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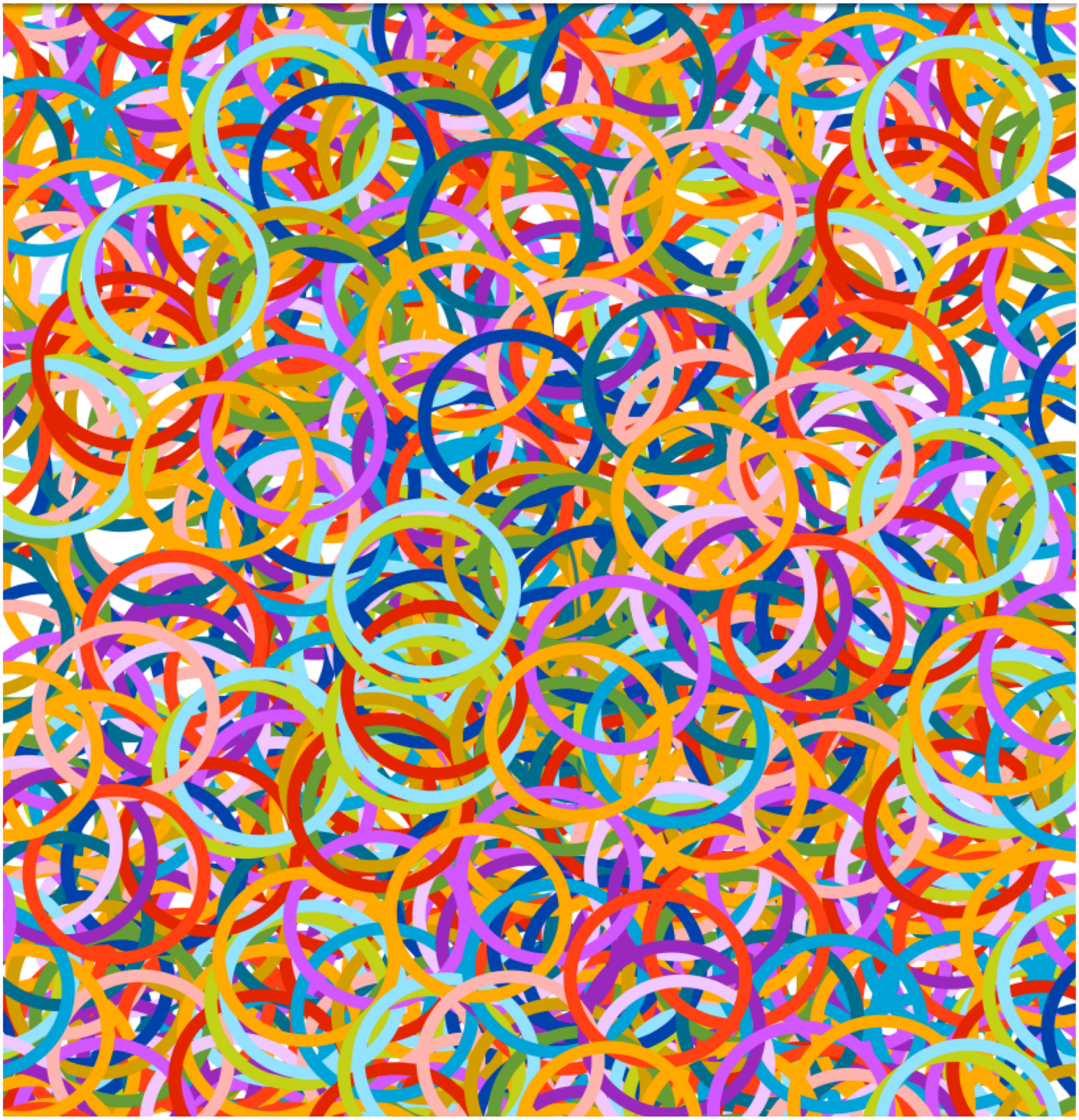

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Towards the science of managing for innovation: conclusion & future research directions

Anne-Laure Mention
anne-laure.mention@rmit.edu.au | RMIT University, Australia
João José Pinto Ferreira
jjpf@fe.up.pt | INESC Technology and Science, Faculty of Engineering, University of Porto, Portugal
Marko Torkkeli
marko.torkkeli@lut.fi | Lappeenranta University of Technology, Finland

We initiated this series with a view to catalyse and extend the focus on conceptualisation and application of behavioural science methods for managing innovation, albeit from a whole human perspective. We started with the notion that *how to increase individual (human) creativity, collaboration productivity and innovativeness in innovation projects* is a common concern for most firms. After discussions on the brain-mind-behaviour triad in the beginning, the interim editorial highlighted behavioural experiments as one plausible method to further the science of managing for innovation. In this final piece on the series, we conclude with a caveat on using experimental methods in examining the human side of innovation (Salampasis and Mention 2017) and discuss avenues for future research in innovation management, which increasingly reflects a collaborative affair (Bogers et al., 2017; Heil and Bornemann 2018).

In the previous editorial, we emphasised the role of behavioural experiments in innovation research, motivated by (and designed to address) questions on human behaviour and performance. Innovation research and practice is naturally based on experimentation, be influenced by reflection of past experiences, judgements in current social context or desired future. The primary object of behavioural experiments is to observe the effects on behaviour and performance of participants in purposively developed behavioural task whilst being subjected to (or controlled from) a treatment condition. They are distinct from neo-classical (game-theoretic) economic experiments in that they explain the behaviour in a treatment condition, as compared to relying on economic assumptions of expected utility principle. The underlying assumption being that humans are intentional, goal-oriented and actively seek meaning, self-worth and creativity. They are also consciously aware (and aware of being aware) that their actions have future consequences (known and unknown). Besides, the humanistic perspective suggests that future lies in the 'eye of the beholder'. That is the individual's socio-cognitive ability to imagine future consequences of actions is what ultimately shapes the formulation of new possibilities for R&D management

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(Botha 2016). A key feature of behavioural experiments is that they can accommodate complex variables and contexts and thus allow for integrated abstraction of individual's socio-cognitive capabilities to inform wider innovation procedures in practice. Thus, to examine the effects of underlying psychological variables on behaviour and performance in an otherwise complex social phenomenon of increasingly open and collaborative innovation (Brunswicker & Chesbrough 2018), it is deemed appropriate to rely on experimental psychology techniques. However, this means that the very setting aimed at deeper understanding of cause and effects, may be contaminated by confounding variables as participants may be asked to receive information, communicate and act in unusual ways, possibly reflecting role-playing or theatrical interactions (see Stokoe, 2014). Indeed, quantitative researchers are under heated debate on the efficacy of the published results from experiments, many of which have failed the replicability tests (Pashler & Harris, 2012; Pashler & Wagenmakers, 2012). The concern is so strong that it prompted Nobel laureate Daniel Kahneman to write a letter to the journal Nature as he saw a "train wreck looming" and urging researchers to "collectively do something about this mess"[1]. A plausible explanation for the failed reproducibility of experimental findings may rest in the theoretical and contextual gaps needing explanations far-fetched from theoretical assumptions (Harding, 2012). The stretching of the truth when coupled with the null hypothesis significance testing (NHST) preference at 5% threshold for rejecting null hypothesis, provides the perfect breeding ground for folk theories (Johnson, 2013; Wagenmakers, 2007; Wagenmakers et al., 2011). Perhaps, a behavioural experiment aimed at understanding the socio-cognitive capabilities and behaviour of individuals is not complete without some study of the interactions during the innovation process.

It is our view that in advancing the science of managing for innovation, experimental researchers need to consider complementing experimental findings with another commonly implemented technique in studying human behaviour and social interactions – conversation analysis (CA). The value of CA rests in reliance on naturalistic data, and can unveil the convergent and divergent explanations of causal inferences of an otherwise complex phenomenon. Integrating CA in behavioural experiments can allow for limiting the explanations based on mock behaviour (Kuhlen and Brennan 2013). It could enrich the experimental findings by providing an avenue to 'stay conceptually closer to our actual social behavior "in the wild"' (Ruiter & Albert, 2017, p.97). Further, the rationale for incorporating CA in the experimental settings is based on the studies by Healey et al. (Healey, Howes, & Purver, 2010; Healey, Purver, & Howes, 2014) which refuted the highly cited laboratory findings of Branigan, Pickering and Cleland (2000), that people copy the verbal statements or words spoken by another during a dialogue more often than by chance. Indeed, it may not be prudent to believe that experimental findings would reveal effects same as those found in natural settings (Doob and Gross 1968, Shaughnessy, Zechmeister & Zechmeister, 2015).

Throughout the series, we have focused at the intersection of behavioural science and human aspects of innovation management. We conclude that the approach of integrating interdisciplinary perspectives to study behaviour and performance in innovation management research reflects similar initiatives in neighbouring fields. For instance, behavioural strategy scholars have started to incorporate theoretical and methodological developments in social and cognitive psychology to

[1] Kahneman's letter can be found at:
https://www.nature.com/polopoly_fs/7.6716.1349271308!/suppinfoFile/Kahneman%20Letter.pdf

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extend theories of social influence and intergroup cognitive mechanisms in the context of strategic decision-making (Finkelstein, Hambrick, and Cannella 2009; Helfat and Peteraf 2015; Narayanan, Zane, and Kemmerer 2011). Likewise, scholarly efforts in leadership and governance literature is starting to converge individual, social constructs to explain organisational-level perspectives (Westphal and Zajac 2013; Zhu, Shen, and Hillman 2014). We believe an integrative behavioural perspective can provide additional benefits to innovation research and practice. First, it is more likely to yield generative theories that generalise to wider R&D and innovation management literature. Second, it offers a 'gold' standard for studying agentic socio-cognitive capabilities and their influence on behaviour and performance at various stages and in various types of innovation. Third, our humanistic research design approach transcends challenges and assumptions rooted in conventional (and economic) experiments, rather using game-theoretic model as an element of the design and standard for evaluating emergent behavioural theories. Lastly, we hope, that the interdisciplinary aspect of behavioural experiments will bridge the gap between otherwise dispersed group of behavioural scholars (i.e. scholars in behavioural strategy, behavioural economics, behavioural innovation, psychology and organisational behaviour) and innovation practitioners, fostering a more open and collaborative environment for innovation research and practice. Scholars have observed that despite the call for new forms of organizing for innovation in practice, research in the area has mostly tackled question of *how to* type (Brunswicker and Vanhaverbeke 2015; Frow, Nenonen, Payne, and Storbacka 2015; Naqshbandi, Tabche, and Choudhary 2018), the questions of why and how remain largely unaddressed. These questions reflect practical managerial challenges of who to include in innovation projects? How to improve productivity and creativity of individuals and groups? Why do some individuals embrace open innovation where others do not? What conditions to put in place to improve (or restrict) cooperation and collaborative efforts? From the emerging humanistic perspective to innovation management (Salzmann and Kock, 2018; Simeone, Secundo, and Schiuma 2017), it becomes an imperative to understand how participation in new open and collaborative environments affects individual's socio-cognitive capabilities and well-being. For the practice of innovation management this means humanistic behavioural research methods provide an opportunity to unveil how individuals on an innovation project are influencing outcomes in the context of the specific innovation problem. More broadly, they could inform the firm's human capital policies and decisions related to innovation processes through systematic investigation of the effects of innovation conditions on individual's social and cognitive capabilities, a cause worthy of attention.

For future research, we identify three streams of investigations to advance the science of managing for innovation, although this list is not exhaustive. First, research at the intersection of humanistic principles and innovation performance seems promising. Much of the academic and practice efforts have been directed to human-centred design in recent times (Galle, 2011; Hassi & Laakso, 2011), yet we know little about firm's share of turnover from innovation and its level of investment in human-centred design approaches. Some recent evidence suggests that this link may be weak (Montresor & Vezzani, 2019). In addition to the humanistic approach to innovation, collaboration across organisational functions and boundaries has been re-ignited in the previous fifteen years since Chesbrough (2003) drew attention to open innovation practices. An open approach to innovation involves a wide range of stakeholders during the design, development and implementation phases. Thus, a second promising research avenue is to explore the interaction between open innovation and the thinking styles of various stakeholders involved

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in the process. In this view Hassi & Laakso (2011) refers to thinking styles in terms of cognitive styles, information processing, reasoning approaches and cognitive framing. Lastly, as this editorial series called for intervention in advancing the science of managing for innovation, it is only appropriate to recommend widespread adoption of multi-level, multi-method analysis at the intersection of behavioural science and (open) innovation. As such, humanistic approaches and its ability to shape meaningful innovation should be a key component for research and practice of innovation management.

Innovatively yours,

Anne-Laure Mention, João José Pinto Ferreira, Marko Torkkeli

The Editors

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Carbon Emission and Plastic Pollution: How Circular Economy, Blockchain, and Artificial Intelligence Support Energy Transition?

Krishnaswamy Sankaran
krish@sankaran.org | Radical Innovations Group, Finland

Letter from Industry

Abstract. What drives growth becomes cancerous when it goes beyond limits. Contrary to this common sense, today, consumerism drives our economies and feeds our appetite for ever-growing wants. As a result, we are damaging our ecosystems and risking our very existence on Earth. Though too late, various efforts are promoted by governments and driven by industries to rapidly decarbonize our energy systems and sustainably consume and recycle raw materials. We have discussed two ongoing projects in the domain of energy transition and circular economy. The first one transforms industrial carbon emissions into green fuels and the second one helps in efficient and sustainable segregation and recycling of plastic waste using multi-sensor-driven AI and blockchain tools. These examples demonstrate how circular economy and energy transitions complement each other in the battle against climate change and pollution.

Keywords. Carbon emission; Plastic pollution; Recycling, Circular economy; Green fuels; Energy storage; Energy transition; Blockchain; Artificial intelligence; AI; Multi-sensor.

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1 Shifting Gears: From Chaos to Cure

How we use and abuse natural resources (energy and raw materials) define our future. Gone are those days of plenty when natural resources were (ab)used as if they are going to last forever. Neither *foresight* nor *insight* guided our actions to differentiate our needs from wants. As a result, we ended up in a situation in which we did not plan to be in. On one hand, our resources are getting scarcer and population is rapidly increasing. On the other hand, we are also wasting a lot of valuable resources and polluting all ecosystems - land, water, and atmosphere (Sankaran & Fortuny-Guasch, 2004; Sankaran, 2019, 2020). Today, consumerism drives our society and feeds our appetite for ever-growing wants. As a result, we are risking our very existence on Earth.

In the last two decades, we have been hearing a lot of concerns from various scientific communities. It took several years for policy makers and legislators to translate data into remedial actions. Still, we are far behind the *ideal* scenario and the consequences of our actions are contrary to our collective commitments. For example, two years after the United Nations deal with roughly 200 countries to protect the climate, the global greenhouse gas (GHG) emissions surged to a record high. Carbon dioxide (CO_2) emissions from energy use increased 1.6 % in 2017 mainly due to emerging and developed economies.

Rehabilitation measures are rolled out in all domains to rapidly decarbonize all state of affairs dealing with energy use. That being said, we will perpetually be in a fire-fighting mode if we only engage in *symptomatic* cures without addressing how we fuel our growth-and-wants-driven society in terms of resources (energy and raw materials). This is the nexus where energy transition and circular economy meet.

Thankfully, several sectors in our society are leading change in this nexus. We will highlight a couple of projects in Radical Innovations Group, Finland that showcase our activities in circular economy and energy transition. In the first example, we will present our ongoing work to produce commercially valuable *green fuels* from industrial carbon emissions. Second example introduces various smart tools that we are currently developing based on *blockchain* and *multi-sensor-driven artificial intelligence* (AI) for efficient segregation and recycling of plastic waste.

2 Energy Transition & Circular Economy

Circular economy is an efficient and responsible model for running our society with the aim of eliminating waste and enhancing resource (material) utility. Through various *principled* actions - reusing, sharing, repairing, refurbishing, remanufacturing, repurposing, and recycling - we can operate a close-loop ecosystem and extend the life-cycle of products, equipment and infrastructure. Thus improving the resource utility, reducing waste, and energy consumption. The energy transition, on the other hand, is a pathway towards transformation from fossil-fuel to zero-carbon-based energy sources. Circular economy and energy transition projects can immensely benefit from the use of *smart* technologies supporting development of relevant policy frameworks and market instruments.

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2.1 Green fuels from industrial carbon emissions

Industrial carbon emissions are a major problem; but not when utilized cleverly. Case in point are different carbon capture and utilisation (CCU) technologies that transform carbon emissions to various value-added products such as fuels, carbonates, polymers, and other chemicals (Yu, Curcic, Gabriel, & Tsang, 2008; Hunt, Sin, Marriott, & Clark, 2010; Jiang, Xiao, Kuznetsov, & Edwards, 2010; Markewitz et al., 2012; Dowell, Fennell, Shah, & Maitland, 2017). CCU has the potential to contribute to a new economy that makes full use of emissions from industries. When we utilize these industrial carbon emissions to produce fuels with the support of renewable energy, we can realize a *green circular economy*. We have studied various processes to recycle CO_2 from industrial emissions to produce value-added products, namely, methanol (CH_3OH) and formic acid (HCOOH) (Patil & Sankaran, 2020b). The schematic of the green circular ecosystem currently being developed in Finland is shown in Fig. 1. Our business plan will not only help in the battle against global warming, but it will also produce commercially-valuable products in an efficient and sustainable manner.

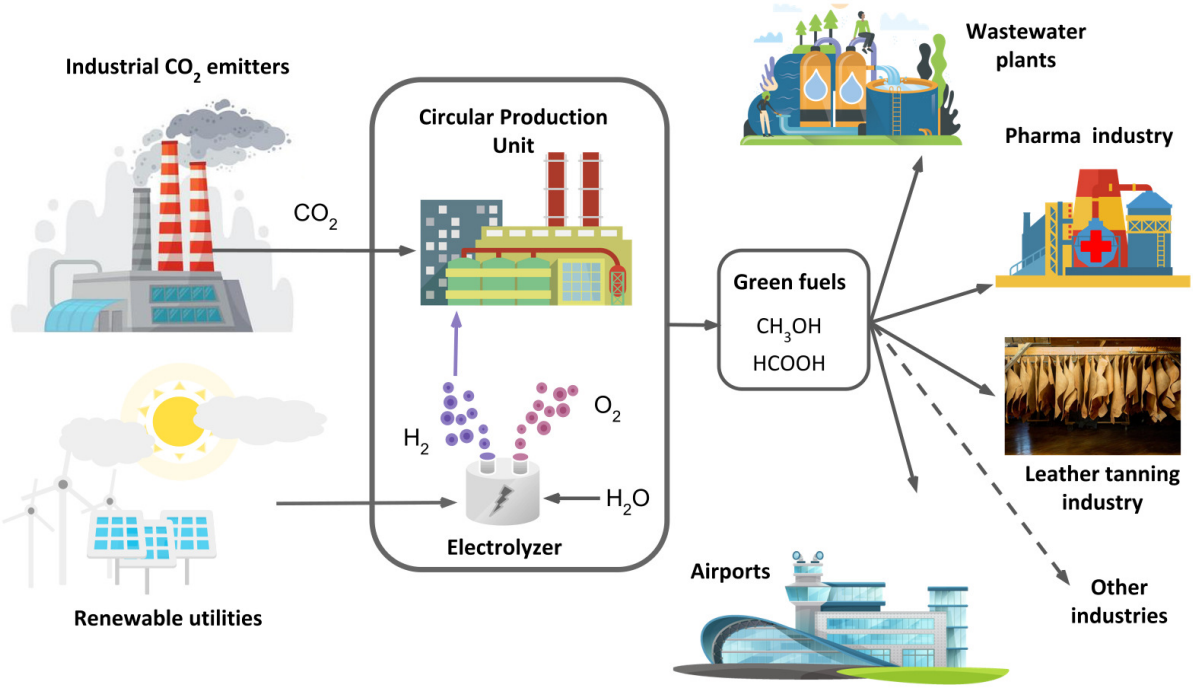

Fig. 1. Green fuel production ecosystem using industrial carbon emissions and renewable energy

Apart from these green fuels, we are also investigating pathways to produce *green* ammonia, which acts as an efficient medium to store renewable energy (Patil & Sankaran, 2020a). We are presently studying the techno-economic and environmental feasibility of ammonia as a future energy source to fuel our industrial and transportation needs.

2.2 Plastic recycling powered by multi-sensor-driven AI and blockchain

The word *plastic* resonates with two contradictory references - one relating to the revolution and the other concerning the pollution created by this man-made material in our society. The magic and the mayhem created by plastics are both incredible and disturbing. For sure, there is no simple way to get rid off this pervasive material. We need to understand and resolve the structural challenges in our system that will systematically enable proper disposal of plastic waste and encourage reusing and recycling. The biggest bottleneck is due to lack of reliable information about the availability, quantity, quality, and suitability of recycled plastic feedstock. Without such a reliable information, manufacturers are not motivated to procure recycled feedstock instead of virgin polymers (Eriksen, Damgaard, Boldrin, & Astrup, 2018). We are developing multi-sensor-driven artificial intelligence (AI) and blockchain tools that bridge this information gap and improve plastic waste segregation and recycling processes (Patil et al., 2020). Fig. 2 illustrates how multi-sensor-driven AI tools help in retrieving vital information such as colour, size, shape, density, physical, and chemical composition of the plastic waste. Gathering such information from plastic waste greatly enhances segregation process. These collected data from plastic waste are also distributed and validated on the blockchain platform, which serves as a trust-based network (Crosby, Nachiappan, Pattanayak, Verma, & Kalyanaraman, 2016; Drescher, 2017; Kouhizadeh & Sarkis, 2018; Mansfield-Devine, 2017; Romano & Schmid, 2017; Sekhri, 2018; Kouhizadeh, Sarkis, & Zhu, 2019; Adebiyi-Abiola, Assefa, Sheikh, & Garcia, 2019; Wang & Qu, 2019). We use this blockchain platform as a backbone to share and validate valuable information (also called as *digital transaction*) between plastic waste segregators, recyclers, and feedstock buyers (manufacturers). Information transacted also contains data regarding supply, demand, specifications (quality), bidding- and offer-price of recycled feedstock as illustrated in Fig. 2. These smart tools increase the use of recycled plastics for manufacturing various products. As a result, we are able to minimize the amount of plastic waste being incinerated and dumped. Hence, circular economy of plastic protects environment and supports energy transition in three ways - reduces our dependence on fossil fuel-derived virgin plastic, minimizes carbon emission from incineration plants, and avoids pollution caused by landfills.

3 Conclusion

Increasing carbon emission and massive waste generation are two major challenges confronting our society. Unless we care about what and how we consume, dispose, and recycle resources, there is no way out of this man-made chaos. Several corrective measures are ongoing in different sectors to rehabilitate our ecosystems. We have discussed two ongoing projects: the first is to transform industrial carbon emissions into green fuels, and the second is to efficiently and sustainably segregate and recycle plastic waste using multi-sensor-driven AI and blockchain tools. Through these examples, we have demonstrated how circular economy supports energy transition in the battle against climate change and pollution.

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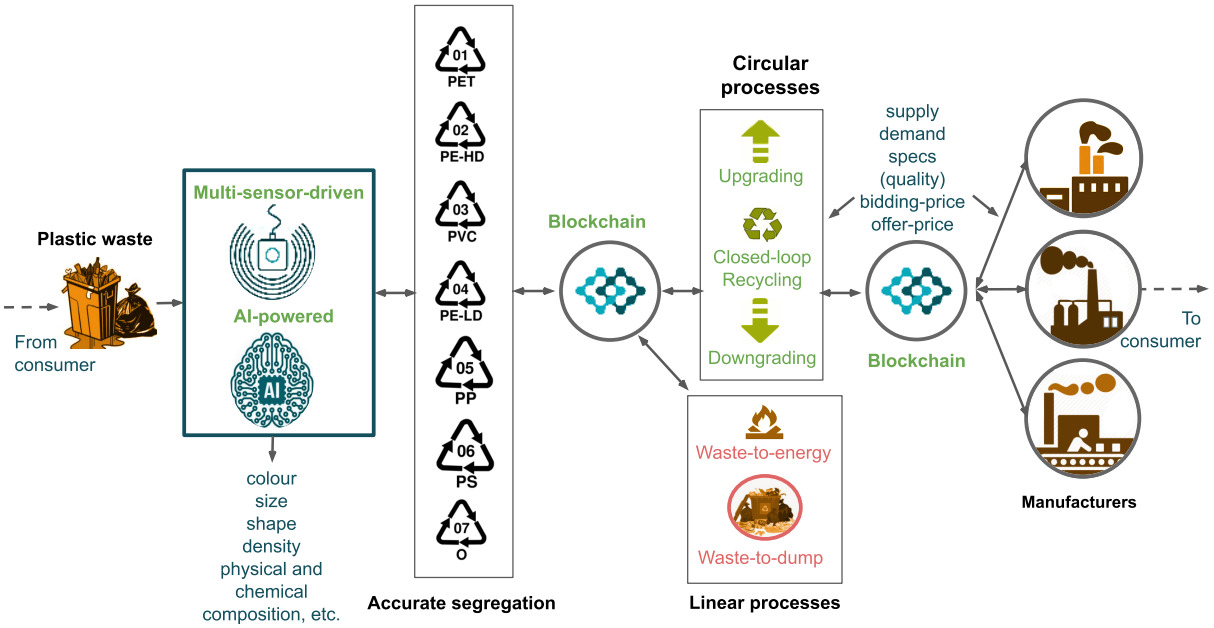

Fig. 2. Multi-sensor-driven AI and blockchain tools for efficient segregation and recycling of plastic waste.

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Biographies

Krishnaswamy Sankaran. Dr. K. Sankaran is an established industrialist with several years of experience in energy, utilities, metals, mining, infrastructure, production, and recycling industries. He is presently the Chief Executive Officer of the Radical Innovations Group AB, Finland. He received doctorate in engineering sciences from the Swiss Federal Institute of Technology ETH Zurich, Switzerland, masters from Karlsruhe Institute of Technology KIT, Germany, and a joint executive masters in organisational development and leadership from Wharton School, Columbia University, INSEAD, and London Business School. He is a recognised thought leader and keynote speaker in many international forums. He has several years of training in Advaita philosophy.

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Success factors for data–driven service delivery networks

Minna Pikkarainen
minna.pikkarainen@oulu.fi | University of Oulu, Oulu Business School; Martti Ahtisaari Institute; Medical Imaging Physics and Technologies, P.O. Box 4600, 90014 University of Oulu, Finland & VTT, Technical research Centre of Finland, Kaitoväylä 1, 90570, Oulu, Finland
Tero Huhtala
tero.huhtala@oulu.fi | University of Oulu, Oulu Business School, P.O. Box 4600, 90014 University of Oulu, Finland
Laura Kemppainen
laura.kemppainen@oulu.fi | University of Oulu, Oulu Business School, P.O. Box 4600, 90014 University of Oulu, Finland
Juha Häikiö
juha.haikio@vtt.fi | VTT, Technical research Centre of Finland, Kaitoväylä 1, 90570, Oulu, Finland

Abstract. Data is becoming a more and more important resource for future innovations. Companies are currently considering how to leverage personal data in preventive healthcare and in other sectors. However, there are many challenges hindering the development of data-driven businesses in extant business networks. The purpose of this paper is to explore the success factors of data-driven service delivery networks in the context of preventive healthcare. The results are examples of the benefits and challenges of data availability and usage, based on a qualitative case study, in which a network of actors is integrating resources to solve the needs of their end customers. The results underline the success factors for service delivery networks, creating a baseline for human-centric, personalized and preventive healthcare solutions. The study enriches the theoretical perspective of data, services and service delivery networks by continuing discussion on how big data resources become cooperative assets not only in a firm but also on the network level. This study has multiple implications for practitioners trying to navigate the turbulent waters of the changing business environment and evolving service delivery network of preventive healthcare. Especially small and medium size of firms could use the identified success factors when planning new data-driven services in their networks. Our analysis brings new perspective between a firm and the actors in its network, particularly in the preventive healthcare sector wherein data needs to be shared between actors via consent of the individuals.

Keywords. Success factors; Service delivery network; Healthcare; Human-centric, Data-driven.

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1 Introduction

The world is increasingly data-infused and the context in which services are delivered is irrevocably changed by advances in technology. Perhaps the most consequential phenomenon regarding technological innovations' impact on business is the ever-growing volume and velocity of data. It is astounding and deeply disturbing to think that most of the data that exists today have been generated only during the last few years (Grierson, et al., 2015). The use of data is becoming a necessity for organizations that wish to remain competitive. In some cases, data-driven businesses can have 5–6 per cent higher output and productivity than similar organizations that are not using data-driven processes (McAfee, et al., 2012). Marketers are recording a wide range of data, for example what people buy and how often, where they go for vacation, and how often they watch movies. The amount of data that a single person accrues over the years is astounding, for better or for worse. The possibilities that the data entails are huge. Especially the healthcare industry can benefit from the use of wide-ranging personal data (Hood & Flores, 2012; Ratia, et al., 2018; Beirão, et al., 2017). Holistic utilization of personal data can enable preventive actions and lifestyle changes that could radically decrease the future amount of chronic diseases. For example, studies have found that there is a possibility to lower the risks of Alzheimer's disease and cardiovascular risks, and increase the psychological well-being of people (Ryff, et al., 2004). Therefore, preventive healthcare solutions provide a way to improve health as an outcome. At the same time this is a huge business opportunity for many companies. However, access to all that data requires extensive collaboration at a level of several actors (Huhtala, 2018).

A widely used and accepted term to describe an adaptive collection of collaborating actors is the *service ecosystem,* which draws heavily from the service-dominant logic (Vargo & Lusch, 2008). Vargo and Lusch (2016) define a service ecosystem as a complex system of actors that are interconnected by shared institutional arrangements and mutual value creation targets. Service-dominant (S-D) logic describes *service* as an action of doing something for another party (Vargo & Akaka, 2009), which works as the fundamental component or basis for economic exchange (Vargo & Lusch, 2004). The organizations in the ecosystems are contributors that intend to help customers (i.e. an actor that purchases solutions (Sawhney, 2006) to achieve a goal, resolve a problem or satisfy a demand (Bettencourt, et al., 2014). Service ecosystems in S-D logic focus on innovation and the role of institutions – rules, norms, values and beliefs – and institutional arrangements that provide the rules of the game (Koskela-Huotari, et al., 2016). The service ecosystem view concentrates on "*the use of resources*" and "the integration of skills to develop new knowledge to apply resources in a more effective, efficient, and sustainable manner" (Akaka, et al., 2013). The resource integration process between the actors of the service ecosystem is called co-creation, which emphasizes resource integration, practices and the linking of actors within an ecosystem. These practices can help gain access to resources, manage resource deficiencies and improve the density of resources with the ultimate goal of refining the resources into valuable benefits for the actors, leading to a healthier ecosystem (Frow, et al., 2016).

In S-D logic, value is always customer-centric, and the ecosystem actors create value propositions and do not automatically create value for the customers. Following this background, service ecosystems can be defined as systems that include resource-integrating actors that are working towards value creation through service exchange (Vargo & Akaka, 2012; Vargo & Lusch, 2016).

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According to Vargo and Lusch (2015; 2017) the conceptual exploration of service ecosystems has just started. Cavities in knowledge still exist, for instance, in regards to what are the uncertainties and opportunities for service ecosystem players when they collaborate to co-create customer value (Vargo & Lusch, 2015). Additionally, it is important to understand how the service ecosystems evolve (Vargo & Lusch, 2017). Moreover, it is unclear what the underlying risks and success factors are that relate to resource generation in evolving data-driven ecosystems or networks specifically.

The various uses of data in all sectors of business is an exciting but also an intimidating development. Typically, data is generated by individuals. This means that the individuals' actions have a direct impact on the value creating actions in data-driven service ecosystems. When individuals are continuously participating in the value co-creation process, the interaction between the actors actually generates increased amounts of data to be used by the ecosystems (Xie, et al., 2016). The data sharing between the actors within an ecosystem could bring new opportunities and ways to differentiate the solution to be something that individuals really want and need (Wang, 2012). Although there are many studies that have examined the role of digital platforms in value co-creation (Ceccagnoli, et al., 2012) few, if any, academic studies have explored what factors actually hinder or enable the ongoing change in service ecosystems in the context of the preventive healthcare sector. Service ecosystems describe the interconnectedness of organizations in a systemic perspective. While organizations can be part of a larger service ecosystem that provides them necessary resources, smaller networked entities can be identified within. A more specific concept is needed to explore and describe a network of actors who strive to offer services to end-customers in a holistic sense in a specific domain. The *service delivery network (SDN)* is a group of organizations that provides a connected service experience to the customer. A service provider may act as a primary organizer directing the service delivery, or have a complementary role in the provision of service. The service itself includes multiple service providers that form a network around the customer. (Tax, et al., 2013).

MyData, a human-centred approach for personal data management, has emerged in Europe to combine this increasing need of companies to work in business ecosystems and access data while simultaneously fulfilling digital human rights. The core idea in the MyData approach is to put individuals (customers) at the centre of value co-creation, letting *them* decide if their personal data is shared for their, and others', benefit (MyData Alliance, 2017). Although the risks of mishandling the data emerge with its use, it is also a risk for companies not to participate in data-driven ecosystems. Some of the challenges of data-driven business exchange mentioned in the literature are fourfold: i) how to extract data, ii) how to refine data iii) how to ensure data is utilized most effectively (Brownlow, et al., 2015) and iv) how to share the data while fulfilling all the rules and regulations related to data protection at the same time (Graeff & Harmon, 2002). The data mishandling concern is especially valid in healthcare, in which people are even more concerned about their data usage than in other sectors of the economy. Even though the increasing amount of data is recognized as a new form of capital in the digital era, little research has been done on how the increased amount of data can be capitalized into a valuable asset (Xie, et al., 2016).

The aim of this paper is to understand what the factors affecting to the success and failure of data-driven service delivery networks are in the context of preventive healthcare. To meet this

aim, we formulated two research questions: 1) How does data, as a resource, affect actions in data-driven service delivery networks? and 2) What are the main challenges to overcome in data-driven service delivery networks?

The work has been conducted as a case study. Because of the systemic nature and interconnectedness of ecosystems and innovation activities, it is necessary to explore "the structure of the ecosystem and its actors and their interrelationships in a particular ecosystem" (Kortelainen & Järvi, 2014). This study explores a service delivery network within a service ecosystem of healthcare actors. The unit of analysis is a service delivery network of eight different organizations (small and medium-sized enterprises [SMEs], insurance companies, large corporations and healthcare providers) that aim to jointly create preventive healthcare solutions using a human-centred personal data management approach.

This paper is structured as follows. The background for this study is presented in Section 2, focusing on personal data as well as on the benefits and challenges of data. Section 3 introduces the research approach of this study. In Section 4, the authors present the results of a case study. Section 5 discusses the implications, limitations and further research avenues of the study. Finally, Section 6 concludes the paper.

2 Background

2.1 Personal data

The amount and availability of data is staggering in these modern times. One of the most rapidly growing categories of data is so-called personal data, which can generally be understood as information pertaining to an individual's personally identifiable data (European commission, 2016). The average individual has massive amounts of personal data stored in many different locations. This data could bring in vast opportunities for service providers and benefit the individual. However, most of that data is inaccessible: the data is owned and operated by the respective organizations that have harvested it. For many organizations, the harvested data is considered either a competitive advantage that is not to be shared or it contains sensitive personal data that is not to be shared (Ctrl-Shift, 2014). Personal data is an important resource for value creation among companies and society. The value of personal data is large and growing (Schwartz, 2014), and is expected to grow into a market worth nearly €1 trillion by 2020 in Europe alone (Ctrl-Shift, 2014; European commission, 2016). Organizations in both public and private sectors have long been collecting personal data to gain insight, efficiency and competitive advantage (Ericsson, 2013), for example, by removing information asymmetries and facilitating efficient transactions (Facebook, 2014).

In Europe, the General Data Protection Regulation enforces the security and transparency of data, and effectively forces organizations to give back personal data in a digital form to individuals upon request (European commission, 2016). These regulations may increase the overall costs of harvesting and keeping information about individuals but will also present huge business opportunities in the form of newly available data resources (Ctrl-Shift, 2014; Poikola, et al., 2014). Poikola et al. (2014) argue that the availability of wide-ranging personal data will

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revolutionize all industries and aspects of society. Organizations utilizing personal data can better optimize resource allocation, create novel service paths and provide personalized services (Ctrl-Shift, 2014).

The healthcare sector cannot afford to overlook the opportunities enabled by the use of technology (i.e. data) with the overall demand for healthcare services continually rising. Researchers widely acknowledge the impact of the extensive use of technology - data in particular - in predicting, preventing and managing health conditions (Collins & Varmus, 2015; Baldwin, 2010; Pinho, et al., 2014). In the US healthcare sector alone, big data and user-generated content are seen to generate approximately $300 billion a year in value, with around 0.7 per cent annual productivity growth (Pujol, et al., 2016).

2.2 Networks, ecosystems, and service delivery

The preventive healthcare actors have a shared mission of preventing illnesses. The overall physical condition of a single individual is dependent on various aspects: for example, eating habits, exercise, mental health, and health conditions. These are all interrelated, but a medical doctor is rarely aware of how the patient really eats and exercises, and a personal trainer rarely consults the customer's doctor or dietitian to attain a holistic picture of the customer's current state of health. Thus, while there are services to attend to each aspect of an individual's overall health, they are separate and rarely, if at all, communicate with each other. However, from the customer's perspective, these services are a connected service entity, focused on maintaining the customer's good health.

Companies are increasingly more connected, and no company can provide their services without the help of other organizations in their network. The locus of value creation has moved from within company boundaries to value being jointly created between various actors within the networked market (Nenonen & Storbacka, 2010). This interconnectedness is referred to with different names for different purposes. While criticized by many scholars (Vargo & Lusch, 2004) for its lack of wider perspective, in industrial contexts, the value chain is still widely used. The value chain describes the whole process of a product or service from conception to manufacturing to delivery to consumption to disposal. Of course, the real world is never that simple, all models are merely necessary simplifications of real life. Networks for instance related to R&D and innovation has been widely researched and characterized by uncertainly during the past decade (Arrow, 1974; Möller & Rajala, 2007; Henttonen, 2008; Hurmelinna-Laukkanen, et al., 2012). Such networks have been exploited from the perspective of independence, stability, dynamism, collaboration, competition, formality, management requirements as well as innovation orchestration roles and practices (Henttonen, 2008; Moenaert, et al., 2000; Hurmelinna-Laukkanen, et al., 2012; Pikkarainen, et al., 2017). Additionally, the innovation network studies have been increasingly done focusing on the organizational interaction and orchestration that is happening in different networks and ecosystems (Dhanaraj & Parkhe, 2006; Laperche, et al., 2008; Reypens, et al., 2016). Although networks have attracted much managerial and academic interest, it is still not clear for managers how to deal with innovation networks having variety actors co-creating and capturing value (Hurmelinna-Laukkanen & Nätti, 2018).

The ecosystem as a concept (Lehto, et al., 2013; Moore, 1996) has risen as an approach to explaining the complexity of different business entities' interconnectedness. For different contexts, there are further defined ecosystems, such as industrial ecosystem, innovation ecosystem, knowledge ecosystem, and business ecosystem (Smorodinskaya, et al., 2017). These ecosystems have common elements defining them: actors, interconnectedness, complex networks of relationships, and resources, all of which are combined and integrated in a unique manner (Valkokari, 2015). Moore (1996) describes business ecosystems as a group of interdependent, interconnected and collaborating customers, agents, channels and sellers of common services. Business ecosystems help companies to generate end-user value and create new markets that single companies could not do by themselves (Adner, 2006). Companies that are part of ecosystems can better develop their capabilities and utilize resources. To be successful, business ecosystems need keystone companies that offer platforms, tools and technologies that support the other players' performance in the ecosystem and share value with other participants (Iansiti & Levien, 2004; Valkokari, 2015; FitzPatrick, et al., 2015). A healthy ecosystem not only assembles the actors who contribute to the system, it also provides a mechanism for building relationships, trust and other intangibles between the actors and entities within (Jackson, 2015). Ideally, a well-managed ecosystem is robust towards external disruptions and capable of increasing meaningful diversity (Iansiti & Levien, 2004). It is particularly relevant for start-ups to be part of ecosystems (Zahra & Nambisan, 2012). Clarysse, et al. (2014) discovered that the success factors for knowledge and business ecosystems look very similar: diversity of organizations, and an anchor/keystone actor. Still, et al. (2016) explored the innovation and business ecosystems of companies in an emerging market of fintech, and found that an individual company may have differing roles in the respective ecosystems, but that the types of interaction and logic of action may also overlap between the ecosystems. This goes to show that innovation managers need to consider interactions in many types of ecosystems.

However, as concepts, networks and ecosystems remain ambiguous and are too often used interchangeably in the literature (Chesbrough, 2007). In service-dominant logic, the network is regarded as one component of a larger service ecosystem, wherein the attention is on the systemic nature of the relationships of the actors (Akaka, et al., 2013; Mele & Della Corte, 2013). For the purposes of this study, we need a concept that describes interconnected organizations that work to fulfil the goals of a single customer in a specific domain. Tax, McCutcheon and Wilkinson (2013) introduced a suitable concept to describe such network: the *service delivery network* (SDN), which is defined as *two or more organizations that, in the eyes of the customer, are responsible for the provision of a connected overall service experience.* Ecosystems are used in this study to describe the larger networked nature of the modern business environment of which SDNs are a part of.

The increasingly networked and connected world has led to fragmentation of service delivery. The benefits afforded by specialization caused by digitalization and technological progress has increased organizations' reliance in complementary service providers (Ostrom, et al., 2015). Data has empowered customers to act as resource integrators, selecting desired service bundles to better suit their individual needs. The value of data is recognized in widely in various industries (Furtado, et al., 2017), but how data can be capitalized remains one of the most pressing topics among academics and practitioners, especially in healthcare sector (Lee, 2018; Ratia, et al.,

2018). Thus, data-driven ecosystems and networks have become an important area of research (Lim, et al., 2017; Ostrom, et al., 2015).

To make a holistic service for preventive healthcare, the actors must form an organizational network, which will jointly provide a connected series of services for the individual customers to upkeep their health. The structure of such network needs to be organized in a way that integrated resources will be focused on addressing the needs of the end customer (Clarysse, et al., 2014), leading to a solution for an end customer in a way that each actor is responsible for a specific component of the overall solution.

2.3 Using data to advance preventive healthcare

Data as a resource that enables actions

Companies have noticed that self-tracked data may provide business opportunities. Many companies provide self-tracking devices, wearable sensors, and mobile applications that individuals can use to measure and compare data to change their behavioural activity. With better access to personal data as a resource, organizations can optimize resource allocation, create solution pathways and provide personalized solutions (Poikola, et al., 2014). Some examples of these types of solutions are health and wellness apps, that can track information about food consumption, sleep patterns, blood chemistry, moods, menstrual cycles, heart rates and stress levels (Sharon, 2015). By utilizing personal data, it is possible to improve consumer experiences by understanding individuals' needs and preferences, usage patterns and behaviour. This kind of personalization can make preventive healthcare solutions more relevant, easier and quicker. This, in turn, can also lead to increased loyalty. With relevant information about the individual, a service provider can "offer the right services, at the right price, through right channels at the right time" (Ericsson, 2013). The benefits of data in business are obvious. In fact, many businesses that fail to align themselves with data-driven practices risk losing a critical competitive advantage, market share and revenue. Therefore, effective data utilization affects not only competitiveness but also survival in tight market competition (Brownlow, et al., 2015). Quite often, the actors of an ecosystem operate around a focal company that is linked to a platform (Valkokari, 2015; Iansiti & Levien, 2004). Networks often arise around a central node – for example, a shared platform – making it possible to collect and share the data, which therefore has an impact on data-driven business creation. There are many examples of players that have created new markets using data and platforms in their ecosystems, for example Apple, Google, Amazon and Airbnb. FitzPatrick, Varey, Grönroos and Davey (2015) introduce the concept of a platform of co-creation that enables and supports direct interactions among those that participate in the value co-creation process.

Data as resource that hinders actions

One challenge in the use of data as a resource is data quality. Low quality data does not bring end-user value. Low quality data can result in misleading analyses, and lead to wrong decisions (Redman, 2015). The benefits of fixing quality of data coming from self-tracking can be enormous for companies. Low quality data presents an inherent risk, as it can cause the reputation of a company to plummet in the eyes of the end-users. Often companies realize the

opportunity associated with data but fail to determine a specific target for their data acquisition and analysis. By targeting a pre-determined outcome, the business can retain its focus on a desired and realistic goal, and reduce any unnecessary waste of resources (Brownlow, et al., 2015).

The actors of the service delivery network should carefully think about the content and purpose of the collected data to avoid enormous data acquisition and analysis costs. The end data is useless, if it does not bring added value to the end-user (Redman, 2015). There will be questions raised related to the legal limits of the data collection, storage and usage. The privacy of data becomes an issue for a company whenever the data it processes relates to people. The legality of data protection and sharing is strongly dependent on the context in which it is used (Otjacques, et al., 2007). In our study, the context of healthcare raises privacy issues to an even bigger focus.

Factors that enable change

Many reasons are driving companies towards the co-creation of preventive healthcare solutions. First, populations are aging rapidly. For instance, the population of the US is predicted to double by 2050. Second, the costs of medical care and especially chronic diseases are increasing, even by 7.3 per cent by 2050 (Kim, et al., 2014). The model of targeted, preventive and participatory healthcare has been identified as a potential solution for the crisis of public healthcare systems (Norris, 2012; Flores, 2013).

Electronic medical record systems improve the coherence of the care process (McDonald, 1997). The large amount of data in the systems, gathered from each individual patient, could be used to improve and personalize preventive healthcare services when it benefits the individual. The challenge is that the medical information is typically under very strict data protection laws and is in different systems with various interfaces (McDonald, 1997). In some countries, such as in Finland, the government has built national databases that can be regarded as an individual's data storage for personal medical and self-measured data (Kanta, 2016).

Data is the key resource in co-creating preventive healthcare services (Ratia, et al., 2018). Due to the nature of sensitive personal data, companies that need access to it, need to collaborate. Companies that are part of such networks can better develop their capabilities and utilize resources. Participation in data-driven networks helps companies to i) differentiate themselves from competitors (Wang, 2012), ii) create new end-user value (Huhtala, 2018) and iii) scale their business (with the help of the ecosystem) in a way that a single company could hardly manage on its own (Adner, 2006). In this context Vargo and Lusch (2004, 2008) use the term *competitive advantage* and *strategic benefit* (2016) to capture the beneficial impact of the operant resources.

Factors that hinder change

Recently, there have been critical discussions about self-tracking for health in the social sciences literature (Lupton, 2012; 2013; 2014; 2015; Morozov, 2013; Whitson, 2013; Ruckenstein, 2014). These critical analyses articulate a number of concerns regarding the social, cultural, political and ethical implications of personal data collection and self-tracking, and the move toward more personalized healthcare (Sharon, 2015). Zainuddin, Tam and McCosker (2016) investigate the

phenomena of emerging, technologically facilitated value self-creation solutions in the healthcare sector. One example of a technology-driven health solution is blood glucose monitoring, in which a person monitors his or her blood glucose several times a day. In this context, consumers are collaborators and value receivers in the value co-creation process. In this context the organizations become value facilitators at the backstage of an overall service exchange (Zainuddin, et al., 2016).

Companies should avoid the situation in which only some of the personal data is shared with the permission of individuals (Redman, 2015). It might be impossible to prevent this from happening, since many companies still consider keeping data to themselves their competitive advantage. However, every actor in the service delivery network would be able to make better services for the end customer by using more and better data provided through collaboration.

The benefits and challenges and the related drivers of data-driven service delivery networks are summarized in table 1.

3 Research Methodology

The aim of this paper is to understand what the success factors of a data-driven service delivery network are in the context of preventive, personal data driven service creation.

Our research strategy focused on understanding the studied phenomena within single settings (Eisenhardt, 1989). The benefit of the case study approach is that it is a way to increase understanding and to get closer to the theoretical constructs related to the evaluated phenomena (Eisenhardt & Graebner, 2007; Siggelkow, 2007, p. 22).

3.1 Context

Theoretical sampling means that cases are selected for the study because they are particularly suitable for explaining the relationships and logic among constructs (Eisenhardt & Graebner, 2007). Organizations that both worked in a specific role in preventive healthcare and had an interest in using human-centred data management approach were given priority in the case selection criteria. To gain a deeper understanding of the various actors involved, data was collected from established stakeholders and start-ups in healthcare, wellness, insurance, tech and application providers and in the telecommunication sector. Some of the selected companies – for example two SMEs, an occupational healthcare provider and an insurance company – already worked together in the same service network, co-creating value for their customers. The rest of the selected players were willing to participate in the service delivery network, bringing additional value to the future customer scenario.

3.2 Data collection and analysis

The theory building case studies are typically done with multiple data collection methods in which the interviews, observations and archival sources are common data collection sources. Multiple

Table 1. An overview of the benefits and challenges of extant data-driven service delivery networks

Author (Year)	Definition of benefits and challenges	Related drivers
Category 1: Data as a resource in data-driven service delivery networks		
(Sharon, 2015; Zainuddin, et al., 2016)	Self-tracking services, devices, wearable sensors, and mobile applications are used as a resource to make it possible for end users to collect, measure, and use data to change their behavioural activity	Value self-creation
(Valkokari, 2015; FitzPatrick, et al., 2015; Redman, 2015)	A shared platform that makes it possible to collect and share the data in service delivery networks	A platform of co-creation
(Redman, 2015)	A network or an institution uses the wrong data and does not bring added value to the customer, losing their good reputation in the market	Customer value not achieved
(Adner, 2006; Vargo & Lusch, 2015)	The service delivery network generates end-user value and creates new markets that single companies could not generate or create by themselves	New market creation
(Redman, 2015)	The content and format of the collected data are not systematic, which leads to enormous data acquisition and analysis costs	Data analysis costs
(Wang, 2012; Vargo & Lusch, 2004; 2008; 2016)	Actors use data as a resource to differentiate a business from that of others, bringing competitive advantage with the resources in the network	Competitive advantage/strategic benefit
(Adner, 2006)	Use of data is a resource to scaling up the business	Business scalability
Category 2: Challenges to overcome in data-driven service delivery networks		
(Ruckenstein, 2014)	Ethical concerns related to data usage	Ethical rules
(Redman, 2015)	The quality of the data	Data quality
(Otjacques, et al., 2007)	Legal limits, the privacy of the data collection, storage and usage	Legal rules & regulations cannot be followed
(Redman, 2015)	Some companies in the same service delivery network still keep customer data in internal silos	Data in internal silos

data collection provides the evidence that leads to the stronger substantiation of constructs (Eisenhardt, 1989). In this study the meetings, workshops, interviews, observations and other material available from studied organizations were used as a source for analysis (Eisenhardt, 1989). A three-phased approach was used in this study (Figure 1).

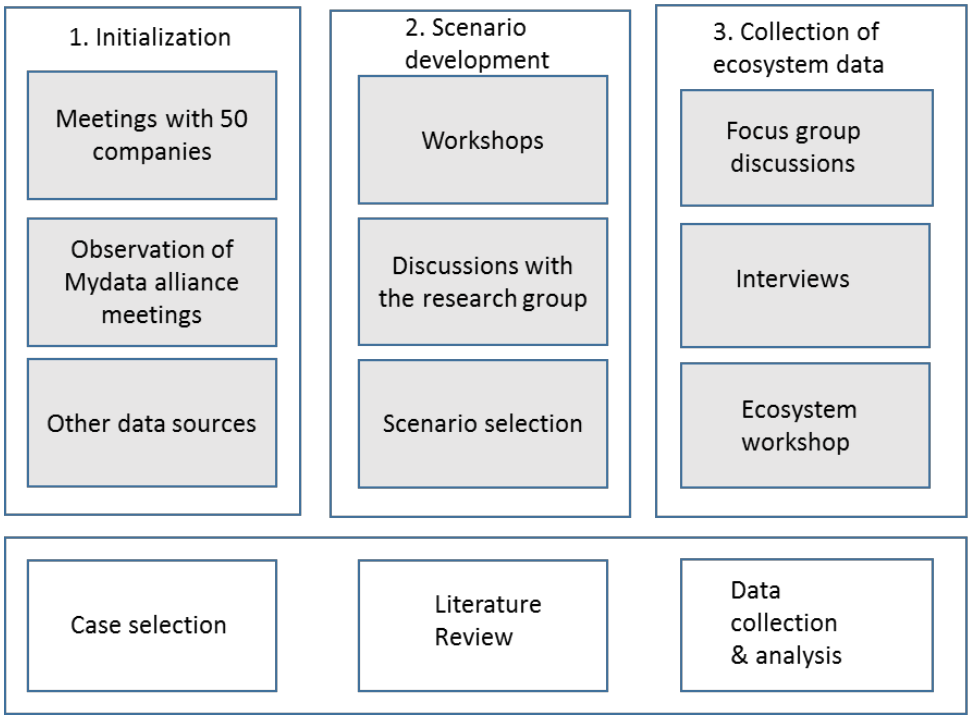

Fig. 1. The research process

The scenario technique is a qualitative method that makes it possible to describe complex situations that may happen in the future. With the rise of strategic and management consultancies the scenario technique has been used as consulting and evaluating tool there (Fink, et al., 2004). According to Fink et al. (2004) the scenario technique covers three steps: i) analysis of the scenario field to find descriptors and their cross linking, ii) the selection of several scenario alternatives and iii) the final scenario development (Muskat & Backman, 2012). In the first step of our study, the *initialization* step of our study the researchers had meetings with 50 different company representatives in the health sector during a six-month time period. Additional data for the service delivery network was collected from the Internet, newspapers, social media and observations that were made in MyData alliance meetings (https://mydatafi.wordpress.com/), in which most of the interviewed companies participated regularly.

We selected a case, which allowed us to understand the benefits and challenges of the data-driven service delivery network from different perspectives. Where possible, we also aimed to identify how prevalent each issue was across the case studied. The selected case (a data-driven service delivery network) involves organizations that are part of a network, targeting to make services for the preventive healthcare domain. In the third phase of our study, several *scenario alternatives* were identified and further developed. The opportunities in each scenario were further explored

in two workshops with the research team, based on the collected industrial experiences. For this study, a single end-user scenario was selected for presentation to the interviewed companies. (See Appendix 2)

After the scenario development, a literature review was conducted focusing on the barriers and benefits of the service delivery network. The *focus group discussions* were conducted between March and May 2016 with the directors of two SMEs, the directors of two insurance companies, a doctor and two nurses from a private healthcare company and two directors of large corporations. The literature review about the benefits and challenges worked as a baseline for the questionnaire that was used in the focus group interviews. In the next phase, we conducted *eight in-depth interviews* with senior personnel of the selected actors of the service delivery network. A future end-user scenario narrative was presented to each of the interviewees of the companies after a few basic questions. The used scenario approach supports the argument of Vargo and Lusch (2016) that "*actors cannot deliver value but can participate in the creation and offering of value propositions.*" In our case, the value proposition (a holistic preventive healthcare service continuum) was then discussed and updated in both focus group discussions and interviews with each company.

The data collection process was finalized with a *workshop* in which all the service delivery network actors were brought together to discuss the benefits and challenges, as well as the updated scenarios. In the data analysis, statements were identified, sorted and structured to identify benefits and challenges that may appear in data-driven service delivery networks. The analysis was conducted with an analysis technique described by Eisenhardt (1989) in which domains (i.e. the benefits and challenges generated from literature) were used to look for within-group similarities coupled with intergroup differences. During the data analysis process, we independently analysed and encoded all the transcribed material using *benefits* and *challenges* that emerged from the literature as starting categories for the conducted analysis.

4 The success factors in data-driven service delivery networks

4.1 Benefits of data in data-driven service delivery networks

Service complementarity between actors via data sharing

Creating value and scaling business via the data availability

The healthcare providers mentioned that it would be an interesting opportunity for them to work as a channel for other actors to get access to customers. This would help both SMEs and healthcare providers to create proper measurements and more holistic services for individuals.

> *The data availability will enable us to create services based on the real needs of a person* [. . .] *If someone has a medical condition there could be a service that tells when to go to a doctor if something happens in terms of eating or feelings. (B, see Appendix 1)*

> *If we know more, we can focus on where the problem really is. I mean that if a person is overweight, but his cholesterol level is fine, we should pay attention to the sleeping and*

mental health situations. These are the kind of things that we could figure out using the data. (Nurse, healthcare provider)

Thus, "*Data will make it possible to produce both individual and group-level focused services, which open business opportunities.*" (Doctor, healthcare organization B)

Better and more personalized services

Two of the interviewed SMEs (A, H) were also looking at data availability as a way to create value for their end customers through novel services. It was mentioned in the interviews that

"*the most important thing in data availability is the possibility to show an individual his or her weaknesses and strong areas.* [. . .] *Certain self-measured values (blood glucose and blood pressure) could be added as additional features to the service, which could provide more meaningful analysis possible to do measurement at home and work*" (Director) (A).

The interviews outlined that many future actions in the private healthcare sector will be more and more focused on preventive healthcare and especially on early signals about an individual's health trends and services supporting wellness. In this context, personalization was mentioned (in all together eight interviews: A–I) as a key benefit in the data-driven service delivery network, used to differentiate a business.

For example, it was noted by a doctor for a healthcare provider (B) that

"*in the future, data from several sources (workplace activities, health checks, electronic health questionnaires) could be connected and utilized when providing occupational wellness or health services for companies, which are based on company-specific profiles. For example, some SMEs already have service offering solutions for work organizations to support preventive wellness improvements among their employees on a group level. In the future scenario, beneficial information from an individual could be about blood glucose, PEF, weight etc."*

Integrated, well-presented data was identified as valuable assets, also for personal trainers. For example

"*[for a personal trainer] receiving data directly from a medical centre would be a great advantage since a person might not know how to describe his or her current state of health sufficiently or might exaggerate" (Personal Trainer) (D).*

In fact, personal data could make it easier to match an individual with a compatible personal trainer. Sharing the personal-training accumulated data for the individual is seen as a good idea, since it could help others help the said individual.

Insurance companies identified the service delivery network and personal data scenario as an enabler that will

"*give more real-time information for a customer, added value for the customers comes through new services, which are built on data and information*" (F).

In fact, both interviewed insurance companies pointed out that a data-driven business scenario and richer data availability are ways to gain a better capability to understand what the customers really want and need and therefore to create better personalized services.

> "*Better collaboration between health and service providers will help us to give better solutions to our customers. Especially in those cases in which the customer needs to contact many organizations.*" (C)

The better visibility of personal data was identified both as competitive benefit and phenomenon which is raising new ways to collaborate and share revenue:

> "*Business is beginning to be so networked and linked that no one is expert in all areas. We must to look for data and new types of profit-sharing business models" (A).*

The representatives from large companies (G, I) commented that better data analysis could help players to create services that are really valuable for individuals. In the interviews, the MyData approach was seen as a great way to generate new businesses.

A personal trainer company (D) saw data-driven business as a way to save time, especially in the early phase of training. It was noted that profiling a person based on data would help them to prepare better for the first meetings and to plan better services since background questioning is typically really time consuming. Additional value for a personal trainer could be to see what the customer has done outside of their training time, for example to see if the established routine has been followed.

 # Personalization can be used as a resource to differentiate a business and to motivate people to share more data

Four of the interviewed actors (from A, H, D, I) mentioned that personalization could be a way to motivate people to share more data. The director of an SME (A) noted:

> "*The knowledge that you get a better health service by sharing your data is actually motivating people to share more data* [...] *people share data if they trust their nurse or personal trainer*". Being able to see one's progress can be seen as a way to motivate people to do more preventive healthcare actions. "*An individual might be more inclined to share data for personalized services*" stated the director of a personal trainer organization (D).

Improved efficiency via cost and time savings

 # Data can be used as a resource to get cost and time efficiency from a professional's perspective

Across the eight cases studied, it was found that data-driven services could bring additional value for the different professionals. Cost and time efficiency were mentioned as benefits of data-driven business by four interviewees. The director of an SME (A) noted:

> "*The target is that the individual owns his or her data but could get better preventive healthcare services when the data is borrowed by a doctor or a nurse*".

It was noted that the behaviour of people has changed a lot in the past decade. A nurse for a healthcare provider (B) observed that

> "*Nowadays people are bringing data to a doctor's appointment without request. They are showing their heart rate data, for example from tracking solutions* [...] *Providing pre-information before the appointment saves time. The doctor does not need to count some values manually and enter information from different papers into a computer*".

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Insurance companies mentioned that the data-driven business approach would help them to decrease insurance costs. Director of an insurance company (F) noted:

> "*For example, if a customer is active and the risk of getting sick is identified to be lower, health insurance cost could decrease*".

4.2 Challenges to overcome in data-driven service delivery networks

Technology issues

Data reliability

Data reliability was mentioned as a challenge by four of the interviewed companies. From the individual perspective it was noted that

> "*If the person is sick and he or she needs to check his or her weight or temperature, it is important that the information is absolutely right. People understand quite well the basic measurements. It becomes more difficult when you start to measure more sophisticated things, for example things that are not so clear for people – then it is not so clear what the meaning of the data is.*"

The reliability aspect was not so big a risk for those SMEs that do not currently have medically certified solutions. However, it was noted by interviewees from both SMEs that medical certification might be needed in the future in order to combine the data in coherent manner.

> "*If the system gives medical advice the data has to be reliable.*" observed the director of two SMEs [A, H]).

It was observed by personal trainers that

> "*Personal data is perceived to be more reliable if it is automated, not input by an individual, since individuals tend to give better impressions of themselves and can misremember, or disregard, something important".*

One reliability challenge mentioned (by an interviewee from D) was also the question of if we can trust our medical data to be handled by foreign operators on the outside of the service delivery network.

Standard interfaces are missing, and data is in the wrong format

The data usage and transformation were clearly seen as an added value for both individuals and organizations in service delivery networks.

> "*If the data usage is not possible between the services, we are actually decreasing the value of the service.*" stated the director of a large corporation (I): "*We should build system in which the data follows a person one way or another.*"
>
> *There are many examples where a person has been visiting some healthcare organization for 10 years and then moves and starts to visit another healthcare organization. Can the person move his or her personal data from place A to place B if he or she has some treatment that demands continuous monitoring? If the new health provider cannot use anything that the*

> *person has been collecting for 10 years, the person is likely to be ready to exert some time and effort to transfer the data.* (Director, insurance company C)

However, the lack of standard interfaces for receiving data was a challenge encountered by all the types of organization studied.

> "*One clear challenge in our business ecosystem is the poor data interfaces – all the knowledge is in internal silos. We need to exert much effort to collect all the data together*"

noted a nurse working for a healthcare provider. "How can we get working interfaces between the services. [. . .]

> *We need someone to tell us what interface to use in order to move the data to healthcare and what interface to use to move the data across to a personal coach. We need standards to help us.*"

stated the director on an SME. "There is a challenge with the standards. What will the winning format be that transforms the data? If we think of any domain, we still have such old-fashioned systems and it means that there will be technical problems if we try to move the data from one service to another" noted the director of an insurance company (H).

According to the interviewed director of an SME, the regulations (European commission, 2016) are telling companies that the data they give back to the individual should be in a machine-readable format. The challenge, however, is that there is no agreement on the format of the data because the requirements for it vary actor by actor.

> "*All the services are a bit different. They have a different perspective on the data regarding what to do with it and how to enrich it.*" (H).

Although the common interfaces were seen as a benefit, the business value of the data integration was not concrete enough for all the interviewed SMEs to make the effort to make better data interfaces.

> "*We are not making that type of data interfaces before there is some business case and business benefit for us because it would require resources from us to make such interfaces.*" (H).

In Finland the Kanta database was seen as a one solution for data transferral. It was however realized that

> "*Kanta does not offer any real-time data. The stable data is only a small part of the whole value for the individuals and health professionals that could be gained from the data*" noted director of a large corporation (I)

The lack of standard interfaces was also a problem for potential data operator, platform players.

> "*We do not have standards. Even if you had an operator, you have to save the data in some format.* [. . .] *In order to use it you need a similar format and a structure so that the data could be converged from one system to another.* [. . .] *We need all kinds of filters and converters and it might be quite a technical challenge to make it happen.*" (G).

Service interfaces must be easy to use

Simplicity was mentioned as a key for successful service creation in three of the analyzed organizations. The director of an SME mentioned that

> "*The services should be easy to use. This means that you push one button and your data is available for healthcare providers and you push another button and your data is in the use of a personal coach. But if the data transformation demands any more than that from an individual it will never happen.*"

And another director of an SME (H) noted that the

> *"Methods of self-measurement must be as simple as possible to reach all potential users. Simple visualization is must for an end user."*
>
> *Wellness and health-related information (e.g. current state and target state) should be delivered for the individual through visualizations, not through numeric values.* [...] *The companies should show positive information using graphs; especially young people want everything to be shown very simply and briefly. One typical challenge in self-diagnosis can also be that too much negative data is shown to the person. (B)*
>
> *When there is much knowledge available, people start to use the knowledge to do self-diagnosis and often get lost. It is great that we collect knowledge but often we are just collecting negative information.* [...] *Why do we not collect information on how strong you feel? On the happy moments of your life? Often people just get angry when they do not get help when they need it. Often people start to self-diagnose themselves and stop using medicine because they get information about its potential side-effects from the internet.* (Nurse, healthcare provider B)

Governance issues

Missing roles in the current service delivery network

Across four companies, it was found that there are missing roles in the business ecosystem that are actually hindering data-driven business development in the domain of preventive healthcare.

> "*Consumers need someone who can take responsibility for their wellbeing during their whole life. --- The insurance companies cannot take this role because people are so suspicious of insurance players. They think that we just want to decrease our costs. --- This could be some private healthcare provider or public healthcare actor. Public service providers have the need, but not the resources, to make this happen. There will be some actor who will take this role and integrate the needs of other actors. Or it may be that the employee organizations take this role, but for now this seems to be a missing role in our business ecosystem.*" *(F)*
>
> *One missing player in the ecosystem seems to be an operator who is making sure that the individual's data is safe and under the control of individual.* (Director of a large company [G])

Unclear revenue model

When the roles in business ecosystems are not clear, it is unclear for SMEs to whom should they actually be selling the new services.

> "*No matter if we sell a consumer service or company service, the end results are often very similar. The key question in the future preventive healthcare scenario in which the individual owns his or her data, is who will buy the end service? Is it an individual or is someone going to buy it for the individual? Is it the employee's organization, private healthcare players, the public sector or an insurance company?"* Director (A).

Insurance company representatives mentioned that

> "*it would be ideal that each person would have their own personal trainer. But it is not possible for insurance companies to buy everything.*"

The director of an insurance company reminded us that the individual who is helped should also be ready to buy something for the future wellbeing services.

> "*The individual's readiness to buy is the basic question that is now hindering the business development in the preventive healthcare domain.*" stated the directors of an insurance company (C, F).

From an individual perspective it was noted that personal data could also be valuable assets to sell to different actors in the future.

> "*Perhaps individual could ask his own data from actor A and sell it to actor B. This would be added value that is not existing now*" stated the director of a large company (I).

The wrong target audience

It was mentioned by three interviewees that one of the biggest challenges of data-driven service delivery networks in the preventive healthcare domain is that it is difficult to reach the audience that would most benefit from the created services.

> "*We can easily make services for the active engineers that get excited about the data. The challenge is how we can make solutions based on data in a way that it is motivating for normal people. That is our usability and commercialization challenge*" observed the director of an SME (H).

> *The problem is that those people who already are active, who are exercising, who are eating well are the people who are using most of the preventive services. The segment of the people who need the services most are not really using them.* (Director, insurance company C)

4.3 A summary of the findings

A key output from this study is a set of success factors to be considered in data-driven service delivery networks. These are discussed throughout this article and summarized in Table 2.

Table 2. A summary of success factors

Benefits of data and related success factors in data-driven service delivery networks

Benefits	**Success factor**	Related literature
Service complementarity between actors via data sharing		
# Creating value and scaling business with the available data	Healthcare providers work as customer acquisition channels for complementary service providers. The data, as a resource, will enable different players to create services based on the real needs of a person	Self-tracking services, devices, wearable sensors and mobile applications are used as a resource to make it possible for end users to collect, measure and use data to change their behavioural activity (Sharon, 2015; Zainuddin, et al., 2016) The use of data is a resource for scaling up the business (Adner, 2006)
Better and more personalized services		
# Personalization can be used as a resource to differentiate a business and to motivate people to share more data	Data can be used as a resource to create personalized services which make it possible to get more personal data and motivate people to do more preventive healthcare actions	The use of data as a resource to differentiate the business from others, bringing competitive advantage with the resources in an ecosystem (Wang, 2012; Vargo & Lusch, 2004; 2008)
Improved efficiency via cost and time savings		
# Data can be used as a resource to get cost and time efficiency from a professional's perspective	The analysed data will work as a resource helping professionals to focus on the right actions and to save wasting their time on irrelevant actions	A new benefit appeared from the case analysis

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Challenges to overcome and related success factors in data-driven service delivery networks

Challenges	**Success Factor**	Related literature
Technology issues		
# Data reliability & quality	Data collection should be made as automatic as possible: the data that is inserted by people is often not reliable because people do not want to tell the truth	Quality of the data (Redman, 2015)
# Standard interfaces are missing and data is in wrong format	The standard interfaces for data transformation are urgently needed	Some companies in the same service ecosystem still keep customer data in internal silos (Redman, 2015)
# Service must be easy to use and supportive	Attention must be paid to service design: unsupportive user interface and complex data presentation deter customers	Using service design to encourage the use of data in service advancement (Ostrom, et al., 2015)
Governance issues		
# There are missing partners and a payment structure in the current service delivery network	The responsibilities and payment structure need to be clarified in preventive healthcare service delivery networks	Actors of an ecosystem often operate around a facilitating anchor/keystone company that is linked to a platform (Valkokari, 2015; Iansiti & Levien, 2004)
# Unclear revenue model	A clear business model is a requirement for the SDN	Business model is essential to articulate the changes wanted or needed by the firm (Keen & Qureshi, 2006)
# The wrong target audience	The future services should be targeted to normal people who currently are not interested about their health issues – not only to people already active and interested in their health	A new challenge appeared from the case analysis

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5 Discussion

Some of the success factors for data-driven service delivery networks revealed in this paper refer to the lack of resources, which hinders the involved organizations' capabilities to co-create common customer value. One example of the missing resources revealed by our data is the missing technology development: the interfaces and access to data. Proper technological solutions are an essential factor in utilizing personal data (Pikkarainen, et al., 2018). The interviewed insurance company directors commented that due to the fairly common belief that insurance companies would use data against people to lower their own costs, insurance providers might not be perceived to be ideal actors to join a network in which personal data would be mutually shared and used for co-creating end-user value. Additionally, our case study shows that many types of actors are needed in the service ecosystem to build a working data-driven service delivery network. It might be difficult to establish a new data-driven service delivery network as long as there are essential unfulfilled roles within the ecosystem. Contrary to Valkokari's (2015) definition of the innovation ecosystem as "geographically proximate actors interacting around hubs facilitated by intermediating actors", no intermediating anchor or keystone actor has emerged to facilitate actions in the preventive healthcare data-driven SDN, and not all actors are geographically close.

It has been argued that business ecosystems only create value for an individual participant if it is unable to commercialize the service relying on its own capabilities (Lin, et al., 2010). Our study shows that participation in data-driven service delivery networks may bring benefits to companies which possess capabilities to utilize shared data. It was noted, for example, that many individuals are currently coming to their occupational healthcare appointments with their own text files, where they have collected their personal data. The healthcare professionals mentioned that it would have been useful and more effective had this data been sent to their systems electronically in a modern manner, with the permission of the individuals. Thus, participation in data-driven service delivery networks may provide added value even if the participant company was able to commercialize services on it own.

Perhaps surprisingly, we did not directly identify discussions about the problems related to the wrong data and data analysis costs mentioned by Redman (2015) in our interview data. This aspect was, however, covered in the analysis in the comments in which the network actors claimed that these types of partners are needed in the future ecosystems to make this a successful business. The participating actors did not mention ethical concerns (Ruckenstein, 2014) or legal limitations (Otjacques, et al., 2007) as factors that hinder their business in the service delivery network. New benefits and challenges to have appeared from the case analysis were the use of data to increase the efficiency in healthcare organizations, and the fear of identifying the wrong target audience and payment structure. The latter seems to hinder service delivery network development, especially in the preventive healthcare domain.

Although the different perspectives of innovation networks have been widely researched in many studies in a past decade looking at e.g. the perspective of independency, stability, dynamism, collaboration, orchestration roles and practices (Hurmelinna-Laukkanen, et al., 2012) there is not much existing research which explore the factors that impact the organizational capabilities required to participate in emerging data-driven service delivery networks. The closest literature

related to the data-driven service delivery network is the literature of digital servitization (see e.g. (Bustinza, et al., 2018; Skylyar, et al., 2019; Vendrell-Herrero, et al., 2014)), in which change in the industry due to digitalization is under the lens. Skylyar et al. (2019) argue that the mind-set of many ecosystem actors is to resist change: they are not yet fully accepting the idea leading towards disruption of the status quo. In our case, the network actors are actively seeking change, and this study explores many issues regarding the benefits and challenges of a data-driven service delivery network.

Thus, we believe that our study makes several important research contributions. First, we shed light on the challenges and the potential of the data-driven service delivery networks. In doing so, we extend the discussion about data and network concepts that has been part of the discussion. The traditional focus in the previous "big data" literature has been in the firms' internal perspective. see. e.g. (Tiefenbacher & Olbrich, 2015; Baro, et al., 2015). When combined with data management and analytics processes, data can act as a valuable resource or asset (Xie, et al., 2016) for both the firm and its network. Typically, companies do not share data or expertise. Instead, the intention of companies has typically been to keep control over the information assets (Ctrl-Shift, 2014). Our analysis brings new perspective between a firm and its network actors, particularly in the preventive healthcare sector, where data needs to be shared between actors via consent of the individuals. Second, this study enriches the theoretical perspective of Xie et al. (2016) continuing discussion on how big data resources become cooperative assets not only in a firm but also on the larger networked level. Our findings show that using data as a resource requires the companies to have a capability to work together with other actors, creating and securing ways of sharing the high-quality data via individual consent. This data sharing is a huge opportunity especially for SMEs, which could have access to data that was previously the privilege of larger corporations and governmental bodies only. It will only be possible if an infrastructure that allows data sharing in a standard manner with relatively low costs is created. Even this does not guarantee that the service delivery network could reach the right target audience.

This study has multiple implications for practitioners trying to navigate the turbulent waters of the changing ecosystem and evolving service delivery network of preventive healthcare. Our managerial contribution lies, first, in the identification of the success factors in the benefits and challenges inherent to data-driven service delivery networks. The introduced success factors can be used as a tool when planning networked service innovation activities. With the help of the identified success factors, the different network actors can determine whether it is worthwhile for them to expend their resources to access the data-driven service market, and if they decide to do so, what are the most important issues to overcome. It was noted that especially SMEs could have key roles in the service delivery network through specializing in collecting the end-user data and, with the permission of individuals, transferring and transforming it for other players. This would make SMEs integrated parts of the service continuum, bringing them the possibility to find customers to whom they can bring added value. In preventive healthcare, however, the challenge in general is to reach those customers that are not so interested in lifestyle changes and health improvements. This is the most decisive target group in promoting health and wellness for society in general, and also from the insurance company perspective and from the health risks point of view.

There are many possible paths to monetizing the data revolution. Choosing the right type of business and revenue model for one's organization is the key issue (Huhtala, et al., 2017). Understanding the characteristics of preventive healthcare as a service delivery network is major defining factor. Only by understanding which business model suits one's organization best can one help the players to make smart decisions on how to build, partner or acquire one's way in the next wave (Wang, 2012). This creates uncertainty related to how the revenue is distributed. It was shown in our study, that currently in the preventive healthcare domain, it seems difficult for organizations to make these decisions and to integrate a revenue model into the data-driven business opportunity. The preventive healthcare network actors seem to be waiting for others to solve the situation, or take new roles in the service delivery network to make data readily available for utilization, rather than proactively seeking to lead the revolution.

The present paper proposes factors that affect actions and change in data-driven service delivery networks, with the aim of enriching current understanding of the benefits and challenges related to the network's creation in preventive healthcare. The work is based on a case study that was conducted using a service delivery network as a unit of analysis, consisting of eight companies from the preventive healthcare sector. Some of the players are already collaborating in the same network but some were selected for the study due to their interest in joining and contributing to the service delivery network, based on identified potential business benefits. Therefore, it should be acknowledged that the studied service delivery network was in a development phase at the time of the study. Thus, the applicability of the proposed success factors should be investigated in various extant operating service delivery networks, such as in the industrial domain, to validate their universal applicability.

Sometimes building theory from cases may result in a narrow theory. Case study theory is a bottom-up approach in which the risk is that the created theory is difficult to generalize (Eisenhardt, 1989). In our study, we did not yet develop a new theory, but we rather aimed to enrich the understanding of the service delivery network, and data as a resource in value co-creation. The next step of the study is to propose a model for organizations to survive in the future data-driven service delivery networks.

Our study has its limitations. For instance, while we conducted multidisciplinary theoretical approach including e.g. the key constructs of ecosystems, service delivery, networks and data, it was not possible to go deep into one research discipline. Unable to include details with regard to different aspects, this may have caused us to miss something. Such limitations also provide a basis for future research. For example, looking at the success factors from the perspective of innovation, network orchestration would be worth further examination. Additionally, the present study opens interesting opportunities for future research. Further research is needed on the design and variety of value that the potential data-driven services could bring. Another research idea is to use the business model construct to identify additional business opportunities. For example, revenue models that could support data-driven service delivery networks both from the network- and the individual organization's perspective. It would be interesting to repeat the study of success factors in extant, successfully created service delivery networks to increase the evidence of validity. It has been argued by Skylyar et al. (2019) that longitudinal network research is needed to bring additional insights into the evolution of ecosystems. This is a relevant future research angle also to this study. Additionally, the study can be extended by providing

specific recommendations (or an action plan) for improving the identified practices in the service delivery network.

6 Conclusions

In sum, real-time personal data is a vitally important resource for companies who are part of data-driven service delivery networks. However, the accessibility of data can be a major issue. The barriers to access and use data are real. The existing standards, payment models, and network roles are not clear enough for organizations to move on and start sharing and utilizing personal data.

It is certain that there will be failures. Solutions targeted for the wrong audience, individuals not realizing the value of personalization, lack of motivation to share data. When the control of data is in the hands of the individuals themselves, data operators capable of supporting people with their data are necessary. To help release personal data from organizational silos, organizations in service delivery networks should adopt a new type of effectual attitude toward business model experimentations. According to our study, it is clear that accessible personal data, as a resource, can provide a lot of opportunities and benefits for companies, insurance players, healthcare providers and individuals - if the challenges can be resolved.

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Appendices

Appendix 1: The companies interviewed

ID	Sector	Type of Company	Business and services / key activities	Interviewed person(s)
A	Technology and application provider	SME	Technology provider, data analytics, wellness application	CEO
B	Healthcare service provider	Large corporation / healthcare provider	Healthcare and wellness	Development Director (Working Life Services) Two nurses and one doctor

ID	Sector	Type of Company	Business and services / key activities	Interviewed person(s)
C	Insurance company	Large corporation / insurance company	Banking, financial, insurance, healthcare and wellness	Chief Actuary (Insurance)
D	Wellness service provider	SME, personal trainer company	Wellness trainer courses	CEO and the Director of International Growth and operation
E	Wellness service provider	SME trainer company	Personal trainer services	Two personal trainers
F	Insurance company	Large corporation / insurance company	Insurance	Two directors
G	Telecommunication device and platform provider	Large corporation / platform provider	Mobile network operator	One director
H	Wellness platform provider	SME / platform provider	Technology provider, wellness application	One director
I	Telecommunication device and platform provider	Large corporation / service device and platform provider	Technology provider, wellness application	Ecosystem director

Appendix 2: The presented scenario

Mary use case:

> *Mary is going for a health check. Mary is a 24-year-old pregnant woman who has just got a new job. She cares about her wellbeing, but the new job and its requirements are making her very stressed out.*
>
> *Mary is exercising once a week, taking long walks, and trying to eat as healthily as possible. She is collecting information about her walking habits using a mobile application. Before the health check Mary makes a health check using a mobile application. She also transfers all of her self-collected data to the doctor.*
>
> *Mary is opening a data account for her unborn child because she wants to make sure that any data transferral is as easy as possible. Mary is moving the child's insurance information and other information to the data operator so that they can easily be used in the future.*
>
> *Mary fell down while walking and her wrist hurts. She is using her mobile phone to check the symptoms. Through the mobile phone she can directly chat with a nurse about the situation. Mary is asked if she wants to share her health check data with a nurse and doctor so that they can take care of her better. She is also asked if she wants to share the status information about the accident with an insurance company.*
>
> *Mary has had her baby and she is back at work. Mary is really stressed out. The baby*

is keeping her awake all night and she does not have time for her weekly walks. Mary is sharing her health data with her health provider, asking for help with her situation. The system is collecting Mary's data for a few days and giving her some guidelines on how to improve her situation. At some point, the system suggests that Mary goes to talk to a nurse and psychologist about her problems. The system also suggests that Mary tries out a personalized personal trainer program that can give her specific guidelines to help improve her situation using the collected data.

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Biographies

Minna Pikkarainen. Minna Pikkarainen, is a joint Connected Health professor of VTT Technical Research Centre of Finland and University of Oulu / Oulu Business School, Martti Ahtisaari Institute and Faculty of Medicine. As a professor of connected health Minna is doing on multidisciplinary research on innovation management, service networks and business models in the context of connected health service co-creation. Professor Pikkarainen has extensive record of external funding, her research has been published large amount of journal and conference papers e.g. in the field of innovation management, software engineering and information systems. During 2006-2012 Professor Minna Pikkarainen has been working as a researcher in Lero, the Irish software engineering research centre, researcher in Sirris, collective "centre of the Belgian technological industry" and business developer in Institute Mines Telecom, Paris and EIT (European Innovation Technology) network in Paris and Helsinki. Her key focus areas as a business developer has been in healthcare organizations. Previously, Minna's research has been focused on the areas of agile development, software innovation and variability management.

Tero Huhtala. Tero Huhtala was born in Oulu, Finland in 1984. He received the B.S. and M.S. degrees in marketing from the University of Oulu, Finland, in 2014. Since 2015, he has been a doctoral student with the department of marketing, management, and international business, University of Oulu, Oulu Business School. The topic of his doctoral dissertation is data-based value creation in service delivery networks. He has seven scientific publications, most of them regarding preventive healthcare. His research interests include the study of digitally enabled services and the value and use of data in advancing services.

Laura Kemppainen. M.Sc. Laura Kemppainen is a Doctoral Candidate at Martti Ahtisaari Institute of Global Business and Economics at the AACSB accredited Oulu Business School, Finland. She holds a M.Sc. in Marketing from Oulu Business School. Laura's research interests include platform business models, human-centered personal data management, digital innovations and value creation. In her doctoral dissertation, the aim is to build understanding about the creation, capture and co-creation of value in the emerging data- and platform-driven ecosystems through the lens of service-dominant logic of marketing.

Juha Häikiö. Juha Häikiö is a research scientist at the VTT Technical Research Centre of Finland and works in the Foresight-driven Business Strategies unit. He holds an MSc in Information Processing Science. His research interests include user-centered design, user experience and digital service ecosystems. He has experience about R&D projects focusing on digitalization in a number of different industrial sectors.

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The Importance of Taking a Process Perspective on the Use and Application of an Innovation Management Self-Assessment Audit

Helena Blackbright
helena.blackbright@mdh.se | School of Innovation, Design and Engineering, Mälardalen University, IDT, Box 325, 631 05 Eskilstuna, Sweden

Abstract. Prior research on innovation management self-assessment audits (IMSA) has a strong focus on the assessment situation, primarily on what to assess. However, several additional tasks are necessary to make purposeful use of an IMSA. This study analyzes the undertaking of an IMSA from a process perspective to better understand IMSA's utilization by looking at how people participate in the process and how the process is integrated in an organizational context. This study adopted an interactive research approach and collected data over a period of 27 months in 45 interviews, six workshops, and 10 meetings with 42 different participants from three companies. Results show a fragmented participation, and that the process was only partly integrated into the organizational context, making it arbitrarily dependent on individual actors. This demonstrates the need to understand challenges related to IMSA use to enable a process that is integrated in the structures intended to be improved.

Keywords. Assessment Process; Innovation Assessment; Innovation Audit; IMSA; IMSA-process; Process, Complexity; Discontinuity; Innovation; Innovation Management; Internal Assessor; Assessor.

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1 Introduction

Innovation management auditing and assessment have long been considered a vital part of good innovation management practices (Adams et al., 2006; Tidd and Bessant, 2013, Dewangan & Godse, 2014), often providing scorecards and tools that give valuable opportunities to identify both strengths and weaknesses and also gaps between current and desired states (Coombs et al., 1998; Cormican & O´Sullivan, 2004; Alegre et al., 2006; Tidd & Bessant, 2013). However, despite giving a valuable indication about potential improvement areas (Chiesa et al., 1996; Radnor & Noke, 2002; Bilsoslavo, 2005; Nilsson et al., 2010; Tidd & Bessant, 2013), prior research has shown that assessors struggle with both making use of the assessment results (Karlsson, 2015) as well as preparing for and undertaking the assessments (e.g., Chiesa et al., 1996; Moultrie et al., 2007; Nilsson et al., 2010; Karlsson, 2015). It does not matter how relevant the assessment variables are or how precisely the gaps between current and desired states were identified; this does not in itself reveal how to actually close these gaps (Langley et al., 2013) in a way that leads to improvements in line with the intended purpose (Moynihan, 2009). To utilize a self-assessment with some sort of improvement purpose, more than just identifying the gap between current and desired states, is important (Samuelsson and Nilsson, 2002; Nilsson et al., 2010; Karlsson, 2015). It is critical to place the assessment indicators in a contextual setting where the assessment is considered from a holistic perspective (Samuelsson & Nilsson, 2002) to understand why things emerge over time (Langly et al., 2013) and how to make purposeful use of the assessment (Kerssens-van Drongelen & Bilderbeek, 1999; Panizzolo et al., 2010; Birchall et al., 2011; Karlsson 2015).

Although prior literature is often based on an understanding of innovation as a process, different studies often had a variance perspective on the process, and only few addressed the self-assessment itself as a process (e.g., Samuelsson and Nilsson, 2002; Hallgren, 2009; Nilsson et al., 2010; Karlsson, 2015). To build a better understanding of how to purposefully use (Moynihan, 2009) an innovation management self-assessment audit (IMSA) inspiration was drawn from scholars in processes and complex adaptive systems (Marion, 1999; Feldman & Pentland, 2003; Ellström, 2010; Langley et al., 2013). In combination with insights from prior research on audits and self-assessment within the field of innovation management and quality management (Samuelsson & Nilsson, 2002; Adams et al., 2006; Nilsson et al., 2010; Karlsson, 2015), this study's approach enables a focal shift from what to assess to instead focus on purposeful use of an IMSA within its organizational context.

In the undertaking of a process the activities interlink the participating actors to its context, more or less firmly binding them together over time, creating a bridge that allows information to be transferred between actors, enabling them to change its context, and also enabling the context to change the actors that populate the process (Marion, 1999). As most IMSAs have a direct or indirect improvement purpose, this purpose is in reality to change something in a way that makes the organization better (improved). Since organizational change in itself means that the structuring of the organization's social system is changed and maintained by its actors (Marion, 1999), the undertaking of an IMSA must therefore lead to both structural and behavioral changes to successfully fulfil its purpose. This motivates a study of both the people who are part of the process and their organizational context. With an overall objective to better understand the

challenges of undertaking and utilizing an IMSA this perspective was applied to a longitudinal study of the implementation and application of an IMSA over a period of 27 months using qualitative data from 46 semi-structured interviews, seven workshops, and 10 meetings involving 39 participants from five assessment projects of three organizations. The following research questions were used to guide the research:

RQ 1: How are people made part of the IMSA process?

RQ 2: How is the IMSA process integrated in its organizational context?

Findings show that both the integration of the process in its organizational context and the inclusion of people in the process were done in an unstructured and informal way. The process thereby became arbitrarily dependent upon the understanding, ability, and will of key actors that possessed critical information, resources, and competence. This affected the process by fragmenting it in a way that created discontinuities in the information transfer that at its best made the process less effective and often constituted a hindrance to its undertaking and progression. Based on this, three major conclusions were drawn. First, the use of an IMSA comes with a meta-level challenge of understanding the challenges of undertaking and utilizing it. Second, to successfully utilize the IMSA it has to be related to the structures it is intended to change and the people that have an impact on these structures. Third, the continuation of the process must be given more consideration to allow information to accumulate and drive change.

2 The process of undertaking a self-assessment

With the goal of taking a process perspective on the use and application of an IMSA to better understand the related challenges this article continues with two sections that address the process of undertaking a self-assessment. First from the perspective of prior research which will then be followed by a section that provides a broader theoretical framework.

2.1 Prior research

Measuring and assessing innovation is considered a vital part of good innovation management (Adams et al., 2006), and there is abundant research on assessments and measurements of different aspects of the innovation process and organizational innovativeness. Although an increasing number of papers address the use of innovation measurements and assessments (Dobni and Klassen, 2018; Janssen et al., 2011), only few focus explicitly on the requirements of the people who participated in the process (Karlsson, 2015), and on how to undertake and utilize the information extracted from the assessments (Birchall et al., 2011; Adams et al., 2006).

Although prior studies on innovation management measurement and assessment often focused on what to assess (e.g. Dobni, 2008), several directly or indirectly addressed issues related to the undertaking and utilization of assessments. While these studies did not directly study the undertaking or the utilization, they often provided valuable input that can be used to place the assessment in a wider use-context. A wider use-context is often represented by the existence of direct and indirect descriptions of issues, tasks, activities, and qualifications that have been

shown to enable or disable a purposeful use of an assessment. Since these areas are often outside the direct research scope of these studies, these aspects are seldom directly addressed, but they still confirm that making use of a self-assessment requires more than simply undertaking the self-assessment of one's current state (Samuelsson and Nilsson, 2002; Nilsson et al., 2010; Karlsson, 2015).

The description of what can be considered a use-context differs between papers. Some described preparatory issues and the tasks that forego the self-assessment in itself, for example, activities performed to raise awareness about the assessed area before the assessment is undertaken (Nilsson et al., 2010). Others are related to qualifications that affect the ability to undertake the self-assessment, for example, senior managers being too far from the assessed area to be the best auditors (Chiesa et al., 1996) or a lack of understanding of the metrics used (Janssen et al., 2011). Others mentioned the contextualization of metrics (Chiesa et al., 1996) and still others described issues and tasks that were related to the utilization of the self-assessment results and the work of transforming them into improvements and changes. The most common of the explicit suggestions is that the assessment results can be used as an input to guide decision making (Birchall et al., 2011) and act as a base for transforming activities that could lead to improvements (Radnor and Noke, 2002; Cormican and O'Sullivan, 2004; Björkdahl and Börjesson, 2012). Some were directly mentioned as something that could be done, others described situations where it could be understood that specific tasks have been undertaken or specific competencies have been part of the undertaking, and others illustrated problems that indirectly described requirements or activities. However, it is unusual to find papers within the innovation management field that focus directly on the undertaking and utilization of the assessment.

Prior studies within the quality management field more frequently address the undertaking of the assessment and the people taking part in the assessment more so than studies within the field of innovation management. The undertaking of the assessment itself, not only the assessment results, has more often been treated as an important part of the improvement groundwork. However, research within quality management is also criticized for not taking a holistic perspective on self-assessments (Samuelsson & Nilsson, 2002), which risks isolating the indicators from the characteristics of the organization against which it needs to be interpreted (Carayannis and Provance, 2008).

A qualitative study by Svensson and Klefsjö (2006) from the field of quality management provided findings that highlighted the issues often addressed indirectly in innovation management research. Personnel that participated in a self-assessment felt that they received too little self-assessment training, and perceived the terminology to be abstract and the questions difficult to understand. The same study further showed that participants did not understand the purpose (for whom it was undertaken and why) and were unable to see how they would benefit from the process. Also, managers underestimated the resources required to undertake the self-assessment. Several of the participants experienced that insufficient time and support were provided to undertake the assessment process (Svensson and Klefsjö, 2006).

Both Svensson and Klefsjö (2006) and Samuelsson and Nilsson (2002) described the self-assessment as a process in a way that reminds much of the work of Hallgren (2009), Nilsson et al. (2010), and Karlsson (2015). All of them approaching the assessment use as a process in a way that

incorporates much of the issues that have often been addressed, directly or indirectly, in prior innovation management studies but outside primary focus. Karlsson (2015), as well as Samuelsson and Nilsson (2002), directly addressed the assessment process in their research. When merging these two studies into one model (Fig. 1) they show great similarities, both describing a process that covers the wider scope of tasks, activities, and participants that is often indirectly addressed in prior innovation management research. The process involves both preparing tasks that precede the assessment and tasks should follow it (Fig. 1). Karlsson (2015) focused primarily on the structural division of the process in relation to the task of self-assessing one's current state. Described as a three-staged process consisting of a pre-assessment phase, where all the assessment preparations are undertaken; an assessment-phase, where an assessment of the current state is undertaken; and finally, a post-assessment-phase, where all the activities required to turn assessment results into activities that lead toward the assessment purpose are conducted. Samuelsson and Nilsson (2002) described a very similar process structure and did unlike Karlsson (2015) also provide a more detailed description of the process content (Samuelsson & Nilsson, 2002). In comparison, Karlsson (2015) addressed the process from three perspectives: what to assess, who to participate, and how to undertake the assessment.

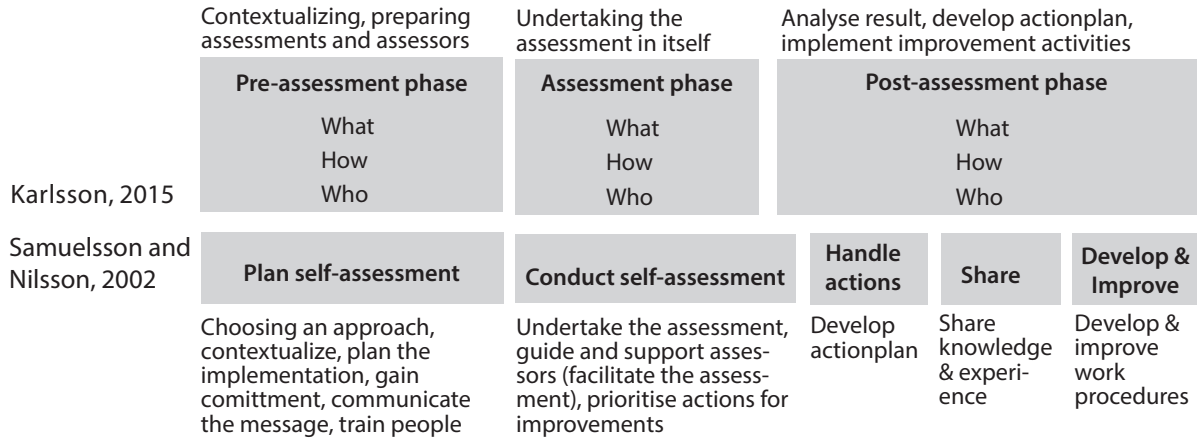

Fig. 1. This shows a comparison between the self-assessment processes as described by Samuelsson & Nilsson (2002) and Karlsson (2015).

The primary focus of prior innovation management research, when compared to Fig. 1, is on the assessment phase where it has its main representation in the what dimension (e.g., Chiesa et al. 1996; Alegre et al., 2006; Moultrie et al., 2007; Björkdahl and Börjesson, 2012; Croplay et al., 2013). However, we can also see that issues that have been addressed but not considered the primary focus of prior innovation management research match well with the pre- and post-assessment phases (e.g., Chiesa et al., 1996; Cormican & O´Sullivan, 2004; Nilsson et al., 2010; Dobni and Klassen, 2018), and that these are also to a large extent related to the dimensions of how and who.

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2.2 Theoretical framework

When addressing an IMSA as a process, the focus is on the interaction and informational transaction that interlink actors, activities, and tasks to each other as well as to their organizational context, giving both the structures and the actors an explanatory power (Langley et al., 2013) as they together bridge time in a way that allows information to be transferred within the system and eventually enables actors that populate the process to change its context and vice versa (Marion, 1999). On the one hand, this results in a complexity that prevents the development of the process to be fully predicted in a deterministic way but on the other hand, this enables the emergence of results greater than the sum of its single parts. (Ibid)

2.2.1 Shifting focus from what to how.

A process in itself can be recognized as a pattern of activities that is continuously changing and developing over time as undertaken by the actors participating in the assessment process, recognizable because it has certain delimitations towards its outer world but also interdependently interlinked in its contextual setting. As soon as the IMSA is described as a process it must come with the recognition of complexity and contextual setting as well as time, interaction, and agency as these are all important elements that impact the continuation of the process (Prigogine, 1997; Marion, 1999; Langley et al., 2013).

Addressing the IMSA as a work process that recognizes time and context helps break the analytical isolation (Carayannis and Provance, 2008) and enables a better understanding of how and why the process emerges and develops the way it does (Langley et al., 2013). It also allows us to address the process from two structural sides, a formalized and a performative side.

The formal structure is the description of the process as it is intended to be undertaken (e.g., as described by the audit). The other side is the practical, actual undertaking of the process, how it is actually done (Ellström, 2010; Feldman & Pentland, 2003).

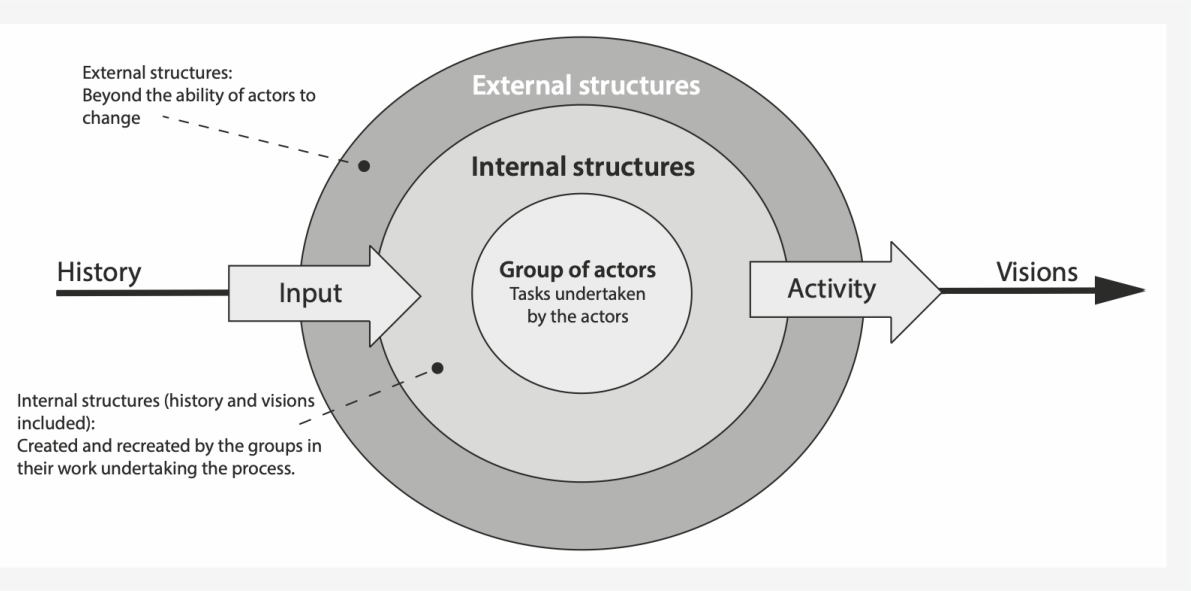
Formalization can be done in several ways, both explicitly and tacitly, through the normalization of operational procedures that codify in a specific context the taken-for-granted norms and tacit elements in procedural knowledge. However, formalization may also be achieved through explicit and formal descriptions of how the process is intended to be undertaken in terms of standards or work descriptions (Ellström, 2010). The formalized structures provided by most IMSAs concern only a limited part of the process suggested by Karlsson (2015) and Samuelsson & Nilsson (2002) (the assessment-phase). Although the formalized side of a work process is often said to be overestimated in terms of importance and impact (Ellström, 2010), the provided structure makes the process less abstract and easier for the assessors to use (Anderson & Krathwohl, 2001; Panizzolo et al., 2010). The formalized side makes it easier for actors to take part in a process even when it is not fully understood (Feldman & Pentland, 2003). When only a small part of an IMSA process is formally codified, less support is provided to the actors involved in the assessment process. Either large parts of the process will have to be undertaken under conditions where no formal codification is provided or formalization of the process has to be made part of the IMSA process as a task in itself. Both scenarios require a certain level of experience and knowledge from those who will be part of such a process (Anderson & Krathwohl, 2001).

However, no matter how well-described the formalized side of the process (or a part of the process)

is, it can never be described in such detail that everyone perceives it and undertakes it in exactly the same way. Every action undertaken is impacted, and to some extent formed, by both the individuals' own structures and the surrounding structures (Backström, 2018). Therefore, besides the formally described process, there is always an actual undertaking, a performance of specific activities performed by specific actors at specific times and places. This is the performative (tacit) side of the process (Feldman and Pentland, 2003; Ellström, 2010).

2.2.2 Structurally formed interaction and complexity.

As with any process where a large number of interactions between interdependent actors and factors[1] (processes) take place, complexity is part of the IMSA process as well. The interdependent actors and factors form a system together in which the interaction between them constitutes the very core of the process (Marion, 1999). At the heart of the process, both driving its progression and causing its complexity, is the interaction. Unlike action that can have a one-way causal effect, interaction is in itself defined as having a mutual effect on its interacting parties caused by the information transaction that regulates the behavior of the involved (Prigogine, 1997). Not necessarily through verbal communication but also by saying nothing, information that has an impact on the social structure is transferred when observing how colleagues work, or through facial expressions, clothing, and a lot of other things (Berger & Luckman, 1979). This has a mutual impact on them as individual actors and on them as a group, affecting their behavior even if only temporarily. The actions of every social group, consisting of two or more actors, are impacted and formed by their surrounding structures that affect the operationalization of an IMSA. Both external and internal structures affect every activity that is undertaken throughout the assessment process with the external being beyond the ability of actors to change, while the internal are created and recreated by the activities undertaken by the group (Fig. 2).



[1] Any "factor" of a complex and dynamic system as a process is actually a reification of a process, constituted "by varying and fluctuating activities" (Langely et al., 2013) that are interdependently connected to other processes.However, for readability reasons the term "factors" will be used here.

Fig. 2. Visualization of structures impacting the assessment groups (inspired by "Fig 5.2 Organisation ur ett perspektiv av social interaktion [Organisation from the perspective of social interaction]" from Backström, Döös & Wilhelmson 2006).

The process in itself is an enactment of these internal and external group structures as well as structures of the individual actor. Together, these three types of structures constitute the prerequisites for all interactions between different actors throughout the assessment process, forming the assessment process through their impact on the individual actors and on their social interactions. As a result, all interactions between different actors lead to either a modification or a reinforcement of individual prerequisites and internal structures (Fig. 3), leading us to a circular causality where interactions are formed by structures at the same time as these structures are reinforced or modified by the interactions undertaken (Marion, 1999).

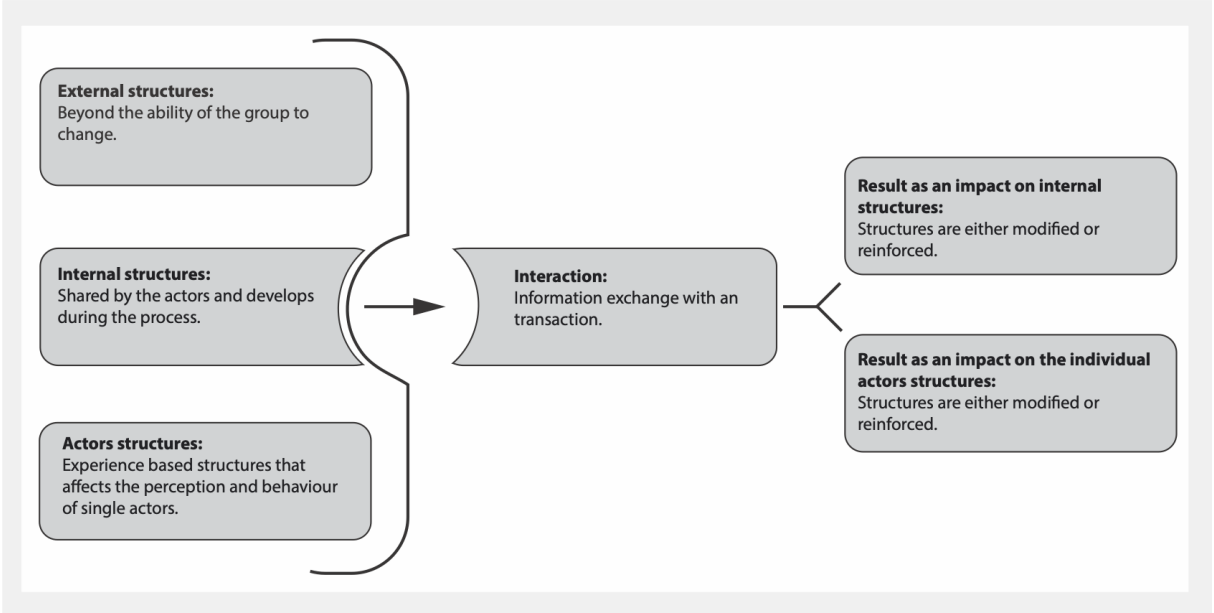


Fig. 3. The GroPro model from Backström, T. (2018): "How to understand and facilitate creative group processes – The GroPro model."

Even though the stated overall purpose of different assessment tools varies, prior research often contain formulations that give them a direct or indirect improvement purpose. These formulations state that the use of the tool should, or could, lead to an improvement of the assessed area by, for example, bringing attention to "what needs to be improved" (Yang et al., 2001), or suggesting that it "... would be a considerable help in improving actions during the innovation process" (Cropley et al., 2013), or "... can be used to manage and optimize the innovation process internally" (Carayannis and Provance, 2008). Purposes that require the undertaking of an IMSA lead to a structural modification and thereby indirectly stress the need to acknowledge the structures that constitute the contextual setting within which these pre-assessment and post-assessment activities (Karlsson, 2015; Samuelsson & Nilsson, 2002) should be undertaken, performed, and formed under the influence of structures that are both within and beyond the actor's ability to

develop through the process, enabling or disabling the required information transfer to take place (Marion, 1999).

Any work process, including the assessment process, is in itself constituted by an interwoven combination of a performative side and a formalized side that co-exist in a continuous change, developing over time through the information transfer that comes with the activities that are and are not undertaken by the actors involved in the process. Over time, this pattern of activities and continuous change bind *what* is done, to *how* it is done, and *why* in that specific contextual setting in time, allowing us to give the activities undertaken (or not undertaken) an explanation value, helping us to build understanding and explain how and why a process develops the way it does (Langley et al., 2013). The process perspective provides us with a possibility to add a timely context to prior IMSA research by expanding the reasoning of, for instance, Karlsson (2015), Panizzolo et al. (2010), and Biazzo & Bernardi (2003) by using Ellström's (2010) and Feldman & Pentland's (2003) research on routines and work processes.

3 Method

Taking a process perspective on an organization (or assessing units) undertaking an IMSA comes with some interesting methodological opportunities and requirements. As a dynamic process, such as the undertaking of an IMSA, is an embedded part of a complex adaptive social system, the process cannot be understood as a set of dependent variables (Maxwell, 2013). Instead, the process can be seen as a "sequence of events or activities that describes how things change over time" (Van De Ven, 1992), this forms a process with an ontological viewpoint that "tends to associate with a dynamic social constructivist view" (Langley et al., 2013). We have to move closer to the actual behavior of people (Pettigrew et al, 2001) as it illustrates the "ongoing interactions among different individuals, between individuals and organizations, and between multiple levels across organizations and contexts permeate and orient change processes" (Langley et al., 2013). The recognition of the complexity and contextual setting, as well as time, interaction, and agency, become important elements that affect the development of the process (Prigogine, 1997; Marion, 1999; Langley et al., 2013). Therefore, choosing case companies where a close relation could be established and where rich qualitative data could be accessed through a longitudinal study (Yin, 2009) that gave an opportunity to be closer to the actual behavior of people (Pettigrew et al., 2001) was prioritized (Maxwell, 2013). Data came from a period of 27 months within a research project that stretched over 36 months that explored the use of an IMSA as a means to increase innovativeness. An interactive research approach (Svensson et al. 2007; Ohlsson & Johansson 2010) was adopted and conducted in close collaboration with three companies referred to as A, B, and C below. All participants were situated in a context of everyday work structures (Ellström 2010, Feldman & Pentland 2003). Case selection, empirical data collection, and analysis of the data used will be described further below.

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Table 1. Description of the case companies

Company	Description	Industry	cases	No of employees
A	Multinational organization active in more than 100 countries	Hi-Tech engineering	One assessment group, within division located in central Sweden.	Globally > 140 000 Division < 500
B	Multinational organization active in 28 countries	Hi-Tech engineering	Two assessment groups, within division located in central Sweden.	Globally > 60 000 Division < 500
C	Nordic organization active in Sweden, Denmark and Norway	Technical IT-Consultants	Two assessment groups, within regional office located in central Sweden.	Nordic organization 600 Regional office < 400

3.1 Case selection and company's motivation to participate

Three companies, here referred to as company A, B and C have been part of the study (table 1)

The three companies were deliberately selected (Maxwell, 2013) for two reasons:

The first reason was that they were facing challenges caused by shifts in technology and new business models. This created high levels of uncertainty and heavy pressure to re-innovate themselves in different ways as they were struggling to keep leading positions and increase revenue. Company A and B were both divisions within large global organizations with tens of thousands of employees. Both were global leaders under heavy pressure when the project was initiated. Company A faced a situation where new technology was assumed to do their core competence (used to be their sign of quality), rendering it almost unnecessary in the immediate future. Company B was struggling to keep up with actors who could offer prices and conditions they could not match, even though they were convinced that their products performed better and were more cost effective in the long run. Company C, a smaller consultancy-based organization that was very successful at the Nordic market, faced a slightly different situation, not threatened by technological development but an increased structural separation between purchaser and customer. Purchasers were experienced to have a strong focus on short-term costs in the procurement situation, caused by a lack of understanding of real needs. As a consequence, they were facing declining opportunities both to build revenue and create customer value.

Second, selection was done because there was a well-established relationship with the participating companies. Some of the company representatives that were involved had collaborated on a regular basis over several years with the researchers as well as with each other outside the research project. This was considered an important design decision as it was believed to facilitate a close interaction with the researchers as well as between companies during the research project (Maxwell, 2013). These conditions were considered important to enable a qualitative research design that required accessibility, openness, and trust between both organizations, the participants and researchers.

Commitment to participate in the research project was developed through several discussions with senior managers and middle managers in all three companies, discussing motivation to participate, expected outcomes, and requirements. The decision to participate was taken by senior managers on a national level and the middle managers who would in practice lead the assessment project. All three companies entered the project with a shared purpose in undertaking

a continuous assessment of innovative climate to involve more people in innovation. The objective was to find new ways of creating value to maintain their leading positions.

3.2 The IMSA used

An existing web-based IMSA focused on ten dimensions of organizational climate for innovation was used in existing groups of 10 to 20 participants. Company A participated with one group, company B and C with two groups each. A link to the assessment form was automatically mailed once a week to the assessors. Assessments were undertaken individually by estimating how well ten predefined statements (inspired by the research of Ekvall from 1996) described their perception of the past week on an ungraded scale that spanned from "not true " to "absolutely true". After each assessment auto-generated feedback with information on the last assessment, comparisons with prior assessments and trend-charts were provided together with brief information on how the assessed items related to innovation. The manager in each group was given the role of a feedback provider who was given feedback on the entire assessment group while the rest of the assessors were provided feedback only on their individual assessments. The purpose was to give the group an incentive to go through the group-level feedback together. Feedback providers were encouraged to regularly integrate discussion, reflection, and analysis of the results in established routines and meetings. Two of the feedback providers in company A had previously participated as feedback providers in a pilot study where the IMSA was used.

3.3 Collection and analysis of the empirical material

The empirical material used in this study came from 46 interviews, seven workshops, one observation, and 10 meetings with the three participating companies over 27 months. Five assessment projects were analyzed in which the focus was on how people were made part of the process and how the process was integrated in its organizational context, trying to see how this affected the undertaking of the process and its continuation. Figure 4 gives an overview of the empirical material used in the article.

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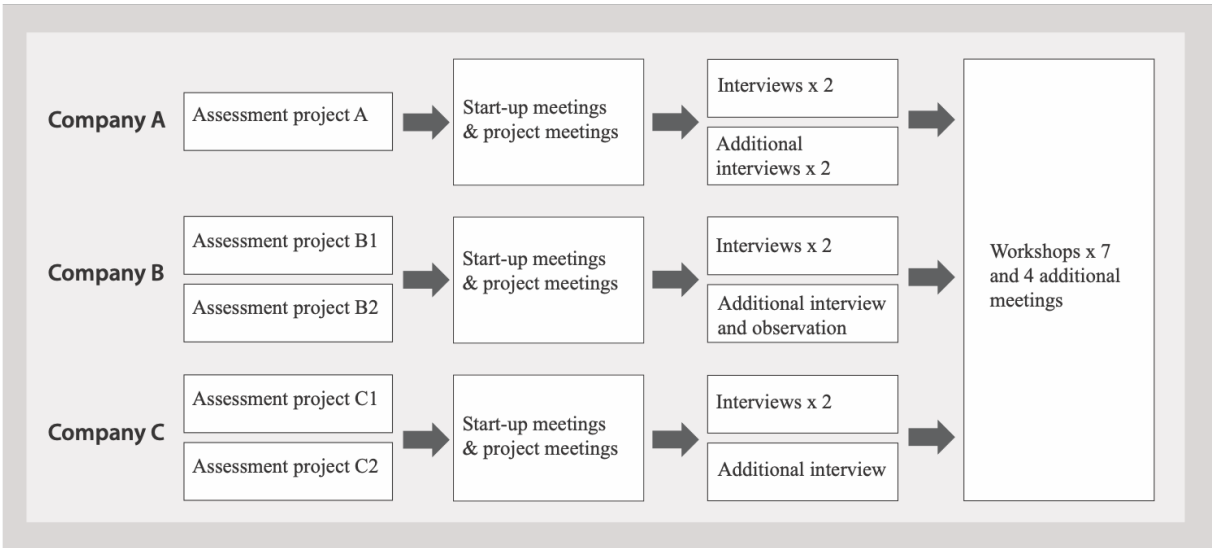

Fig. 4. Overview of the empirical material used in the article

Workshops and meetings. Both workshops and interviews gave access to rich data (Maxwell, 2013) that provided information from both the perspectives of single individuals and each of the organizations that hosted the assessment groups that were not as accessible in the interviews.

The feedback provider and one assessor from each assessment group were invited to the workshops that lasted for four hours, and consisted of three parts. The first part was used for an interactive focus group discussion (Merriam & Tisdell, 2016). These provided an opportunity for the participants to reflect and share experiences about progression, use, attitude, and important contextual factors and also gain support from each other and from the researchers. This was then followed by a discussion and undertaking of practical exercises related to their own organizational context. Finally, each workshop was summarized in a forward-oriented discussion where the participants reflected on the theme of the workshop and decided if and how they wanted to work specifically with the theme.

Short reflective field notes were taken during the workshops (Merriam & Tisdell, 2016) and all workshops were thereto audio-recorded in their entirety.

The ten meetings were held with both individual participants and groups of participants. Initial and start-up meetings were planned and initiated by the researchers, addressing pre-assessment issues related to goal-setting, selection of assessors, expectations, and other similar matters. Remaining meetings were initiated by participants and were all related to the undertaking of the assessment process. Meetings lasted between 30 minutes and two hours and were audio-recorded. Written documentation on goals and expectations was used in the start-up meeting.

3.3.1 Interviews and observation.

Forty-six semi-structured interviews were conducted (Saunders et al., 2012) with 26 different participants, 20 of which were undertaken initially in the project and another 18 after 18 months. The interviews covered open-ended questions (Peterson, 2000) concerning the participants' con-

ceptions about innovation and how they were working with innovation on a daily basis, as well as more specific questions concerning the use and impact of the IMSA. The interviews lasted from thirty to ninety minutes.

Four additional interviews were conducted when circumstances provided especially interesting situations that offered a deeper understanding of the situation. As an example, a second interview was conducted with one of the feedback providers in company C when he left the organization.

One interview with a feedback provider from company B was foregone by an observation of a feedback meeting where the feedback provider shared assessment results with the assessment group with the researchers participating as observers (Merriam & Tisdell, 2016). An observation guide was used to collect data and was then used as basis for a following dialogic interview (Rossman & Rallis, 1998) with the feedback provider.

All interviews were audio recorded.

3.3.2 Managing and analyzing the empirical material.

A first analysis (Fig. 5) was done while listening to the audio recordings from workshops, meetings, and interviews using written memos for a first open coding (Merriam & Tisdell, 2016). Based on this a selection of recordings was summarized in text and transcribed in whole or in part.

Thereafter, a second analysis was done focusing on how people were made part of the assessment, how it was integrated in its organizational context, and how that affected the undertaking of the process (Fig. 5).

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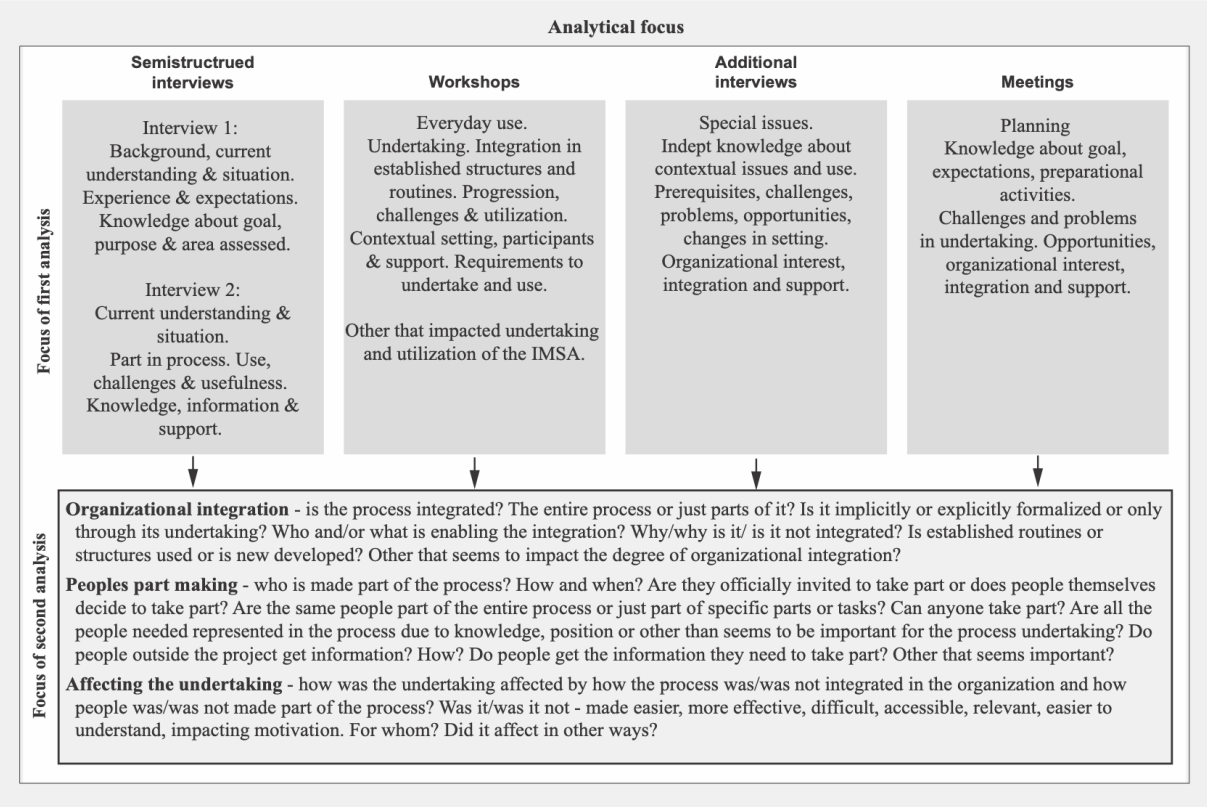

Fig. 5. The analytical focus of interviews, workshops and meetings.

To validate the results and analysis, these were presented to the participating companies in two workshops where they were given the opportunity to provide input to and reflection on the ongoing analysis.

4 Discontinuities breaking the progression

In the search for better understanding of the challenges related to the undertaking and application of an IMSA a process perspective was used when researching five assessment processes, focusing on how people were made part of the IMSA process, and how the IMSA process was integrated in its organizational context.

A major part of the assessment process in terms of content, design, and undertaking (e.g., participants, tasks, activities, support, and organizational utilization) was provided undefined and thereby neither formalized nor structured. How people were made part of the process and how it was integrated in its organizational context was to a large extent closely related to the participants' ability to define and structure the process. The undertaking of these activities was often largely intertwined that they were sometimes hard to separate from each other.

Handling unbalanced and discontinuous interlinkages between actors, tasks, and support constituted the major integrating and interacting challenges. All together this gave a discontinuous

IMSA process that was highly interdependent, and as a consequence, dependent upon the competence and will of individual actors.

4.1 Organizational integration

None of the assessment processes was in its entirety explicitly or implicitly formalized and integrated as part of its organizational context and neither was any of the assessment processes organizationally integrated in its entirety through its undertaking. Even though the assessment process in project A was successfully undertaken in its entirety, only parts of it could be considered integrated in the organizational context as the major part of the process was unformalized and undertaken by one single individual. When that individual no longer found the process meaningful, no one else had enough information to maintain its continued undertaking and thus, the process stopped.

The major part of the assessment process in terms of content, design, undertaking, and utilization was provided undefined and thereby unformalized. As a consequence, organizational integration, to a large extent, became related to the definition and formalization of the tasks and activities necessary to undertake as the process in its provided shape seemed to be difficult to grasp, discuss, and relate to existing structures, routines, and positions. Defining the process content was a highly intertwined part of the organizational integration.

As the definition of tasks was shown to play such an important role for the integration, this section starts with a summary of the identified tasks and how the project participants managed to undertake them.

4.1.1 Defining, undertaking and integrating.

When analyzing the assessment projects, 18 areas of assessment tasks were identified as important to the project's quality and progression (Table 3). Not all tasks were part of all projects but proved to be important as they were undertaken; or caused problems or hindered the process as they were not undertaken. Some were chronologically dependent on other tasks (e.g., assessments needed to be undertaken before their result could be analyzed), others were not (e.g., assessments could be undertaken before the assessment purpose was formulated). Some could be mapped within an assessment phase while others had a role throughout the entire project (e.g., enabling interaction).

The tasks that were provided explicitly formalized and automatically undertaken by the IMSA (distribution, compilation, and dissemination) were integrated in the everyday work of those who participated as assessors and feedback providers. The tasks that needed to be defined by the participants in the assessment projects did, however, show to be a challenge. Three out of five assessment projects (B2, C1, and C2) did not undertake or manage to integrate (in either the process´s internal organization or the wider organizational context) any of the activities that was not initiated by the researchers or provided explicitly formalized.

Three of the five projects (B1, C1, and C2) identified and addressed several tasks that were never managed, formalized, or undertaken. In B1 the feedback provider wanted to integrate the assessments in a new work group but needed support from senior management to enable

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Table 2. Identified assessment tasks, clustered in relation to task content and phase undertaken (Tasks in italics have caused problems in three or more of the assessment projects.)

Assessment tasks Identified assessment tasks. Clustered in relation to task content and phase undertaken. Tasks initiated, formalized or undertaken by the researchers, IMSA or participants in assessment project (A, B1, B2, C1 or C2). Tasks in italic have caused problems in more than half of the assessment projects.		
Pre-assessment phase	**Assessment phase**	**Post-assessment phase**
Engaging in the assessment (Initiated by researchers) ***Purpose** formulation* (No clear purpose shared within any project) **Assigning** participants (Initiated by researchers, undertaken in all projects) ***Goal** formulation* (Initiated and formalized by researchers, undertaken in all projects) ***Contextualization** of tool or process* (Initiated and undertaken in project A, initiated in project C1 and C2 but not undertaken)	**Distribution** of assessment form (Formalized and partly undertaken by IMSA) **Undertaking** the assessment (Formalized by IMSA, undertaken in project A, B1, B2, C1 and C2)	**Compile** results (Formalized and undertaken by IMSA) **Dissemination** of individual results (Formalized and undertaken by IMSA) ***Dissemination** of group results* (partly formalized and undertaken by IMSA, for a delimited time formalized and undertaken in project A and B1) ***Result** analysis* (for a delimited time formalized and undertaken in project A and B1) ***Formulate** improvement activities* (Formulation of activities undertaken in project A) ***Undertake** improvement activities* (To some extent undertaken in project A)
Integrating** in organization* (delimited parts of the process organizationally integrated by project A and B1) *Defining and structuring **tasks that were not provided defined and structured (Major part of the tasks defined, structured and undertaken by single key actors in project A, single tasks defined, structured and undertaken in project B1,single tasks defined but not structured and undertaken in project C1 and C2) *Providing required **recourses*** (To a delimited extent undertaken in project A and B1) ***Goal dissemination*** (Goal dissemination not undertaken in any project) ***Enable interaction*** (To a delimited extent formalized and enabled in project A and B1) *Provide required **support*** (To some delimited extent provided in project A and B1)		

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this. The assessment group in B1 identified several improvement areas in their analysis of the assessment results but needed senior management's support to proceed with the formulation and undertaking of improvement activities. Feedback providers in C1 and C2 also identified the need for senior managers' support and provision of resources (i.e., time, similar to the situation in B1). Support was not provided in any of these situations and the process stopped. In C1 and C2 feedback providers, together with senior management, identified the need to contextualize but did not manage to do so. C1 and C2 had the will and ambition to establish a routine to share, discuss, and analyze the group level results with the assessment group but never managed to figure out how to actually do so.

4.1.2 Successfully undertaken tasks.

Two of the projects (A and B1) managed to define, formalize, and undertake the result dissemination for discussion and analysis in established meeting routines. For a time, these tasks were successfully integrated in the organizational context of those who participated as assessors and feedback providers. Both these meeting routines ceased as a result of organizational changes. In B1 the feedback provider managed to create a new meeting routine where the assessment group continued to discuss and analyze the assessment results. This ceased after a while as the group was unable to integrate with the outside organization to access support and authority required to formulate and undertake improvement activities.

Lack in interaction between different participants caused problems at several points throughout the project. For instance, the feedback providers at both company B and C in several occasions were unable to access the required support in terms of both competence and authority. This was particularly evident during the post-assessment phase, where support from senior managers was needed but not provided. At company B, the feedback provider struggled with the task of turning analytics into actions. He claimed that he lacked the required authority linked to the IMSA and stressed the need for a stronger organizational commitment and support.

> *"There is a lack of managerial commitment," (Feedback provider, project B1).*

In a very similar way both feedback providers in projects B2 and C2 experienced a problem in accessing the required support from senior managers initially due to low engagement and later due to a lack of competence where senior managers could not provide the support needed. This caused repeated disruptions in the assessment work.

> *"If our organization had been interested and been driving this, it would have become a more natural part of our business. . . ," (Feedback provider, project C2).*

In project A the feedback provider continued to initiate an ongoing analysis of the assessment results, sometimes involving other actors but mainly on his own. However, the planning and undertaking of the activities in both projects A and B1 were primarily related to the work of single individuals and could not be considered formalized or integrated in the organizational context other than in limited parts. In project A the feedback provider used internal communication channels (internal screens) to publicize written information about the ongoing project to the entire organization.

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4.2 Depending on single individuals

Overall the undertaking of the assessment process was arbitrarily dependent upon the single individuals taking part in the process. The integration depended on a combination of his or her engagement, competence, and position within the organization, how he/she understood his/her role in the process, the area assessed, and how important it was considered; and also how the content of the assessment process was understood. This, in combination with their role within the organization, greatly affected their real and experienced need of support and their ability to access support through their established relations and communication channels. Together, these factors had a major impact on how the individuals strived to and were able to integrate the process content within its organizational context.

Two feedback providers, who had prior experience of using the IMSA and of the area assessed, managed better than the others in defining and undertaking the tasks that were not directly described and supported by the IMSA. They also acted as assessment champions both internally in their organization (A) and in interaction with participants from the other projects. They defined and structured the tasks in project A. However, the project in itself could only be considered as partly integrated in its organizational context as it was not formalized and highly bound to them as individuals. They served as the link between single tasks and participants, becoming key actors where the more senior of them "owned" the process as a whole, binding different tasks together and linking them to a purpose. If they would have left the process it is doubtful if anyone else would have had access to information enough to maintain the process. Project A was the only project where all three assessment phases were successfully undertaken.

> *The feedback provider says he believes that they being champions has been "crucial." I believe he said "that the individual's personal drive and conviction is essential when trying to elicit the development of other individuals' personal drive and conviction. ... one individual's drive can expand by being absorbed by other individuals, and I think we have succeeded in that because it is no longer just me; now there are other individuals who have adopted this and continue to drive it," (Feedback provider project A).*

No single individual in the other projects possessed the required combination of knowledge, position, and engagement to single-handedly take a holistic lead on the project throughout the entire process. No process champion who "owned" the entire process could be identified in any of the other projects and neither was the process in any of the projects formalized or integrated in the organizational context in such a way that the project was successfully given an organizationally-shared "ownership" that could provide it with the required competence, authority, and engagement.

Key actors

As none of the assessment processes was formalized or organizationally integrated the process progression was highly dependent on single individuals' ability to define tasks and activities and access organizational structures themselves when needed. Therefore, individuals that possessed information, competence, or authority that was critical to the process continuation became key actors.

These key actors were found both in formalized assessor roles as the feedback provider, in unof-

ficial roles as the champion, and roles associated with the formal structures of the organization as senior managers. The underlying structural causes for who became a key actor differed with the single situation and task, sometimes related to the structures of an individual actor and sometimes related to the boundary between internal and external structures making information or resources more or less inaccessible to the participants. Despite that, the result was the same, turning single key actors into gatekeepers upon whom process participants and potential stakeholders became dependent in accessing support, critical information about, for instance, the purpose, the assessed area, what had been done, and what needed to be done.

The intention behind the IMSA design that only gave feedback providers access to the group result, was to create a situation where the feedback provider is "forced" to gather the group in joint feedback meetings. It was intended to promote integration and increased learning compared with an alternative situation where each assessor would be given access to the results individually. However, this also made key actors out of the feedback providers as they were the only ones who had access to assessment results on an accumulated group-level.

Negative gatekeepers

The process continuation became highly dependent upon the key actors' competence and will to give access to critical information, support, or authority, sometimes hindering the continuation within the process (tasks, actors, support) and other times hindering the process from interconnecting with the rest of the organization (information, authority, support). Tasks undertaken were only weakly and arbitrarily interlinked to each other. No structure or routine that merged the tasks into a recognizable pattern of interlinked actions had been identified in any of the projects. These key actors, several times throughout the project, became negative gatekeepers as they had exclusive "ownership" to a specific task or part of the process that hindered the process progression when not undertaken or when others were not given access.

The feedback provider in C1 is an example of a key actor that became a negative gatekeeper even though he had the will and intention to inform and invite the assessment group to an analysis discussion. He struggled with what seemed to be a weak confidence in his role as a feedback provider, feeling a need to present something more than just the results but did not know how to do that. This was reflected upon at several shared workshops with the other feedback providers. At one of these workshops, one of the feedback providers from project A tried to convince him that it did not have to be so complicated. His experience was that it was enough to share the results provided by the IMSA. He meant that saying nothing more than "this is the result from last week, what do you think it means" had been enough to provide a basis for a good discussion. Despite this, the feedback provider in project C1 repeatedly addressed the issue of not knowing "how to interpret the results and what to do" when sharing the results. Not feeling confident in what to do, he refrained from sharing the results and we could see how his individual structures became a hindrance that eventually stopped the process.

4.3 Making people part of the process

Even though actors were assigned roles in the process as assessors, sponsor, or feedback provider there was no formalized structure that defined how people should take part or be made part of

the process other than in the assessment phase. In three of the five projects there existed no structural support for interaction between people, between people being part of the process, or with people in the rest of the organization. The support for interaction was highly delimited in the other two projects as well. The only structured interaction support identified were the feedback meetings in projects A and B1 and the workshops arranged by the researchers where the feedback provider and one assessor from each project met and discussed the project.

Fragmented participation

For various reasons participants came and went during the entire time data was collected partly because different competences and roles were required at different parts of the assessment process or to support different tasks because of unplanned reasons such as re-organizations and redundancies, and planned reasons like job change and parental leaves. Only in project A did two single individuals take part throughout the entire project. No structured routine was developed to ensure that the single individual was actively made part of the process as a whole. When someone left the project, there was no routine that ensured information was documented or passed on, and the knowledge held by that individual left the project with him/ her. Similarly, no routine existed that supported the introduction of new participants to the project; instead, this aspect critically depended on single individuals to take active part in the process by searching or providing required information or support.

> *"... the commitment disappeared in the staff turnover and our current manager hardly knows what this is," (Feedback provider C2).*

During the first year of the study, fragmented participation was, to a great extent, an effect of the fact that all three organizations were struggling with major re-organizations. Even before the assessment started, company B was hit by threats of major redundancies, and the assessment start was postponed while waiting for the final outcome. Meanwhile, the other projects started their assessments and company B re-entered the project after approximately three months. In total, 12 individuals participated in the pre-assessment phase, out of which seven left their projects before the assessment phase started.

> *"This decision, to participate in the research project, has been taken by people who are no longer with the organization," (Feedback provider, project C2).*

In Company B two project groups that were assigned to participate as assessment groups dissolved as their project was indefinitely halted. At short notice, five new participants were assigned to take part in the project. Assessment groups and roles were not yet set.

> *"I found out about this yesterday... or, I was told to join yesterday," (Feedback provider, project B1).*

Only one of these five new participants from company B remained in the project and had a continuous participation. Except for the sponsor, none of the participants from the pre-assessment phase was still part of the project when the assessments started, leaving them with an assessment group where no one within the group's internal structures had knowledge about the purpose of the project, leading to frustration as even the feedback providers that were very engaged in the project and interested in the assessed area (even considering it of critical importance) did not know what to do with the assessment results nor how to handle them.

"What are we supposed to do with it? What should we change?" (Feedback provider B1).

Only in project A did two single individuals take part throughout the entire project; both were highly engaged feedback providers with prior experience and knowledge about the IMSA and the assessed area. One was also a senior manager with a formal position that gave him access to both the internal and external structures of the assessment group, which all together provided the competence and authority needed throughout all three assessment phases.

> *"I think my position in the organization is at quite a good level to be able to influence the organization. I am far enough down in the organization to have a feeling for daily activities as I am high enough to get some form of mandate," (Feedback provider 1, project A).*

The situation was very different in both company B and C where no single individual represented the entire spectrum of competence or position required to undertake all three assessment phases. Senior management was part of the most initial discussions on whether they should engage in the project or not but was not made active part of the every-day structures of the project. Once the companies had committed themselves to the project, existing groups of suitable size were appointed to participate as assessment groups. Middle managers of these groups were given the roles of feedback providers and were from that point on responsible for the projects. About halfway into the project the C1 and C2 projects got a new sponsor who took a more active part in the projects. Two years into the project he initiated a series of meetings where goals, purpose, and methods to reach them was again discussed. The purpose of these meetings was to give the project a re-start. The meetings had a strong pre-assessment character and involved people that represented different internal structures: feedback providers, researchers, upper management, and a manager from human resources. However, whether the sponsor continued to have an active engagement in activities of assessment and post-assessment is unknown as this was at the end of the data collection.

People were primarily made part of the project through their assigned roles in the project and only as an exception were people without an explicit project role made an active part of the process. One example was CC-Solution that invited managers from human resources to take part in goal formulation and meetings to discuss utilization challenges. In project A people from the entire organization were made more indirect part of the process through written information about the project.

The main way that people were made part of the process was through the weekly assessments and the automatically generated feedback on assessments that were sent to all assessors by the IMSA. For three of the assessment projects (B2, C1, and C2) this was the only way that people were routinely made part of the process, meaning that they only took part through their individual undertaking of the assessment task without any recurrent interaction with other people related to the IMSA. These gave the IMSA a primary and potential possibility to have an effect on the individual structures of the participating people and only a potential secondary effect on the internal group structures of these people.

In the two assessment groups that met on a regular basis to discuss and analyze the group level results, people were made part of the process due to their roles as assessors and on the initiative of the feedback providers of their groups. All interactions were undertaken within

internal structures of established groups with a potential effect on internal group structures and structures of individual people.

4.4 Affecting how the process was undertaken

As both people's integration in the process and the process integration in its organizational context to a large extent were undefined and unformalized, the undertaking of the process was to a high degree dependent upon single individuals and groups of individuals. The characteristics of the single participants and groups of individuals (such as knowledge, ability, position, interest, commitment, and will to take part in the process) had a major impact on how the process was undertaken. As a consequence, the processes were undertaken in an arbitrary way due to the participating individuals' will and ability to access and utilize the required structures, information, competences, and resources that were a prerequisite for their undertaking. In turn, this led to an undertaking where the people in the process, to a large extent, participated in a form of process isolation with little interaction between groups of different internal structures. This excluded people from getting and sharing information, and limited how the task results and the process progression were made available. It also affected how information was accumulated both within the assessment process and in its organizational context.

This resulted in five discontinuous and fragmented processes where continuation in tasks, interaction, support, and activities were held together over time only by single individuals.

5 Discussions

At first glance, the empirical results indicate that the successful use of an IMSA is dependent on strong individuals who see the big picture, bridging the discontinuities and avoiding the pitfalls of the pre and post-assessment phases (Svensson & Klefsjö, 2006; Karlsson, 2015), which prior research has shown cause problems (Chiesa et al., 1996; Nilssonet al., 2010). On the contrary, the empirical results could be seen as an illustration of the shortcomings in the undertaking of an IMSA as a process (Langley et al., 2013). These strong individuals that were taking a very personal responsibility for the process could instead be seen as an effect of the major challenges in defining the IMSA as a process where discontinuities appeared as a symptom of an inadequate formalization (Feldman & Pentland, 2003; Ellström, 2010) of the process in relation to the internal and external structures as well as structures of individual actors (Backström, 2018). When the contextual prerequisites provided by these structures were not acknowledged (Carayannis & Provance, 2008) the process fragmented and the purpose and progression could not hold together and evolve in an emergent way (Marion, 1999). The undertaking of the IMSA then became dependent upon single individuals acting as bearers of required knowledge and structural access (Anderson & Krathwohl, 2001), providing them with a power over the process that makes them become a necessity. The individuals who stepped forward and carried on the work prevented the process from a total fragmentation but also hindered interaction (Prigogine, 1997), which confirmed prior research (e.g., Panizzolo et al., 2010 and Biazzo & Bernardi, 2003).

However, when taking on a process perspective, focus is shifted from single elements towards the

structural interconnection between different processes (Langley et al., 2013), not as something that needs to be deconstructed into simpler pieces of "what" in order to become more manageable, but rather the opposite, as providing a base for a higher order of emergence that is greater than the sum of its single parts (Marion, 1999). With this focal shift comes a recognition of complexity that implies that context and competence are not only factors that need to be matched and considered to enable a successful utilization of the IMSA; these are rather to be considered interdependent constituents of the process in itself.

Further, with this focal shift comes recognition of complexity that implies that all constituents are of secondary importance, that no single event in the IMSA-process (Samuelsson & Nilsson, 2002; Karlsson, 2015) is more important than the process in its entirety, consisting of the interdependent connection between its constituents (Marion, 1999; Feldman & Pentland, 2003; Langley et al., 2013). This means that the assessors' knowledge or key actors' willingness to give access to support is of equal importance as the validity of the indicators. However, as we can see from the empirical evidence, this is only true as long as no single constituent such as a task, activity, or actor is disrupting the continuity of the process by breaking the structures of interconnections that enable the continuous information transfer that in itself constitutes the process (Marion, 1999; Langley et al., 2013). The discontinuities in activities, interaction, and support that were detected made clear how single events and actors such as a negative gatekeeper could be decisive under certain temporal conditions (Langley et al., 2013). Even something as insignificant, from an innovation management perspective, as the self-confidence of one single individual, became crucial in a specific contextual setting, having the power to compromise the progression of the IMSA process and thereby hindering a desired result to emerge (Marion, 1999). Or should we see this as an indication that the IMSA should not be considered as one process but instead consisting of several sub-processes that need to be addressed to be able to undertake the whole assessment process in an effective way?

The very process can, in itself, be seen as the actual interconnection between intention and results, the current situation, its past, and the future (Feldman & Pentland 2003, Ellström 2010). When the process perspective is lacking in the undertaking of the process, we can see how the process fragments into a discontinuous set of participants and tasks that do not hold together on their own. We lose the dynamics that can only occur in the interaction (Prigogine, 1997) between the process actors that over time binds different organizational structures together around the area assessed. The power of the process is lost. We do not get the intended development of internal structures that could include and link more actors and tasks to the subject at hand, allowing the innovative climate to emerge over time. Instead, a discontinuous actor-participation make the process bounce between temporarily open and closed organizational structures, structures that fluctuate, opening up as internal structures to then become non-accessible external structures depending on who at the moment is taking active part in the process (Backström, 2018). As a consequence, some of the structures that need to develop to increase our innovativeness become unattainable; interactions become limited, fewer participants can contribute to the development, and systemic learning is jeopardized (Marion, 1999).

A well-functioning work process provides participants with an explicit and/or implicit (Ellström 2010) formulated *how* (Langley et al. 2013), connecting the assessment tasks with the participants who undertake them and allowing single participants or single activities to form a whole

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even if they constitute only a fraction of the entire stock of activities or participants (Marion 1999). Instead, the process becomes dependent on single individuals' will and ability to value, plan, and coordinate the tasks, activities and the participants that need to be part of the assessment work in every specific situation (Langley et al. 2013), driving the progression to become highly demanding for a few (Andersson & Kratwhol, 2001) and losing flexibility, which makes the process more vulnerable to external changes. At its best, the work toward the desired goal of building more innovative structures that involves more people becomes costly and less effective and at its worst, is never attained. (Marion 1999).

5.1 Conclusion and future research

Aiming for a better understanding of the challenges related to the undertaking and utilization of an IMSA, this study focused on how people were made part of the IMSA process and how the IMSA process was integrated in its organizational context. Based the analysis, it can be concluded that how people are made part of the process and how the process is integrated in its organizational context affects how the actors, activities, and tasks can merge into a coherent process that can drive change. This is further described through three main conclusions from the analysis discussed below.

First, the dynamics of both the IMSA process and its contextual setting comes with a meta-level challenge related to how people can be made part of the process and how the process can be integrated in its organizational context. This is a meta-level challenge of understanding the issues of undertaking the process so that the process can be dynamically adjusted to enable the process to stay on track, even though prerequisites are constantly changing. Taking a meta-level perspective on the process requires a combined awareness of the area assessed, the process of undertaking and utilizing the IMSA, and understanding how both of these are related and affected by its organizational setting.

Second, it can be concluded that it is not only how the process is integrated in its organizational context that affects how and if a purposeful use is enabled, but rather a question of how the process integration in its organizational context binds to the structures it is intended to change. A formal or informal integration that gives the people who are part of the process access to the targeted structures over the entire process increases the chances for a purposeful use of the IMSA. This shows that there is an interdependency between how the process is integrated in its organizational context and how the people are made part of the process, together affecting how a purposeful use of the IMSA is or is not enabled.

Third, it is suggested that the undertaking of the IMSA process could be considered a dual process consisting of two closely interlinked and interdependent processes. These processes include an implementation process concerning the practical undertaking of the IMSA and a support process concerning the meta-level requirements to be addressed in order to avoid fragmentation and an arbitrary dependency on single individuals that are part of the process.

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5.2 Practical implication

When undertaking an IMSA, it is suggested that the undertaking should be considered a dual process. One process, the implementation process, concerns the actual and practical undertaking of the IMSA. This is the process where actors undertake tasks and activities to enable the desired improvement to emerge. While the other process, the support process, concerns the planning, enabling, and dynamic adjusting of the conditions to meet changes in internal and external prerequisites. The two closely intertwined processes are highly interdependent upon each other and both processes need to be considered and managed.

How people are made part of both these processes, and how they are integrated in their organizational context, will affect how a purposeful use will be enabled to emerge. A practical implication of this research is that the competences that can be made available and accessible throughout the process can be considered a strong indicator of what achievements can be expected from the undertaking of the IMSA. When undertaking the implementation process, focus needs to be on that people with the required competences in terms of both knowledge and authority are made part of the process, either as active participants or as support providers. Further, it is essential to ensure that the process is made part of its organizational context in such a way that it provides the required accessibility throughout the entire process in terms of support, structures, and interaction.

When undertaking the support process, focus should instead to be on the meta-level, ensuring that the purpose fits with the requirements of the process and the competences available. The parts of the process that are not provided formalize needs to be identified so that these can be designed, and the undertaking can be prepared. The process needs to be monitored over time to identify changes in conditions that will require a redesign of the process and support. Focus of the support process is on providing a setting that enables a continuous process that allows situational leadership and permits actions to emerge that influence established structures and routines. Enabling peoples' participation in the process includes, assuring they understand who should be involved in what part of the process, empowering the people, and adequately supporting them in terms of time, knowledge, information, and structural accessibility, among other factors.

5.3 Limitations and future research

The major limitations of this study are related to the difficulties in capturing the content of a process and the challenges related to case selection. First, it is challenging to observe a process as it is not a visible entity that can be observed in itself due to its content, but it must instead be observed through how the behaviors develop over time. Therefore, observing how people are made part of the process and how the process is integrated in its organizational context requires a data collection that allows a close interaction with the people that are populating the process and its context. This helps identify not only what is said, but also the behavior and what is actually done. The complexity of both the process and its contextual setting make it impossible to observe a process in its entirety, and there is always a risk that the data collected at a specific moment in time, with specific participants, does not give a strong representation of the process.

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A longitudinal study like this study is a way of increasing the quality of the study as it focuses on the abstraction of how relations, interactions, changes, form patterns over time. An ethnographic approach, with more time on site, could be a way to improve the quality of future studies.

When working with case studies, the quality of the empirical results is not only dependent upon the way information is collected, but also, it is highly dependent upon the selection of the cases. Even though the selected cases gave adequate access to data, these cases did not provide the desired data width as none undertook the entire IMSA process without being dependent on single individuals. However, the cases did provide valuable insights that probably could not have been captured in a process with less problems and complications. Including strong, successful cases in future studies is however desirable to provide a greater variety to explore.

To advance the IMSA research, it is suggested that future studies take a systemic perspective on the assessment situation that would allow the acknowledgement of the bigger picture of use and application. Even when researching a limited part of the process, such as a development of assessment indicators, it is suggested that these are considered from the perspective of use and application by discussing them in relation to purpose, contextual setting, and competence requirements.

Knowledge from other fields of research could also be used to accelerate IMSA research such as the field of education and learning that concerns knowledge, competence, and structural support for learning. One example is the research on self-regulated learning that addresses self-assessment issues similar to those within the field of innovation management. One example is research by Kostons et al. (2012) that shows that training students' self-assessment and task-selection skills can significantly increase the amount of knowledge they can gain from self-regulated learning where they choose their own learning tasks. This might provide an interesting research opportunity within the context of innovation management.

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Biographies

Helena Blackbright. Helena Blackbright received two B.Sc. degrees in 2005, one in innovation technology and one in business economy from Mälardalen University, Sweden. In 2015 she received the Ph.Lic. degree in innovation management, also from Mälardalen University. She has over 20 years of industrial and academic experience from the field of innovation and innovation management. Since 2016 she shares her time between PhD studies in innovation management at Mälardalen University and as a project manager at Automation Region, Västerås, Sweden. Her research focus lies in the field of conditions for maintained and increased organizational innovativeness in complex adaptive systems and she is currently writing on the manuscript of her PhD thesis, Exploring Purposeful use of Innovation Management Self-Assessments. Ph.Lic. Blackbright has over the last years developed a great interest in human centred AI and AIs impact on innovation management and is one of the co-founders of the Swedish based initiative addAI.org that focuses on exploring the impact of smart algorithms and AI on society. She is also the initiator of the ISPIM Special Interest Group, AI & Innovation Management, exploring the encounter of AI and innovation management.

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Resources Capability of Government Co-operative Supporting Organizations for Innovations Dissemination to Primary Co-operative Societies in Tanzania

Luka S. Njau
lukasnjau@yahoo.co.uk | Department of Development Studies, College of Social Sciences and Humanities, Sokoine University of Agriculture, P. O. Box 3024, Morogoro, Tanzania
Christopher P. Mahonge
mahonge@sua.ac.tz | Department of Policy Planning and Management, College of Social Sciences and Humanities, Sokoine University of Agriculture, P. O. Box 3035, Morogoro, Tanzania
Fatihiya A. Massawe
mnkya74@gmail.com | Department of Policy Planning and Management, College of Social Sciences and Humanities, Sokoine University of Agriculture, P. O. Box 3035, Morogoro, Tanzania

Abstract. This study assessed resources capability of government co-operative supporting organizations (GCSOs) in innovations dissemination to primary co-operative societies (PCSos) in Tanzania. Case study research design using multiple cases was used involving five cases. Primary data were collected using key informant interviews, focus groups discussions (FGDs), documentary reviews and personal observations. Data were analysed using content analysis. The Atlas.ti computer software assisted in analyzing data solicited from key informants and FGDs. Findings indicate that most GCSOs in Tanzania were poor in terms of resources to disseminate innovations to PCSos. Most GCSOs were also not determined at prioritizing and utilizing available resources for dissemination of innovations to PCSos. Furthermore, some external factors e.g. inadequate government resources commitment, employment freezing and others have been adversely affecting GCSOs resources capability to disseminate innovations to PCSos. Moreover, there were no formal and comprehensive incentive systems to reward innovation dissemination activities in most of the GCSOs. It is recommended that GCSOs executives should mobilise more internal resources and ensure sufficient innovation resources prioritisation and utilization to adequately facilitate innovations dissemination to PCSos. The GCSOs executives should also establish clear incentive systems to reward innovation dissemination activities.

Keywords. Government Co-operative Supporting Organizations; Resources Capability; Innovations Dissemination; Primary Co-operative Societies.

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1 Introduction

Organizations require resources as inputs to become innovative and competitive (Goedhuys, Janz & Mohnen, 2014). Thus, resources are as important to organizations as is blood in human body. Organizational resources refer to assets/inputs which an organization owns, controls and has access to for the purpose of facilitating its day to day activities (Piening, 2013). However, possessing such inputs does not automatically lead to creation of value (Ndofor, Sirmon & He, 2015; Sirmon, Hitt & Ireland, 2007). Organizations must therefore be able to accumulate, combine and exploit resources in order to extract value from them (Grant, 1991). This paper intends to assess the resources capability of Government Co-operative Supporting Organizations (GCSOs) for dissemination of innovations to Primary Co-operative Societies (PCSos). There are several categories of resources. Classical economics recognizes three basic categories of resources, also referred to as factors of production: land, labour and capital (Gaffney, 1967). Entrepreneurship is often considered the fourth factor of production (Turtle, 1927). Other categorization includes natural (renewable and non renewable) and human (structures, institutions, quantity and quality) resources (Lamon, 2014). Another categorization is based on the biotic resources including all resources obtained from biosphere and have life e.g. human beings, flora and fauna, fisheries, etc and abiotic resources composed of non-living things e.g. rocks, metals, etc (Cbsemocha, 2013). This paper adopts the categorization of resources from Christensen (1997) who grouped them into physical, human, financial and technological resources. Barney (1991) indicates that an organization will attain innovations if it possesses and allocates its resources on the same. Organizational resources capability is therefore directly related to the search for, absorption and generation of innovations (Srholec, 2011).

Innovation has long been cited as essential for organizational competitiveness and success (Bekkers, Edelenboss & Steijen, 2011; Edwards, Delbridge & Munday, 2005). This awareness has generated a great deal of literature on the subject matter. As a result, innovation has become an extensive concept that can be perceived in a number of different ways (Smith, Bursi, Ball & van dee Meer, 2008). Osborne (1998) indicated that there are over 20 different definitions of the term innovation. The World Bank (2006) defined innovation as the process by which individuals or organizations master and implement the design and production of goods and services that are new to them, irrespective of whether they are new to their competitors, their country or the world. This paper adopts a modified version of this definition that regards innovation as the process by which government organizations, in this study, the co-operative supporting organizations, creates and offers goods and services that are new to them, including changes in an old or existing way of doing things, irrespective of whether they are new to their competitors, their country or the world, which are intentionally directed at improving targeted end users i.e. primary co-operatives performance. In this case, the public or private sector organizations are faced with only two options: innovate or perish (Mathew, Jose & Thomas, 2006). Most public organizations in developing countries operate below the technology frontier with lower levels of managerial and production skills (Goedhuys and Sleuwaegen, 2010) resulting from organization's resource inadequacies (Bradley, McMullen, Artz & Simiyu, 2012; George, Gorbishley, Khayesi, Haas & Tihanyi, 2016). Despite this shortfall, some of such organizations have been playing a key role in developing and disseminating innovations (Barasa, Knoben, Vermeulen, Kimuyu

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& Kinyanjui, 2017). In most of the developing countries, there are several government support organizations that have been established and financed by the government for the purpose of facilitating innovations dissemination from where the innovations are produced to the targeted users (Tefera, 2008). Among such government organizations, in Tanzania, are the government co-operative supporting organizations - referred to as government institutions responsible for facilitating co-operative organizations in terms of innovations creation and dissemination, education and training, promotion, regulation, production, marketing, etc. The organizations include the Moshi Co-operative University (MoCU), Tanzania Co-operatives Development Commission (TCDC), Office of the Director and Registrar of Co-operatives (ODRC-transformed into TCDC in 2013), Small Industries Development Organization (SIDO), Co-operative Audit and Supervision Corporation (COASCO), Tanzania Research Institutes e.g. Tanzania Coffee Research Institute (TaCRI), Vocational Education and Training Authority (VETA) among others.

1.1 Conceptualization of the problem

The co-operatives, particularly the Primary Co-operative Societies (PCSos), have been an important part in the development of Tanzania for nearly nine decades now. During this period, they have seen many successes in terms of increased incomes and social benefits to members and community at large (Chambo, 2018). They have also experienced many failures resulting from mismanagement, embezzlement, weakness of supporting organizations, state interference, inability to compete in free market economy and general lack of co-operative education. During such period, however, no other institution has brought so many people together for a common cause than PCSos (Borda-Rodriguez, 2014; Chambo, 2018; United Republic of Tanzania [URT], 2006). Co-operatives salient features i.e. member owned and controlled organizations and attribute of involving the poor and weak members who have always been on the sidelines of rural and urban mainstream economy has attracted the attention of many governments and organizations into their support in terms of resources (Chambo, 2018). It is from such recognition that the government of Tanzania has established and facilitated operations of several GCSOs for the purpose of facilitating PCSos growth and development.

Most of these GCSOs have continued to attract resources from the government in terms of skilled manpower, finances and other resources like vehicles, land, technological facilities, etc to meet operational costs, staff salaries, infrastructural demands and implementation of research agenda (R & D). All these efforts target at facilitating PCSos in areas of innovations creation and dissemination, production, marketing, education and training, etc. This study focused solely on innovations dissemination referred to as intentional spreading of innovations from the source to targeted audience (Lomas, 1993). This is because, in the context of this paper, innovation dissemination is considered to be an important node that links innovation sources (GCSOs) and targeted users (PCSos). Likewise, innovation was considered to be underdeveloped in most public organizations in Tanzania and hence necessitates assessing its dissemination in specific organizations.

Despite government resources support to GCSOs, empirical literature has indicated that few innovations are disseminating to PCSos in Tanzania (International Co-operative Alliance [ICA], 2013; URT, 2006; World Bank, 2012). As a result, significant number of co-operatives in Tanza-

nia currently totalling 8,040 has been denied access to necessary innovation packages that could be disseminated from such organizations (URT, 2016). This study posits that the government is supposed to support GCSOs by providing them with resources to enable among other activities, innovations dissemination to PCSos, and thus many innovations are expected at PCSos level. Contrary to such expectations few innovations have been disseminated from GCSOs to PCSos in Tanzania (ICA, 2013; URT, 2006). This paper argues that having resources alone may not necessarily lead to innovations dissemination to PCSos and perhaps there is potentially existence of other factors limiting innovations dissemination from GCSOs to PCSos. Resources are an important determinant of innovations dissemination in most organizations (Bradley et al., 2012; Laursen, Masciarelli & Principe, 2012; van Uden, Knoben & Vermeul, 2017). However, possessing resources alone is not enough to enable innovations dissemination (Barasa et al., 2017; Ndofor et al., 2015). This is because; organizations' innovation resources capability is influenced by other complementary forces (Barasa et al., 2017). The key ones include the organizations' determination to prioritize and utilize available resources for innovation (Srholec, 2011), innovation incentives available (Johnson & Lybecker, 2009) and external factors influencing innovation (Patana, 2014). Studies have shown that insufficient resources prioritization and utilization for innovation activities is a problem inherent in many public organizations in Tanzania (Diyamett & Wangwe, 2006; DFID, 2014). Nevertheless, scant literature is available on the extent to which GCSOs in Tanzania have been prioritizing and utilizing their resources for innovation dissemination to PCSos. Available literature indicated that most public organizations have been prioritizing and utilizing most of its resources in activities other than innovations (Sambua and Mghwira, 2014; World Bank, 2016). This shortfall thus lands us on the first question: How do the innovation resources prioritization and utilization occur in the studied GCSOs? This paper argues that few innovations dissemination originating from GCSOs to PCSos in Tanzania are a consequence of lack of determination by GCSOs executives to prioritize and/or utilize available resources to enable innovations dissemination to PCSos. Similarly, empirical literature has indicated that effective innovations dissemination does not occur at its own sake instead there should be incentives behind it (Johnson & Lybecker, 2009). Incentive is defined as a thing that motivates or encourages someone to do something. It includes payment or concession to stimulate greater output or investment (Oxford dictionary online, 2001). Johnson & Lybecker (2009) indicate that innovations dissemination responds quickly to incentives in place. Incentives like performance reviews, funds, promotions or simply getting recognition of what has been done, increase the likelihood for successful innovations dissemination (Damschroder, Aron, Keith, Alexander & Lowery, 2009). Studies have shown that there is association between incentives and resources utilization capability (Hollander and Kadlec, 2015; Murphy *et al.*, 2016). In Tanzania, however, literature on the linkages between incentives available and GCSOs resources capability to disseminate innovations to PCSos are nonexistent. This deficit therefore, lands us to the second question: Are there incentive systems in place to reinforce the GCSOs skilled workforce to disseminate innovations to PCSos? The argument put forward in this paper is that inadequate incentives to activate GCSOs operatives is among the reasons as to why few innovations are disseminated from GCSOs to PCSos in Tanzania.

On the other hand, external factors like government innovation policy focus and its related regulations, innovation resources commitment, directives and others can influence GCSOs resources capability to disseminate innovations to PCSos. The well enforced, coordinated and affirma-

tive government innovation policy and related regulations can potentially facilitate innovations dissemination (Barasa et al., 2017; Patana, 2014; United Nations Conference on Trade and Development [UNCTAD], 2015). However, literature has shown that most developing countries lack organizations and institutions to regulate and coordinate innovation activities (Oyelaran-Oyeyinka, 2014). Similarly, the Department for International Development [DFID], 2014) and UNCTAD (2015) review of Science, Technology and Innovation (STI) policy in Tanzania established existence of incoherence and lack of coordination between STI policy and other government organizations, lack of government resources commitment and inadequate collaboration among innovation actors as the factors limiting innovation activities. However, it is not well known on how such external factors are specifically influencing GCSOs resources capability to disseminate innovations to PCSos in Tanzania. Available literature generally shows that the country suffers inherently from a lack of innovation policy focus and co-ordination among its actors (Diyamett & Wangwe, 2006; DFID, 2014; UNCTAD, 2015). The shortfall thus lands us to the third question: How do the external factors influence GCSOs resources capability to disseminate innovations to PCSos? The argument put forth by this paper is that few innovations disseminating from GCSOs to PCSos is a result of limiting external factors. The combination of the three arguments posed in this paper, necessitates the assessment of the GCSOs resources capability in innovations dissemination to PCSos.

2 Theoretical Review

This paper draws insights from two theories; the Resource Dependence (RD) Theory (Pfeffer & Salancik, 1978) and the Carrot and Stick (C &S) Theory (Bowring, 1962; Hixson, 1989). The first theory examines the relationship between organizations and the resources they need to operate. The main argument in this theory is that when one organization possess or maintains the majority of the resources, then another organization will become dependent on the one possessing such resources in order to operate. This scenario creates a dependence syndrome (parasitic kind of) to the organization that depends on such resources. This implies that when the government maintains the majority of resources and the GCSOs maintain too little resources then the GCSOs become symbiotically dependent on the government. Continued and too much dependence creates unreliability which leaves such organizations subject to risk of external control. Such external control basically imposed by the government can have significant effects on GCSOs operations especially on resources capability. The theory thus requires managers to work and strive in strategising in alternative business plans or activities to lower the dependence risk. This implies that the managers in this study the GCSOs executives should work to reduce the resources dependence risk or syndrome for the purpose of lowering the innovations dissemination failure. This study applies the theory in assessing the relationships between GCSOs and the government in terms of innovation resources availability to facilitate innovations dissemination to PCSos. The theory is nevertheless criticized for most of its empirical work focusing on dependence of one actor on another rather than on reciprocal interdependence (Hillman, Withers & Collins, 2009). The second theory i.e. C&S Theory also known as Reward and Punishment Approach is based on the principles of reinforcement. It asserts that in motivating people to elicit desired behaviors, sometimes rewards should be given in form of financial or non financial

benefits and sometimes punishment should be exerted to push such people towards the desired behavior. The study applied the theory in ascertaining whether there are any formal incentives or reward and punishment systems pertaining to innovations dissemination activities in the studied GCSOs. In this study, the term formal incentive system was used to mean clearly stipulated, documented and adhered motivational arrangement. It is assumed that for innovations dissemination to PCSos to occur, there should be some incentives and or reinforcements from either the government or GCSOs to motivate personnel to do so. The C & S Theory however, is critiqued that, widespread use of tangible rewards or punishments as motivators do not promote intrinsic motivation (Restrepo & Valencia, 2014). The two theories i.e. the RD Theory and C & S Theory complement each other deriving from the possibilities that the problems of innovations dissemination to PCSos can be within and beyond the reach of GCSOs.

3 The Conceptual Framework (CF)

As shown in Fig. 1 it is assumed that innovations dissemination from GCSOs to PCSos is a function of resources availability, GCSOs determination to prioritize and utilize available resources for innovation, external factors influence and innovation incentives in place. This means that resources availability in form of skilled man power, funds, appropriate technologies and

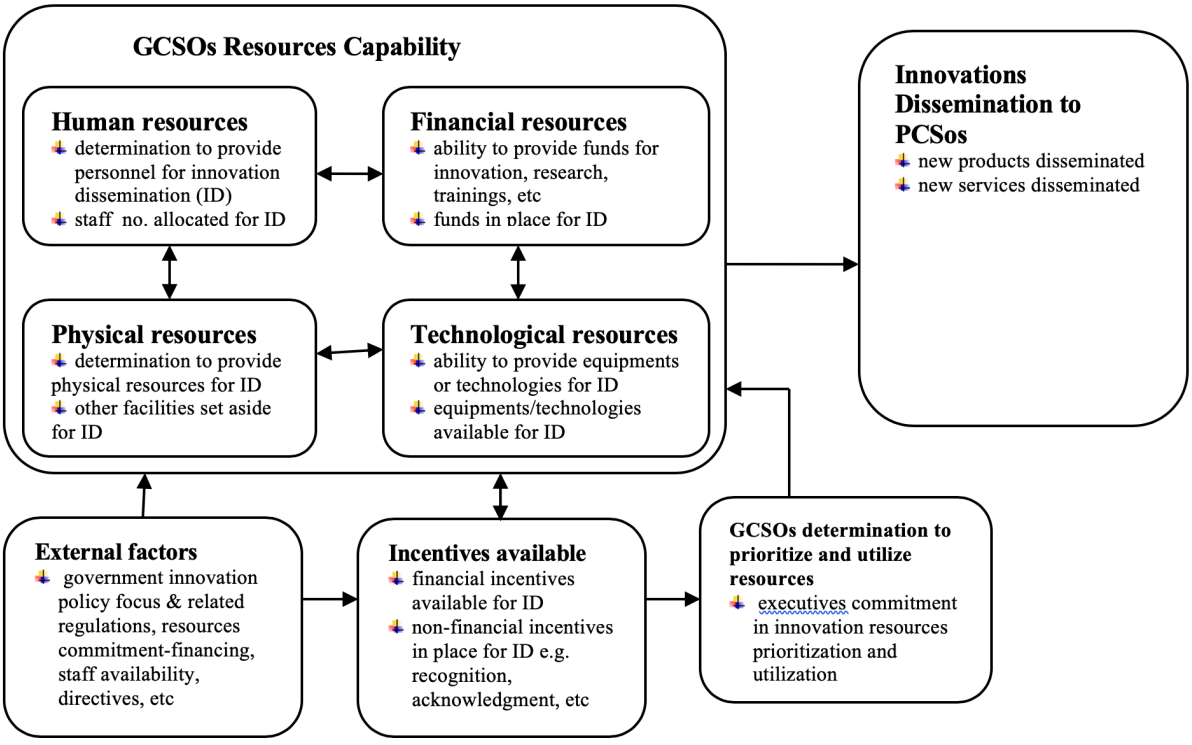

Fig. 1. The CF Summarizing Relationships between GCSOs Resources Capability and Innovations Dissemination (ID) to PCSos (Source: Own Construction)

physical facilities e.g. land, innovation incubators, workshops and laboratories can positively influence innovations dissemination. Nevertheless, availability of resources alone is not sufficient to enable effective dissemination of innovations. This is because having resources alone does not necessarily mean that they will be directed at enabling innovation dissemination activities. Thus, there should be determination or willingness by GCSOs executives to prioritize and utilize such resources to facilitate innovations dissemination to PCSos. Moreover, the availability of the resources can be influenced by some external factors. The well organized and assenting external factors to innovation including government innovation policy focus and its related regulations, innovation resources commitment e.g. financing and personnel commitment and affirmative government directives activate GCSOs resources base by capacitating it to disseminate innovations to PCSos. Equally, innovation incentives from either the government or GCSOs in form of recognition of innovation activities performed, financial rewards, promotions, training opportunities and others can activate GCSOs' operatives to actively participate in innovations dissemination to PCSos.

4 Methodology

4.1 The Study Areas and Scope

The study was conducted in three regions i.e. Kilimanjaro, Dar es Salaam and Dodoma where the key GCSOs are located i.e. MoCU and TaCRI, SIDO and VETA and TCDC respectively. The study focused only on GCSOs, though there are other private and member-based organizations that support PCSos. The rationale for focusing on the GCSOs is that unlike other organizations, they have been receiving resources from government aiming at, among other activities, strengthening co-operatives. Equally, they are mandated by the law to reinstate competitive and innovative co-operatives in the country (URT, 2013).

4.2 Research Design and Data Sources

The case study research design using multiple case studies (MCS) was used. Given the varying primary mandates of selected cases, theoretical replication was assumed implying that cases were selected on the assumption that they will produce differing results (Bengtsson, 1999). MCS follow the replication and not the sampling logic approach. This means that more than two cases i.e. five cases were included in this study to enable comparisons and drawing patterns across the cases and obtaining more reliability in the overall results (Yin, 2004). Multiple cases increase the methodological rigor by strengthening the precision, the validity and reliability of findings (Miles & Huberman, 1994) making it more compelling (Yin, 1994). It also ensures generalization of the findings i.e. analytic generalization as opposed to statistical generalization.

Sources of data constitute GCSOs documents e.g. strategic plans and innovation policy documents, key informants (KIs) constituting the GCSOs executives, some heads of departments/units and staff responsible for innovation activities, FGDs participants involving GCSOs heads of departments/units and staff and direct observation e.g. innovation facilities in place. A total

of 14 FGDs, three per each GCSO were conducted except for TaCRI where two FGDs were conducted mainly due to data saturation realization. Several FGDs were conducted in the same GCSO aiming at soliciting more facts and verifying some data. The number of focus groups depend on the amount of facts needed (McDougall and Fudge, 2001). Most studies use at least two groups and few use more than four groups (Stewart, Shamdasani & Rook, 2007). Each focus group comprised of 6-8 participants. There are no definitive numbers of focus group participants. However, Stewart et al. (2007) emphasized that FGD should comprise of 6-12 participants since fewer than six tends to reveal less information and can be dull. Likewise, too many participants may be difficult to manage. Similarly,the KIs educational and working experience profiles were established for the purpose of establishing their capability and or skills relative to the subject matter under investigation i.e. organizations' resources capability for innovations dissemination. The tools for data collection included: FGDs guide, key informants (KIs) interview guide, observation guide and an audio recorder where consent from study participants was sought before recording them.

GCSOs' ratings and harmonization of the participant's responses

In this study, the responses that require organization rating were first collected from specific participants. Then to harmonize some differing opinions from different study groups of the same GCSO, validation meetings comprised of participants from all groups were conducted. The standardized scale and criteria for rating the specific GCSO was used where it was clarified and agreed upon by study participants prior the actual validation meetings.

Study Participants

The units of analysis for this study were the GCSOs. A total of five GCSOs, two purely co-operative supporting organizations i.e. MoCU and TCDC and three quasi co-operative based i.e. SIDO, VETA and TaCRI were picked for the study. Purely co-operative based GCSOs refer to those whose primary mandate is to serve co-operatives and the vice-versa is true for the quasi co-operative based GCSOs. In the course of their undertakings, quasi co-operative based organizations deal with co-operatives as one among their key actors. The rationale for such number and categorization is that the study aimed at capturing data from all forms of GCSOs based on their prime functions. Equally, since the study involved MCS strategy, five cases identified by research scope were sufficient to provide the necessary data (Yin, 2004). The study participants were all heads of technical and academic departments/units and at least two staff from each department/unit that were conversant with innovation activities.

Data Analysis

Content analysis was used to analyze data obtained from the key informants (KIs) and FGDs. Data collected through recording and field notes were transcribed prior to its analysis. First, the responses and opinions of the interviewees were coded. Second, data were categorized, where a data base for categorizing, sorting and retrieving data was prepared. The categorization was done according to the topics in the interview guide and also the research objectives. In the third step, the categorized data were analyzed and this was done in three stages viz. reduction of data (i.e. selecting, simplifying and transferring raw data to an analyzable format), displaying the data and drawing research conclusion (Taylor, Sinha & Ghoshal, 2011). The fourth step was

documenting the case studies sets in form of qualitative descriptions and interpretations. The Atlas.ti computer software facilitated the analysis of data solicited from KIs and FGDs.

5 Findings and Discussion

5.1 Profiles of the studied GCSOs

MoCU is a public organization with its headquarters in Moshi Town in Kilimanjaro Region. It has one teaching centre in Kizumbi, Shinyanga Region and 15 regional offices for outreach services provision throughout mainland Tanzania. Its key mandates include providing education, training, research and advisory services to enhance co-operative development and other development affairs. It trains skilled co-operative practitioners, technocrats and managers at various levels including certificates, diploma, bachelors and postgraduate levels. Equally, the TCDC is a public organization headquartered in Dodoma city with key mandates of regulating and promoting co-operative sector in Tanzania. It promotes, provide education and training and facilitate development of co-operatives. Moreover, it regulates co-operatives i.e. register, deregister and provides legal advices to co-operatives among other legal issues. TCDC has regional and district level offices manned with regional and district co-operative officers in all regions of Tanzania.

On the other hand, TaCRI is a public-private entity headquartered in Lyamungu Village in Moshi Rural District. It has six sub-stations i.e. Lyamungu, Kilimanjaro, Maruku, Kagera, Mwayaya, Kigoma, Sirari, Mara, Mbimba, Mbeya and Ugano, Ruvuma. Its core functions include providing coffee producers with relevant practical technological innovations and advise to improve productivity and quality for enhanced productivity and livelihoods of coffee producers. SIDO is a public organization with its headquarters in Dar es Salaam city. SIDO has a regional office in all regions of mainland Tanzania. Its core mandates includes technology innovation and commercialization, technology and product development, incubator services, artisan support programmes and other related roles.

Similarly, VETA is a public organization with its headquarters in Dar es Salaam City. It operates its functions through nine geographical zones to enable effective coordination of vocational education and training in different regions. They include Dar es Salaam zone, Central, Lake, Western, South West, South East, Eastern, Highlands and Northern zone. Its core functions are to provide, coordinate, regulate and promote vocational education and training in Tanzania. It provides training through 27 training centres and institutes that it owns. It also offers vocational teachers training at its college in Morogoro Region. Given their strategic regional and or zonal centres and core mandates, some explicitly focusing on innovation activities, studied GCSOs were assumed to be resourcefully capable in disseminating innovations to PCSos.

Four of the five aforementioned GCSOs are public organizations while TaCRI is a public-private organization owned by stakeholders it serves. It was necessary to study both categories as they have all been receiving some resources mainly financing from the government. Its inclusion provides a proportional ground on their resources capability for innovations dissemination to PCSos.

5.2 Key Informants (KIs) Education and Experience

The KIs education and working experience profile was established for the purpose of establishing their capability and or skills in relation to studied organization's resources capability for innovations dissemination. The study revealed the adequate level of formal education to most of the interviewed KIs. The majority of them had a minimum of bachelor's degree education whereby very few were diploma holders while others had postgraduate education i.e. masters and doctorates (PhDs). Most of the KIs were also having sufficient working experience with co-operative organizations and or related organizations. Regnar et al. (2002) emphasized that the ultimate objective of education is to increase labour productivity and thus it is a productive factor that is crucial for one's ability to utilize efficiently various resources that are available in a certain organization. This implies that the studied GCSOs had KIs with sufficient knowledge on the subject matter under investigation. It also shows that such KIs have sufficient education that can be used to enhance labour productivity in terms of innovation activities.

5.3 Resources Capability of GCSOs for Innovations Dissemination to PCSos

MoCU resources factor assessment

The study findings revealed existence of some resources at MoCU (Table 1). Technically, given such resources, one would argue that it is relatively able to disseminate innovations to PCSos. Nevertheless, study participants rated MoCU as poor in terms of resources for facilitating innovations dissemination to PCSos (Table 1). The KIs findings show that available financial resources were limited and mainly utilized to cover operational costs that include examination expenses, electricity and water bills, stationeries, classrooms and offices renovation, part-time lecturers' expenses, etc. Similarly, lack of practical innovation skills and training to personnel was revealed. One of the KIs said that:

> "*Two perspectives exist; first we have staff (Yes) but who are lacking the necessary skills to initiate innovations. Secondly, the executives seem not to bother about this that is why we lack trained staff especially on innovations dissemination to PCSos*" (KI 1, MoCU, Feb., 2018).

The findings further, showed that the technological and physical resources available were not fully utilized for innovation activities. ICTs laboratory, website and efficient internet access connected to the national optic fibre had not been tailored to enable innovation dissemination to PCSos. One of the key physical resources; the Co-operative Entrepreneurship and Innovation Centre (CEIC) was reported to be highly under resourced in terms of financing, personnel-having only the coordinator and lacking facilities such as vehicles, innovation incubators, dissemination unit, etc. The CEIC was seen by MoCU as an income generating source than innovation facilitator. One of the KIs claimed that:

> "*Instead of funding and utilizing CEIC for innovations design and dissemination, it is considered by the management as an income generating facility*" (KI 2, MoCU, Feb., 2018).

Table 1. MoCU resources capability attributes

Attributes	Summary of the key findings	Attribute rating	Reasons for the rating
Resources availability	**Human resources:** reasonable number (154 academic staff) is available. **Financial resources:** Some funds from internal sources e.g. tuition fee, house rent, consultancies etc, government and donor agencies were present. Mainly used to cover operational costs and non-innovation expenses. **Technological resources**: modern ICTs laboratory, ICT department, website, internet connected computers exist. **Physical resources:** libraries, co-operative entrepreneurship & innovation centre, radio unit, regional centres, correspondence/distance education department exist.	Resources availability for innovations dissemination is poor.	No considerable resources were specifically allocated and or utilized for innovations dissemination to PCSos.
Determination to prioritize & utilize resources for innovation	Currently not determined to prioritize and utilize resources for innovation dissemination. The strategic document misses clear innovations implementation and dissemination strategies. Innovation policy was as well missing.	Poor	Not determined at financing innovation.
Innovation incentives available	Limited innovation incentives are in place as there were no innovation prizes, competitions, bonuses and the like. Few available ones include an incentive process embedded into academic staff promotion system requiring one to produce a patented material or innovation to score some points for promotion.	Poor	No inclusive incentive systems and the few available were too meagre. There were also some bureaucratic hurdles in accessing some incentives.

Attributes	Summary of the key findings	Attribute rating	Reasons for the rating
	However, there was no any registered patented material at the time of the study. Moreover, a royalty of 5 percent of the 60 percent of the consultancy fee budget awarded to an individual or team managed to successfully secure and register a fundable assignment. Others include limited competitive fund for small scale research projects targeting junior researchers where winning proposals are awarded TZS one million each. Two publication avenues were also available for free to staff. No formal innovation dissemination reward system.		
Influence of external factors on innovation resources	Government declining funding has affected resources availability. In the years 2015, 2016 and 2017, the organization got no funding in form of other charges (OCs) from the government. No clear innovation resources policy-neither national STI policy nor other policies were clear on resources availability and commitment for innovations dissemination to PCSos.	High	Reduced resources availability.

Note: Organization resources capability in ID to PCSos rating:
1=Very Poor, 2=Poor, 3=Fair, 4=Good/High, 5= Very Good
(criteria applied in all studied GCSOs)

Influence of other factors on MoCU resources capability. The study revealed that MoCU was not determined at prioritizing and utilizing resources for innovations dissemination to PCSos. Contrary to the KIs results, FGDs participants expressed concern that despite financial limitation innovation was not among MoCU's priorities. They expressed concern that MoCU was not determined at financing innovation activities as it did not feature in its budget items. One FGD participant said that:

> "*Despite financial constraints, if MoCU was real pro-innovations, it could not fail to allocate at least one percent of its internally generated revenues for innovation undertakings*" (FGD1, MoCU, Feb. 2018).

Equally, there were limited innovation incentives that included some financial incentives. However, study participants expressed concerns in terms of bureaucracies in securing the reward especially after the money is deposited in the institution account (Table 2). Some financial incentives were also noted to be too meagre to undertake genuine innovative/research activities. Cessation of government financing to some development activities was also reported to have affected its funds ability to facilitate innovations dissemination to PCSos.

TCDC resources factor assessment. The study established that TCDC has some resources strength ranging from human, financial, technological and physical resources (Table 2). It was however, revealed that since its establishment in 2013, TCDC has not been able to mobilize sufficient resources especially funding to enable innovations dissemination to PCSos. One of the KIs said that:

> "*Little financial resources available have been used to put in place necessary working tools and thus done little on innovation aspects*" (KI 1, TCDC, Feb. 2018).

The organization was also found to have not sufficiently directed and utilized other available resources such as personnel, physical resources and others for innovation dissemination activities. This was verified by another KI who emphasized that:

> "M*any co-operative stakeholders especially PCSos are unfamiliar to TCDC and or its innovations" (KI 2, TCDC, Feb. 2018).*

This implies that TCDC has not yet taken sufficient efforts to invest on its available resources at ensuring organization publicity and importantly innovations disseminations to PCSos.

Influence of other factors on TCDC resources capability. The study revealed that resources prioritization and utilization for innovation activities was not among TCDC key concerns. Equally, there were no formal incentive systems to reward innovation activities. Moreover, the government's requirement to its organizations, TCDC inclusive, to finance most of its activities themselves, employment freezing at the co-operative sector and unclearly defined and communicated STI policy has compromised its ability to serve co-operatives (Table 2).

VETA resources factor assessment. The findings show that despite some resources existence at VETA (Table 3), it was ranked poor in terms of resources availability for innovations dissemination to PCSos. The available personnel mainly focused on conducting curriculum based vocational education and trainings and funds were mainly directed at covering operational costs and not at innovations dissemination activities. One of the KIs claimed that:

> "*Innovation activities in VETA has all along not been supported through a dedicated funding or financial allocation*" (KI 1, VETA, Dec. 2017).

Findings further showed that available technological and physical resources such as computers, training machines/equipments, laboratories, workshops, etc were utilized for innovations design e.g. excavators, fish traps, eggs hatching incubators and other designs that were limited for students trainings and showcasing only i.e. were not commercialized. None were disseminated to PCSos for the reason that resources constraints mainly limited government funding has been compromising its capability to disseminate innovations. Moreover, much of the technological and

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Table 2. TCDC resources capability attributes

Attributes	Summary of the key findings	Attribute rating	Reasons for the rating
Resources availability	**Human resources:** reasonable personnel (800 country wide) at head office, regional and district levels. **Financial resources:** The organization gets funding from the central government. Internal sources e.g. fees charged on co-operatives, donor support, etc exists. **Technological resources**: the organization has computers and internet connectivity (at head office only); none at regional or district levels. **Physical resources:** The physical resources include office premise (head office has acquired own land for office use) and some vehicles.	Resources availability for innovations dissemination is poor.	Not much of its resources were specifically allocated or utilized for innovations dissemination to PCSos.
Determination to prioritize & utilize resources for innovation	Resources prioritization and utilization for innovation dissemination to PCSos is not among TCDC key concerns. Its strategic document misses clear plans on innovations dissemination to PCSos. The innovation policy was also missing.	Poor	Most resources were directed to non-innovation activities.
Innovation incentives available	No formal innovation incentive system to reward innovation dissemination activities is in place.	Poor	Missing formal incentive systems.
Influence of external factors on innovation resources	Government employment freezing and declining financing has affected resources availability. STI policy insufficiently communicated and translated into practice.	High	Reduced human and financial resources availability.

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physical resources in place were found to be outdated while others were not operating. One of the KIs indicated that:

> "*Most of our technological resources are old-fashioned making us lagging behind in terms of science and technology including innovations designs and dissemination*" (KI 2, VETA, Dec. 2017).

This implies that despite some technological and physical resources availability in VETA, most of them are not in desired standards to be effectively utilized for innovation activities.

Influence of other factors on VETA resources capability. The study revealed that VETA was fairly determined at prioritizing and utilizing resources for innovation activities for the reasons that it has designed some for training students and showcasing. Equally, most innovations were not commercialized and mainly emanate from individual staff efforts than organization's efforts. Likewise, lack of formal incentive systems to reward innovation activities and declining government financing to the organization were reported to be affecting its ability to develop and disseminate innovations (Table 3).

Table 3. VETA resources capability attributes

Attributes	Summary of the key findings	Attribute rating	Reasons for the rating
Resources availability	**Human resources:** the organization has reasonable personnel (665 technical staff) working in 28 training centres throughout the country. **Financial resources:** It solicits funds from the central government, the industries owners through Skills Development Levy (SDL). Other sources include fees charged to students (short-term and long term courses) as well as from donor agencies. **Technological resources**: the available technological resources includes training machines/equipments, computers, internet connectivity, laboratories and workshops. **Physical resources:** The physical resources include premises for office and training use, libraries, vehicles and classrooms.	Resources availability for innovations dissemination is poor.	No resources were specifically allocated for innovations dissemination to PCSos. However, some resources were used for innovations designs that were limited for students training and showcasing.

Attributes	Summary of the key findings	Attribute rating	Reasons for the rating
Determination to prioritize & utilize resources for innovation	It has designed some innovations but none have been disseminated to PCSos. It design some for showcasing and training students only, it has devised own innovation policy (2014) and a strategic plan document which explicitly stipulates on innovation undertakings. The documents however were largely unimplemented.	Medium	Limited resources specially funding.
Innovation incentives available	No formal incentive/reward system for encouraging innovations dissemination activities was in place.	Poor	Formal incentive system missing
Influence of external factors on innovation resources	Declining government financing to VETA has affected resources availability.	High	Reduced VETA ability to innovate.

SIDO resources factor assessment. Findings in SIDO revealed some resources availability (Table 4). Nevertheless, SIDO was rated as poor in terms of resources ability for innovations dissemination to PCSos. Available funding was mainly used to cover operational costs and other non-innovation related activities e.g. office renovations and setting new centres. Personnel were mainly utilized to undertake conventional trainings to SMEs, limited products development on demand basis e.g. hides processing, machines fabrication, spare parts and other related duties. Available technological tools e.g. computers and machines were observed to be old and obsolete and some key physical resources e.g. premises were hired to private owners. Most other facilities e.g. machines and equipments were old and manual. One of the KIs emphasized that:

> "*SIDO has been suffering from inadequate investment in innovation technologies advancement, making it unable to cope with the influx of imported low price products and services" (KI 1, SIDO, Dec. 2017).*

As a result most of the innovations were generated from private operators who have hired SIDO premises. DFID (2014) found that the main relevant structures in Tanzania for implementing innovations particularly SIDO strongly lack resources mainly funding to enhance innovation activities. Some few innovations e.g. modern milling machine motors and other designs were found to be outsourced for a fee from technology suppliers such as the Centre for Agricultural Mechanization and Rural Technology (CARMATEC) and Tanzania Engineering and Manufacturing Design Organization (TEMDO) and others. One KI affirm that:

> "*Our regional centres are manned by qualified managers but lacking skilled artisans to design and disseminate innovations" (KI 2, SIDO, Dec. 2017).*

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This shows the lack of skilled personnel in most regional centres is likely to affect SIDO's ability to fully engage in innovation activities.Limited facilities however were available for innovation activities, the key one located at SIDO Vingunguti office in Dar es Salaam, with an innovation incubator where novel ideas from SMEs and other individuals are nurtured, developed and financed through a special innovation programme. No PCSo however, was found to have benefited from the innovation incubation services. Other regional offices miss such facility.

Influence of other factors on SIDO resources capability. SIDO scored poor in terms of its determination to prioritize and utilize resources for innovation activities due to unimplemented plans and focusing more on non-innovation related activities. Moreover, it lacks formal innovation incentives system. Likewise, lack of practical implementation of STI policy and linkages to other strategies like industrialization agenda has contributed to SIDO's inability to innovate (Table 4).

Table 4. SIDO resources capability attributes

Attributes	Summary of the key findings	Attribute rating	Reasons for the rating
Resources availability	**Human resources:** personnel are spread throughout the country (about 275 professional staff). **Financial resources:** It gets funds from the central government. Internal sources of fund include charges from trainings offered, services and or equipments sales and premise rent. Donor support is another source. **Technological resources**: some old machines/equipments are available. Workshops, computers, internet connectivity mainly at head office and some regional offices exist. **Physical resources:** Existing physical resources include land for office use and for renting under the build and rent programme and an innovation incubator-Dar es Salaam office.	Resources availability for innovation dissemination is poor.	No considerable human, financial, technological or physical resources were specifically utilized for innovations dissemination to PCSos.

Attributes	Summary of the key findings	Attribute rating	Reasons for the rating
Determination to prioritize & utilize resources for innovation	SIDO is not determined at prioritizing and utilizing resources for innovations dissemination e.g. most funding were used for non-innovation related activities. Some innovation plans were apparent in its strategic plan document but remain unimplemented. The innovation policy was also missing.	Poor	Focus more on conventional trainings than innovation aspects.
Innovation incentives available	No formal innovation incentives are in place.	Poor	Formal incentive system lacking.
Influence of external factors on innovation resources	National STI policy and other strategies e.g. industrialization agenda not clearly translated and communicated to be grabbed as an opportunity to SIDO. There is also inadequate funding.	High	Reduced SIDO's capability to innovate.

TaCRI resources capability assessment

TaCRI assessment of its resources strength revealed that most of its resources were allocated and utilized for innovation activities (Table 5). It utilizes its personnel and funds in designing and disseminating improved coffee seedlings to farmers and PCSos throughout coffee growing areas of Tanzania. Its technological resources including modern laboratory for soil and tissue culture experiments and physical resources e.g. land, piloting/experimentation plots, vehicles and others were utilized for developing and disseminating improved coffee seedlings to farmers and PCSos.

Influence of other factors on TaCRI resources capability. TaCRI was ranked as good in terms of determination to prioritize and utilize resources for innovation activities since innovation is part of its daily routine and core activities. It has also clear formal incentive system with several attractive packages that was reported to have positively encouraging innovations dissemination (Table 5). Nevertheless, the government directives through the minister responsible for Agriculture, Livestock and Fisheries to supply improved coffee seedlings to farmers and PCSos free of charge with unfulfilled pledge to subsidize the organization and declining government funding to TaCRI have amounted to declining resources for innovations dissemination (Table 5).

Table 5. TaCRI resources capability attributes

Attributes	Summary of the key findings	Attribute rating	Reasons for the rating
Resources availability	**Human resources:** reasonable technical personnel (65) employed under the organization policy to have a lean but efficient staff. **Financial resources:** It solicits funds from the government (about 13% of total annual budget). Main source of funding is from stakeholders i.e. coffee growers. It also gets substantial donor aid mainly from the European Union. Internal sources include selling coffee, seedlings and services offered. **Technological resources**: modern laboratories, website, internet connectivity and computers exist. **Physical resources:** Physical resources include land (254 hectares), vehicles, coffee farms, piloting/experiment plots and coffee nurseries.	Resources availability for innovation dissemination is good.	Most of the resources in place were utilized for innovations dissemination (PCSos inclusive)
Determination to prioritize & utilize resources for innovation	Innovation activities have been part of TaCRI daily routines and hence core activities. Determined at prioritizing and using resources on the same. TaCRI's strategic plan document clearly stipulates plans for innovations design and dissemination.	Good	Focused at financing and implementing innovations

Innovation incentives available	Formal innovation incentive systems were in place including financial bonues, staff promotion based on innovations developed and disseminated, financing innovative publications where up to 500 US dollars were available per each publication. Others include staff promotion to a higher rank based on innovations performance and recognizing innovators contributions in special TaCRI manuals. Existing incentives have positively encouraged innovations dissemination. About 23 improved coffee varieties have been disseminated to farmers and PCSos in Tanzania.	Good	The incentives have positively enabled innovations dissemination.
Influence of external factors on innovation resources	Unfulfilled government directives to subsidize TaCRI and declining government funding have amounted to declining resources availability for innovations dissemination. Financing fell from previous TZS 500m in 2005 to 150m in 2015 and sharply to TZS 4m in 2016 and 2m in 2017.	High	Reduced resources availability for innovations dissemination.

5.4 Discussion

GCSOs resources factor assessment for innovations dissemination to PCSos

There was availability of resources in all studied GCSOs whereby some could be directed at innovations activities. Nevertheless, in most GCSOs except TaCRI resources were directed at covering non innovation related activities. TaCRI was able to utilize some of its funds and other resources for innovations dissemination because apart from innovation being among its core mandate, it was not too reliant on government to finance its activities. Most of the innovation funding came mainly from stakeholders contributions i.e. coffee growers as the main source, donors and own sources. The implication drawn here is that as most funding came from the stakeholders, they have always been demanding value for the money invested and this therefore explains TaCRI's activeness in utilizing available resources for innovations dissemination. On average, government financing to TaCRI between the years 2007-2017 was only 13% of its total annual budget, unlike other GCSOs which stood at more than 75%. It was revealed that in most cases, government financing to GCSOs was not fulfilled as planned due to financial limitation. Osakwe & Moussa (2017) found that while governments have a major role to play in promoting innovation, it is not its responsibility alone. Organizations also have important role to play.

This implies that GCSOs are equally obliged to ensure sufficient innovation finances through own sources to reduce too much reliance on government.

Availability of some human resources featured in all studied GCSOs. However, the majority of them except TaCRI were not capacitated by their GCSOs with adequate innovation skills and trainings. This shows that as most GCSOs are not equipped with such necessary innovation techniques they are likely to be incapable to successfully undertake significant innovation activities. This is because, usually innovation skills and trainings are among the key innovation inputs in organizations and thus its lacking translates into poor innovation performance. Oyelaran-Oyeyinka (2014) and van Uden et al. (2017) established that public organizations in Sub Saharan Africa (SSA) are suffering from substantial lack of human competencies and skills due to inadequate investment on the same. Usually, employees need to be trained and educated before they can have a positive impact on the innovation process (Shipton, West, Dawson, Birdi & Patterson, 2006; Texeira & Tavares-Lehman, 2014). This implies that trainings like on-job/off-job innovation trainings, seminars, conferences, etc are crucial at enhancing personnel capabilities to disseminate innovations. Moreover, some technological and physical resources were available in all GCSOs but only those of TaCRI were fully dedicated for innovations dissemination to PCSos. This shows that resources availability alone is not sufficient to enable innovations dissemination. Thus, other attributes including willingness and or determination to implement desired innovation activities are equally important.

Influence of other factors on GCSOs resources ability to disseminate innovations

Innovation resources prioritization and or utilization in the studied GCSOs. The study established that most GCSOs were not determined at prioritizing and utilizing resources for innovations dissemination to PCSOs. Several reasons including unwillingness by GCSOs to finance innovation activities and limited resources were established by study participants. Some participants expressed concern that resources were too little to be directed for innovation activities and that their GCSOs had not got such resources from the government specifically for innovation activities. The implication drawn here is that there was a misconception among some study participants on innovation resources, in the sense that for innovation activities to be possible there must be a special innovation package branded "innovation resources" that should come from the government to GCSOs. This was so because, some resources like personnel, finances and others were available but unutilized for innovation activities. Thus, the findings implied that apart from unwillingness by some GCSOs executives to prioritize and or utilize resources for innovation activities as earlier postulated in this study, the misconception on innovation resources also contributed to their incapability to disseminate innovations to PCSos.

Innovation incentives for motivating staff to disseminate innovations to PCSos. This study revealed that innovation incentives in most of the studied GCSOs were not only inadequate as earlier assumed in this paper, but were also unpromising and missing in some organizations. In most GCSOs except TaCRI and to a lesser extent MoCU, there were no formal incentive systems for rewarding innovation dissemination activities. There were also some incidences where available incentives were claimed to be too little and difficult to acquire in terms of associated bureaucratic hurdles. The Carrot and Stick Theory emphasize that employees should be rewarded for them to elicit desired behaviours. This means that for them to be able to actively partici-

pate in innovation dissemination activities, they should be rewarded with some incentives such as innovation prizes, competitions, recognition, training opportunities, promotions and others. This implies that the failure by most GCSOs to facilitate innovations dissemination to PCSos partly result from the lack of incentives from the government or GCSOs to activate its resource base particularly personnel to elicit innovation activities. The negative incentives in form of reinforcement e.g. special directives from the government or GCSOs boards demanding them to innovate were also missing. Moussa, McMurray & Muenjohn (2018) found that governments around the world have repeatedly ignored the need for developing incentive systems to promote innovation in public sectors. Unlike other GCSOs, TaCRI had clear reward system that is well implemented and considered as a key activator in disseminating innovations to coffee farmers, PCSos inclusive. MoCU also had a limited form of rewarding innovation activities.

Influence of external factors on GCSOs resources capability. This study revealed that some external factors were found to affect the GCSOs resources capability to disseminate innovations to PCSos. They include government interventions such as the freezing of the new employments and unprecedented decline in government financing to GCSOs. DFID (2014) established that there has been lack of government resources commitment especially funding to enable innovation activities in Tanzania. Likewise, most GCSOs except VETA lacked own innovation policy expressing concern that the national STI policy is not sufficiently communicated and translated into GCSOs practice especially on resources availability and commitment for innovations dissemination to PCSos. Thus, the study affirms that some external factors have been affecting GCSOs resources capability to disseminate innovations to PCSos. Equally, in most GCSOs except TaCRI, there was no funding specifically allocated for innovation Research and Development (R & D). R & D expenditure is an important innovation input in all innovative and competitive organizations (Goedhuys et al., 2014). Most GCSOs claimed that they were not provided with R & D funding by the government. Nevertheless, Osakwe & Moussa (2017) show that governments in SSA, have been allocating only 0.42% of their domestic expenditure (% of GDP) for R & D. Studies have shown that Tanzania has been allocating only 0.25% of its domestic expenditure for R & D against the national target of 1% set in 1995 (DFID, 2014; World Bank, 2005). This amount is incredibly minimal to enable significant innovation activities in all government sectors. This implies that R & D government financing to GCSOs will continue to remain significantly low unless sufficient funds are allocated for the same.

The contribution of the study to the body of knowledge. Based on the Resource Dependence Theory grounds, the study established existence of GCSOs resources reliance syndrome skewed on the government side, in the sense that, most GCSOs feel they were unable to facilitate innovation activities because they were not provided with innovation resources from the government. Nevertheless, the study revealed that some resources were available but unutilized for innovation activities. This then was taken care by the second theory i.e. the Carrot & Stick Theory, in that perhaps there were no incentives to reinforce GCSOs executives and personnel to utilize available resources for innovations dissemination to PCSos. But again, the study identified some cases where incentives were available but personnel were not motivated towards such incentives (outcome based) because of some bureaucratic hurdles to acquire them, too meagre incentives and lack of clear incentive systems. Thus, this study contributes to the C & S Theory

in the sense that for incentives to result into desirable outcomes they should not only focus on the ends (outcome based) but on means (process) as well.

Study Limitations and Areas for Further Research

As is with the majority of studies, the design of the current study is subject to some limitations. The first limitation concerns the type of research design used i.e. case study research design. The case study has long been stereotyped as a weak sibling among social science methods. Case studies have continued to be denigrated as having insufficient precision (i.e. quantification), objectivity or rigor (Yin, 2003). To address this weakness multiple case studies approach was applied. The approach is considered to increase methodological rigor as it strengthens the precision, validity and reliability of findings (Miles and Huberman, 1994). The second limitation is that this work was conducted at a time when some key GCSOs i.e. the Tanzania Co-operatives Development Commission (TCDC) and Moshi Co-operative University (MoCU) were still readjusting from major re-organization. This is due to the fact that TCDC was established in 2013 following the transformation of the former Co-operative Department in Tanzania and MoCU was established in 2014 following the upgrading of the former Moshi University College of Co-operative and Business Studies (MUCCoBS) itself having been transformed from the Moshi Co-operative College in 2004. Thus, some organisational transformation events and or changes that may in one way or another influenced organisations' resources capability for innovations dissemination to PCSos are likely to have continued to happen beyond the study period and coverage. The researchers therefore may not claim to have seen, cover and present all of the facts required for this study at its entirety through to their conclusion. A similar study is therefore recommended after some time in future to assess the resources capability of such organizations in dissemination of innovations to PCSos. The third one is that this study was limited to GCSOs only despite the fact that there are other member-based and private organizations that support co-operatives in Tanzania. A more inclusive study covering and comparing other co-operative supporting organizations is advised in future to establish their resources capability for dissemination of innovations to PCSos.

5.6 Conclusions and Recommendations

This study concludes that most GCSOs were not determined at prioritizing and utilizing resources for innovations dissemination to PCSos. It is advised that the GCSOs executives should ensure sufficient resources commitment and its utilization to enable innovations dissemination to PCSos. The study further concludes that lack of incentives to support innovation activities amongst GCSOs executives and personnel has been hindering dissemination of innovations to PCSos. Most GCSOs lack formal and comprehensive incentive systems to reward innovation activities. In that case, GCSOs executives should establish and implement clear incentive systems to reward innovation dissemination activities. The incentive systems should include inclusive rewards e.g. innovation trainings, prizes, competitions, financial rewards, salary hikes based on innovation activities done, recognition of innovators and others. The government through GCSOs boards should do the same to motivate executives so that trickledown effect can be attained. This is because, findings established incidences where innovation dissemination activities were neither amongst GCSOs priorities nor rewarded e.g. through provision of innovation skills. Equally,

some negative reinforcements e.g. directives from the GCSOs boards to the executives and from executives to personnel demanding them to implement innovations dissemination to PCSos, as part of their performance appraisal system are suggested. It is also concluded that some external factors including government freezing of employment at the co-operative sector and declining government funding commitment to GCSOs have affected GCSOs resources availability to enable innovations dissemination to PCSos. Then GCSOs should strive to minimize the resultant negative effect from such factors through mobilizing more internal resources to arrest the situation. Other external factors include unimplemented government directives e.g. failure to subsidize improved coffee seedlings production and dissemination as promised at TaCRI and uncoordinated and poorly translated national STI policy to GCSOs. It is recommended that GCSOs executives should strive to mobilize more internal resources to cover such unimplemented gaps. Moreover, the GCSOs should strive to derive and translate the national STI policy into their context to come up with own and practicable innovation policies.

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Biographies

Luka S. Njau. Luka Njau is a Lecturer at the department of Community and Rural Development of Moshi Co-operative University (MoCU), Tanzania. He is currently pursuing Ph.D. studies in Rural Development at Sokoine University of Agriculture (SUA). He holds a Master of Art degree in Rural Development, a Bachelor of Science degree in Agricultural Education and Extension and a Certificate in Managing Agricultural Marketing Co-operatives (My.Coop) from International Training Centre of the International Labor Organization. He has extensive teaching and field work experience accumulated over ten years period working at the university, the community, community based organizations as well as international organizations. He teaches extension education courses, co-operative extension, adult training methodologies, participatory techniques and research methodology. His research interest includes co-operative innovations, co-operative development, rural development interventions, adult learning aspects, community economic development (CED) philosophy & interventions and cross-cutting issues.

Christopher P. Mahonge. Christopher Paul Mahonge is an Associate Research Professor in the Department of Policy Planning and Management, College of Social Sciences and Humanities at Sokoine University of Agriculture, Tanzania. He is specialised on Governance of complex Social-Ecological Systems. His research experience has focused on community-based natural resources management and livelihood improvements, linkages among the state, non-governmental and community actors and institutions, socio-economic implications of climate change, land use planning, and institutional analysis (government-based, organisation-based, and community-based formal and informal rules systems associated with governance of social-ecological systems), out-scaling and hybridization of institutions, and informal politics.

Fatihiya A. Massawe. Dr. Fatihiya A. Massawe received a Ph.D. in Rural development from the Sokoine University of Agriculture (SUA) in 2014, Postgraduate Diploma in Poverty Analysis jointly offered by ESRF, REPOA, and ISS (Netherlands) in 2009, an MSc in International Development Studies majoring in Rural Development Sociology from Wageningen University Netherlands in 2006 and BSc in Home Economics and Human Nutrition from SUA, 2000. She is currently serving as a senior lecturer at the Campus College of Social Sciences and Humanities- SUA and the head of the Department of Policy, Planning, and Management at the same College. Before joining SUA, she was working as a Community Development Officer in the Vice President Office and the Ministry of Community Development Gender and Children for 7 years. Her interest in teaching, research and consultancies focuses on Poverty analysis; Nutrition & Gender; HIV & Gender; energy and livelihood, adoption of technology. She has participated in many projects and published in the same area of specialization. Ms. Fatihiya is a recipient of the year2018/2019 Martha Farrell Foundation Fellowship award that foster institutionalization of initiatives against sexual harassment at workplaces.

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Enabling the diffusion of sustainable product innovations in BIM library platforms

Soheila Bahrami
soheila.bahrami@construction.lth.se | Division of Construction Management, Faculty of Engineering, Lund University, Box 118, 22100, Lund, Sweden
Brian Atkin
brian.atkin@construction.lth.se | Division of Construction Management, Faculty of Engineering, Lund University, Box 118, 22100, Lund, Sweden
Anne Landin
anne.landin@construction.lth.se | Division of Construction Management, Faculty of Engineering, Lund University, Box 118, 22100, Lund, Sweden

Abstract. Building Information Modelling (BIM) objects represent building products in design, simulation, and procurement processes. This paper explores how BIM objects could be created and exchanged to enable the diffusion of innovative products with enhanced sustainability performance. Two BIM library platforms were examined by taking a new approach that integrates the concepts of sustainable value, diffusion of innovations, information, software usability, and platform ecosystems. The findings show that the diffusion of sustainable products can be inhibited due to problems with the mechanisms for creating and exchanging BIM objects, quality of BIM objects, the usability of BIM library platforms, and participation on the platforms. This study deepens an understanding of the problems by focusing on ventilation products in Sweden. Identified shortcomings in the current practices of BIM platform owners and participants could be reduced by effective platform strategies, certification schemes for BIM objects, and BIM object creation processes integrated with product lifecycle management.

Keywords. Innovation diffusion; BIM object; BIM library platform; sustainable value; product information management; software usability.

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1 Introduction

Building Information Modelling (BIM) is widely considered as the main tool for the exchange of digital information about buildings throughout their lifecycles. On BIM library platforms, BIM objects represent products such as ventilation system components within applications including design, simulation, and purchasing processes. Thus, BIM libraries have a central role in disseminating information about innovative products.

In Sweden, some heating, ventilation, and air conditioning (HVAC) manufacturers have attempted to create value through sustainable innovations such as patented solutions for controlling airflow and noise in their ventilation products (World Intellectual Property Organization, 2015, 2018). Diffusion of such innovations can enhance the indoor environmental quality and the sustainability performance of buildings. However, the retrieval of accurate information (Gao et al., 2017) and valid comparisons between building products is limited due to the heterogeneous methods by which building product information is provided (Bahrami et al., 2019) and BIM objects are created (Gao et al., 2017).

In the context of innovation diffusion, researchers have studied BIM as a process innovation (Bosch-Sijtsema et al., 2017; Gholizadeh et al., 2018; Gledson, 2017) in relation to standardization (Hooper, 2015) and its evolution as a digital infrastructure (Holmström et al., 2014). However, previous studies have overlooked the role of BIM in creating sustainable value through the diffusion of product innovations. In the context of information, studies on BIM objects have focused on one aspect, such as software structure (e.g. McGlinn et al., 2017), product information management (e.g. Palos et al., 2014), or information retrieval (e.g. Gao et al., 2017). There is still a need for a holistic approach in studying the creation and exchange of BIM objects in relation to the diffusion of sustainable innovations. This need is critical for BIM objects of HVAC products due to their major impact on the sustainability performance of buildings. Hence, efficient BIM object library platforms are required to direct HVAC design and simulation processes towards selecting products with enhanced sustainability performance. The growing number of BIM applications (Gao et al., 2017; Pasini et al., 2017) offers a pivotal role to BIM library platforms as ecosystems in which BIM objects are created and exchanged. However, research to date has not investigated platform business strategies adopted in BIM libraries.

The study presented here aims to explore the creation and exchange of BIM objects on BIM library platforms for supporting the diffusion of sustainable HVAC innovations. The focus is on the ventilation BIM objects on two BIM library platforms used in Sweden. The BIM objects are manufacturers' objects based on products available on the market. In this paper, sustainable innovations are ventilation products with enhanced sustainability attributes. The sustainability attributes are energy efficiency, indoor environmental quality performance, and carbon footprint of the products. A new approach has been developed by modifying and integrating elements and methods from related research fields. The conceptual framework is broad in order to address the areas neglected in previous studies. On the other hand, this work deepens the understanding about BIM objects by focusing on ventilation products with enhanced sustainability attributes. The implications of these findings concern the stakeholders involved in creating and exchanging BIM objects.

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The remainder of the paper has the following structure. First, it gives a review of related previous research conducted on the concepts of sustainable value, diffusion of innovations, quality of information, usability of BIM libraries, and platform ecosystems. Next, it describes the research method, which has been developed by integrating these concepts and designing a multiple case study, consisting of two BIM library platforms. The subsequent section discusses the findings in relation to the conceptual framework and the implications for BIM platform owners, HVAC manufacturers, and researchers. The final section summarizes the main findings of this study and identifies areas for further research.

2 Literature review

The literature on sustainable value, diffusion of innovations, information quality, usability and platform ecosystems are reviewed to construct a conceptual framework for this study. Sustainable value is defined as mutual benefits for society, the environment, and a firm, which can be co-created through collaborative relationships between stakeholders (Sulkowski et al., 2018). Firms can benefit from developing new business models and sustainable offerings through sustainable value chains (Nidumolu et al., 2009). To capture sustainable value from their innovations, firms must effectively communicate the advantages of their offerings. For ventilation products, the common sustainability indicators are energy efficiency and indoor environmental performance, including indoor air quality, thermal comfort, and acoustic performance (Sweden Green Building Council, 2019). Manufacturers can also quantify and communicate the sustainability impacts of their products by reporting the carbon footprint of their products. This indicator is defined as the net sum of greenhouse gas emissions and removals in a product system, expressed as carbon dioxide equivalents based on a life cycle assessment (ISO, 2018).

The process in which an innovation is communicated over time among members of a social system is referred to as the diffusion of innovations (Rogers, 2003). Research has shown that as suggested by epidemic (Bass, 2004) and bandwagon theories (Rogers, 2003), the diffusion of innovations is driven by information dissemination (Frattini et al., 2014). It begins with communicating the information about the existence of an innovation, while its success depends on the user's perception of the following characteristics of the innovation (Rogers, 2003).

- Relative advantage: the degree to which an innovation is perceived as better than other offerings
- Compatibility: the degree to which an innovation is perceived as being consistent with user values
- Complexity: the degree to which an innovation is perceived as difficult to understand and use
- Trialability: the degree to which an innovation can be assessed
- Observability: the degree to which the performance of an innovation is visible

Information serves to influence the receiver's perception of something (Davenport & Prusak, 2000). Firms can provide information on the relative advantages of their offerings by persuasive

value propositions (Anderson et al., 2009). They can utilize value propositions as strategic tools to communicate (Payne et al. Eggert, 2017) the benefits customers can gain from their offerings (Osterwalder et al., 2014) when compared with the alternatives offered by their competitors (Lindic & Silva, 2011). To communicate the relative advantage of their sustainable innovations, firms must employ sustainable value propositions. A sustainable value proposition is defined as "a promise on the economic, environmental, and social benefits that a firm's offering delivers to customers and society at large, considering both short-term profits and long-term sustainability" (Patala et al., 2016). The compatibility of an innovation accelerates its diffusion (Olson, 2013; Rogers, 2003); whereas, complexity decelerates the diffusion (Grimpe et al., 2017; Rogers, 2003). Trialability and observability are characteristics influencing the level of uncertainty about an innovation faced by potential adopters (Hall, 2006). Various sources and types of information about an innovation enable its diffusion by reducing uncertainty about its attributes, use, and impacts (Rice, 2017).

The growing application of BIM has made BIM libraries significant sources of product information, which is presented in the form of BIM objects (Gao et al., 2017; Pasini et al., 2017). A BIM object is a data file detailing information about the identity, dimensions, appearance, and performance of a product (BSI, 2018). It can facilitate the trialability and observability of an innovative product in a virtual environment, and consequently foster its diffusion. Nonetheless, this cannot be achieved if BIM objects lack sufficient quality; of particular concern are the technical data and features required for HVAC design calculations and performance simulations, due to their impact on the perceived sustainability performance of products. Therefore, in order to enable the diffusion of sustainable HVAC innovations, BIM objects representing such products must contain high-quality information.

Information quality is defined as "desirable characteristics of the (information) system outputs" (Peter et al., 2013). It can be assessed by indicators such as relevance (Holliman & Rowley, 2014; Myrelid & Jonsson, 2019; Pazeraite & Repoviene, 2016; Peter et al., 2013), accuracy, currency, usefulness (Holliman & Rowley, 2014; Peter et al., 2013), sufficiency, comprehensibility (Myrelid & Jonsson, 2019; Peter et al., 2013), accessibility (Myrelid & Jonsson, 2019), and reliability (Myrelid & Jonsson, 2019; Pazeraite & Repoviene, 2016). An attempt to assess the quality of BIM objects is the BSI Kitemark for BIM objects, a third-party certification scheme to validate the accuracy and functionality of BIM objects (BSI, 2018). A shortcoming of the existing BIM libraries is that they provide different names (Chen et al., 2017) and types of information for products in the same category made by different manufacturers (Gao et al., 2017; Pasini et al., 2017). Dissimilarities between two distinct methods of representing data stem from different types of data, value differences, semantic differences, and missing values (Anumba et al., 2008). A recent study has identified the problem of dissimilarities in product information provided by HVAC manufacturers in Sweden as a potential barrier to the diffusion of innovations (Bahrami et al., 2019). Product lifecycle management (PLM) is a system for the integrated management of product information and processes through the product lifecycle (Schuh et al., 2008), which can be applied to facilitate the diffusion of innovations (Stark, 2015). PLM tools enable integrating business information with engineering information (Ferreira et al., 2017). So far, however, integrating the creation of BIM objects with the PLM tools has not been investigated.

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Unlike the cost of information which is determined by the producer, the value of information is determined by the user (Feather, 2013). The value of information is not inherent in information itself, but rather dependent on its availability, suitability (Feather, 2013), context, and use (Rowley, 2008). Therefore, providing valuable information for users depends not only on the quality of information, but also on how the information can be used. On BIM library platforms, users access the product information through the BIM library interfaces. This shows how the usability of BIM library interfaces is a significant factor in the value of their information. The ISO/IEC 25062 standard defines usability as "the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency, and satisfaction in a specified context of use" (ISO, 2019). For example, the usability of a software tool for improving energy efficiency in buildings has been evaluated by investigating whether the data can be accessed and comprehended by facility managers (McGlinn et al., 2017). Software usability can also be evaluated by investigations on searching, differentiating, and selecting behavior at the resource, source, document, and content levels (Makri et al., 2008). However, previous studies have overlooked this approach in investigating the usability of BIM library interfaces. Factors affecting the usability of an interface include informativeness, reachability of desired content, density, readability, and comprehensibility of the information (Speicher et al., 2015), and credibility of the website (Holliman & Rowley, 2014). Some usability problems are primarily system issues arising when information or functionality is missing, inadequate, misplaced, unnecessary, or misaligned (Tarkkanen et al., 2015). In this paper, the term usability is defined as the functionality and applicability of a BIM library interface in promoting innovative products with enhanced sustainability performance.

The most common BIM libraries are provided on digital platforms; for example, SmartBIM library (SmartBIM, 2018), Bimobject platform (Bimobject, 2019), NBS National BIM library (National Building Specification, 2019), and MagiCloud (MagiCAD, 2019). The platform business model enables external producers and consumers to create value in an interactive ecosystem (Parker et al., 2017b), and is used as an effective strategy for delivering innovations (Kim, 2016). Information technology platforms, in particular, can reform innovation ecosystems (Parker et al., 2017). In a platform ecosystem, value is co-created through iterative and reciprocal processes of shaping institutional arrangements (Fehrer et al., 2018) by all participants in a complex value matrix instead of the traditional linear value chain (Parker et al. 2017b). In innovation ecosystems, innovative firms must collaborate with other actors to achieve a complex value proposition (Talmar et al., 2018). Every platform has a core interaction defined by three key elements: the participants, the value unit, and the algorithmic software tool (filter) for delivering the value unit to the users (Parker et al., 2017a). Information and interactions are the principal assets in platform businesses (Van Alstyne et al., 2016), and because every interaction starts with the exchange of information, even platforms intended to exchange physical goods must facilitate the exchange of information (Parker et al., 2017a). In addition, platform owners need to define and adjust the optimum level of openness of their platforms continuously (Van Alstyne & Parker, 2017). Openness enables access to user creativity (Kohler & Chesbrough, 2019) and third-party developers' innovations (Parker & Van Alstyne, 2018); however, open platforms are more fragmented and more difficult to monetize and control (Parker et al., 2017), which can result in poor quality contributions (Van Alstyne & Parker, 2017). Platforms can develop a culture of quality control to create value units which are relevant, useful, and accurate (Parker et al., 2017a).

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Although platform is the common business strategy for BIM libraries, the effects of different platform structures on the creation and exchange of BIM objects has yet to be understood. Previous research has investigated the role of information, promotion (Song & Parry, 2009), social media (Bhimani et al., 2019), and early adopters in the diffusion of innovative products (Bianchi et al., 2017). However, the role of BIM library platforms in disseminating information about innovative building products for sustainability, and supporting the diffusion of such innovation, has not been studied thus far. In the fields of information and software usability, there is still a need for a holistic approach to study product information and software structure, while considering the needs of specific BIM users (e.g. the HVAC sector); particularly, with a focus on the sustainability attributes of BIM objects as user requirements. Limited understanding about these issues runs the risk of restricting the diffusion of sustainable innovations.

3 Methodology

The literature review has revealed that a holistic approach needs to be developed for investigating the creation and exchange of BIM objects on BIM library platforms in support of the diffusion of sustainable innovations. To address this need, the conceptual framework of this study (Figure 1) has been established by integrating the concepts of sustainable value, diffusion of innovations, information quality, software usability, and platform ecosystems.

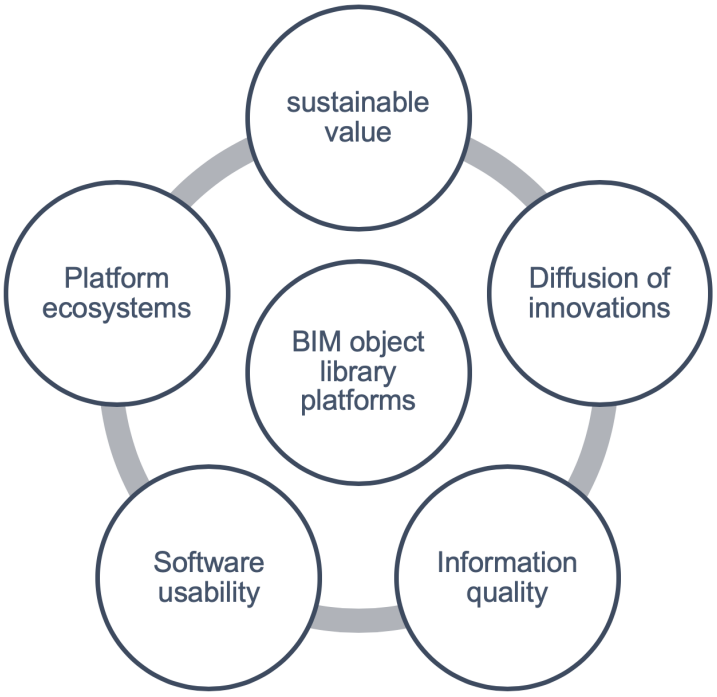

Fig. 1. The conceptual framework for studying the role of BIM object library platforms in the diffusion of sustainable innovations

The methodology of this study is qualitative, characterized by selecting and juxtaposing an

assortment of relevant information to develop an in-depth understanding of interconnected phenomena (Young & Munksgaard, 2018). A qualitative approach is an effective way of conducting research in the field of management (Singh, 2015). It allows researchers to use various sources of information (Yin, 2016) to establish the basis for retroductive reasoning through inferring patterns and causation from different data sources (Kessler & Bach, 2014). Moreover, in qualitative research, the emphasis is on words rather than quantifications (Bryman & Bell, 2015) as this enables the study of textual information in BIM objects especially when the information is limited.

As one of the approaches in qualitative research (Creswell & Poth, 2018), this study has adopted a multiple-case study approach. It is an effective empirical approach for investigating a contemporary phenomenon in depth and within its real-world context (Yin, 2018), and has been applied in studies on BIM in the contexts of the diffusion of innovations (Gledson, 2017), usability (McGlinn et al., 2017), and standardization (Hooper, 2015). Figure 2 illustrates the multiple-case design for this study, which covers two cases in the context of the diffusion of sustainable product innovations. The cases are two BIM library platforms referred to as platform A and platform B in this paper, details of which are provided in the next section. Based on the key elements of the core interaction on a platform suggested by Parker et al. (2017a), the embedded units of analysis in each case are participants, BIM library platform, and BIM objects. The platforms have been selected based on the results of an initial survey on the BIM libraries commonly used by HVAC design engineers in Sweden. The respondents were from seven major and three medium-sized architecture, engineering, and construction (AEC) companies in the country. The cases have been selected-to-difference (Kessler & Bach, 2014) that enables investigating how different aspects of the platforms affect the creation and exchange of BIM objects and the diffusion of sustainable innovations. An initial review of the platforms' websites revealed a considerable difference between the platforms regarding the number of BIM objects and their offerings.

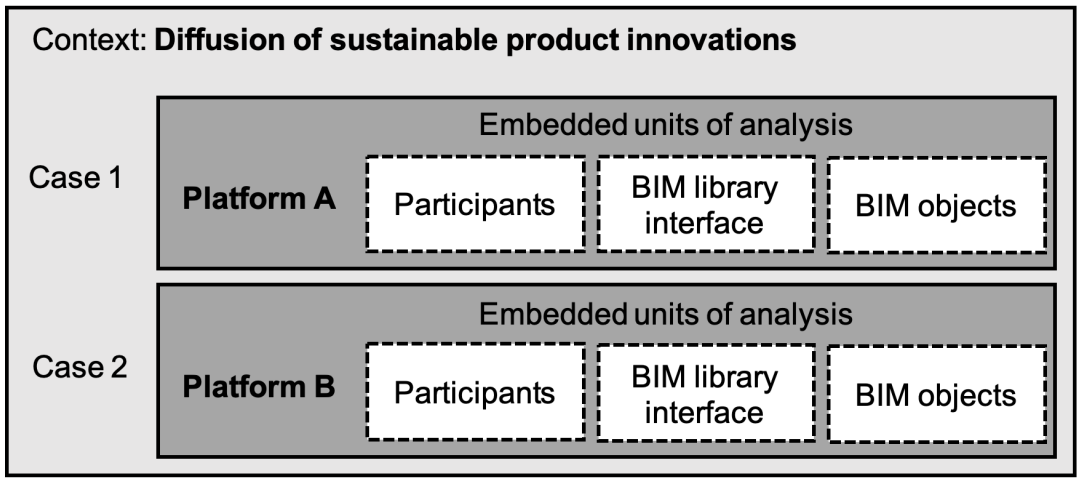

Fig. 2. Multiple-case study design

Next, based on abductive re-description and re-contextualization of the conceptual framework components (Bhaskar, 2014; Danermark et al., 2002), a tool for data collection and analysis was developed in three stages. First, the matrix shown in figure 3 was developed by integrating

the concepts of platform ecosystems, software usability, and information quality in order to reconceptualize the BIM library platforms. The creation and exchange of BIM objects has been determined as the core interaction on BIM library platforms. The key elements of this core interaction are BIM object producers and users, BIM library interface, and BIM objects. The criteria determined for assessing the key elements are participation quality, usability, and information quality. The indicators have been selected and modified from the literature reviewed in previous section.

	Key elements	Criteria	Indicators
Core interaction (creation and exchange of BIM object)	Participants (BIM object producers and users)	Participation quality	Access to BIM objects Participant categories Roles Attraction Control
	Filter (BIM library interface)	Usability	Availability of desired content Searchability of desired content Comparability of BIM objects
	Value unit (BIM object)	Object quality	Compatibility Functionality
		Information quality	Accessibility Accuracy Adequacy Comprehensibility Currency Applicability Reliability

Fig. 3. Matrix for the qualitative analysis of BIM library platforms

Table 1. The characteristics of a sustainable innovative product represented by its BIM object to enable its diffusion (After Rogers, 2003)

Relative advantage	The superiority of the sustainability attributes of an innovative product over other brands
Compatibility	The degree to which the sustainability attributes of an innovative product comply with the users' requirements
Complexity	The difficulty of understanding the information about the sustainability performance of an innovative product
Trialability	The possibility of using a BIM object to perform more accurate design and sustainability performance calculations
Observability	The accuracy of the simulated sustainability performance of an innovative product compared to its actual performance

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Second, the characteristics of an innovation suggested by Rogers (2003) were redefined by integrating the concepts of sustainable value and the diffusion of innovations and re-contextualizing BIM library platforms in the setting of the diffusion of sustainable innovations (table 1). Third, the questions listed in table 2 were formulated to integrate the indicators shown in figure 3 with the definitions in table 1. The questions enabled the retroduction of possible explanatory mechanisms or structures as a necessity in interdisciplinary research (Bhaskar et al., 2010) and the implementation of a holistic approach in data collection and analysis.

In qualitative research, data collection and analysis, and report writing are interrelated and often concurrent (Creswell & Poth, 2018)). In this study, those processes took place concurrently from September 2018 to September 2019. Case study research relies on multiple sources of evidence (Yin, 2018) including observations, audio-visual material, documents, reports, and interviews (Creswell & Poth, 2018). The data regarding the structure of the platforms was collected from the platforms' websites, YouTube channels and LinkedIn pages. This study has focused on HVAC professionals in AEC companies as the users of BIM libraries. Thus, the data regarding the usability of the BIM library interfaces and the quality of BIM objects was collected and analyzed by one of the co-authors proficient in HVAC design software and an HVAC design expert. As suggested by Creswell and Poth (2018) data was collected in natural settings sensitive to the objects under study. The data was collected through critically studying approximately seven hours of webinars, tutorial, and demonstration videos on the platforms' websites and their YouTube channels as well as studying six hours of tutorial videos made by HVAC designers and shared on YouTube. The latter has served as a valuable source of data in natural settings that allows the researcher to observe different ways of using the BIM libraries and objects by HVAC professionals.

In addition, the participant observation method (Bryman & Bell, 2015) was followed through which the abovementioned members of the research team used the BIM platform libraries and their BIM objects in common HVAC design software. The aim was to answer the questions listed in table 2 regarding the usability of the interface as well as the compatibility and functionality of the BIM objects. In total, 80 ventilation BIM objects composed of 50 objects from platform A and 30 objects from platform B were selected for analysis. The reason for selecting fewer objects from platform B was the number of available objects on the platform. Content and semantic analysis (Young & Munksgaard, 2018) was applied to explore the quality of BIM objects. The keywords were selected based on the sustainability attributes (i.e. energy efficiency, indoor environmental quality performance, and carbon footprint of products). The keywords were completed by adding units and different terms adopted in the industry. For example, "db", "sound", "noise", and "acoustic" for searching information about the acoustic performance as one of the aspects of indoor environmental quality.

For each platform, a within-case analysis was performed through the analysis of each embedded unit (figure 2) followed by a process-tracing method (Beach & Pedersen, 2013; Goertz & Mahoney, 2012) to conduct an analysis across the three embedded units. Furthermore, a cross-case analysis of the platforms was conducted in order to externally validate the findings from the analysis of each platform by cross-case comparison (Frattini et al., 2014). It was conducted by exploring patterns, themes, differences, and similarities across the cases (Creswell & Poth, 2018; Mathison,

Table 2. Questions for data collection and analysis

	Indicators	**Questions**
Participation quality	Access to BIM objects	How open is the access to the BIM objects published on the platform?
	Participant categories and roles	Who are the BIM object creators and users?
	Attraction	How does the platform attract the participants to the platform?
	Facilitation	How does the platform facilitate the creation and exchange of BIM objects on the platform?
	Control	How does the platform control and assure the quality and reliability of the BIM objects?
Interface usability	Availability of desired content	Does the library have BIM objects for all ventilation products available on the market?
	Searchability of desired content	Do the search criteria include the sustainability attributes of products?
	Comparability of products	Does the interface enable its users to compare the sustainability attributes of different brands?
BIM object quality	Compatibility	Is the object compatible with common design and calculation software?
	Functionality	Is the object sufficient for performing accurate calculations and simulations?
	Accessibility	Can users easily access the information about the sustainability attributes of the product in the content of a selected object?
	Accuracy	Is the information on the sustainability attributes of the products accurate?
	Adequacy	Is sufficient information on the sustainability attributes of the products included in the BIM objects?
	Comprehensibility	Does the information give a clear understanding of the sustainability attributes of the product?
	Currency	Is the information up to date?
	Applicability of the content	Does the information enable the user to compare different brands and choose the products with better sustainability attributes?
	Reliability	Has the information on the sustainability attributes been verified or certified?

2005). As proposed by Creswell and Poth (2018), both inductive and deductive reasoning were used to analyze the data.

The researcher's professional experience is considered to be an important analytical tool in qualitative data analysis (Mauthner & Doucet, 2003), which utilizes personal reflection to seek insights in research on business relationships, networks, and markets (Young & Munksgaard, 2018). In this study, the authors' long experience of AEC management as well as HVAC and IT engineering and management was applied to analyze the data and identify the problems. In addition, diverse sources of data helped the authors to cross-check and verify (Saunders, Lewis, & Thornhill, 2009) the identified problems and minimize the risk of researcher bias. Furthermore, to ensure the interpretative validity (Huberman & Miles, 2002) of findings, eight semi-structured interviews were conducted. The interviews were conversational in order to answer questions listed in table 2, complete and verify the findings, and include the aspects that could possibly be neglected by the authors. Regarding the usability of platforms and the quality of the BIM objects, six semi-structured interviews were conducted with IT, product, and marketing managers in three major HVAC manufacturing companies, and three HVAC design engineers in three major AEC companies. As mentioned, regarding the information quality and usability, this study focuses on the characteristics of the BIM objects and the BIM library interfaces. Therefore, experienced HVAC designers were selected as interviewees in order to exclude the probable problems caused by insufficient knowledge of users. The industry validation (Leising, Quist, & Bocken, 2018) was continued by two semi-structured in-depth interviews with the area and technical managers in the platform companies. The interviews were conversational and based on the questions listed in table 2. They were recorded, transcribed, and coded based on the indicators mentioned in figure 3 and the characteristics defined in table 1. After analyzing the final results, the findings were visualized and are described in relation to the conceptual framework in the following section.

4 Findings and discussion

This study set out to assess the creation and exchange of ventilation BIM objects as the core interaction on two BIM library platforms in Sweden. The findings indicate that both platforms have problems with participation, the usability of the BIM libraries, and the quality of BIM objects.

4.1 Participation on the platforms

Spreading the information on products with enhanced sustainability performance is the first step in the diffusion of such innovations. However, this study found that limited participation on the platforms has reduced the access to information about the existence of innovative products. Platform A targets the mechanical, electrical, and plumbing (MEP) sector (including HVAC) as a niche market. Figure 4 demonstrates the interactions among the participants on the platform. The platform company offers a BIM library platform and BIM software for MEP design and energy modelling of buildings that complement AutoCAD and Revit. It also creates BIM objects

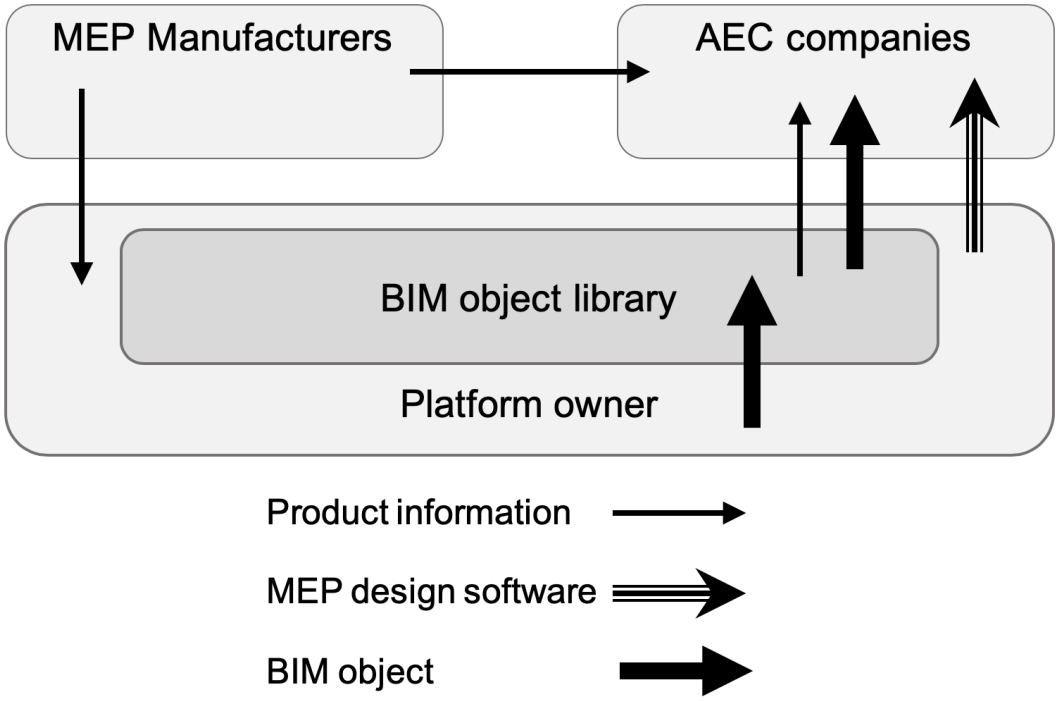

Fig. 4. Interactions on platform A

and plugins; the latter connect the manufacturers' product selection and calculation software to the MEP design software. Manufacturers must pay the platform owner for creating BIM objects and plugins and maintaining BIM objects in the library. According to the interviewees in manufacturing companies, these services are expensive. For ventilation products in Sweden, 93 brands have BIM objects on this platform, while the number of objects is very limited in comparison with the number of products available in the market. More than 50% of the available BIM objects belong to five main brands in the country.

As shown, the manufacturers send their product data sheets to the platform owner for creating the BIM objects. The users of BIM objects at AEC companies access the BIM objects and install plugins through either the design software offered by the platform owner or the library interface. According to the platform A's area manager, more than 95% of HVAC designers in Sweden use the design software offered by the platform. The designers using Revit instead of the software have free access to a mere 20% of BIM objects. That can be increased to 70% by purchasing the premium version of the connection tool while they must purchase the software in order to gain full access. This represents a closed strategy where the platform owner uses its products and services to control the interactions on its BIM library platform.

Figure 5 shows the interactions among participants on platform B. This platform has a wider range of participants including architects, MEP designers, those involved in purchasing building products in AEC companies, and third-party software developers. The platform owner has opened the development of BIM objects to building product manufacturers and third-party developers by providing them with required application programming interface (API) and software

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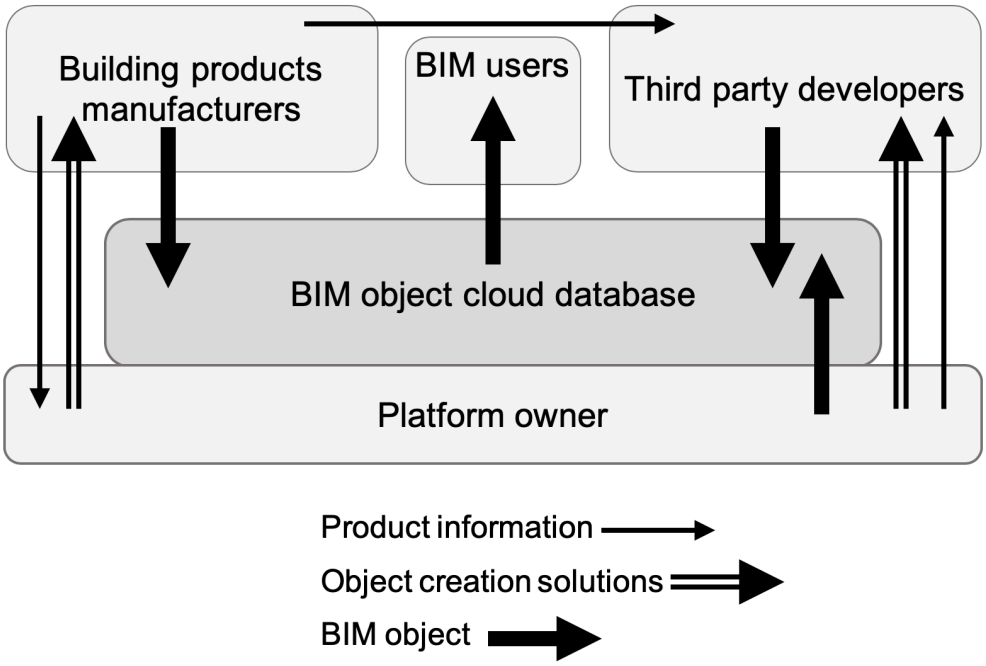

Fig. 5. Interactions on platform B

solutions. Thus, manufacturers can create and publish BIM objects on the platform's cloud database. They can also outsource the creation of the BIM objects to the platform owner or third-party developers. The software solutions supplied to manufacturers include tools for using the BIM object cloud database in business analytics and marketing applications. However, for ventilation products in Sweden, merely 26 brands have BIM objects on platform B, which is 3.4 times fewer than the brands on platform A. Another interesting finding is that the main HVAC brands in the country are not active on platform B. As a new strategy for motivating interactions on their platforms, both platform owners approach facility owners, i.e. the AEC companies' clients, to increase their awareness of BIM and its impacts on facility management. In other words, they encourage the facility owners to demand BIM-based workflows and create a demand-pull mechanism for creating high quality BIM objects.

4.2 The usability of the BIM libraries

None of the platforms have sufficient number of BIM objects to represent the market for ventilation products in Sweden. According to the interviewees at HVAC manufacturing companies, creating BIM objects for every product is impossible due to technical limitations of the platforms, existing methods of creating BIM objects, required resources, and associated costs. Another important finding is that the usability of BIM libraries in supporting the diffusion of innovative products has been impeded by inadequacy of information and improper architecture of the websites. On platform A, BIM objects can be searched by product type (e.g. ventilation), BIM application (Revit or AutoCAD), and country. It is also possible to search by keywords to find

a specific product or manufacturer. A search for ventilation BIM objects in Sweden resulted in 16270 product families across 93 brands. The search results could not be filtered by the sustainability attributes of products. Clicking on an object opens a window with brief information about the product and a link to the manufacturer's websites. The user might find the information about the sustainability attributes of products through links to the manufacturers' websites or requests sent to the manufacturers. That means the user has to select an object randomly and search for the information outside the platform. Downloading plugins enables users to access manufacturers' product selection and calculation tools; however, the number of available plugins is very limited.

On platform B, BIM objects can be searched by brand, category, file type, country, and object type. Ventilation objects are classified as subcategories of HVAC which is one of the 22 categories of the BIM objects. Searching for ventilation BIM objects in Sweden resulted in 428 product families across 26 brands, which means that in the scope of the search, platform A had 38 times more BIM objects and around 3.4 times more brands than platform B. The most likely explanation is that targeting the MEP sector as a niche market has helped platform A to allocate professional resources and satisfy the specific needs of its users. Similar to platform A, searching for BIM objects on platform B by the sustainability attributes was impossible and the only way to access such information was random selection of an object and through links to the manufacturers' websites. Therefore, neither platform A nor platform B enables users to apply the sustainability attributes of products as a basis for comparison between different brands.

4.3 The quality of BIM objects

The quality and reliability of BIM objects on the platforms is not assured through any third-party certification schemes. The BIM objects on platform A are compatible with Revit and the design and calculation software offered by the platform. As noted, the latter is used by over 95% of HVAC designers in Sweden. However, the objects are not sufficient to perform accurate calculations; users need access to manufacturers' selection and calculation tools through plugins. The information about the sustainability attributes was missing in 12% of the selected objects and it was inadequate in the other ones. Regarding the currency of information, the date of the edition is provided, but that does not necessarily mean the BIM object has up-to-date information.

On platform B, Revit and AutoCAD are among 53 available file formats. Despite that, the available BIM objects cannot be used to perform calculations required in HVAC design or to predict the sustainability performance of HVAC products. By selecting a BIM object from the search results, users access an internal page with the product information including identification data and menus for descriptions, classifications, properties, and links to the manufacturers' technical data sheets and websites. Only 10% of selected objects had statements about sustainability attributes and certifications. The information architecture of BIM objects on platform B facilitates access to categorized information. However, both missing and misplaced information were detected as problems with the content of the objects. For each object, information about the date of publication and the edition number is provided. Users can access the latest version of an

object by clicking on the "update" button in a downloaded object. It is not yet clear whether the manufacturer has updated its product information.

As inferred from the interviews, the functionality of BIM objects in design and calculation software is critical for manufacturers in order to differentiate their products. This appears not to be a major concern for AEC companies, unless their clients (e.g. facility owners) demand it. The accuracy of product information is not controlled in any of the platforms. Therefore, if there is an error, as found in some acoustic information provided by manufacturers, it remains in the content of the BIM object. Both platforms are faced with the same problem of inadequate information about the sustainability attributes of products. Comprehensibility of the information is another neglected issue on both platforms. Although some information in manufacturers' technical data sheets is confusing (e.g. the terms, notations, and units used for representing the acoustic performance of the products), it forms the content of the BIM objects. Product information provided by manufacturers is the sole source of information about the sustainability attributes of BIM objects. Thus, the problem of heterogeneous methods used by manufacturers for presenting sustainability performance of their products (Bahrami et al., 2019) hinders comparisons between different brands.

5 Implications

5.1 Implications for BIM platform owners

This study found that users in AEC companies cannot select sustainability attributes as the search criteria for finding products on the studied platforms. Consequently, BIM libraries are unable to provide manufacturers with the opportunity of differentiating their sustainable products and creating sustainable value through the diffusion of their innovations. Adopting an effective business strategy is a major challenge for platform owners (Van Alstyne et al., 2016). Platform A is limited to the MEP sector and generates profit by selling MEP design and calculation software as well as creating BIM objects and plugins. The platform owner creates BIM objects in a closed system which is easier to control and monetize; however, increasing the friction through strict controls can reduce participation and impede value creation in a platform (Parker et al. 2017a). In contrast, platform B is open to various BIM users and generates profit by selling software solutions for creating BIM objects and BIM-based supply and marketing solutions. This strategy might enable the platform owner to absorb innovative solutions (Parker & Van Alstyne, 2018) for creating BIM objects in the future.

The large difference between the BIM object for HVAC products on platform A and platform B shows the significance of allocating professional resources by platform A to satisfy user requirements for HVAC applications. Another contributory factor is that more than 95% of HVAC designers at AEC companies in Sweden use the design software offered by platform A. Therefore, HVAC manufacturers in the country prefer BIM library platform A as the database for their BIM objects. Nonetheless, even on this platform, BIM objects are not available for a large number of available products in the market. As confirmed by our interviewees in manufacturing companies, this problem is caused by current methods of creating and maintaining BIM objects on the

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libraries and the associated costs. Thus, BIM library platform owners need efficient methods for creating BIM objects to increase the interactions on their platforms.

Increasing the facility owners' awareness of BIM is a viable strategy adopted by both platforms to generate demand for BIM objects and increasing the interactions on the platforms. Moreover, platform B's BIM-based marketing and supply solutions have a great potential to stimulate demand for high-quality BIM objects. Such objects can increase the accuracy of design calculations and performance simulations and enable the users to select the innovative products with enhanced sustainability performance. To create high-quality BIM objects for HVAC products and satisfy the specific needs of HVAC professionals, platform owners must acquire proper expertise. Nonetheless, creating high-quality BIM objects in supporting the diffusion of innovations needs high quality product information to be provided by HVAC manufacturers.

5.2 Implications for manufacturers

To trigger the diffusion of their sustainable innovations through BIM library platforms, manufacturers must effectively communicate the information about their products by high-quality BIM objects. This study identified that manufacturers have not provided high-quality product information for the content of BIM objects. As a result, BIM library owners are unable to provide BIM library interfaces which include sustainability attributes of the products in their search criteria. Consequently, the users at AEC companies cannot search for products with superior sustainability attributes on BIM library platforms. For example, they cannot search for BIM objects for energy efficient fans and find a fan which is more energy efficient than the other brands. Supporting the diffusion of innovations with enhanced sustainability performance through BIM libraries requires affecting the user's perception by communicating high-quality information embedded in BIM objects. Moreover, high-quality BIM objects enable designers to perform more realistic designs and simulations that can affect the user's perception of a product by virtual trialability and observability. Creating high-quality BIM objects needs product information that is accurate, adequate, comprehensible, applicable, and reliable. This study suggests that manufacturers must implement effective product information management systems and consider integrating the creation of BIM objects into the PLM tools. This could facilitate the creation of BIM objects for all products and provide platform owners with the information they need to improve the architecture and enhance the usability of their BIM library interfaces.

5.3 Implications for research

This study has developed an interdisciplinary approach to explore the functionality of two BIM object platforms as the enablers for the diffusion of innovations with enhanced sustainability performance. The broad conceptual framework enables a holistic approach in investigating various factors and stakeholders involved, while the focus on the specific case of ventilation products in the Swedish market deepens the understanding about related problems. Figure 6 illustrates the proposed model for presenting the theoretical effects of a BIM library platform on communicating the information about an innovation, influencing the user's perception of its characteristics, and consequently its diffusion. As shown, a BIM library platform influences the diffusion of

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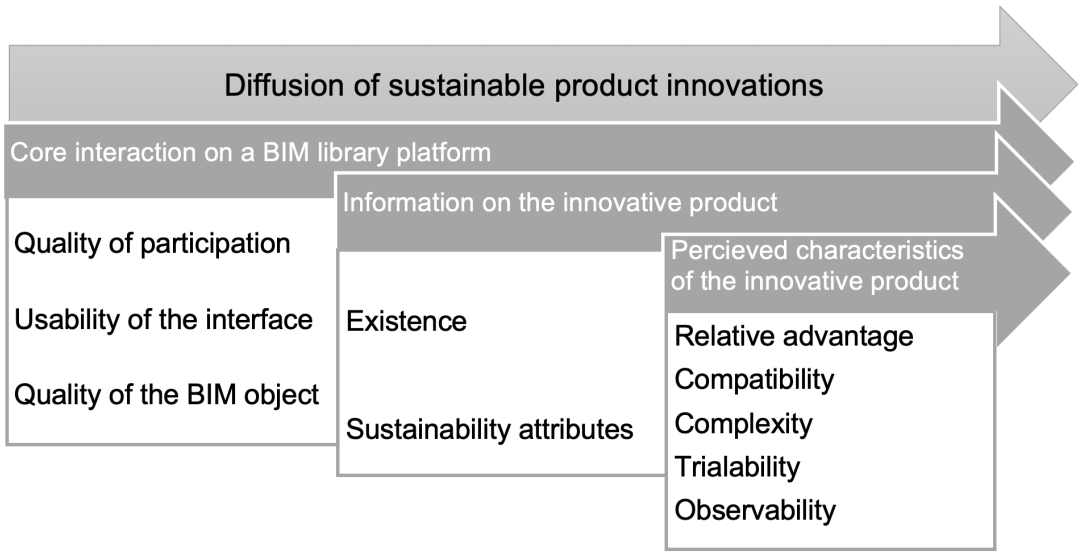

Fig. 6. The role of the BIM library platforms in the diffusion of sustainable innovative products

sustainable innovative products through its core interaction of which three key elements are the quality of participation, the usability of its interface, and the quality of its BIM objects. The sustainability attributes can be defined based on each case study e.g. energy efficiency, indoor environmental quality performance, and carbon footprint of the products.The characteristics are defined in the methodology section (table 1).

6 Conclusions

The present study was designed to investigate the creation and exchange of BIM objects on two BIM library platforms in supporting the diffusion of sustainable HVAC innovations. BIM platform library platforms have a pivotal role to play in the exchange of information about innovative HVAC products with enhanced sustainability attributes, and consequently the diffusion of such innovations. Nevertheless, the findings of this study indicate that this role has not been served by the platforms studied. On both platforms, access to information about the existence of products is very limited. In addition, poor quality of BIM objects prevents virtual trialability of products and observability of their sustainability performance. Thus, manufacturers cannot show the sustainability attributes of their products and affect the user perception of their sustainable innovations. This in turn, hinders the diffusion of their sustainable innovations through BIM platforms. The causal factors are low-quality product information provided by manufacturers, ineffective mechanisms for creating BIM objects, ineffective strategies for attracting participants to the platforms, and usability problems of BIM library interfaces.

These findings suggest that HVAC manufacturers need effective mechanisms for creating BIM objects. Integrating BIM object creation into the PLM systems is recommended as a solution. This could facilitate providing high-quality product information that enables platform owners

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to improve the information architecture and usability of their BIM libraries in supporting the diffusion of sustainable innovations. Platform owners must consider the technical requirements for the HVAC applications in order to attract HVAC professionals at AEC companies to the BIM libraries. The growing application of BIM makes the BIM object quality as significant as the product quality. Therefore, quality assurance and certification schemes such as the BSI Kitemark for BIM objects are recommended to be developed according to the national regulations in order to ensure the quality of BIM objects by third party certification bodies. Addressing these issues requires active collaboration among BIM platform owners, HVAC product manufacturers, AEC companies, and facility owners. The generalization of the findings is limited due to the study being constrained to the use of just two BIM library platforms in Sweden. Nevertheless, we believe that our study could be a framework for future studies on the use of BIM libraries in supporting sustainable innovations. Another significant area of further research is the feasibility of integrating BIM object creation into the PLM systems. Moreover, this study was not specifically designed to evaluate the monetization strategies adopted by the platform owners. Therefore, further research is needed to investigate the effects of platform monetization strategies on the exchange of information through the platforms and the diffusion of sustainable innovations.

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Biographies

Soheila Bahrami. Soheila Bahrami received her Licentiate degree in construction and architectural engineering from Lund University, Sweden in 2019. She holds an MEng degree in mechanical engineering-HVAC systems from the University of Western Ontario in Canada, an MSc degree in environmental management from Lund University in Sweden, and a BSc degree in technical inspection engineering from the Petroleum University of Technology in Iran. She has work experience in process engineering, industrial marketing, and technical training in petrochemical and natural gas industries. Since 2008, she has been involved in research projects on innovative building ventilation systems, energy efficiency, and thermal comfort at Lund University. In 2015, she conducted research and worked as a consultant on energy management solutions for building HVAC systems in Canada. She is currently pursuing a PhD degree in construction management at Lund University. Her research interests include innovative ventilation systems for sustainability, exchanging product information in BIM platforms and HVAC engineering education for sustainability.

Brian Atkin. Brian Atkin gained his doctorate from the University of Reading in the UK. He holds a master's degree by research into the costs of major engineering infrastructure. Presently, he is Professor in the Division of Construction Management at Lund University, Lund, Sweden and Adjunct Professor in the School of Civil Engineering and Built Environment, Queensland University of Technology, Brisbane, Australia. Brian has also held professorial and visiting fellow positions in the UK, Hong Kong, Finland and Iceland. As a member of the British Standards Institution (BSI) Facilities Management Strategy Group and Technical Committee, he has been closely involved in the drafting of all national standards in facilities management. In addition, he represents BSI on the International Standards Organization Technical Committee for Facility Management where he has also been involved in drafting. Brian is co-author of the standard textbook on Total Facility Management and the author of numerous research papers and reports. His work as an examiner covers all levels, including higher doctorates.

Anne Landin. Anne Landin gained her Doctorate from Lund University, where she is Professor and Head of the Department of Construction Management. In 2007, she received the award of Excellent Teaching Practitioner of the Faculty of Engineering. Landin has been involved in several academic positions and commissions. Anne has a great interest in many issues related to Lund University and its students and as a consequence, she has been engaged in several contexts such as having responsibility for faculty-shared (Science & Engineering) postgraduate courses in project management, Chairman of the Board for the Collegium Michael Hansen, a residential centre for 350 students. Anne recognises the importance of having a healthy dialogue with industry and society and has undertaken various assignments. Anne is a certified teacher for quality issues in the construction industry and has secured various consultancy commissions covering quality, environmental and management issues. During her years in academia, Anne has published many articles and has been a constant supervisor of doctoral students. Anne has also been responsible for a number of research projects both nationally and in cooperation with other countries.

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