences in OI processes due to enterprise specifics and size do not necessarily lead to differences in the relevant risks and benefits. Nonetheless, particularly since innovation potential is usually highly available in SMEs, and especially when they are exporting (Love and Roper, 2015) and might lack more in scale effects of commercialization rather than in the development of products or technologies (Lee et al., 2010), it would have to be assumed that benefits such as "improvement of products or services" (average agreement of 87.2%) and "access to new product and production technologies" (average

agreement of 88.2%) would show perception discrepancies. However, these do not comprise any significant evaluation differences between the enterprise size categories.

Although the three subsets are highly correlated with one another, considering scatter plots of the data (Fig. 2) reveals that there is some non-negligible evaluation difference between the subgroups. Hence, one cannot say that no evaluation differences exist.

The item "improvement of market knowledge and market requirement detection" exhibits a moderate association (*Cramer's V* 0.236) between enterprise size and the evaluation of this item. This means that along with a change of enterprise size category comes a moderate tendency to differently assess the relevance of this benefit. The relevance thus differs according to enterprise size. It can be fundamentally noted that, across all subsets, quite a lot of participants considered the item to be a relevant benefit (average agreement 84.8%). Medium- (93.8%) and large-sized (89.3%) enterprises did not reveal any noteworthy differences on this. On the contrary, the assessment difference between small- (72.7%) and large-sized enterprises is significant. Vanhaverbeke (2017, p. xii) points out that the specialties of innovation in SMEs remain under-researched. Tailor and Greve (2006) argue that large enterprises usually tend to have a broader knowledge base that, in turn, makes them more likely to generate innovations. It can therefore be concluded that large enterprises might already be aware of this benefit. Small enterprises, on the other hand, rarely conduct holistic knowledge management (uit Beijerse, 2000), and thus might simply either not be sufficiently aware or might not have or see the necessity of handling such knowledge-related issues. Furthermore, SMEs posses more specialized knowledge in a certain industry or product range and are more locally embedded (Freel, 2003), and for this reason can adapt products, services and innovation attempts perfectly to the relevant markets (Hausman, 2005; Madrid-Guijarro et al., 2009; Bianchi et al., 2010). Despite the significant differences, a large number of small enterprises consider this item a benefit. Thus, the managerial and policy implications that can be derived include the understanding that small enterprises should use OI projects even more intensively to increase their own market knowledge. This needs to be accompanied by a systematic knowledge management approach, however.

The item "benefits from foreign cultures" shows a moderately strong association (*Cramer's V* 0.297) - which is the strongest association found in all items - between enterprise size and the assessment of this item. The perceived relevance of this item differs somewhat strongly by enterprise size. Fundamentally, it can be stated that indecisiveness is prevalent across all enterprise sizes (average agreement 54.1%), whereby the largest distance (and significant difference) is between large (69%) and small (38.2%) enterprises. Small and medium-sized enterprises (41.9%) do not show a noteworthy difference. Medium and large-sized enterprises, however, differ significantly.

According to the literature, cultural differences among small, medium-sized, and large enterprises are present and influence their performance: SMEs are considered to be more flexible, less bureaucratic and less rigid in decision making, as well as able to respond more quickly to new opportunities and threats (Carlsson, 1999; Kuratko et al., 2001). This is seen as their competitive advantage over large enterprises. Small enterprises in particular have less formal structures (Hill and Wright, 2001) and are characterized by a close interaction between management and employees. As a result, their culture is stronger and they are perceived to be considerably more stable than medium-sized or large enterprises. On the other hand, however, "SMEs are handicapped

by 'resource poverty' resulting from financial constraints, lack of professional expertise, and the lack of material and human resources" (Gray et al., 2003). Nevertheless, benefiting from foreign cultures should be a perk regardless of the enterprise size, which would imply that encouraging enterprises towards OI projects in order to leverage this perk would be a notable managerial implication. Furthermore, since benefiting from foreign cultures is perceived relatively strongly as an advantage of OI projects, this perk (as well as others) might be used as a barrier-reduction factor in influencing employees' attitudes. Additionally, enterprises enjoy such gains as new impressions, ideas, etc. from this kind of collaboration. In the case that this item is not sufficiently perceived as a benefit, the responsible person (i.e. innovation manager, entrepreneur, etc.) should put more emphasis on highlighting the immanent benefits of collaboration, because a variety-rich organizational culture enables innovation (Ahmed, 1998).

Considering the item "easy benchmarking of competitors" unveils a moderate association (*Cramer's V* 0.256) between enterprise size and the perception-based assessment of this item. The relevance of this item varies moderately by enterprise size category. Essentially, the item was affirmed indecisively (average agreement 55.0%). Thereby, 78.1% of the medium-sized enterprises consider this item as a relevant benefit. The assessment by small enterprises (58.2%) does not significantly differ from that of medium-sized enterprises. However, the assessments by both small and medium-sized enterprises in comparison to the assessment by large enterprises (44.0%) do differ. Reasons for this might lie in the fact that large enterprises clearly benefit from measurement techniques such as benchmarking (Monkhouse, 1995) and are often the benchmarking partner. Small enterprises, on the other hand, have their niche, and due to their different organizational structure do not necessarily conduct benchmarking (Anand and Kodali, 2008) or have systematic benchmarking procedures (Cassel et al., 2001). Medium-sized enterprises tend to be very competitive and thus rely on benchmarking for continuous improvement and development of the business units. This is not limited to medium-sized enterprises, however; it might be useful to apply benchmarking especially for small but also for large enterprises. Along this line of reasoning, therefore, they could also use OI projects to get a view behind the curtain of other enterprises.

Considering the item "identification of further potentials during the innovation process sequence," the association between an enterprise's size and its perception-based assessment is moderate (*Cramer's V* 0.244). According to this, the relevance of this item varies moderately depending on enterprise size. Given the high average agreement of 83.5%, the majority of respondents consider this benefit as relevant. To be more precise, this item has the greatest importance for medium-sized enterprises (96.8%), followed by large enterprises (86.3%) and small enterprises (71.7%). The assessment is also significantly different between small enterprises and both of the other two enterprise categories. Questions thus arise as to why this item is of less importance for small enterprises. One possibility is that the benefits may be negatively assessed for two different reasons: on the one hand, something could be non-beneficial because it is not seen as important. On the other hand, however, it could be seen as important, yet inapplicable. For small enterprises, the second reason should be convenient - their typically strong core business focus and specialized knowledge basis (Bianchi et al., 2010) could have a negative impact on the perceived benefit of the identification of further potentials.

Given the importance of process innovation for SMEs (Madrid-Guijarro et al., 2009) and the

limited resources of small enterprises, the cooperation with external partners should be seen as an opportunity not only to gain financial benefits but also to gain insights into process structure and flows and to use the lessons learned in order to stay innovative and competitive.

The item "shorter product development times" shows a weak association (*Cramer's V* 0.175). The respective importance thus differs according to enterprise size. The agreement with this item being a benefit is inconclusive across all categories (57.3%). Here, its perception as a benefit from the perspective of medium-sized enterprises shows the greatest strength (67.7%), while small enterprises significantly differ with a value of 45.3%. Large enterprises (61.3%), on the other hand, do not markedly differ from either category. March-Chorda et al. (2002) found that small and medium-sized enterprises generally have shorter product development times, although this depends on the sector. Against this background, it can be argued that small enterprises do not extensively perceive this benefit, since they already have very short product development times and are quite agile in product development (cf. Vanhaverbeke, 2017, pp. 33ff.). However, it is surprising that the perceived relevance of this item for medium-sized enterprises is considerably greater. Medium-sized enterprises are very competitive and try to close the gap with market leaders, which means they aim to grow (Man et al., 2002) and become one of the benchmarks. This might allow them to perceive this benefit as quite relevant, as they are driven by external pressure. Large enterprises do not necessarily depend on very fast development times. This benefit might then simply be less relevant for them than for medium-sized enterprises. Nonetheless, OI projects seem to be an appropriate means to catch up with benchmarks; in our understanding, however, it is not one of the most efficient means to reduce product development times.

The item "faster time to market" shows a weak but noteworthy association (*Cramer's V* 0.191) between enterprise size and the item's assessment. Essentially, the agreement to consider this item as a benefit of OI projects is inconclusive (average agreement 45.7%). However, there does exist a slight tendency towards less relevance. Medium-sized enterprises show the highest agreement (54.8%), followed by large enterprises (51.3%). Small enterprises (32.1%), on the other hand, show a significant difference from medium-sized and large enterprises. Enkel et al. (2009) argue that the inside-out process of OI enables enterprises to bring their ideas to the market faster than they could through internal development. Hence, at a first glance, the perception should not necessarily differ between the categories. In alignment with the competitiveness discussion around the above item "shorter product development times," it can be argued that the market pressure that medium-sized enterprises perceive forces them to reduce the time to market as much as possible and are thus very sensitized to this benefit or, to put it another way, they rely on it to become or stay competitive. Nevertheless, large enterprises do not consider this benefit as noteworthy, which implies that this is also a relevant motivation for them to participate in OI projects. Only small enterprises acknowledge the considerably faster time to market as a benefit of OI. Reasons for this may be found in the fact that they are usually quick to the market with their products.

For the item "partner-specific threats" - which is the only risk item that shows an association between enterprise size and assessment - a weak association (Cramer's V 0.197) is found. The average importance thus differs between the enterprise size categories. As with the items discussed above, the perceived general relevance of this item is broadly inconclusive (average agreement

62.0%). Medium-sized enterprises reveal the highest agreement (76.7%) and small enterprises (50.0%) the lowest value, with large enterprises (64.5%) in between. Small and medium-sized enterprises show a significant difference, and large enterprises do not differ significantly from the other two categories.

The key message in the context of this item is related to perceived insecurity over the decision for or against a particular cooperation partner. According to Diener and Piller (2013), the questions "Who is an external actor that can contribute input for my innovation challenge? How do I find these external actors?" are among the most relevant issues in the context of entrepreneurial OI processes. Here, two basic forms for the selection and involvement in interaction and collaboration can be distinguished: an Open Call - which refers to a publicly announced problem statement, and an Open Search - which refers to a proactive search for information and sources - that is, the active search for potentially appropriate external partners (ibid). Both paths can be associated with 1) insecurities regarding the enterprise's own input and approach, e.g. clear problem statement formulation without disclosing too much critical information, or an appropriate search concept; and 2) insecurities regarding the suitability or trustworthiness of the selected partner.

The low value for the small enterprises could be interpreted as a result of their often passive role in OI projects. The perception by large enterprises shows their awareness of possible risks, yet also their confidence, based on existing mechanisms and methods for facing these challenges. Medium-sized enterprises, however, often actively search within OI projects and do not enjoy the well-resourced position of large enterprises. In order to face this challenge, current applied OI research addresses the important role of intermediaries in the context of the search for an appropriate partner. Enterprises benefit from the intermediaries' tools, methods, existing access to an established community, education and process consulting in order to establish an OI project (Diener and Piller, 2013).

Except for the benefits and risks already mentioned in this section, the results show almost no differences between the evaluation results from different perspectives. Thus, the underlying question of whether the size of an enterprise affects its perception of the benefits and risks of OI projects can be answered generally in the negative. By answering this question, this article contributes to the existing theory regarding the benefits and risks of OI: 1) It finds that they are perceived mostly independently of enterprise size. Thus, the often-emphasized specifics of OI in SME (cf. Bianchi et al., 2010; Gassmann et al. 2010; Brunswicker and Vanhaverbeke, 2015; Santos, 2015; Vanhaverbeke, 2017) seem to have almost no influence on their perception towards the perks and shortcomings of OI. 2) The risks and benefits gathered from the literature (as well as those identified in the expert interviews for this study) were all indirectly confirmed as more or less relevant for OI practice and managerial decision making. This can be concluded by the respective average agreement. Thus, previous research on benefits and risks (see references in sec. 2.2) could be verified and elaborated. 3) A finer distinction between their degrees of relevance for small, medium, and large enterprises has been enabled and elaborates also the existing theory. This allows researchers and enterprises to better understand the importance of certain aspects of OI projects with respect to enterprise size.

6 Conclusions, limitations and future work

This paper presents empirical findings regarding the effect of an enterprise's size on its perception of the benefits and risks of participating in OI projects. It was revealed that enterprise size does not necessarily have an effect on the perception of the benefits and risks. In a few cases, however, significant effects were identified. Even though small and medium-sized enterprises are usually lumped together in one category, the data analysis shows that the assessment of benefits and risks often significantly differs between these two categories. Medium-sized enterprises in particular show similarities with large enterprises in terms of their assessments. The findings of this paper may be taken as an indication of obvious differences between small and medium-sized enterprises. The results also enable SMEs to gain an understanding of which aspects they particularly need to focus on. Enterprises can use the opportunity to compare their own understanding of the importance of particular benefits and risks with the understanding of other OI experts. Along this line, a managerial tool for assisting enterprises to cope with OI projects, which supports them by weighing the benefits and risks of a given OI project, was developed on the basis of this study's underlying data.

The benefits and risks investigated here focus mainly on the outside-in perspective of OI. The inside-out perspective, in which an enterprise allows unused and underutilized knowledge outside its boundaries, is not explicitly examined here. The same applies for coupled processes (describing cooperative innovation processes with complementary partners or competitors in strategic alliances or network structures) (Gassman and Enkel, 2004). The specifics of each of these paths could influence the perception of benefits and risks in different ways.

Although the goal of the study was achieved and the underlying question was answered whether the perception of benefits and risks differs depending on enterprise size, inevitable limitations do exist. Due to the study's exploratory character, it was merely asked whether or not a listed benefit/risk was perceived as such. The present results are therefore based on a dichotomous dependent variable and thus do not give any information about the extent of the perceived relevance. The use of rating scales would seem to be useful for identifying the differences between more important and less important benefits and risks in future research, which in turn could depend on the size of a company. The study is also based on a low response rate. A return of less than 2% is not satisfying, although the number of participants (236) is acceptable and methodologically unproblematic for this kind of study. Nevertheless, the uneven distribution of enterprise sizes and the number of dropouts also needs to be pointed out. While from large enterprises the answers of 84 participants could be taken into consideration, this only applied to 32 participants from medium-sized enterprises. An additional 65 participants quit before assessing the benefits/risks. Another 16 participants stopped the survey during the assessment, so that not all benefits/risks could be analyzed on the same basis. This also led to the discovery of much less significant differences with rather small effect sizes. However, the aim of the study was not to examine assumed differences. Rather, the intention was to demonstrate the possible influences of enterprise size. For future surveys, however, an increased and more balanced sample should be sought.

Even though numerous benefits/risks were assessed in the context of the survey, this study does not claim that the presented list of benefits and risks is complete. Certainly, other benefits

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and risks are conceivable or can be found in the literature. On the other hand, some of the identified benefits and risks could also be aggregated based on existing similarities in terms of content. Another limitation could be the rather general formulation of the specified risks. This may have led to difficulties in answering the survey. A revised version with concrete examples would certainly be useful in further research.

Future research may involve the comparison of regional differences in the assessment of benefits and risks by conducting the same survey in different regions such as Asia, North America, Africa, or the Middle East. In this way, some light could be shed on regional or even culturally-based assessment differences and the resulting implications for OI. The survey data could also be used to create stylized facts regarding the benefits and risks of OI projects, however the sample size would need to be increased. The present study could therefore be a starting point for the creation of such stylized facts.

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Appendix

A1. Perception of organizational benefits according to enterprise size.

Organizational benefits	Agreement by enterprise size in % (*by number of employees*)			Average agreement
	>50	50 – 250	250>	
Inclusion of external experiences	96.4	96.8	97.6	97.1%
Expansion of the enterprise?s knowledge base	94.5	93.5	95.2	94.7%
Filling of internal knowledge gaps	92.7	83.9	91.7	90.6%
Access to new product and production technologies	92.7	83.9	86.9	88.2%
Improvement of market knowledge and market requirement detection	72.7	93.8	89.3	84.8%
Technological synergy effects	81.8	81.3	85.7	83.6%
Extension of the range of products and services	85.5	78.1	82.1	82.5%
Benefits from the partner's network	78.2	74.2	88.1	82.4%
Advantages in technology transfer	76.4	75.0	83.3	79.5%
Higher market acceptance through reference effects	70.9	84.4	77.4	76.6%
Use of the partner's intellectual property as a strategic asset	70.9	62.5	75.0	71.3%
Improvement of the organizational culture	61.8	61.3	71.4	66.5%
Better forecasting of future developments	56.4	78.1	66.7	65.5%
Easy benchmarking of competitors	58.2	78.1	44.0	55.0%
Benefits from foreign cultures	38.2	41.9	69.0	54.1%
Risk diversification	47.3	58.1	53.6	52.4%
Use of competitive synergies	49.1	67.7	46.4	51.2%
Enforcement of standards and designs for new products	50.9	53.1	45.2	48.5%
Synergy gains by patent pooling	38.2	41.9	69.0	46.5%

A2. Perception of process-related benefits according to enterprise size.

Process-related benefits	Agreement by enterprise size in % (*by number of employees*)			Average agreement
	>50	50 – 250	250>	
Availability of external experts	88.7	96.8	96.3	93.9%
Increased innovation performance	84.9	96.8	92.5	90.9%
Improvement of products or services	86.8	87.1	87.5	87.2%
Identification of further potentials during the innovation process sequence	71.7	96.8	86.3	83.5%
Enrichment of project evaluations with various facets	58.5	58.1	61.3	59.8%
Establishment of multifaceted decision making	60.4	61.3	56.3	58.5%
Shorter product development times	45.3	67.7	61.3	57.3%
Process improvements through process design by the partner	50.9	58.1	46.3	50.0%
Faster time to market	32.1	54.8	51.3	45.7%
Use of the advantages of external IT infrastructures	32.1	25.8	33.8	31.7%

A3. Perception of organizational risks according to enterprise size.

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Organizational risks	Agreement by enterprise size in % (*by number of employees*)			Average agreement
	>50	50 – 250	250>	
Selection of the wrong partners	82.7	73.3	81.6	80.4%
Unclear communication of OI goals	78.8	70.0	76.3	75.9%
Insecurities over including the external partner	59.6	66.7	71.1	66.5%
Unintended knowledge drains	59.6	63.3	67.1	63.9%
Coordination problems	61.5	63.3	63.2	62.7%
Partner-specific threats	50.0	76.7	64.5	62.0%
Lack of cultural values	55.8	70.0	61.8	61.4%
Integration of security-critical partners	55.8	70.0	55.3	58.2%
Rejection of the process opening by employees	46.2	50.0	61.8	54.4%
Inefficient resource allocation	57.7	53.3	51.3	53.8%
Submergence of enterprise and OI strategy	46.2	60.0	53.9	52.5%
Opening of enterprise boundaries	48.1	63.3	46.1	50.0%
Dependence on external alliances	44.2	53.3	39.5	43.7%
Increased employee needs for training and motivation	44.2	36.7	40.8	41.1%
Monetary inefficiency	46.2	46.7	32.9	39.9%
Information overload	34.6	40.0	28.9	32.9%
Financial bottlenecks	28.8	16.7	17.1	20.9%

A4. Perception of process-related risks according to enterprise size.

Process-related risks	Agreement by enterprise size in % (*by number of employees*)			Average agreement
	>50	50 – 250	250>	
Delays with effects on the project progress	67.3	51.7	64.9	63.2%
Inefficient integration of internal and external IT systems	44.2	37.9	33.8	49.0%
Insecure and inaccurate decision making through more complex decision structures	46.2	48.3	47.3	47.1%
Unused result potentials	40.4	41.4	43.2	41.9%
Non-consideration of innovation potentials during the process sequence	48.1	44.8	33.8	40.6%
Pursuit and realization of unattractive ideas	50.0	37.9	35.1	40.6%
Slower product development	44.2	41.4	33.8	38.7%
Outflow of employees with expert knowledge to the partner	44.2	37.9	33.8	38.1%
Deficits in project evaluation through wasted potentials	40.4	34.5	29.7	34.2%
Inefficiencies in production and distribution	34.6	27.6	35.1	33.5%
Decreasing innovation capability	23.1	34.5	17.5	22.6%

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Biographies

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Validating a Design Thinking Strategy: Merging Design Thinking and Absorptive Capacity to Build a Dynamic Capability and Competitive Advantage

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Abstract. Design thinking in the management context has suffered from vague definition, gaps in literature, and lack of theoretical foundation. Research streams in absorptive capacity and dynamic capabilities have reached a point of convergence with respect to design thinking and absorption of external knowledge. As such, this study draws on both absorptive capacity and dynamic capability theory to provide theoretical foundation for the strategic consideration of design thinking in strategy, organization design, and organizational learning. In doing so, this study extends seminal absorptive capacity theory providing empirical evidence of design thinking as a dynamic capability to enhance absorptive capacity. Additionally, this study extends dynamic capabilities theory by confirming design thinking as a means of integration, learning, and reconfiguring knowledge to build competitive advantage. Therefore, this study merges existing research streams to empirically validate design thinking as a dynamic capability which must be strategically considered.

Keywords. Design Thinking; Absorptive Capacity; Dynamic Capability; Competitive Advantage.

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1 Introduction

Strategic management of dynamic capabilities are required by executives and managers to sense and seize opportunities in markets, and the knowledge processes of integrating, earning, and configuring are core elements of dynamic capabilities (Teece & Pisano, 1994; Teece, Pisano, & Shuen, 1997; Teece D. J., 2007). Based on this view of the importance of knowledge, the knowledge based view proposes that acquisition and the management of knowledge, is the most important strategic based resource to gain a sustainable competitive advantage (De Carolis, 2002; Wiklund & Sheppard, 2003; Curado, 2006). Zahra and George (2002) first identified absorptive capacity as a dynamic capability by highlighting the need for organizations to continually invest in sustaining absorptive capacity to exploit new external knowledge. As such, previous research by Acklin (2013) and Llamas (2015) offered absorptive capacity as the theoretical foundation for design thinking as a means to acquire external knowledge, but cited the need for further research on how design management could be used as a dynamic capability for competitive advantage.

Design thinking has recently been proposed as a dynamic capability but scholars have identified that more studies are needed related to its impact in organizations due to vague definition, gaps in literature, and lack of theoretical foundation within the management research (Johansson-Skoldberg et al., 2013). Recent theoretical advances have linked design thinking as a dynamic capability to facilitate absorptive capacity of external knowledge which has led scholars to call for additional empirical research to understand how design thinking is a management process for absorptive capacity (Acklin, 2013; Llamas, 2015). The application of the two research streams of dynamic capabilities and absorptive capacity are substantially similar in their recognition that organizations must be customer focused and have the capability to acquire and commercialize knowledge external to the organization.

This qualitative multiple-case study describes and documents the perspectives of subject matter experts (SMEs) on how design thinking can support an organization's absorptive capacity and thus provides a dynamic capability and competitive advantage to acquire, assimilate, and apply external knowledge for value creation. This study advances the theoretical framework postulated by Llamas (2015) and Acklin (2015) that design thinking is a management process for absorptive capacity by acquiring, assimilating, and applying external knowledge (Llamas, 2015; Acklin, 2013). This theoretical framework supports the purpose of this study by providing a foundation on which to apply design thinking as a dynamic capability and competitive advantage by enhancing absorptive capacity of an organization (Llamas, 2015). The scholarly foundation for this framework is both the seminal work on absorptive capacity by Please confirm the year Cohen and Levinthal (1989) as well as the dynamic capabilities framework provided by Teece and Pisano (1994).

2 Previous Research

The concept of design thinking, from a scholarly point of view, has been developed in two different discourses of the design and managerial discourse (Johansson-Skolberg et al., 2013; Gasparini, 2015). Theoretical development of design thinking has primarily been accomplished

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through the more scholarly design discourse, which, despite significant attention in academic and practitioner based literature, lacks theoretical foundation and is anecdotal (Johansson-Skolberg et al. 2013; Llamas, 2015). Within the design discourse, there are five clear sub-discourses that have theoretical foundation as well as an academic following (Johansson-Skoldberg et., 2013). The younger management discourse of design thinking, which has gained significant popularity since approximately 2003 with management practitioners (Johansson-Skoldberg et al., 2013), was developed primarily in the business media and practitioner testimonial .

2.1 Designer Thinking in the Design Discourse

Schon pragmatic-based philosopher and educator concerned with the study of organizational knowledge acquisition (Visser, 2010; Johansson-Skolberg et al., 2013). Schon (1983) seminal work on reflection in action described the practice, or methods, in which designers deal with ambiguity in problem solving (Kimbell, 2009; Kimbell, 2011) depending on the situation. Schon's hermeneutics view of design problem solving relied on the designers ability to create a solution and reflect upon that creation for continual improvement and re-creation (Johansson-Skoldberg et al., 2013) to revise understanding . Artistry and intuition are inherent in the ability of the designer to frame and reframe the problem space to offer possible solutions based on the individual solving the problem and context of the problem . This is relevant, as it inspired the post-rationalist, design methods movement , moving design-management theory from a problem solving cognitive concept toward a situational concept.

The design-methods movement (Buchanan, 1992; Buchanan & Margolin, 1995; Jones, 1992) highlighted situational aspects of design as designers reflect on the problem, solution and context which frames the problem space . Buchanan (1992) moved design from its cognitive roots to focus on patterns of reasoning employed by designers to approach ill defined, or wicked, problems noting innerrelationship of the analytic and synthetic phase where designers combine and balance requirements to produce a solution (Buchanan, 1992; Johansson-Skolberg et al., 2013). Cycling through contextual exercises to make sense of things (Wylant, 2010; Johansson-Skolberg et al., 2013) facillitates communication and interaction among participants identifying participant views and concerns. In Buchanan's view, integrative nature of design is relevant to developing the hypothesis and a set of acceptable solutions (Buchanan, 1992). Wylant (2010) noted this ability of designers to select the context, and recursively cycle through solutions, as an integral part of the designer's choice of a dominant context on which sense can be made of things (Johansson-Skolberg et al., 2013; Wylant, 2010). The highly dynamic, recursive and heuristic nature of problem solving which the designer continually reflects on a problem situation, interprets feedback, and reframes the problem relies on the context which the problem is approached .

Krippendorff (2006) identified stakeholders, and ultimately the user, as the focus of design thus moving away from technology centered design toward human-centered design . Krippendorff (2006) further proposed a new science of design whereby designers, due their unique capabilities and competencies, claim expertise in a second order understanding of how others use and understand artefacts. Second order understanding is dialogic and interactive by creating a new, more dynamic, form of knowledge which uncovers dynamic ways in which artifacts change user interpretation, functional parameters required, and influece selection of the appropriate design

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2.2 Design Thinking in the Managerial Discourse

Development of design thinking in the managerial discourse has taken a bottom-up approach highlighting design contributions to innovation prior to integrating management . Since the majority of content is practitioner based, to facilitate understanding, literature is dominated as a case-based approach referencing successes of design as a metaphorical and a managerial way to approach design. This bottom-up approach contributes to curiosity surrounding the concept and its contibutions to innovation (Johansson-Skoldberg et al.,2013). Consequently, popularity of design thinking as applied to innovation has been engineering-realated, based on statistical relationships and rational models of innovation. As such, development of design thinking in the management context was initially based on overly positive descriptions without contextualized meaning (Johansson-Skoldberg et al., 2013) and rich theory building indicative of scholarly work. Focus on the successes of design thinking related to practitioner accounts and innnovation has neglected theory from design research areas related to professional designers and how they think and work .

Hassi and Laakso (2011) identified the concepts of human-centered approach, visualizing, collaboration, thinking by doing, and divergent and convergent work styles. Of these concepts, the human-centered approach is highlighted in much of the literature on design thinking and usually involves empathy for the subjects (Brown T. , 2008; Clark & Smith, 2008; Dunne & Martin, 2006; Holloway, 2009; Junginger, 2007) through a putting people first approach (Brown T. , 2008; Porcini, 2009; Ward, Runcie, & Morris , 2009; Porcini, 2009) which uses integrative thinking to identify the most important aspects of problems and creating a compromised solution from competing possible solutions (Brown T. , 2008; Fraser, 2009). Divergent and convergent approaches as well as combinations of the two, is a practice of creating, or visualizing, multiple possibilities without assuming that these possibilities are the best (Boland & Collopy, 2004) but are instead paths toward a solution . Visualizing is a way to make sense of things in an intangible manner other than words or symbols in order to communicate ideas to be discussed as the process moves toward convergence and mutual understanding. Thinking by doing is an iterative practice which uses prototypes and reflection in action to stimulate thinking and explore multiple ideas (Boland & Collopy, 2004; Lockwood, 2009) by turning the visualized concepts into tangible representations to stimulate further reflection and exploring (Boland & Collopy, 2004).

Boland and Collopy (2004) expanded on Simon (1969) theory of design as a method of changing existing states into more preferred states. Simon (1977) proposed a new science of management decision making which, due to management's responsibility to change existing situations into preferred situations, should be treated similar to applied sciences of engineers and architects. Previously, design was viewed as a noun describing a completed process rather than as a verb indicative of an ongoing process or management action (Boland & Collopy, 2004; Boland & Collopy, 2007). This distinction in the action, as a verb, of changing an existing situation into a preferred, is a key aspect of design making which makes organizational leaders an active part of the process rather than passive responders to presentations. Boland & Collopy (2007) state that this verbal form of design, where the management are active participants, is a critical skill

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for successful organizational leaders and the design attitude is an important cognitive mode for practising managers which should be addressed by management education and practice.

From an organizational perspective, design thinking used as a method to approach organizational problem solving as well as a skill for managers, developed by Dunne and Martin (2006) noted cognitive, affective, and interpersonal skills designers have developed. Hassi and Laakso (2011) note methods designers have developed as practices, thinking styles, and mentalities which underscore the close relationship of the organisational practices sub-discourse with the practitioner-focused sub discourse of design as a way of working with innovation and design. As such, Dunne & Martin (2006) notes the need for management education to build the skills necessary for a deeper understanding of the end user and end user experience using observational research techniques to uncover needs that are not easily articulated (Leonard & Rayport, 1997). Building on Argyris and Schon (1978), Martin references the need for management education to develop skills of inquiry within MBA students which note the importance and usefulness of others to understand the value of curiosity and inquiry in problem solving . By developing design thinking separately from the practioner-based discourse, which focuses on design and innovation, Martin removes the concept of designerly ways of working and focuses on the mental processes used by designers which can be adopted by everyone who follows the process . By decoupling design thinking from design, innovation, and new product development, Martin opened up the design-thinking concept as a process to use in a variety of disciplines and industries which in turn validates the concept as a skill needed by practising managers. As a result, design thinking has grown within the management community, due to Martin's wide reach as a speaker and author, to influence work in a wide range of disciplines, including strategy and organizational change and development (Johansson-Skolberg et al., 2013; Sato, Lucente, & Meyer, 2010).

Despite the lack of empirical evidence and firm theoretical base within the management context, design thinking has increasingly been applied by organizations (Liedtka, King, & Bennett, 2013; McCreary, 2003) in a variety of industrial contexts . The relatively small amount of empirical research that exists on design thinking in organizations has evolved from a performative perspective focused on the performance of the design-thinking methodology and accompanying tools (Seidel & Fixson, 2013; Carlgren, 2013). Additionally, empirical research has been conducted in experimental settings involving students however the results have been mixed . The lack of substantive empirical research has led to reliance on practitioner based accounts of design thinking resulting in overly positive views of the value of design thinking. As a result of overly positive practitioner accounts, academic researchers have been apprehensive to approach the concept . Accordingly, prior scholarly research had called for additional studies to determine the success of design management absorption as a dynamic capability to build a competitive advantage and unless research builds on the scholarly aspects of the design discourse the concept of design thinking in the management discourse will likely die (Johansson-Skoldberg, et al., 2013).

3 Absorptive Capacity

Organizational level absorptive capacity was introduced by economists Cohen and Levinthal (1989) seminal work explaining why organizations invest in research and development. Absorp-

tive capacity conceptualized an organization's ability to exploit external knowledge through a sequential process to recognize the value of external knowledge, assimilate this new knowledge through exploratory learning, and apply assimilated knowledge to create new knowledge and value . Early research into absorptive capacity focused on learning and innovation with respect to the performance of the firm (Volberda et al., 2010) and the firm's ability to acquire, assimilate, and apply external knowledge . Much early empirical research focused on an innovation based learning process evident in research and development projects and firms.

Todorova and Durisin (2007) extended seminal work of Cohen & Levinthal (1989), subsequent research by Zahra and George (2002) and Lane (2006) as well as drawing on learning theory, to propose the acquisition of knowledge by an organization utilizes internally existing organizational knowledge to recognize the potential value of external knowledge. With resepect to assimilation of knowledge, Todorova and Durisin (2007) note that organizational assimilation is contingent on the social integration process of transformation as proposed by Zahra and George (2002), and Todorova and Durisin, 2007. Likewise, the application phase of the model highlights the dynamic capability perspective of absorptive capacity previously overlooked by Zahra and George (2002) as well as this dynamic nature of feedback loops use during application.

The knowledge based view of absorptive capacity is an outgrowth of the resource-based view of the firm proposed by Barney (1986) which highlights the impact of partner contributions and outward knowledge transfer to absorptive capacity .The knowledge-based view of absorptive capacity stresses the importance of developing knowledge, promoting organizational learning, enhancing open innovation, managing alliances, creating strategic variety, and impacting financial performance . Research by Lichtenthaler (2016) noted both benefits and drawbacks of absorptive capacity along with tendency of prior research to only focus on benefits. Volberda et al. (2010) highlights the impact other factors such as a dynamic environment have on the level of absorptive capacity.

According to Barney (1991), firm resources are all capabilities, processes, attributes, assets, information, and knowledge controlled by a firm, which can be strategically manipulated to gain competitive advantage.

Grant (1996) confirms the importance of knowledge as the most strategically important resources of the firm and Kogut and Zander (1992) maintain knowledge is the main determinant of competitive advantage. Accordingly, the strategic importance of knowledge strongly reinforces the relevance of absorptive capacity as a key resource in developing and increasing a firm's knowledge (Volberda et al., 2010). Building on the concept of dynamic capability proposed by Barney (1991), Zahra and George (2002) furthered the theoretical base of absorptive capacity as a dynamic capability related to the management and successful exploitation of knowledge. Zahra and George (2002) recognized the need for organizations to continually invest in sustaining absorptive capacity to exploit new information which Todorova and Durisin (2007) built on this point stressing additional dynamic factors of social and organizational factors. Zahra and George (2002) was important from the organizational standpoint as it recognized organizational absorptive capacity does not reside in any one individual but resides in the accumulation of all individual capabilities (Cohen & Levinthal, 1990; Volberda et al., 2010).

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4 Dynamic Capabilities, Competitive Advantage, and the Business Model

Chandler's (1962) seminal work on strategy and structure is credited with first identifying a firm's strategy for growth as determining the strategic management of an organizations valuable resource . Penrose (1959) in her theory of the growth of the firm first viewed the firm as a competitive bundle of resources (Hoskisson et al., 1999). Building on Penrose (1959), the resource based view gained widespread attention in a variety of theoretical streams in the 1980's resulting in Barney (1991), which identified the resource traits necessary for sustainable competitive advantage as value, rareness, inimitability, and substitutability.

The resource-based view postulated by Barney (1991), created a concrete base on which to build a variety of research streams related to the resource-based view of the firm (Hoskisson, et al., 1999). Porter (1991) proposed the dynamic theory of strategy noting the most important of all resources is the ability to learn and adapt to the changing environment. Subsequently, to overcome the limitations of the resource-based view and building on Porter (1991), Teece and Pisano (1994) proposed the dynamic capability framework to address the changing global business environment which requires organizations to respond quickly to the market, engage in rapid innovation, and adapt to future competition and markets. To compete in this changing environment, organizations must develop capabilities to adapt, integrate and reconfigure both internal and external competencies (Ambrosini & Bowman, 2009; Teece & Pisano, 1994). Accordingly, the dynamic capability framework proposes that competitive advantage is achieved in the global, fast moving, markets by an organization's ability to sense, seize, and transform opportunities by creating, renewing, or altering the resource mixes (Teece, Pisano, & Shuen, 1997; Teece D. J., 2007).

The dynamic capabilities framework is a strategic view descending from Schumpteter (1934) theory of economic development. Teece and Pisano (1994) propose managerial and organization competencies of integrating, learning, and reconfiguring are three key components to dynamic capability and competitive advantage. Similarly, Ambrosini (2003) identified four organizational and managerial dynamic capability processes; learning, creative integration, reconfiguration, and leveraging. The dynamic capability of knowledge exploitation can be leveraged into a competitive advantage when customer-centric, value creating, business models are developed which focus on user needs and delivery (Chesbrough & Rosenbloom, 2002; Mansfield & Fourie, 2004). Of the resources and assets of the firm, knowledge related assets are most valuable due to their ability to be coordinated and integrated in a manner, which creates value but cannot be replicated in the market . Therefore, strategic management of dynamic capabilities is required by executives and managers to sense and seize opportunities by allocating, reallocating, combining, or recombining the resources and assets of the organization to provide customer solutions . Accordingly, De Carolis (2002) offers knowledge-based view of the firm as an extension of the resource based view which considers knowledge as the most important strategic based resource of the firm . Wiklund and Sheppard (2003) notes if a resource is difficult to formalize, articulate, and transfer to other organizations, and the resource is also organized and valuable, then it meets the threshold of rare and inimitateable, thus providing a sustainable competitive advantage.

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5 Research Method

The problem this study addresses are gaps in literature on how design thinking can support an organization's absorptive capacity and competitive advantage to acquire, assimilate, and apply external knowledge for value creation (Llamas, 2015). Empirical studies have been conducted and point to absorptive capacity as a key factor for multiple outcomes (Jansen, Van Den Bosch, & Volberda, 2005; Schildt, Keil, & Maula, 2012), however, results are inconsistent and question the assumptions that firms perform better because of absorptive capacity. While results are inconclusive as to the extent absorptive capacity contributes to firm performance, research has shown that as firms perform higher, they invest more in absorptive capacity . The inconsistencies in empirical results, along with base assumptions on which prior research was based, has caused the need for further research to understand the trade-offs and conflicting contingencies that impact the functioning of absorptive capacity at the firm level .The purpose of this qualitative multiple-case study is to describe and document the perspectives of SMEs on how design thinking can support an organization's absorptive capacity and competitive advantage to acquire, assimilate, and apply external knowledge for an organizations value creation.

This research study utilized a qualitative, multiple-case study to describe key insights of six SMEs in the field of design thinking to study the application of design thinking in various settings to determine how design thinking is used to facilitate absorptive capacity. According to Yin (2014), a unit of analysis is the phenomenon or population that must be defined, therefore, within the context of this research, the term *case* means a single person, a SME, and how SMEs describe the application of design thinking to acquire, assimilate, and apply external knowledge. Therefore, for the purpose of this study the unit of analysis is the case and how SMEs view design thinking promotes absorptive capacity to acquire, assimilate, and apply external knowledge (Acklin, 2013; Llamas, 2015) to build a dynamic capability and competitive advantage.

The resulting six-design thinking SMEs are all recognized design-thinking practitioners within the design-thinking community and skilled in the application of design thinking in various organizational contexts. A wide range of organizational contexts was selected for this research study in order to provide a wide range of perspectives in order to view the application of design thinking in multiple contexts. Participants who were deemed to have little experience, knowledge, or lacked breadth of application of the concept were disqualified from the research study. Six participants was determined to be an appropriate amount for this exploratory research where an in depth, open ended, interview process was used to engage a small number of samples and determine replication logic across the multiple case research study design .

5.1 Data Collection, Processing, and Analysis

To facilitate rich exploration, and description, of the perspectives of SMEs this research study chose semi-structured interviews to increase understanding the phenomenon or phenomena from the participant's point of view . The six participants in this research study were taken through a semi-structured interview process, which consisted of a series of open ended questions to describe how SMEs view the ability of design thinking to facilitate absorptive capacity and competitive advantage to acquire, assimilate, and apply external information for organizational value creation

(Acklin, 2013; Llamas, 2015). Replication of results by conducted cross-case synthesis was used to indicate the extent to which the replication logic was either a literal replication whereby the outcome was predicted or a theoretical replication based on a prediction of contrasting data . The research data collected was triangulated to provide cross-data validity checks of the data collected from the multiple cases to achieve more accurate and valid estimates of results (Merriam, 2009; Stake, 1995).

To gain better understanding of the research outcome as well as improve the quality of the investigation and study, triangulation was accomplished by both theory and investigator triangulation. Investigator triangulation involves using multiple investigators to analyze the same set of data which, in the case of this research, also supports theoretical triangulation by using multiple perspectives to interpret a single set of data. In this research study, investigators included the researcher, and two independent evaluators outside of the field of design thinking and management in the fields of Organizational Behavior and Finance and Statistics. Each evaluator read the entire transcript, reviewed the data analysis process and results, and validated the researchers' interpretations of transcript data. Therefore, investigator triangulation was accomplished via two independent investigators who also provided theoretical triangulation by offering multiple perspectives outside of the field of study .

6 Empirical Results

This study confirms the ability of design thinking to support an organizations absorptive capacity to provide both a dynamic capability and competitive advantage relevant to absorption capacity of external knowledge. The study viewed the flow of external information through the lens of absorptive capacity as a means to explore the potential dynamic and competitive nature of design thinking. As such, this study's central research questions were concerned with acquisition, assimilation, and application of knowledge outlined in the economic model of absorptive capacity. The study's findings confirm design thinking is a dynamic capability, which provides a competitive advantage to facilitate absorptive capacity of external knowledge and as such, three significant themes emerged throughout this multiple-case study of SMEs.

The first theme evidenced in this study is the ability of design thinking to dynamically integrate the external into an internal process for the purpose of learning as highly dynamic requiring management interaction. The design-thinking process builds deep understanding of end user and end user experiences through observational research techniques uncovering needs not easily articulated (Leonard & Rayport, 1997). Llamas (2015) referred to design thinking as a project based method to facillitate collaboration between new product design, engineering, and end users to create effective solutions to meet social needs. In Buchanan's view, the very act of assessing and formulating the problem is part of the problem and allows simultaneious development of analytic and synthetic phases in which designers combine and balance requirements to produce a solution (Buchanan, 1992; Johansson-Skoldberg et al., 2013) According to Teece et al. (1997), dynamic capabilities are defined as the three processes of integrating, learning, and configuring. Ambrosini (2003) added to this dynamic view stating, the four organizational and managerial processes of learning, creative integration, reconfiguration, and leveraging are a dynamic capability. Executives and managers are required to sense and seize opportunities by

allocating, reallocating, combining, or recombining the resources and assets of the organization to provide customer solutions and if a resource is difficult to formalize, articulate, and transfer to other organizations then it meets the threshold of rare and inimitateable, thus providing a sustainable competitive advantage. As such, design thinking spans several of these capabilities as it integrates customers or users into the learning and configuring process for the purpose of leveraging insights to create value and therefore must be considered a dynamic capability.

The second theme identified participant views of the contingent nature of competitive advantage in acquiring knowledge and difficulty in maintaining sustainability. Participant seemed to focus on the tendency of design thinking overly focus on tools to engage and acquire knowledge, which most participants viewed as imitable. SME's indicated contingency exists in the degree of competitive advantage and sustainability relative to a host of organizational factors. Additionally, participants noted the contingent nature of speed and efficiency in application of knowledge as a factors impacting competitive advantage. The immediacy assumption of prior absorptive capacity research, assumes that knowledge acquired must financially materialize immediately and does not allow for time lags. Furthermore, Leonard and Barton (1995) noted that effective use of knowledge is an important factor in value creation, which is impacted by a lack of understanding of the sciences involved in the newly acquired knowledge as well as the misunderstanding by management of the capabilities of the firm to apply external knowledge . Teece (2007) described the business model as a reflection of management perspective about what customers want, and recognizes the acquisition and the management of knowledge as dynamic capabilities that provide sustainable competitive advantage (Wiklund & Sheppard, 2003; Curado, 2006). Furthermore, Teece (2007), also highlights the ability to take advantage of opportunity and remain competitive through management of the resources of a business enterprise's tangible and intangible assets as dynamic capabilities. Teece (2007) goes on to indicate the business model as a reflection of management perspective about what customers want and how the organization can meet those needs and get compensated. Therefore, design thinking is a dynamic capability to build competitive advantage, however, contingency is related to organizational factors which promote aborptive capacity, speed and efficient application of knowledge.

The third theme identified competitive advantage of design thinking is derived from a highly dynamic interrelationship between assimilation and application of knowledge in design-thinking. This dynamic interrelationship is based on integration of the customer or user into the prototyping and iteration process. Integration of the external source of knowledge into prototyping is boundary spanning as assimilation and application of knowledge happens simultaneously. The process gets more dynamic as prototypes go through the iterative process whereby prototype improvements are made until an acceptable solution is achieved. Hassi and Laakso (2011) referred to this as an iterative practice which uses prototypes and reflection in action to stimulate thinking and explore multiple ideas (Boland & Collopy, 2004; Lockwood, 2009) by turning visualized concepts into tangible representations to stimulate reflection and exploring (Boland & Collopy, 2004). Design thinking is explorative and experimental, tolerant of ambiguity, oriented toward the future, and optimistic involving a wide range of stakeholders as an integral part of design thinking (Brown T. , 2008; Brown T. , 2009; Clark & Smith, 2008; Dunne & Martin, 2006;Holloway, 2009; Lockwood, 2010). Boundary spanning activity in absorptive capacity research outlined by Todorova and Durisin (2007) draws on learning theory to propose the acquisition of knowledge by an organization utilizes internally existing organizational knowledge

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to recognize the potential value of external knowledge and subsequently, the assimilation phase is contingent on a social integration process of transformation as proposed by Zahra and George (2002). This is also supported from the dynamic capability perspective, which highlights the dynamic nature through the contribution and value of feedback loops . Considering this dynamic nature, Llamas (2015) referred to design thinking as collaboration between new product design, engineering, and end users to create effective solutions.

7 Theoretical Contributions

This study contributes to previous research by Acklin (2013) and Llamas (2015) that design thinking is a management process for absorptive capacity by acquiring, assimilating, and applying external knowledge. The scholarly foundation is seminal work on absorptive capacity by Cohen and Levinthal (1989) that proposes firms benefit from investing in absorptive capacity to preempt environmental changes by taking a knowledge based view of absorptive capacity to promote organizational learning, enhance open innovation, manage alliances, create strategic variety, and impact financial performance . This was later extended by Lane and Lubatkin (1998) noting organizations must focus on understanding their internal knowledge and the process which it acquires new knowledge, converts that knowledge to capabilities, and the ability of those capabilities to meet demands of the environment. Barney (1991), and Zahra and George (2002) extended the theoretical base of absorptive capacity as a dynamic capability related to the management and successful exploitation of knowledge. As such, this study is a further extension of the seminal work of Cohen and Levinthal (1989) absorptive capacity theory by providing empirical evidence in supporting design thinking as a dynamic capability and competitive advantage to enhance absorptive capacity of organizations (Llamas, 2015).

This study also extends dynamic capabilities theory as an extension of Schumpteter (1934) theory of economic development. The dynamic capabilities framework proposes managerial and organization competencies of integrating, learning, and reconfiguring are key components to dynamic capability and competitive advantage. Consequently, executives and managers are required to sense and seize opportunities by allocating, reallocating, combining, or recombining the resources and assets of the organization to provide customer solutions and if a resource is difficult to formalize, articulate, and transfer to other organizations then it meets the threshold of rare and inimitateable, thus providing a sustainable competitive advantage. As an extension to this theory, Teece (2007) extended the dynamic capabilities theoretical framework to include the business model which must have capabilities to analyze multiple alternatives, understand user needs and deliver what users want . As such, this study provides empirical support for design thinking as a dynamic capability to provide a competitive advantage due to its understanding of the customer which facilitates learning and customer solutions; however, this research recognizes the need for further empirical investigation relative to managerial interaction in a variety of contexts.

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8 Conclusion and Recommendations for Future Research

Organizational learning literature highlights the needs for organizations to take a system thinking approach to building a framework to promote absorptive capacity to adapt to the dynamic and increasingly complex nature of external knowledge, this is particularly relevant in the new digital economy. This study has provided empirical evidence of design thinking as a dynamic capability to enhance absorptive capacity to acquire, assimilate, and apply external knowledge (Acklin, 2013; Llamas, 2015) and provides a foundation on which to strategically consider design thinking (Llamas, 2015). The knowledge uncovered in study empirically extends previous research by Acklin (2013) and Llamas (2015) by further validating design thinking as a strategy and organizational design consideration thus bridging theoretical gaps and providing a basis for further study of the effects of design thinking in a variety of managerial contexts. Future empirical research is needed to extend the findings of this study with respect to; dynamic integration of the external into the internal, dynamic interrelationship between assimilation and application, and contingent factors impacting competitive advantage and sustainability. Furthermore, future research should seek to investigate these findings in a variety of strategic, organizational, and managerial contexts.

According to Teece (2007), a good business model must have capabilities to analyze multiple alternatives, understand user needs and business models should be based on customer focused value creation (Chesbrough & Rosenbloom, 2002; Mansfield & Fourie, 2004). While this study provides validation of design thinking as a strategic in nature, future researchers should explore the organizational effects of structure, people, and culture on degree of competitive advantage realized by design thinking in a variety of contexts through empirical based qualitative research. Similar to Carlgren, Rauth, & Elmquist 2016, this study also confirms the need for further empirical research to understand how design thinking is used in a variety of organizational settings and contexts in order to gain a deeper understanding of the impact of these factors on the absorptive capability, dynamic nature, and related competitive advantage of design thinking to validate its strategic and competitive importance. In addition to organizational settings, future research should consider more widespread adoption of design thinking management training in higher education as well as practical settings. Therefore, future research should focus on establishing a design thinking management body of knowledge for the purpose of both higher education development as well as as organizational and practitioner training.

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Should Attitudinal Views toward Innovation Development Play a Role in Policy in Peripheral EU Regions? New Evidence from Vouchers Program in Northern Ireland

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Abstract. The impact and effectiveness of policies to support collaboration for Research & Development (R&D) and Innovation is critical to determining the success of regional economic development. (O'Kane, 2008) The purpose of this paper is to evaluate the level of success of the Innovation Vouchers Program operated by Invest Northern Ireland (Invest NI) from 2009 to 2013 and address if attitudinal views towards innovation development should play in a role in future policy design in peripheral EU regions.

Keywords. Peripheral Regions; Regional Economic Development; Innovation; Attitudes; Market Failure; R&D.

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1 Introduction

Historically, spatial separation and lack of funding have negatively affected innovation development. This has created entrenched attitudinal views against innovation development, which has subsequently affected the ability of Northern Ireland, a peripheral region within the United Kingdom (UK), to translate innovative activity into innovative behavior despite heavy investment in its ongoing Research and Development (R&D) vouchers program. Evaluative studies have largely focused on assessing the short-term economic impact of innovation vouchers programs in Northern Ireland, the UK and other European Union (EU) regions. These studies have failed to consider the implications of attitudinal views towards innovation. This represents a significant gap in the academic literature. This paper makes a first attempt at utilizing primary source survey data to not only explore the economic impact of an R&D subsidy program, but also how attitudinal views toward innovation play a major role in the greater scheme of innovation development of peripheral regions.

Academically, the benefits arising from research collaboration to stimulate innovation and improve business performance have long been recognized by both those working in the public (government and academic) and private sectors. The challenge that arises is business advisory and services associated with research collaboration may not be affordable to SMEs located in peripheral regions. As continually high unemployment rates and low productivity are often characteristic of the small business sector in peripheral regions, (Krieger-Boden, Morgenroth and George, 2008) there is an inherent need for funding to not only cultivate organic growth but also to foster a supportive environment to sustain it.

Peripheral regions in the UK have lacked funding due to spatial separation from more central economic hubs. This absence of funding effectively diminishes an SME's ability to benefit from 'knowledge transfer,' and subsequently weakens its capacity to innovate. To compensate for market failure in these regional economies, 'government agencies have introduced and developed several policy initiatives over the years since the free market mechanism does not adequately support the flow of new [and sustained] ventures' (Vadnjal and Nikolovski, 2008).

To address Northern Ireland's own productivity gap, Invest NI launched a one-year pilot program in May 2008 that provided an investment channel to stimulate innovative activity primarily through research collaboration. As peripheral regions typically receive block grants due to the lack of performance history and available collateral necessary to satisfy private investors, Invest NI distributed vouchers valued at up to a maximum of £4,000 redeemable by local SMEs against the cost of practical advice and expertise on specific operational projects (Johnston & Buchanan, 2016, Invest Northern Ireland, 2012). Following the one-year pilot program, an internal review of the Innovation Voucher Program was undertaken. This was followed by an independent economic appraisal and Ministerial approval for £2.7 million to launch a new Innovation Voucher Program to benefit 576 SMEs in Northern Ireland covering the period 26 October 2009 to 31 March 2012

The key objectives of the Innovation Voucher Program were to:

1. Encourage small enterprises in Northern Ireland to engage with public sector Knowledge Providers to access knowledge and expertise to develop innovative solutions to business issues;

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2. Increase the level of innovation activity in Northern Ireland's small enterprise sector;
3. Stimulate innovation and encourage research and development in small enterprises; and
4. Increase productivity in Northern Ireland's small enterprises.

More specifically, the Innovation Voucher Program was designed to help enterprises registered in Northern Ireland establish links with the 41 public sector Knowledge Providers (Universities, Regional Colleges, Research Centers and Institutes of Technology) across Northern Ireland and the Republic of Ireland to access knowledge and expertise to develop innovative solutions to business.

The remainder of this paper will first focus on providing a conceptual background of innovation policy in support of small to medium sized firms, the use of R&D as a policy mechanism in peripheral regions, and objectives set by Invest NI for the Innovation Vouchers Program. Using primary source data gathered from voucher recipients, this research specifically addresses the effectiveness of the Innovation Vouchers Program in its ability combat intrinsic market failure in Northern Ireland and the gap in academic literature regarding attitudinal views toward innovation development. Lastly, this research will evaluate the Innovation Vouchers Program's economic impact, value for money and additionality in addition to providing insight into whether the current design of the Innovation Vouchers Program fosters innovative activity and long-term innovative behavior.

2 Concept & Objectives

Historically, innovation support programs have targeted different sized firms within a variety of industries. Since the 1980s, the intended demographic has shifted towards 'smaller' firms, which varies in number of employees per country specification (Cunningham, Gok, & Laredo, 2012). The rationale for direct support to small firms stems from the theory that increased R&D within firms will lead to small-scale innovations that may include production of new products, services or processes. Cunningham et al. (2012) argues that 'limited government subsidies can have a proportionately greater effect (and certainly reach a much larger audience - potentially increasing the likelihood of successful intervention) if allocated to smaller companies rather than larger companies who have a more diverse portfolio of R&D interests and greater resources with which to support these.' While there is a counter argument that indicates a greater spillover effect regarding R&D activities within larger firms, the generally accepted rationale is that public intervention stands as the primary vehicle for protecting inventors and aiding the development of technology that could benefit an industry (Almus, & Czarnitzki, 2003).

There is a comparatively long history regarding measures to foster longer-term cooperation between science and industrial actors. These now represent a significant part of the portfolio of innovation policy support measures in many countries. Direct measures designed to foster R&D within the private sector originated in the aftermath of the World War II, in the form of support programs designed to stimulate innovation within the manufacturing industry (Cunningham et al., 2012). In the 1970s, these programs benefitted from the addition of technological support, which were based on the idea of bringing together groups of researchers and end-users (O'Kane, 2008). The early programs have played a major role in influencing the design of similar programs

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in several other countries.

There has been a shift in the primary rationale for collaborative support mechanisms, from a set of 'technology transfer' objectives (based very much on the old linear model of innovation and which sought to directly transfer the results of public sector research into the creation of commercialized products, process and services) towards 'knowledge transfer' objectives (Bruno et al., 2011). While the benefits of research collaboration to boost the economic performance is clear, it is important to note that knowledge creation is costly to sustain.

One of the key drivers behind utilization of R&D as a policy mechanism (as opposed to other types of support) is the ability to hone in on specific areas where state intervention will likely make a positive economic impact (Cunningham, Gok, & Laredo, 2012). In light of the global financial crisis in 2008, direct support mechanisms in the form of R&D stimulation were rationalized even as the need to maintain a sustainable degree of innovation within sectors of industry or specific geographic areas that faced higher levels of economic hardship was recognized. Theoretically, direct support would ultimately alleviate the financial strain that these firms face (Albors-Garrigos, & Barrera, 2011). The objectives of direct support programs have changed over the years to reflect an increase in the functional desire of individuals to achieve goals as well as to simply to reflect the current economic climate.

3 Innovation Vouchers Program

Launched as a pilot program for SMEs in 2008, the Innovation Voucher Program granted vouchers that would offset the cost of expertise on operational projects including:

1. Innovation or technology audits;
2. Tailored training in innovation management;
3. New business model development;
4. New service delivery and customer interface;
5. New product development;
6. Product and service testing and economic impact assessment; and
7. Efficiency audit and process change.

At its core, the Innovation Voucher Program was designed to spark the transfer of knowledge between area experts ("Knowledge Providers") and small to medium-sized enterprises in Northern Ireland in the realm of a specific innovation, 80 percent of whom had never participated in R&D efforts before (Invest Northern Ireland, 2012). The Innovation Voucher Program corrected perceived market failures in Northern Ireland by creating a more self-sustained environment and fostering a sense of competitiveness through both financial appropriations and assistance in identifying a functional structure for innovation activities. This should inherently improve the 'absorptive capacity' of SMEs across Northern Ireland and effectively develop the ability to address 'internally incremental innovation demands' (Northern Ireland Invest, 2012). Although the primary aim of the Innovation Voucher Program was the assistance of SMEs in Northern Ireland by creating a cultural shift toward innovation, an additional objective was the 'positive externality of enhancing the commerciality capability of knowledge providers.' (Invest Northern

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Ireland, 2012)

4 Academic Theory

4.1 Effects of Spatial Separation

Historically, regions in the UK have suffered from lack of funding due to spatial separation. As the financial sector in the UK is largely concentrated in London, 'firms in peripheral regions face a challenge in accessing finance which is often located in core regions' (Lee & Brown, 2016). The financing of innovation in peripheral regions should largely be standardized due to the technological advancements that make credit scores and balance sheets more readily available. However, Lee and Brown (2016) found there are increased levels of demand for financing for firms looking to foster innovation in peripheral regions, but due to spatial separation, there is a greater chance for rejection.

Regional economists have historically believed spatial separation should not be a contributing factor in a firm's access to funding as technological advances have improved interconnectivity between peripheral regions and centralized economic hubs (Lee & Brown, 2016). However, a recent study indicates that firms located in peripheral regions of the UK suffer from a disequilibrium in the supply and demand of financing. Since the UK remains characterized by highly spatialized markets, economic geographers indicate that this may be a key reason why UK firms located outside of centralized hubs report the inability to access finance. As a result, 'innovative firms in peripheral regions may be less likely to be aware of specialized financiers or financial alternative' (Seghers, Manigart, & Vanacker, 2011).

The culmination of effects due to spatial separation lead to 'search costs [being] higher outside core areas, and so financiers are discouraged from looking; those providers of finance in peripheral areas which remain are less likely to [specialize] in financing innovative firms; they tend to focus on less resource-intensive early stage finance; and do not develop the appropriate specialisms to fund them' (Lee & Brown, 2016). This highlights that spatial environments can very quickly turn into 'thin' markets, which makes it highly difficult and expensive for entrepreneurs in peripheral regions and outside investors to connect.

Economic Implications

As larger companies in Northern Ireland outpace SMEs in the region in R&D as well as innovative activity, Northern Ireland struggles with a 'productivity gap' as it continues to fall behind both the Republic of Ireland and the UK (Johnston & Buchanan, 2016). There is a strong indication that SMEs in Northern Ireland oppose investment in innovation due to associated costs, a conservative approach to operations and the lack of exposure to knowledge providers who can aid in the demonstration of how SMEs will secure benefits. These sentiments lead to an important concept Lars Tvede described in behavioral finance that directly affect innovation development in peripheral regions: 'We have an irrational tendency to be less willing to gamble with profits than with losses' (Taran and Betts, 2011). Kahneman's and Tversky's Prospect Theory posits that 'negative changes are weighted more heavily than gains' when individuals make decisions in a state of uncertainty (Ito et al., 1998). As limited financial resources make it more difficult for SMEs to outsource technical and managerial competences, the risk 'of getting it wrong may

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be a real threat to the survival of an SME.' (Brown, 1997) In effect, loss aversion plays a major role in the willingness of SMEs to engage in innovation related activity.

4.2 Effect on Attitude

Obstacles associated with funding and loss aversion have fostered a collective apathy towards innovation development, despite innovation being a widely recognized critical success factor in the long-term growth and stability of regional economies. Furthermore, 'Actions to increase entrepreneurial motivations and skills are thus important not just for increasing the pool of people interested in and capable of starting and running a business, but also for shifting the nature of business activity in the districts towards opportunity rather necessity entrepreneurship and towards incremental innovation' (OECD, n.d) Due the lack of emphasis on attitudinal and cultural shifts toward innovative behavior, the majority of SMEs have a narrow understanding of both the markets and growth opportunities that subsequently affects both motivation and the capacity to innovate.

While many theoretical studies acknowledge the significance of cultural elements such as attitude in the success of enterprise activities, very little associated empirical research results are associated with public policy. Culture cannot be measured in a systematic way, as it 'acts as a background variable that manifests itself in attitudes and patterns of behavior.'

4.3 Link to Policy

The capacity to innovate as related to attitudinal views has led researchers to place increasing importance on internal factors associated with psychological underpinnings of human capital within a firm. Yet, this is not reflected in modern innovation policy that does not 'focus directly on the improvement of attitudes per se, but on an improvement of the framework conditions relevant to the business foundation.' The reason for the focus on improvement of framework conditions instead of the root of the problem can be linked to the theory behind the R-H model of business performance management. The R-H model directly lends to the behavior of the government and policy participants. At its simplest, the government acts as the principal and voucher recipients act as the agent. The principal seeks to maximize value of money - which is the 'difference between the monetary value of the agent's output and the payment required to induce effort from the agent' (Neely, 2011).By this logic, policy objectives must have direct measurability.

In effect, the most critical question associated with policy evaluation is if those participating can prove improvement in a cost-effective manner. As truncating, 'pressures worldwide mount to reduce the size of governments and expand private sector and nongovernment involvement, it becomes increasingly important to justify public spending and ensure that the funded interventions are achieving intended objectives.' As a result, 'it is easy to focus too much on so-called "hard" support, such as finance, premises and start-up counselling, and too little on "softer" support for encouraging the right skills and motivation' (Cooney, 2012).

The gap between targeted support and cost-effective support is apparent in a recent vouchers program that funded SME's in Manchester, UK that had applied to invest in creative projects.

The evaluative study found that 'the firms who were awarded Creative Credits enjoyed a short-term boost in their innovation and sales growth in the six months following completion of their creative projects. However, the positive effects were not sustained and twelve months after the completion of these projects there was no longer a statistically significant difference between the groups that received the credits and those that didn't' (Bakhshi et al., 2013)

Due to the nature of policy design around R&D support mechanisms, evaluative studies around the impact and effectiveness of policies to support collaboration for R&D and innovation are forced to largely concentrate on the diffusion phases of innovation including adoption and implementation, while not addressing the importance of the initiation stage of innovation. The lack of research on how to target the attitudinal aspects of innovation behaviors in peripheral regions has led to a substantial gap in academic literature regarding regional economic development. There has been an absence of primary source data available to derive significant conclusions regarding the importance of attitudes and preconceptions around innovation in peripheral regions.

5 Data Collection Methodology and Focus

In order to bridge this gap, Invest NI distributed an online survey to the 576 firms who were voucher recipients over the course of 2008 to 2011-2012 to capture both the Innovation Voucher Program's impact on the economic and cultural environment as well as to ensure the Innovation Voucher Program reflected its original objectives in practice (Invest Northern Ireland, 2012). In 2014, Invest NI conducted a follow up evaluation consisting of telephone interviews of program participants. This effectively complemented initial survey data by providing a clearer picture of Innovation Voucher Program evolution and effectiveness from both an economic and innovation development perspective. The nature of data collection focused on the following matters:

- Structure/Focus of initiative (voucher recipients, size of firm, firm lifecycle stage)
- Performance against objectives (see objectives)
- Quantitative performance (firm success rate, employment, turnover, degree of additionality, value for money)
- Qualitative viewpoints on program impact at firm-level (preconceptions regarding innovation, degree of satisfaction with level of support, outlook on future firm performance)

To assess the economic outcomes on both a micro and macro level, each survey measured employment, turnover, value for money and the degree of additionality. Most importantly for our research, the survey also asked qualitative, opinion-based questions to gauge the how the Innovation Voucher Program affected participants' current outlook on business operations because of their interactions with Knowledge Providers.There are a number evaluative studies based on past and ongoing efforts around government sponsored R&D support measures in OECD countries, but . We examined research on an innovation vouchers program in the Netherlands as well as a study that examined nine R&D support mechanisms across nine GEM (Global Entrepreneurship Monitor) countries to provide a supplementary commentary on our findings.

In alignment with previous studies, the following survey data incorporated traditional, quantitative variables that generally serve as criteria for determining the success of an R&D support program. Additionally, we have incorporated qualitative attitudinal questions to highlight the

research gap that currently exists in the impact and effectiveness of policies to support collaboration for R&D. This survey data is the first data driven element in a multi-part study to prove that the short-term economic boost of a vouchers program does not result in the attitudinal shift needed to create a long-term innovative culture.

6 Limitations

We acknowledge limitations within the scope of our methodology. Primarily, the dataset did not include those who are not accepted to be a part of the Program, which will be critical in ongoing efforts to evaluate the longevity of Program effectiveness (i.e. whether those who received vouchers were more likely to engage in innovative activity after Program end). The nature of self-reported data limits the ability to derive significant, statistical conclusions, but as there is little research around policy inclusion of attitude-based objectives, we believe this data provides a first step to establish correlation. From a longitudinal perspective, additional time between Program end and survey distribution would have beneficial to determine the ability of the Program to mitigate entrenched attitudinal views toward innovation development, but this will be a major consideration in future evaluative studies of the Vouchers Program.

7 Survey Data

The online questionnaire received a 27.8 percent response rate, with an additional 9.5 percent recorded as partial responses. As the average response rate for external surveys is 10-15 percent, the survey data gathered from participants in the Innovation Voucher Program provides significant value to our research. In terms of respondents' respective employment sizes and geographic location, 98.2 percent of respondents primarily represented firms from County Antrim and County Down that employed less than 50 workers (Invest Northern Ireland, 2012). The majority of respondents represented firms established for less than three years, more than nine years or pre-start up. The survey determined that 55 percent of respondents were Client Managed companies of Invest NI, and the remaining 45 percent Non-Client Managed Companies which broadly fit the initial objective to have the Program function on a 60/40 spectrum.

7.1 Reported Barriers to Innovation

In conjunction with previous literature, survey participants responded that the most common barriers to innovation were access to finance, lack of personnel to execute innovation activities, the high cost of direct innovation, and lack of information on technology (Invest Northern Ireland, 2012). The Innovation Voucher Program was designed to overcome these barriers to innovation by providing a range of support activities that would ultimately aid in correcting market failure in Northern Ireland.

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7.2 Satisfaction with Innovation Voucher Programme

Over 40 percent of respondents revealed that, they were new to any type of innovation activity prior to the Innovation Voucher Program, and nearly 50 percent of respondents stated that they did not interact with Knowledge Providers prior to the Innovation Voucher Program. Overall, 90 percent of respondents reported being either very satisfied (59 percent) or satisfied (39 percent) with the content and delivery of the Innovation Voucher Program, including performance, range of activities and equality. A sample of people that were not part of the Innovation Voucher Program but fell into one of the three following categories were also surveyed: (1) had been rejected during the application process; (2) had chosen to not pursue the Innovation Voucher Program after being accepted, or (3) they had not been aware of the Innovation Voucher Program but could have potentially benefited. This additional sample largely responded that it had not fully comprehended eligibility requirements or that there had been too many restrictions on the timing of calls.

7.3 Interaction with Knowledge Provider

At its core, the Innovation Voucher Program connected SMEs in Northern Ireland with Knowledge Providers. According to the survey, respondents were largely satisfied with Knowledge Provider's ability to *meet* needs, the Knowledge Provider's *understanding* of firm's needs, the level of communication between the firm and Knowledge Provider, and the quality of the end product/service the Knowledge Provider delivered. 85 percent of survey participants reported being either satisfied or very satisfied with the overall quality of innovation support from the firm's specific Knowledge Provider (Invest Northern Ireland, 2012). Knowledge Providers' expressed that a number of voucher recipients had unrealistic expectations about what could be delivered given the time frame and financial parameters which would largely explain the remaining percentage of Innovation Voucher Program participants who responded that they were dissatisfied.

40 percent of respondents stated that they chose to interact with a specific Knowledge Provider because there had been a previous engagement with that particular Knowledge Provider (Invest Northern Ireland, 2012). The overwhelming majority of respondents reported that they allocated some portion of the awarded voucher to services supplied by the Knowledge Provider and were subsequently satisfied with the overall quality of innovation support from the Knowledge Provider. Additional respondents chose a Knowledge Provider based on a recommendation from a client/colleague or due to convenient geographic proximity, which lends itself to the idea of liability of distance. Knowledge Providers located in Northern Ireland took on a significantly greater number of projects than Knowledge Providers in the Republic of Ireland due to the proclivity of voucher recipient to contact a local Knowledge Provider as well as the willingness of the local Knowledge Provider to assist.

According to participating colleges, contracts signed through the Department of Employment and Learning do not allow for the degree of flexibility required to 'facilitate commercialization of knowledge.' This decreases the ability of individuals to assist with the Innovation Voucher Program, which may further exacerbate the economic lag associated with spatial separation.

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7.4 Perceived Limitations of Program

In terms of the Innovation Voucher Program's broader impact at firm level, respondents generally felt that they were constrained by application deadlines because of unpredictability in relation to business need (Invest Northern Ireland, 2012). As a result, participants believed services provided by Innovation Voucher Program should be available to firms' year round with the ability to apply for different voucher amounts by potentially applying for fewer vouchers valued at higher amounts. Stakeholders stated concerns about a significant amount of first time voucher recipients who falsely assumed they would automatically receive a second and third voucher. Expectedly, 43 percent of respondents desired to have unlimited support via the Innovation Vouchers as opposed to maintaining the current three voucher limit.

7.5 Reported Outlook on Business Performance

At firm level, survey respondents were asked to estimate the impact the Innovation Voucher Program had on turnover, market conditions, competition and overall degree of benefit in 2010-2011. It should be noted that questions were based on short-term impact, while respondents generally believed that support activities could have a long-term benefit on firm performance.

Regarding turnover, 39 percent of respondents reported that rate of turnover generally remained the same while 23 percent of respondents shared that there was a higher level of turnover and an addition 31 percent was not sure how activities supported by the Innovation Voucher Program affected turnover (Invest Northern Ireland, 2012). In order to identify net turnover, it was key to factor in economic displacement.

At its simplest, the purpose of the Innovation Voucher Program was to provide an overall boost to the Northern Ireland economy. If firms that were awarded vouchers detract business from local competitors, then there is zero net benefit to the regional economy. In order to assess the relationship between turnover and displacement, the survey asked how market conditions in a firm's area of business have changed over the last three years as well as the geographic location of the firm's main competition. There was little consensus as 45 percent of respondents stated that market conditions have declined moderately/strongly, 17 percent identified market conditions as about the same, and 34 percent reported that conditions either improved moderately or strongly (Invest Northern Ireland, 2012).

Respondents were asked to compare current figures and future predictions around profit and employment costs, to evaluate the perceived impact of support activities made available through Innovation Vouchers over the next three years (Invest Northern Ireland, 2012). The majority of firms reported no change in profit and wage expenses, but expected an increase in profit, wages and employment levels over the next three years. By in large, respondents identified little to no change in short-term turnover, market conditions and overall benefit. 42 percent of respondents expect gains from turnover to be 'realized for five or more years as a result of participation.' An additional area of consideration in the survey was the effect on employment as a result of participation in the Innovation Voucher Program. The majority of firms identified changes in employment as nonexistent at the time of the survey which is typical for firms who have received recent financial assistance or are in the early stages of establishment.

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8 Analysis

Through exploration of survey results over the evaluation period from 2008-2014, we can identify that attitudes toward innovation in Northern Ireland fit into the greater context of the impact and effectiveness of policies to support collaboration for R&D and innovation, and therefore need to be considered in future policy design. Based on the quantitative evaluation of the Program, Project Managers successfully met initial objectives to stimulate innovative activity, but there is no evidence that the Program had a positive impact on attitudinal views that recipients had toward innovation development.

While studies regarding regional innovation have historically focused on the more tangible phases of innovation, the survey distributed to voucher recipients largely reflects on the initial preconceptions SMEs have about innovation. In accordance with previous literature, peripheral regions such as Northern Ireland do not have a strong history of innovative tradition which is supported by the figure that 40 percent of voucher recipients were new to the idea of innovation activity (Invest Northern Ireland, 2014). While there survey responses showed expectations of benefits 2-5 years in the future, there was no indication that recipients recognized immediate benefits around knowledge creation, which as a function of human capital, is a critical factor in ongoing innovation efforts.

As previously noted, there 'are few studies that refer to the determinants of positive or negative attitudes toward business foundation,' and in effect, little research on how to address them from a policy standpoint because attitude-based objectives are extremely difficult to measure scientifically (OECD, n.d.). We understand that the most common barriers to innovation experienced by respondents was the availability of finance/cost of finance, lack of qualified personnel, lack of information on technology and the direct cost of innovation being too high. We know this fits into the hypothesis presented by Coronado et. Al (2008) that the most influential factors around aversion to innovation on a global level include cost of R&D, absence of qualified personnel, technological competition in the sector and level of financial indebtedness. What we don't know is to what degree these obstacles have created entrenched attitudinal views towards innovation that cannot be solved by point in time financial assistance. As evidenced by both survey results of the Innovation Vouchers Program and comparable programs in other regions, we do know there is a correlation.

Piloted in 2004, the Dutch Innovation Vouchers Program identified this very issue. Like the Innovation Vouchers Program in Northern Ireland, the Dutch program aimed to bridge the divide between 'science and industry,' in order to promote productivity and economic growth through innovation activity. The program provided vouchers at a maximum value of EUR 7,500 with a six month expiration with no additional contribution required by SMEs. The CPB Netherlands Bureau for Economic Policy Analysis conducted an interview based evaluation after one year and two years following the program, and discovered that voucher winners did not realize more innovations than their counterparts who did not receive a voucher (Van der Steeg, 2010). Additionally, voucher winners did not attempt to carry out any more assignments related to innovation than those who did not receive vouchers within the period of one and a half years after the program. The reasons reported were further investment in innovation related activities were cost and lack of confidence in capability of performing own research.

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As noted in the Dutch program evaluation, the objective was ultimately to, 'lead [voucher participants] to water and pay them to drink' (Angrist, Lang and Oreopoulos, 2006). Why weren't voucher participants willing and/or able to carry out additional activities following program end? One theory is that that generic innovation systems are highly knowledge intensive, but knowledge creation to support certain areas of business becomes costly and extremely specific to territory (Fischer et al., 2000). As knowledge spillovers are concentrated near the source as a function a spatial proximity, regional SMEs are unable to influence innovative activity at a macro level (Fritsch and Franke, 2003). As a result, there is a greater emphasis placed on the individual firm's capability rather than industry capability in regional economic development. These marginalized spillover effects around knowledge creation in regional economies force firms to invest their own financial resources to recognize the effects of innovation, which they simply do not have the means to do.

A second theory is the nature of R&D support programs may place a larger emphasis on the diffusion phases of innovation instead of honing in on the development of an SME's ability to frame and evaluate opportunity. Autio, Kronlund and Kovalainen (2007)'s research on High-Growth SME support initiatives in nine GEM (Global Entrepreneurship Monitor) countries utilized 'successful' examples of policy initiative purely focused on entrepreneurial firms. While the sample itself was non-random, it offers a representation of what is considered 'top-end of the policy spectrum' (Autio et al., 2007). The review largely focused on policy organization, policy objectives, and lessons learned from experience. One interesting aspect about this study is it found that the common denominator among the successful policy initiatives were that they were 'quite new.' While the research commented on the fact that while the newest initiatives may have not fully proven themselves, the expectations for ongoing success were high.

This leads to the question of whether the quantitative calculation of success in the short-term can be extrapolated into a longer-term projection of success. As argued by Negassi (2004), the success of innovations in firms not only depends on size and market share, but also the intensity of R&D and quality of human capital. These factors greatly affect 'longer-term economic outcomes in a peripheral region given the limited absorptive capacity of firms in such regions and uncertainties around the longer-term sustainability of public R&D investments' (Hewitt-Dundas and Roper, 2011). While any given program may boast a positive ROI, degree of additionality and positive job creation, intensity of ongoing R&D and investment in human capital is an essential component in increasing the longevity of perceived components.

While continued self-investment is a healthy expectation for firms in growth economies, SMEs in peripheral regions often do not have the luxury of investing limited financial resources in the unknown, which is supported by basic behavioral finance theory that the weighted probability of potential gains falls short to the weighted probability of potential loss. As innovation "cannot be easily justified by average financial returns to investment" due to the degree of uncertainty related the costs, it becomes highly unrealistic that a single investment at firm-level will create a self-sustaining innovative environment. In effect, Autio et al. (2007) suggests that in the future, policy initiatives need to target improvement of motivation, opportunity evaluation skills and self-efficacy of the entrepreneur in order to maintain a growth process in the firm.

The idea that human capital is an essential component when accounting for a firm's capacity to innovate is not new in the academic literature, but often only solved for in the form of

employment creation (Negassi, 2004, Malul 2012). Pollard (2003) argues that the 'most direct, easily discernible relationship between financial infrastructure and local economic development is a quantitative one of employment creation,' but it appears that these spatial separations are largely exacerbated by a more qualitative factor around the idea that there are few accessible resources to continually benefit from knowledge transfer. In effect, there needs to be a larger emphasis on the direct correlative effect between increase in employee qualifications and an increase in willingness to innovate.

As a function of human capital, the key input in innovation is stock of knowledge capital, which is limited by time constraints provided by any regional economic development scheme (Fritsch and Franke (2003). As 'the first venture idea is only seldom the one that provides the platform for future growth,' there is a critical need for the SME to develop the ability to frame and execute opportunities outside of the Program (Autio, Kronlund and Kovalainen, 2007). In effect, the maximization of economic impact greatly depends on fostering ongoing learning around the emergence phase challenges, rather than the diffusion phases on innovation in a peripheral environment.

9 Conclusion

Historically, policy objectives were set based on what could systematically be measured, not what truly needed to be measured based on what theory says about the importance of attitude in innovation development. Policy objectives that concern attitudinal views and in turn, culture, would need aim to optimize a broader range of innovation characteristics and involve less tangible interactions and feedback loops between the actors engaged. These knowledge transfer objectives necessitate a more sophisticated policy design in order to optimize the full range of potential benefits arising from the collaboration. In turn, this poses a greater challenge for evaluating the success of such policy interventions since many of the outcomes and impacts are subtler and less evident through simple metrics.

While the Program's initial objectives remain valid, Northern Ireland's geographic separation from more centralized hubs in the UK adds an extra dimension of complication in innovation policy due to uncertainty-related costs (Boeh and Beamish, 2012). Assessment of economic impact and value for money was largely founded on the Program's ability to address initial objectives in the context of meeting target figures, to quantify the increase in knowledge regarding innovation across Northern Ireland's small enterprise sector, to identify overarching regional economic benefits and to conclude on the level of additionality and displacement, but there was little evidence that the Program could create sustained innovative behavior at firm-level. Current policy in the UK does not reflect the firm-level need to see the longitudinal gains in engaging in innovation activity. While the life of any direct measure to support R&D within a particular firm is fundamentally limited, targeting the innovation culture at its core is essential to the long-term qualitative shift in attitudinal views toward innovation.

As SMEs provide nearly two thirds of private sector employment in the EU, it is vital to not only alleviate the social underpinnings but also the psychological underpinnings caused by spatial separation and a inherently smaller resource base (Costa, Panyik and Buhalis, 2013). A greater emphasis needs to be placed on the initiation stage of innovation as resource provision and

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consulting services may be more appropriate for high-growth SMEs. The continued lack of 'innovatory tradition' in peripheral regions lends to the idea that the critical success factor in the realm of localized innovation lies in the preemptive, attitudinal stages of the innovation cycle. In effect, targeted objectives need to not only support 'pre-launch' but the exposure to opportunity and the process of opportunity framing as well (Coronado, Acosta and Fernandez 2008, Angrist, Lang and Oreopoulos, 2006). This paper acts as a first step in a multi-part study to examine behavioral finance in the context of regional economic development in an effort to quantify the long-term impact of attitudes on economic growth in peripheral regions.

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User-driven innovation and technology-use in public health and social care: A systematic review of existing evidence

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Abstract. This systematic review revealed and discussed empirical evidence generated from 21 international user-driven innovation studies in the public health and social care. We used PRISMA guideline to ensure a transparent and replicable research process. With the guide of relevant theoretical models, we identified the distinct characteristics of user-driven innovation in current public social care sectors, in respect of its strategic innovation process and user-oriented, empower-based objectives. We categorized different end- and intermediate user groups and discussed how them directly and indirectly engaged in various innovation phases via the support of different methods, and how their participation helped to fulfill users? roles for exploration, experiments, test, and innovation. We also took a closer look at technological options addressed via included studies and in particular discussed how technologies interact with users in the innovation process.

Keywords. Innovation; Technology; Systematic Review; Health Care; Child Care; Care for the Elderly.

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1 Introduction

For decades, public health and social care in most industrialized societies have encountered significant challenges in delivering better and high-quality services. Most countries, for example, experience substantial demographic changes and the resultant projected increase in need of eldercare combined with a concurrent decline in the number of professional careers (Couture et al., 2016; Huber et al., 2017). Also, health agencies today have to address the sophisticated threats, including morbidity and mortality associated with chronic, infectious and lifestyle diseases, in the context of flat or constrained funding and new and changing healthcare legislation (Lister et al., 2017; Tursunbayeva et al., 2017). Nevertheless, due to the high tax level, citizens urge to receive public services shaped for their needs and of the best quality (Granier and Kudo, 2016). At the same time, technologies open for new services that lead to social, political, economic, and legal transformation. Such transformation accelerates citizens' expectation on states in harnessing technology advances for value creation and social inclusion (Chan and Holosko, 2016; Keys, 2016; Huber et al., 2017).

Innovation is high on the agendas in most developed economies to meet undergoing challenges in public health and social care. In classic innovation theory, technology is an essential driver for innovation (Schumpeter, 1934). It has also been the same situation in the public sector where the introduction of technologies lead to the change in services (Marsan and Paré, 2013; Pang et al., 2014; Huber et al., 2017). However, the development of technologies in public domain conforms to an expert-driven and top-down process where users of those technologies, including service recipients and employees, are not actively involved (e.g., Hill and Shaw, 2011; Andersen and Jansen, 2012; Moen, 2012). This brought common problems such as dehumanized and undemocratic technical services and the loss of valuable views, resources, and knowledge from users in the innovation process (Hill and Shaw, 2011; Baker et al., 2014). Furthermore, due to the mass implication of new technologies, primarily increasingly digitized production/service process, citizens gradually grew their demand for a better and open system where they can be part of service design and delivery (Von Hippel, 2009; Sørensen and Torfing, 2012; Andersen, 2013). All these present issues make the public health and social care sector to further explore an innovative approach to work with different user groups, exchange their views and knowledge, and eventually facilitate the value co-creation process in service design and delivery (Chan and Holosko, 2016; Palumbo, 2016).

User-driven innovation (UDI), in this light, has been gaining attention over the years, especially in the welfare sector of Northern Europe (e.g., Pässilä et al., 2013; Hvenegaard Rasmussen, 2016; Puig-Pey et al., 2017). It refers to a process of "tapping users' knowledge" to develop new products, services, and concepts"(Von Hippel, 2009, p. 30). Users, instead of technologies, become the primary driver for innovation. UDI concerns both an understanding of users needs and a systematic involvement of users at different stages of the innovation process. Its strengths lie in the fact that both service recipients and professionals working in the public sector perform as crucial players in the provision of solutions for defined problems in the field. Those individuals thus will have better insight to innovate and spur development of precisely what they want (Andersen and Jansen, 2012; Wihlman et al., 2014; Scupola and Zanfei, 2016).

Since user knowledge is gradually seeing as a crucial source of innovation in the public sector,

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there is a rasing need to discuss questions such as what ultimate goals of UDI in public health and social care, how to support user participation in the innovation process, and how to gather accurate user knowledge in the practice for UDI. However, there has been relatively little research discussed those questions (Andersen, 2013; Kallio et al., 2013; Szymańska, 2017). Further, some previous studies in the public sector have argued that although users, instead of technologies, became the primary drive in UDI, we cannot neglect the fact that technology is still the force of all kinds of innovation in today's digitalized world. It can, for example, help gather, store and sort out user knowledge for innovation, supporting the institution access user knowledge and making the access cost inexpensive (Hill and Shaw, 2011; Barlott et al., 2016). However, even fewer studies investigated if technologies can facilitate UDI by providing easy and inexpensive access to user knowledge. To address current literature gap, we conducted a systematic review of existing international evidence related to UDI in public health and social care. Our study aims to support an in-depth understanding towards research topic by providing answers to following three essential questions:

1. What are distinct characteristics of UDI in public health and social care, in respect of its objective and process?
2. Who are users of public health and social care, and how different groups of users can be engaged in UDI process?
3. What roles of technologies play across UDI process, and what their relationship with users?

2 Theoretical Framework

Previous studies are valuable resources shaping a fundamental view towards the study topic. Some of these useful theoretical perspectives on innovation, UDI, the process of UDI, the role of users, and interaction between technology and user, are briefly presented in the following paragraphs.

2.1 Innovation

Early in 1934, Joseph Alois Schumpeter (1934) defined innovation as "combinations of resources" that drive the economic development substantially (p.66). Technology plays a significant role in innovation process - leading to the launch of a new product, method, market, sources, or industry structure (Joseph Alois Schumpeter, 1934). Over decades, Schumpeter's classic innovation theory has inspired practitioners and scholars to understand the meaning and the process of innovation in private and market-based sectors. Now innovation is often viewed as the new and improved application of the product, process, marketing and organizations (OECD 2005). Indicative of growing cross-sector exchange, the proliferation of innovation has been developed in public domain (Phills et al., 2008). However, it is also subject to varying definitions. In this article, we operate on the definition that innovation is the creation and implementation of new products, services, process, and methods, which helps to meet new requirements and unarticulated needs in public health and social care (Albury, 2005).

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2.2 User-driven Innovation

The user-driven approach is an interdisciplinary concept, which derived from fields such as architecture and design, IT and engineering, business management and social sciences. In architecture and design, for example, UDI refers as "systematic approach to develop new products and services, building on the investigation of adoption of users' life, identity, praxis, and needs" (Christiansson et al., 2008, p. 249). Shaped within multiple disciplines, in this article, we use Von Hippel's definition on UDI that mentioned in the Introduction. UDI is a process of drawing on users' knowledge" to develop innovation (Von Hippel, 2009). It often links with terms such as co-design (Dekelver et al., 2011; All et al., 2013; Habicht and Thallmaier, 2017) and co-production (Pestoff, 2012; Durose et al., 2017). UDI is open in character and focuses on identifying existing and potential users, systematic searching and understanding users' explicit and implicit needs, knowledge, and ideas, and intensive involving users in co-creation and innovation process (Tuomi, 2002; Wise and Høgenhaven, 2008; Von Hippel, 2009). Users in this definition include intermediate users (e.g., user organizations) and consumer users (individual end-users or user communities), who are distinguished from suppliers (e.g., producers or manufacturers) (Trott et al., 2013).

2.3 UDI Process and Users' Roles

The Innovation Wheel (Fig.1) is a model for UDI described by Wise and Høgenhaven (2008), which has been applied to describe an organization's innovation process and the involvement of users throughout the process (e.g., Røtnes and Staalesen, 2010; Pugh, 2014). As Fig.1 indicates, to launch a new UDI, the first crucial phase is to focus on what to produce, referred as WHAT periods, including stages of opportunity identification, data collection, pattern recognition, and concept ideas that meet users' needs. The second phase addresses how innovative ideas can be implemented, referred as HOW stages, including steps of conceptualization, prototype, test, and implementation.

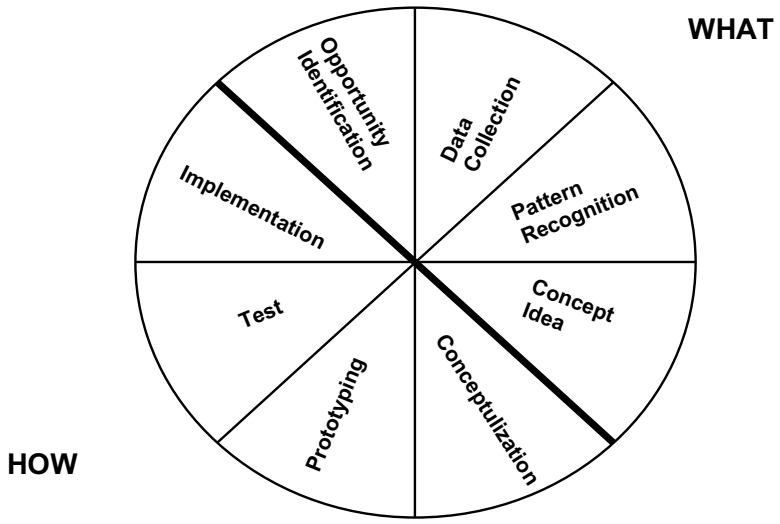

Fig. 1. The Innovation Wheel - cited from Wise and Høgenhaven (2008, p. 17)

To support The Innovation Wheel, Wise and Høgehaven (2008) outline another framework (Fig.2) which was modified in this study to help to understand the users' four different situations, namely observation, experiments, tests, and innovation, across WHAT and HOW phases in the innovation. These four categories suggest users' direct/indirect involvement in innovation steps, together with their various roles and responsibilities. Innovation teams often applied different methods and strategies to fulfill specific functions of user in particular innovation stages (Wise and Høgenhaven, 2008).

Above two models are beneficial to our review study especially in a situation where there is rare literature offers a systematic theoretical view to understanding UDI process and users' roles inside (e.g., Røtnes and Staalesen, 2010; Paiva et al., 2016; Szymańska, 2017). Both models are valuable frameworks developed through many scientific case studies upon UDI. Also, they have been continuously applied and further developed via other innovation practitioners and scholars who dedicate to identify new and better ways to facilitate UDI (e.g., Røtnes and Staalesen, 2010; Pugh, 2014). In this study, therefore, we use these two models as conceptual tools to help us extracting, categorizing, comparing and summarizing existing evidence regarding UDI process, users' roles, and methods applied to encourage user participation. It worth to note that these two models lack a particular focus on technologies that can be the force in supporting all kinds of innovation (Burgelman et al., 1996; Lundvall and Borrás, 2005) and the tool of helping tapping user knowledge (Bhatt, 2001; Wang et al., 2017). In next paragraphs, thus, we placed attention on previous studies that address the interaction between technology and users.

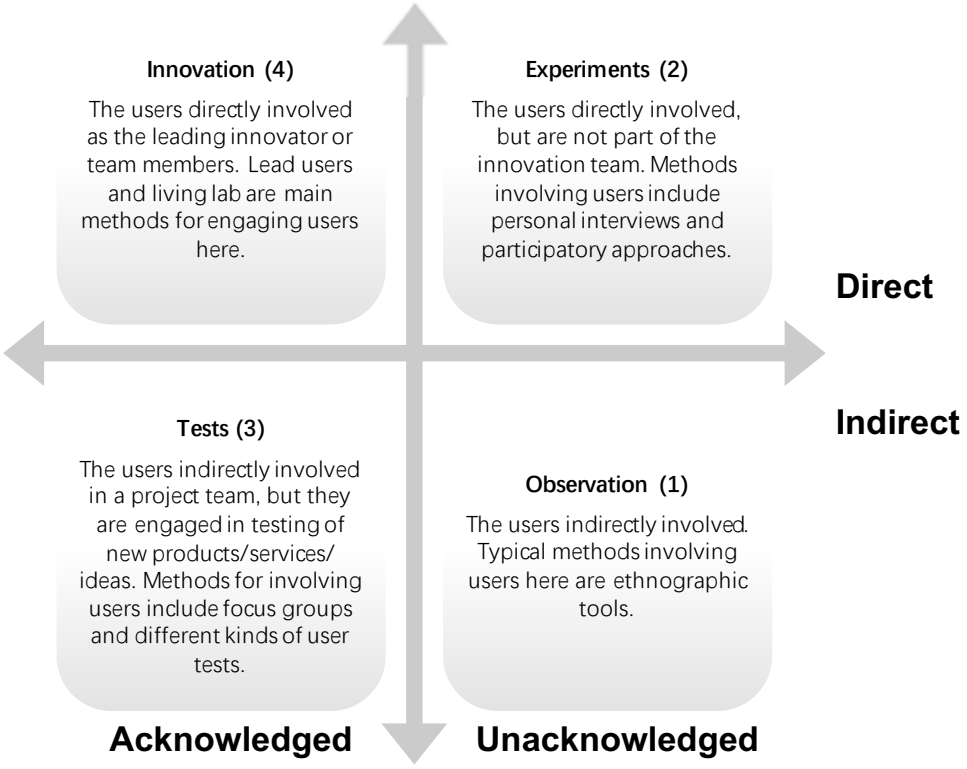

Fig. 2. Map of Users' Roles in Innovation Process - Adapted from Røtnes and Staalesen (2010)

2.4 Interaction between Technologies and Users

The need to create and deliver innovation at an ever-increasing rate is requiring organization today to apply a more deliberate and systematic approach to manage and utilize collective knowledge stemming from users (Jenny and Rod, 2002; Wang et al., 2017). In previous studies on technology and knowledge management, we found that efficient technology appliances can help users with the facilitation of knowledge creation and diffusion (Jenny and Rod, 2002; Marina, 2007; Wang et al., 2017). For example, information and communication technologies (ICTs), particularly social media, may accelerate the speed of knowledge transfer and creation by affording new types of behaviors that were not possible with the previous form of computer-mediated communication (Lewis et al., 2010; David et al., 2014; Hussain, 2017). Favorite technological tools such as employee competence databases, online search systems, expert networks, workflow software, decision support systems, data warehouse and so the forth, all can enable organization to gather, store, response, sort out and utilize user knowledge more efficiently and economically (Sher and Lee, 2004; Park et al., 2015).

While technologies are used for knowledge management, their adoption in practice sometimes meets resistance from users. Many existing studies focus on the interaction between human and technology, which aims to make technologies more usable and useful to provide people with experiences fitting their specific background knowledge and objectives. For example, technology acceptance theory identifies two main factors that affect users' acceptance of technological appliance, namely perceived usefulness and perceived ease of use (Davis, 1985). Also, there are some key determinants of perceived usefulness and usage intention constructs, which can be divided into two groups as social influence processes (e.g., subjective norm, voluntariness, and imagination) and cognitive instrumental processes (job relevance, output quality and result demonstrability)(Venkatesh and Davis, 2000).

From performance-based perspectives, on the other hand, the utility and usability of technical systems can be assessed by effectiveness, efficiency (Bevan, 1995) and user satisfaction (Dillon, 2002). More recently, increasing studies highlight that user emotion and intrinsic motivation, influenced by personal experience with technology, preferred working style, and the aesthetics of system design, can be more crucial for users to adopt a particular technological system (Venkatesh, 2000; Beaudry and Pinsonneault, 2010; Cohen, 2014). Further, from an engagement aspect, factors such as attributes of challenges, playfulness, endurability, aesthetic and sensory appeal, perceived user control, etc., might also influence people's interactive relationship or experience with the use of technologies (O'Brien and Toms, 2008; Kim et al., 2013).

3 Methodology

We used the systematic review as the method in this research. In this section, we elaborate on the research strategies that were used to select studies and the detailed review process across research stages.

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3.1 A Systematic Review

A systematic review of previous research can bring together the results of existing evidence and provide a reliable answer "how" and "why" of a particular phenomenon (Booth et al., 2016). This study used a systematic review as a methodology because this form of review differs from traditional narrative review by adopting a replicable, scientific and transparent process (Thomas and Harden, 2008). It helps us to minimize bias through exhaustive literature searches of both quantitative and qualitative studies and by offering an audit trail of the reviews decision, procedures, and conclusions (Tranfield et al., 2003). During the review, we followed Proffered Reporting Items for Systematic Review and Meta-analysis (PRISMA) guidelines developed by Moher et al. (2009). This guideline has been widely used in various systematic review studies related to public services across countries (e.g., Lopez-Hartmann et al., 2012; Seys et al., 2013; Elia et al., 2016). It helped us to ensure a transparent and replicable research process.

3.2 Search Strategies

This review searched two international electronic databases including ISI Web of Science and Scopus. To focus on very current studies, search centered in January 2013- December 2017 texts. Only articles published in peer-reviewed academic journals in English were included. The search strings we applied include "user-driven" OR "co-design" OR "co-production" AND "innovat*" in the title/abstract/keywords. With ISI Web of Science, we further refined results by choosing exiting categories including Health Care Sciences Services, Health Policy Services, Public Environmental Occupational Health, Social Sciences Interdisciplinary, Social Work, Sociology, and Rehabilitation. Similarly, for Scopus, we refined results by selecting categories such as Social Sciences, Medicine and Health Professions.

3.3 Sample Selection

The literature search was conducted from 1st to 12th March 2018. Initially, the database yield 197 hits based on our search keywords (45 from Web of Science and 152 from Scopus). Scopus included more studies in our case because it has a relatively less extensive category system that failed to help us further refine results as Web of Science did by narrowing down research subject areas. All outputs from both databases were exported in Endnote X8 software for reference management. We deleted manually 25 duplicates and led to 172 records for further reviewing.

To examine the most rigorous studies and to adequately address the research questions, we applied following inclusion and exclusion criteria. As these criteria suggest, we only want to select studies that are empirical, and directly addressed the concept of UDI by offering a precise definition of it. Since this research target exclusively on public health and social care, we want to particular include studies within public fields of healthcare, eldercare, childcare, community services, etc. Also, to answer research questions, we also need to select studies that have a clear description towards UDI objectives and process, together with roles of users and technologies in UDI.

Table 1. Inclusion and Exclusion Criteria

Inclusion Criteria	Exclusion Criteria
1) The empirical study directly addresses UDI in public health and social care, which may include fields of healthcare, community services, work welfare, eldercare, childcare, etc.; 2) It has a description towards innovation concept, process, and outcomes; 3) It has a precise categorization of users in innovation process; 4) It has a clear explanation towards the roles of technology in innovation process; 5) It is theory-guided.	1) The study is not empirical; 2) It is irrelevant to public health and social care; 3) It lacks detailed description towards innovation concepts, targets, and process; 4) It has no explanation towards the roles of users in innovation process; 5) It has no focus or lack of detailed information towards technologies; 6) Lack of full-text access to the article.

After screening by title, keywords, and abstracts, we deleted 105 studies since 77 studies are irrelevant to public health and social care while 28 hits are not empirical studies. Further, 67 studies went through a full-text assessment, and 46 were removed. In total 21 studies were selected for this review as they fully meet all inclusion criteria. Each study was then independently reviewed using our inclusion criteria by both authors, to ensure their election eligibility. The stage of selection is illustrated in Fig.4, using a PRISMA flow chart.

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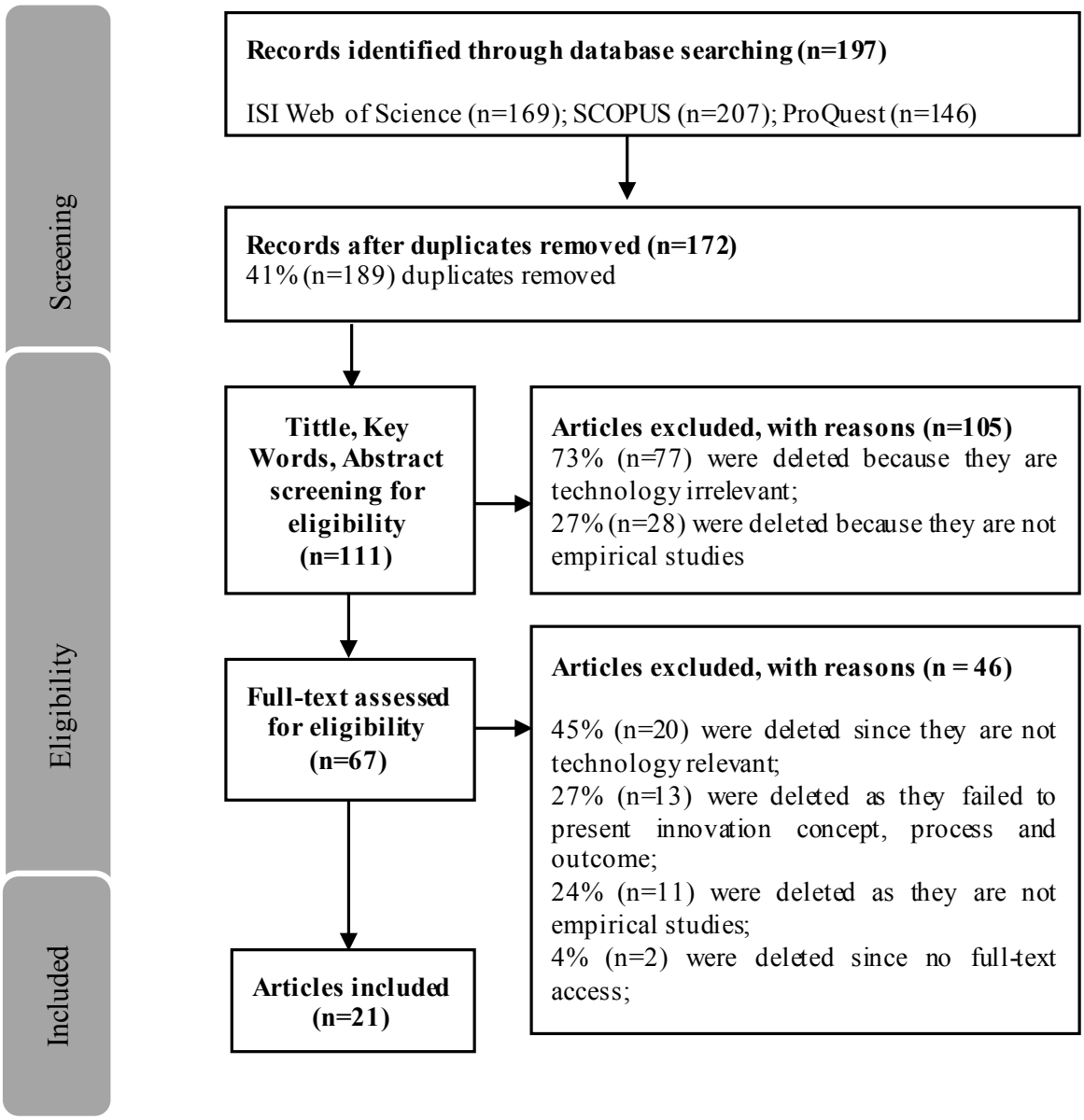

Fig. 3. PRISMA Flow Chart

3.4 Critical Appraisal of Study Quality

In order to ensure quality of included studies, we rated each study using the Critical Appraisal Skills Program (CASP, 2017) checklist (Appendix A), which was slightly modified by adding a "not clear" (1) option for each questions and to the standard "yes" (2) or "no" (0) . There are ten questions on CASP checklist, so the final score of a study can be between 0 and 20, where 20 was most applicable while 0 was least applicable. The first author assessed all the eligible studies, while the second author independently assessed a random sample to appraise inter-rater consistency and resolve any ambiguities.

3.5 Qualitative Synthesis

The systematic review helped us to collect and assess both qualitative and qualitative evidence related to the investigated topic. The qualitative synthesis was further used to interpret the meaning of the received data. The strength of qualitative synthesis is to provide in-depth focus and contextualized details towards phenomenon under the review (Bearman and Dawson, 2013).

We first extracted and coded information from all eligible studies with the support of a structured form. It contains the following items: the study's publication features; description of technologies applied; the categorization and description of users; the innovation objectives, process, and outcomes; research questions; theoretical frameworks; study methodology; and main findings and conclusion. Followed, with the support of theoretical underpinnings, we categorized and summarized the extracted information into key 'themes' to answer research questions.

4 Finding

4.1 Publication Characteristics

Table 2 reports the essential publication characteristics of selected studies (n=21). All eligible studies were published between January 2013 and December 2017. Data collection for those studies was undertaken during 2006 and 2016. The length of data collection period of selected studies was varied: seven studies less than two years (S1, 6, 7, 8, 17, 19, 21); while ten within two to five years (S2, 3, 5, 9, 10, 12, 14, 15, 16, 20). Also, there are four papers (S4, 11, 13, 18) did not specify the timeframe of their data collection. We observed that, on average, almost one or two years typically passes during the period of data collection and the publication of results, although research on innovation should, represent a rapidly changing landscape. It indicates that the conventional academic literature may be lagging behind as a source of relevant information on UDI in studied sectors.

Chosen articles targeted different areas in public health and social care: eleven in healthcare (S4, 5, 6, 7, 11, 12, 16, 17, 18, 19, 21), five in eldercare (S1, 2, 10, 13, 15), three related to community service or protection (S8, 9, 20), and two address childcare and service (S3, 14). Our review supports the current assumption - there is growing literature to discuss UDI in health- and eldercare, while such discussion in other social care sectors, such as community work and childcare remain less (e.g., Adedoyin, 2016; Szymańska, 2017).

Empirical materials from chosen studies were collected from 16 countries. There are 20 studies targeting high-income countries: thirteen from Western Europe (S1, 2, 3, 4, 5, 6, 8, 13, 15, 17, 18, 19, 21), seven from Scandinavia countries (S2, 3, 7, 9, 10, 14, 21), and two from Canada and USA (S12, 21). There is only one study addressing lower-middle-income state, India in particular (S16). No studies meeting our inclusion criteria took place in low-income countries, despite there being a high need for bottom-up technical innovation as the leading force in sustainable development and establishment of universal health and social services for citizens in those regions (UN, 2016).

Regarding the methodology of selected studies, only one adopted quantitative approach (S3) and one with mixed methods (S21). The rest of studies were qualitative, using mainly a single or multiple case study approach. In addition, there were four articles applied comparative studies across different countries (S2, 3, 13, 21). As we notice, a qualitative bias may prevail among studies regarding UDI in public health and social care sector. It might because qualitative have an in-depth and detailed focus on user-innovation processes including different actors (Konsti-Laakso, 2017).

According to CASP assessment, none of the qualifying studies received a maximum score of 20 on the quality evaluation scale, although all of them were ranked as being of good quality (scoring 14+) and 14 as high quality (scoring 16+).

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Table 2. Basic Publish Characteristics of Selected Studies

No.	Authors and Year	Study Topics	Related Sectors	Study Countries	Study Design	Journal Name	Data Collection Year	CASP Score
S1	Angelini et al., 2016	Co-develop products and services for the elderly	Eldercare	Switzerland	Qual.	Future Internet	2015	18
S2	Bugge et al., 2017	Co-design in assistive living	Eldercare	UK & Norway	Qual.	European Planning Studies	2014-2016	18
S3	Calvo-Lerma et al., 2017	Mobile appliance for childcare	Childcare	Spain, Germany, Italy, Norway, Belgium, Portugal & Netherland	Quant.	BMJ Open	2015-2017	14
S4	Cosma et al., 2016	Co-design game for cancer evaluation and education	Healthcare	UK	Qual.	Journal of Assistive Technologies	Unclear	16
S5	De Souza et al., 2017	Patient involvement in service design	Healthcare	UK	Qual.	Health Expectations	2014-2016	19
S6	Devlin et al., 2015	Digital healthcare	Healthcare	UK	Qual.	Research and Applications	2014	18
S7	Dithmer et al., 2016	A telerehabilitation game program for heart patients	Healthcare	Denmark	Qual.	Games for Health Journal	2015	18
S8	Gasco, 2017	Living labs in supporting citizens' participation	Community service	Spain	Qual.	Government Information Quarterly	2014	15
S9	Kallio et al., 2013	Co-innovation in public service	Community service	Finland	Qual.	The Innovation Journal	2010-2012	16
S10	Lehto, 2013	Assistive technology for aging at home	Eldercare	Finland	Qual.	Australasian Medical Journal	2006-2010	16

No.	Authors and Year	Study Topics	Related Sectors	Study Countries	Study Design	Journal Name	Data Collection Year	CASP Score
S11	Lindgren, 2013	End-user development of health record system	Healthcare	Sweden	Qual.	Studies in Health Technology and Informatics	Unclear	14
S12	Luck et al., 2015	User-driven design for cancer care	Healthcare	USA	Qual.	Journal of Oncology Practice	2009-2013	17
S13	Mort et al., 2013	Aging with telecare	Eldercare	UK, Spain, Netherlands & Norway	Qual.	Sociology of Health and Illness	Unclear	16
S14	Pihlainen et al., 2016	Co-development of technology for children with special needs	Childcare	Finland	Qual.	International Journal of Child-Computer Interaction	2009-2013	18
S15	Pratesi et al., 2013	Co-design of a smart monitoring system	Eldercare	UK	Qual.	Innovation Journal	2009-2011	18
S16	Purkayastha et al., 2015	Care-coordination	Healthcare	India	Qual.	Yearbook of Medical Informatics	2012-2014	16
S17	Rubinelli et al., 2013	Co-design of health websites	Healthcare	Switzerland	Qual.	Patient Education and Counseling	2013	15
S18	Savory and Fortune, 2016	Open technology innovation systems within a teaching hospital	Healthcare	UK	Qual.	Journal of Health Organization and Management	Unclear	15
S19	Sugarhood et al., 2014	Co-design of assistive technology	Healthcare	UK	Qual.	Disability and Rehabilitation: Assistive Technology	2012	18

No.	Authors and Year	Study Topics	Related Sectors	Study Countries	Study Design	Journal Name	Data Collection Year	CASP Score
S20	Southern et al., 2014	Co-designing prototypes with vulnerable communities	Community service	UK	Qual.	Technological Forecasting and Social Change	2009-2012	19
S21	Timmings et al., 2016	End-user driven approach to develop telecare	Healthcare	Canada, Sweden & Switzerland	Mix	BMC Medical Informatics and Decision Making	2014	18

4.2 The Distinct Characteristics of UDI in Public Health and Social Care

We identified the distinct characteristics of UDI in public health and social care by addressing two important elements of innovation: objectives and processes. Through comparing, summarizing and discussing those two elements among different UDI, we can, in general, understand where the UDI in public health and social care is going, how it distinguishes itself from other types of innovation in the studied sector, and what kinds of action and effort needed for goals achievement.

4.2.1 UDI objectives

Specific motivation for each UDI varied across projects and fields in public health and social care. However, in general, there are three common objectives of involving users to generate bottom-up innovation, including creating a user-centric service/product, to democratize service-designing process and support a partnership, and to empower service recipients. In details, among studies in healthcare, the most mentioned objective of UDI is to create a user-centric service, expressed in terms such as "tailoring service", "customized treatment", and "people-oriented" healthcare (S 5, 7, 11). This target is quite closely followed by another two objectives - changing the "culture of care" by bringing a relatively equal cohort between patients and care provider (S5, 17) and increasing services' effectiveness through better-addressing patients' needs (S7, 11, 17).

In eldercare, the principal purpose of involving different user groups in the innovation process is to develop user-centric, value-added service/products, and to support a partnership between the elderly and healthcare professionals (S1, 2, 10, 13, 15). By achieving those objectives, the innovation can further empower the elderly by enabling their "security" "independence" "mobility" "self-management" and "social interaction", which in general increase the elderly's quality of life, expressed in terms such as aging well and active aging (S1, 10, 13). Likewise, for childcare, the use of UDI is to create service that addresses children's particular needs and

eventually improve children's quality of life and potentials for development (S3, 14).

Within three studies related to community service, we found that empowering citizens (S8, 20) and supporting citizen engagement (S9) were primary reasons for adopting UDI. Additionally, developing the ailment among different stakeholders in the community for a better social, culture and economic return was also an essential aim (S8, 20).

4.2.2 UDI process

With the guide of the Innovation Wheel (Fig.1), we categorized UDI process in public health and social care into eight progressive stages: opportunity identification, data collection, pattern recognition (data analysis), concept ideas, conceptualization, prototypes, test, and implication. Not all included studies described this eight-step innovation process in detail, nor did an innovation go through those stages consecutively.

First, a UDI often starts with opportunity identification. Such step aims to identify an exciting field where organizations might have a chance to offer a better or improved service in the future. Illustrated in S7, the innovation opportunity and objectives were initiated collectively by Department for Health Science and Technology at Aalborg University and Vendsyssel Hospital, Denmark, who decided to develop a new application, "The Heart Game", to support heart patients' participation in rehabilitation activities. According to S7, only 13 percent of heart patients engage in rehabilitation activities in Denmark. The reasons for low participation are manifold, including long transportation times, lack of information about activities, emotional instability, lack of motivation among the patients, and the time of day due to patients having a job. To better address existing problems, relevant organizations decided to apply UDI to develop a more individualized rehabilitation program (Dithmer et al., 2016).

After identifying the innovation direction, steps of data collection and analysis (pattern recognition) have to be taken to generate a better understanding towards targeted users' demands. Data collection and pattern recognition usually happen consecutively, and they are two essential stages across UDI since all included studies have addressed them particularly. Different approaches usually applied to ensure the richness and quality of collected data. S15, for instance, demonstrated a UDI project that used older people as co-innovators in the design, development, and implementation of an intelligent activity monitoring system. Abundant data were collected through multiple methods including in-depth interviews, telephone interviews, focus groups, and workshops. This led to an intensive analysis of older people's technological, psychological and social needs and preferences, as well as their requirements for an activity monitoring system for use in homes and residential care setting (Pratesi et al., 2013).

As the outcome of pattern recognition, organizations or innovation teams usually can better present innovation concepts in detail and evaluate the possible solution regarding how well they can be adapted to users' requirements. The Innovation Wheel (Fig. 1) recognize these as two stages, concept idea and conceptualization, which were perceived as difficult to separate from each other in our included papers. The UDI project in S11, for example, concept ideas and conceptualization were completed together with the participation of 176 elderly and 105 experts in the selected municipality. The outcome of conceptualization led to defining six important themes for further developing interactive programs for eldercare. Likewise, S14 presented a UDI

program that supports parental co-development of technology for children with special needs. This project included nine parents, eleven children, three researchers, and four student teaching assistants in data collection when 79 ideas related to technology development were generated. After pattern recognition, five themes related to created concepts were identified and presented to fuel the further growth of technologies.

In the prototype stage, the first concrete example of a new product/service/idea is created. This stage was emphasized via all qualifying studies as it helps to visualize the original idea and improve the innovative concepts. Prototypes addressed via qualifying studies are most physical products or models, as the Cancer Evaluation and Education game presented by S4, new home-based telecare solutions in S13, and an ICT-based decision support tool in S20. Few articles presented non-physical prototypes, as the form of descriptions or experiments. S17, for example, discussed how an interactive health customer website could facilitate user-driven self-care solution. The prototypes, as a description of the new solution, were pitched from different online scenarios at this site. Such user-generated solutions were further discussed and expanded by various other end-user groups (Rubinelli et al., 2013).

Followed by the prototype, the next stage of UDI is testing. Not all studies (e.g., S5, 6, 9, 11, 14, 17, 20) have detailed information towards this stage although it is crucial to provide an opportunity for users to react and further provide input, and for the further adjustment to the innovation. Presented via S2, a Norwegian UDI conducted its testing via involving 31 municipalities (out of 426 nationally) to generate feedback and further help for the improvement of methodologies and practical tools and service models (Bugge et al., 2017). It is important to mention that the innovation process is not never linear, and often there are loops in which the project circled. In S2's scenario, the new problems or needs from users were addressed after the test, which created a deep collaborated loop within prototype and test.

In the final stage of implementing, new products or services are launched in the market, or the new concepts are adopted. In S12, an innovative product, the Lung Cancer Care Toolkit, was launched nationwide after the one-year development process. During the implementation, a social marketing approach was applied to accelerate dissemination to target end-users (Luck et al., 2015). There is often another loop between implementation and test, where the innovation process may jump back and forth. As S15 stated, during the first year of implementation the new monitoring system for the elderly care, the advisory user group continually reported their feedback towards the system and helped the technical team to improve how the system affects the everyday lives of end-users in different settings (Pratesi et al., 2013).

4.3 Categorization of Users and Their Roles in UDI

Guided by previous literature, we categorized user groups in public health and social care into two main types: end- and intermediate users (Von Hippel, 2009; Szkuta et al., 2014). End-users referred to those who use innovation directly (Von Hippel, 2009). In our selected studies, they are groups of health and social care recipients (e.g., citizens, the elderly, patients, as well as children and their families); health and social care professionals (e.g., clinicians, nurses, social workers, researchers, and others); and relevant organizations' administrators. Intermediate users referred to users' organizations (Bogers et al., 2010). They included public bodies (e.g., health authority

and institutions, municipalities, research agencies, and universities); private sectors; and NGOs. All selected studies have presented both end- and intermediate users in their innovation. However, recipients and professionals of health and social care are two primary end-user groups while public organizations are dominated intermediate users in our reviewed studies. Also, both end- and intermediate users were involved intensively in eight innovation processes. However, in the first stage of the process, opportunity identification, intermediate users play the central role in identifying an innovation direction. In stages of concept ideas, conceptualization, or prototype, there are some cases (e.g., S7, 11, 17) that only involved the participation of technical developers; users were excluded. In the project of S7, for example, application designers analyzed alone the qualitative data from interviews with end-users and developed an initial architecture of prototype for addressing identified needs.

With applying the framework for Mapping of Users' roles (Fig.2), we grouped different end-users' activities and responsibilities across UDI into four generic categories: exploration, experiments, tests, and innovation. Different groups of end-users may be involved in different stages of UDI and play various roles in the innovation process. At the early stage of UDI, especially in data collection, some end-users can play an indirect role in contributing knowledge towards their unacknowledged needs (exploration). In this scenario, the innovation team often apply a range of ethnographic methods, such as shadowing, participation observation, focus group, workshops, personal interviews, and user dairies, to obtain information and perspectives towards users' unacknowledged needs (e.g., S1, 7, 13, 14, 17, 21). In S1' UDI, for instance, three ethnographic methods were adopted including shadowing technique, focus group, and world café. The shadowing technique allowed discovering the latent needs of the users (the elderly), by following them during their daily activities and doing observations. Focus group was a method to debate about open topics, such as nutrition, mobility, and interpersonal communication; it also helped to investigate the users' perception of existing technological options. The World Café was a gathering that involved the users in discussing prepared topics, such as the most valuable elements that relevant to the older adults' health aging and the innovative ways to obtain them (Angelini et al., 2016).

In many cases, end-users can also directly involved in innovation process together with the project team (experiments) throughout the WHAT phase of UDI; however, they act as participator rather innovators. Those individuals' direct participation aims to help innovation team to fully understand their unexpressed requirement through a range of participatory approaches, such as co-design workshops and participatory research/design (e.g., S6, 8, 9, 11, 14, 15, 16). In S15's program, end-users (old adults) have been invited as co-designers who has a partnership with technical designers. The co-designers' role is both to advise the technical team about the research methods, and to participate in collaborative design workshops where their input and ideas will assist to "design" assistive technologies for themselves (Pratesi et al., 2013).

When coming to the WHEN phase of UDI, end-users are mostly involved in testing step. Common methods applied to involving end-users in testing include interview, focus group, questionnaires, clinical trial, usability testing, and user acceptance test (e.g., S2, 3, 4, 12, 14, 16, 19, 20, 12). Usability testing is a most common technique used in UDI to evaluate a prototype by testing it on users. It is a crucial usability practice because it offers direct input from real users who use the system (Bugge et al., 2017). Usability testing focuses on measuring a human-made product's

capacity to meet its intended purpose. In contrast with other inspection methods where experts adopt different tools to evaluate a user interface, usability testing empowers users to modify and improve new product/service/concepts to ensure a successful diffusion in the future (Devlin et al., 2016; Timmings et al., 2016).

There are some UDI programs addressed via selected articles involved particular groups of the end-users as co-innovator who have specific control over whole innovation process. Those users can be part of expert teams, who are highly qualified in their area of expertise and possess specific knowledge that will contribute most to the innovation. The lead-user method, such as seminars, workshops and dialogue conferences, is most often applied to support the involvement of this group of users in UDI (e.g., S2, 8, 9, 12, 17, 18). Beside of experts, advanced end-users can also be co-innovator in UDI. They refer to those who often stay enthusiasm when it comes to specific products/service/concepts, and they are more knowledgeable than the average users. The living lab is an emerging approach used to support advanced users as co-innovator into UDI process (e.g., S1, 8). It offers a real-life setting and platform for learning and experimenting, facilitates the management of innovation process, and actively encourage continuous and meaningful interaction among user groups (Angelini et al., 2016).

4.4 Technologies' Roles with Users in UDI

All selected studies have a particular focus on the technology-use in UDI. However, the purpose of these technological appliances varied across different sector and projects. On the one side, many studies focus on how to adopt a user-driven approach to develop new technologies. In eldercare, for example, a dominative discussion was draw upon the engagement of the elderly into co-development of assistive technologies, such as monitoring, electronic sensors, and computer-based cognitive stimulation, which are likely to make significant contribution to the care of end-users in institutions and at home (e.g., S2, 10, 13, 15, 19). By involving end-users into co-production, those new assistive technologies can better meet individuals' special requirements on safety, security, mobility, and social contact. In healthcare, likewise, many studies examine the use of co-design approach for developing new health technologies, such as clinical information system and ICT-enhanced treatment, to fulfill end-users' ever-changing demands (S5, 7, 11, 16, 18).

On the other side, some studies locate their attention on the issue how to use different technological options to facilitate UDI (S4, 8, 14, 16, 17, 20). According to those studies, ICTs, such as the internet (user websites), social media, and mobile applications, are most popular options to support UDI. Those tools can help with reaching out new users, encouraging their participation and communication, and empowering individuals in knowledge contribution for self-care, rehabilitation, or other social, cultural and economic development.

Users' relationship with technology is heterogeneous, depending on characteristics of user groups, type and features of technology, and many other tech-social factors. Therefore, at the initial stages of UDI, users' technology acceptance, preference and expectation are often examined (S1, 2, 3, 5, 8, 10, 12, 14, 19). As selected studies argue, the perceived usefulness of technologies is not enough to make such technical options acceptable. However, personal experience with technologies (familiarity) can greatly decide users' preference and acceptance (S1, 3, 5, 7, 12). In

both projects of S3 and S5, the choice of the technical solution was made by collective decision among different user groups. Through workshops and meetings, users considered mobile technology serve as a most appropriate platform for support designed health service. Such platform leads to a reduction in traveling and operation cost. More importantly, it already owns large scale of installed base - most end-users have familiar with such technology and use it in daily life. This user-friendly, familiar mobile phone network can offer a technical platform making it easier for the users to participate in the innovation development and implementation (Calvo-Lerma et al., 2017; de Souza et al., 2017).

Further, if the innovation team wants to reduce impact of familiarity on users' adoption towards technology, it should consider applying invisible technological options (technologies that are transparent to the users' eyes) or options that easy to learn and operate reduce users' fear of novel solution (Pratesi et al., 2013; Angelini et al., 2016; Dithmer et al., 2016). Few studies also argued that some intrinsic motivation, such as playfulness, pecuniary interests, as well as aesthetic and sensory appeal, could also attract users to participate in the innovation process. In this sense, a widely adopted technology in the society that encourages that intrinsic motivation may be a promising way to support user engagement (S4, 7, 8, 12, 17). By using user websites and social media, S17 demonstrated how creating an online entertainment environment can facilitate user engagement, interaction, and knowledge sharing and learning (Rubinelli et al., 2013). Similarly, in the S7 project, mobile technology and gamification work tother as useful tools to motivate end-users in rehabilitation. Digital games apparently offer a promise for stimulating and entrainment, while mobile platform creates a connection between players and offer the chance for social and dynamic experience while also allowing these individuals to access the game independent of time and place (Dithmer et al., 2016).

No double, in some cases, the groups of end-users might not be cognizant of or automatic users of much of the more basic technologies that are fundamental for innovation. Therefore, suggested via included papers (S2, 8, 18), involving those people directly as a participator in WHAT phase of UDI are crucial. Such direct participation helps to explore appropriate technological options and methodologies to users; simultaneously; it can empower end-users by enhancing their technical knowledge and innovation competencies (Bugge et al., 2017; Gasco, 2017). In another word, UDI in health and social care with a technology end goal must apply deliberate methods for experiencing the potentiality of technologies for more significant innovation by co-designers themselves to made possible (Savory and Fortune, 2015).

5 Discussion

The most distinct characteristic of UDI in public health and social care is to involve wide ranges of the end- and intermediate users into both WHAT and HOW innovation stages to meet specific goals in the fields. Unlike the private sectors where the concept of UDI was often discussed within the last decade, UDI in the public sector is still a emerging theme which has been brought into focus very recently (Andersen and Jansen, 2012; Lassen et al., 2015; Dithmer et al., 2016; Hennala and Melkas, 2016). In general, UDI in public and private sectors pursue very different objectives. Where the private companies usually apply user-driven approaches to create value-added products/services for maximizing the profit and enhance the competitive position in the

market, the public institutions are engaged in UDI aiming at increased welfare and democracy (Waugh et al., 2013; Savory and Fortune, 2015; Paiva et al., 2016; Bugge et al., 2017). Also, the health and social care sector may different from other public sectors, with regard to a wider range of user groups with different interests and a more complex dimensions of user involvement (Rubinelli et al., 2013; Bugge et al., 2017; Gasco, 2017; Pihlainen et al., 2017).

Generally speaking, all included studies demonstrate a strong believe that UDI in public health and social care is far more sustainable than innovations generated by a single institution. By focusing on the end-users, health and care recipients and professionals, UDI first unfolds welfare principles, such as empowerment and client self-determination (Humphreys, 2015; Lassen et al., 2015; Angelini et al., 2016); it also facilitates changes of culture of care, and organizational structure where top-down innovation process was dominate (Sugarhood et al., 2014; Wihlman et al., 2014; Luckock et al., 2017; Valaitis et al., 2017). Through involving different intermediate users, UDI brings closer cooperation among different health and social care stakeholders and facilitate the change of existing system for a better solution to addressed revealed challenges (Lindgren, 2013; Purkayastha et al., 2015; Savory and Fortune, 2015; Bugge et al., 2017). However, despite benefits of UDI, many user-driven projects presented via include articles encountered challenges during the operation, and the management of which was not always successful. We will further explain this in the following two section.

5.1 Challenges of Continuous and Adequate Engaging Users

Our findings indeed suggest that end-users can play various roles across UDI process, and there are comment methods available to apply to support user participation. However, we also noticed that challenge exist concerns the need for the continuous and adequate engagement of different groups of end-users in public health and social care. Many UDI projects in our review only involved end-users in specific innovation steps, and there is still rare case that users are seen as co-innovators from beginning to the end and take significant control of whole innovation process. Moreover, several dominative barriers can hinder user participation in UDI: namely differences in willing of involvement, inefficient communication, and constrained resource.

We know that the willingness to innovate and learning are crucial to stimulate individuals to innovate (e.g., Savory and Fortune, 2015; Bugge et al., 2017). However, at beginning of many UDI projects, it is often to have some end-users were not necessarily enthusiastic, not with the same level of intensity at least, to involve the innovation process, and to learn and share relevant knowledge or experience (Pratesi et al., 2013; Pihlainen et al., 2017). To address such situation, early relationship-building with the members of innovation team beyond the innovation context may be necessary for identifying most enthusiastic participators, and cultivating a genuine partnership based on understanding, respect, and trust (Pratesi et al., 2013). Also, a more creative, flexible and interactive work approach needs to be adopted during the innovation process, and the presentation of complex information should be easy to understand. It might be beneficial to emphasizing the importance of participation as a democratic form of inquiry and grounding the outputs in the experiential aspects of users themselves (Pihlainen et al., 2017). Above two solutions, however, are time-consuming which might not be realist within a planned UDI within the constrained timeframe.

When there are many end-user groups involved in UDI process, inefficient communication between different parties can quickly rise because of diversity in individuals' interests, knowledge background, and purposes of participation (Purkayastha et al., 2015; Gasco, 2017). Ensuring that channels of communication are opened up and transparent across all partners, therefore, is essential to avoid significant conflicts and misunderstanding (Gasco, 2017). Further, reducing geographical distance could be promising in supporting the open discussion on the innovation progress and share ideas in real time (Purkayastha et al., 2015). Also, exploring new and interdisciplinary methodological tools to address communication issues is necessary (Savory and Fortune, 2015).

Finally, facing constrained innovation resource might be the most critical challenging of UDI. Budget and time constraints all limit the number of users can be engaged and the degree of their participation (Pratesi et al., 2013; Sugarhood et al., 2014; Angelini et al., 2016). In addition, further efficiently tailoring user-driven solution requires sustained assessment, support, and review over a period. However, in reality, lack of a financial and human resource often leave this continued work unclear (Sugarhood et al., 2014). Argued via Timmings et al., (2016), given the complexity of UDI, preparatory work to avoid costly implementation errors should be considered including assessing barriers and facilitators to change, developing a detailed budget plan, and assessing and establishing organizational readiness for change. Resources should be adequately assessed and evaluated from the outset and built into the development of the innovation proposal. During the UDI process, it is also vital to assess resource in real time to relocate resource if challenges arise (Pratesi et al., 2013).

5.2 Challenges of Creating Synergy between Users and Technologies

Included studies suggested that users' relationship with technology in UDI, is heterogeneous, depending on users' characteristics, the types and features of technology, and availability of technology facilitator. Technologies can be the outcome of a UDI process or a supportive tool for innovation. No matter of which is the case, users' perception towards specific technological options more or less affect their motivation, the kind of, and the degree of participation in UDI process. Such finding rises our concern about the issue upon how to create synergy between users and technologies across UDI process. Firstly, although it is essential that user insights and knowledge generated find their way into the development process, it is still challenging to adequate translation and transformation of users information and requirements into more technical requirements (and vice versa)(Joseph et al., 2010; Durose et al., 2017).

For example, when health professionals need to translate their medical knowledge into formal computer-interpretable formats, they might face the challenge of switching their role from clinician to a knowledge engineer, because such process requires learning the relevant tools, in addition to time resources. Further, the laws and regulations in health and social care often restrict the members of the care providing organizations in how they can use information and system (Lindgren, 2013). Some selected studies suggest using deliberate methods to support experiencing the potentiality of technologies by participated end-users for knowledge translation and transformation. For instance, through the live lab approach, end-users were free to experience different technical systems in a real-life setting, and they eventually turned to knowledge engineer who

can develop new ideas via the support of technologies they have tried (Gasco, 2017). Likewise, by inviting end-users to join different technology clubs where workshops, seminars, and product presentations were frequently organized across a period, those people were encouraged to try the different technological options, to learn relevant knowledge, and eventually they could contribute their ideas for further technology improvement (Pihlainen et al., 2017).

Although above studies to some extent presented and discussed methodologies for creating synergy between users and technologies in UDI process, there are still problems remain. First, those methods are primarily on certain technologies and new applications, instead on the way users interact with different access network in their natural context. In addition, we lack enough evidence to see if those methods in UDI can fulfill the promoting objectives of projects and further lead to radical and sustainable innovation in public health and social care. As we can see, indeed, the living lab approach, interactive workshops and other methods, might support knowledge transfer and empower end-users to innovate. However, there is no study conclude those methods are better than other methods or innovation system in leading a better innovation outcome and more sustainable impact.

6 Conclusion

In summary, through a systematic review of existing evidence, we illustrated how current UDI in public health and social sectors operates with distinct characteristics in respect of its strategic innovation process and user-oriented, empower-based objectives. Both end- and intermediate users in directly and indirectly engage in different innovation stages and fulfill their roles for exploration, experiments, test and innovation. Exploring users with ethnographic tools and participatory methodologies are very popular at WHAT stages to in-depth understand what problem user face and therefore what solution can be offered. During HOW phases, however, living lab and lead users approaches often operate to encourage users as innovator or co-innovator for the innovation conceptualization and prototype, while various user testing tools are available for helping users to experience and evaluate designed prototypes. However, users as completely innovators seem less popular than users as co-innovators who only contributed partially to innovation teams. It may because the former is a relatively new field regarding its application in innovation processes and organizations in public health and social still face challenging to learn how to achieve the best results when the users have the most powers in the innovation process.

6.1 Further Implementation

With an understanding of how diverse the role of users is, it is likely that users will participate in UDI in many different ways. However, in some cases in practice, there is still a discrepancy between theory and practice. We discussed two crucial challenges among UDI in public health and social care: the need for continuous engagement with users cross each step of the innovation process, and the demand for creating mechanisms to integrate users and technologies to support a better innovation outcome. For addressing those challenges, we have to continuously explore and test new interdisciplinary methodologies or tools to support user participation in a natu-

ral setting, to encourage a smooth interaction and communication, and to balance the power relationship between human and technologies. Further, we have to continuously and critically evaluate UDI outcome in respect of their promising objectives with a large scale of research evidence. By focusing on how UDI took place in public health and social care is not enough; we need to further systematically evaluate if UDI can achieve better results than other innovation types, can help to solve the confronted challenges in the field, and eventually change organizational culture towards innovation or the innovation system in policy network.

6.2 Limitation and Further Research

Since UDI is a somewhat new concept in public health and social care, which leads to this article become one of the first systematic reviews on this topic in which has a limited number of empirical evidence available. It decides the nature of this review to be more explorative and be descriptive in general and lack of an in-depth critical reflection due to constrained materials. Further, although we developed a research protocol in advance and used PRISMAS to guide the whole review process, there might be still bias in the selection of publications included and inaccuracy in data extraction. If we want to fully understand of UDI in the public health and social care, it is necessary to develop a theoretical and methodological framework, which is based on the concept of innovation but re-defined in a way that takes into account that the public health and social care is operating on other conditions than private companies. At the same time, the framework must take into account that users of present public services are a variety of different actors, who play different roles and participate in the process of innovation in very different ways. Also, more evidence needed to conduct a proper evaluation of the effect of UDI in the studied sector, as well as an assessment towards various methods applied to support user participation.

7 Reference

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Appendix A: Quality Assessment Criteria

This assessment is developed based on the methodology quality assessment criteria (CASP, 2017)

Category (Questions)	**Considerations**	**Yes**	**Not clear**	**No**
Is there a clear statement of the aims of the research?	What is the goal of the research? Why it is thought important? Its relevance.	S1-21		
Is a research methodology approriate?	If the research seeks to interpret or illuminate the action and/or subjective experiences of research participants? Is the right methodology for addressing the research goal?	S1-21		
Is the research design approriate to address the aims of the research?	If the researcher has justified the research design?	S1-21		
Is the recruitment strategy approriate to the aims of the research?	If the researcher has explained how the participants were selected? If they explained why the participants they selected were the most appropriate to provide access to the type of knowledge sought by the study? If there are any discussions around recruitment (e.g. why some people chose not to take part)?	S1-21		

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Category (Questions)	Considerations	Yes	Not clear	No
Is the data collected in a way that addressed the research issue?	If the setting for data collection was justified? If it is clear how data were collected (e.g. focus group, semi-structured interview etc.)? If the researcher has justified the methods chosen? If the researcher has made the methods explicit (e.g. for interview method, is there an indication of how interviews were conducted, or did they use a topic guide)? If methods were modified during the study. If so, has the researcher explained how and why? If the form of data is clear (e.g. tape recordings, video material, notes etc) If the researcher has discussed saturation of data?	S1,2, 4-10, 12-15, 18-21	S3, 11, 17	
Has the relationship between researcher and participants been adequately considered?	If the researcher critically examined their own role, potential bias and influence during (a) Formulation of the research questions (b) Data collection, including sample recruitment and choice of location? How the researcher responded to events during the study and whether they considered the implications of any changes in the research design.	S1, 2, 6, 7, 11, 12, 14, 15, 21	S5, 20	S3, 4, 7, 8, 9, 10, 13, 16, 17, 18, 19
Have ethical issues been taken into consideration?	If there are sufficient details of how the research was explained to participants for the reader to assess whether ethical standards were maintained? If the researcher has discussed issues raised by the study (e.g. issues around informed consent or confidentiality or how they have handled the effects of the study on the participants during and after the study)? If approval has been sought from the ethics committee?	S5, 7, 11, 12, 20, 21	S1, 2, 6, 14, 15	S3, 4, 8, 9, 10, 13, 16, 17, 18, 19

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Category (Questions)	Considerations	Yes	Not clear	No
Is the data analysis sufficiently rigorous	If there is an in-depth description of the analysis process? If thematic analysis is used. If so, is it clear how the categories/themes were derived from the data? Whether the researcher explains how the data presented were selected from the original sample to demonstrate the analysis process? If sufficient data are presented to support the findings? To what extent contradictory data are taken into account? Whether the researcher critically examined their own role, potential bias and influence during analysis and selection of data for presentation?	S1-21	S3, 8, 11, 18	
Is there is a clear statement of findings?	If the findings are explicit? If there is adequate discussion of the evidence both for and against the researchers arguments? If the research has discussed the credibility of their findings? If the findings are discussed in relation to the original research question	S1-21		
How valuable is the research?	If the researcher discusses the contribution, the study makes to existing knowledge or understanding? If they identify new areas, where research is necessary? If the researchers have discussed whether or how the findings can be transferred to other populations or considered other ways the research may be used?	S1-21		

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