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Unpacking the provision of the industrial commons in Industry 4.0 cluster[1]

Marta Götz [2]

Abstract: This paper argues that provision of industrial commons (IC), might be considered as a crucial factor of a cluster's attractiveness in digital transformation, e.g. in Industry 4.0 (I4.0) time. By drawing on the qualitative case study method of Hamburg Aviation cluster (HAv), it aims at exploring the nature of IC in the leading German I4.0 cluster. Proximity emerges, even if sometimes not explicitly, as the recurring topic facilitating the provision of IC, along with the advancement of I4.0. As Industry 4.0 stipulates much uncertainty, the closeness featuring in clusters, seems to bring various benefits, which can help address challenges associated with I4.0, and faced mainly by small and medium firms (SMEs). The vicinity to key actors and the gains of networking, reflect the importance of (un)articulated proximity.[3]

Keywords: cluster, industrial commons, digital transformation / Industry 4.0, aviation.

JEL codes: R1, O3, M2, L1, L2.

Introduction

Cluster is a location-bound geographic phenomenon, a spatial concentration of entities, united by some common field of activity; whereas Industry 4.0, aka I4.0, or the fourth industrial revolution, is all about Internet-assisted world--wide activity. Clusters are about agglomeration economies and specialisation, I4.0—about diversification and urbanisation. Clusters promote local learning and production, whereas I4.0 fosters a worldwide dispersion of activities. I4.0 seems to suspend the importance of collocation or spatial proximity, and supports the idea that "distance is dead". Yet the literature review, and the obtained results illuminate that it does not have necessarily to be true (Götz & Jankowska,

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2017). The multiple advantages offered by clusters (Porter, 2000; Jankowska, Götz, & Główka, 2017; Götz & Jankowska, 2018), purported by the closeness of actors, can also contribute to the advancement of business digital transformation, surrounded by uncertainty, whilst involving the promised benefits, and also, various challenges.

Idiosyncrasy of the fourth industrial revolution results in a more interdisciplinary and integrative approach (Kagermann, Wahlster, & Helbig, 2016). It determines that the necessary manufacturing and technical capabilities, e.g. the *industrial commons*, are facilitating innovativeness across industries. Some of the available definitions highlight this "compositional" aspect of I.40. The Italian law *Piano Industria 4.0* defines modern smart technologies of the I4.0 as encompassing, among others, additive manufacturing, augmented reality, cloud computing, big data, and analytics. They aim at greater flexibility, thanks to the production of small lots, lower maintenance costs, reduced shutdowns, increased productivity—thanks to shorter set-up time, better quality, and less waste (MAKERS, 2018). Part of the law is the idea to create innovation hubs and competence centres resembling clusters-based policy. These hubs should act as bridges between research, business, and finance; whereas centres—only a few, and selected on a national basis—would concentrate on specific and complementary technologies, and be provided with managerial skills and business models. The commitment of the Italian authorities to develop Industry 4.0 deserves to be appreciated, yet it needs to take into account the idiosyncrasies of national companies, and acknowledge the territorial specialisations. A large share of SMEs typical for Italy, but also many other EU regions—including the Central and East European transition economies, calls for smart adoption of smart manufacturing, which integrates and rewards territorial specialisation and local peculiarities. Thus, similar activities might be found in other countries, such as in Germany, where clusters are utilised as promising and effective instruments of place-based innovation and technology policy (Dohse, Fornahl, & Vehrke, 2018). Clusters seem to provide environment facilitating risk-sharing, e.g. an ecosystem, particularly important for SMEs.

This paper can contribute to the advancement of our knowledge on a potential cluster's role, during digital transformation. In particular, based upon the Hamburg Aviation cluster (HAv), it seeks to unpack the importance and the nature of provision of industrial commons (IC). This study aims to explore the IC concept in the realm of I4.0 cluster. In particular, it seeks to unearth the idiosyncrasy of such commons in one of the leading and reputable clusters in Europe. Hamburg Aviation cluster (HAv) has been selected as case-study as it is highly rewarded German cluster. It is the winner of the Leading-Edge Cluster Competition and officially listed as Industry 4.0 cluster (Cluster Platform Deutschland). As it seems, it is well-positioned to serve as best practice for other cases. The extensive case study of HAv can shed some light on the weight of selected elements, subject to cluster typical proximity, as the antecedents of implementation of I4.0.

Research questions as applied for semi-structured in-depth interviews revolved around the importance of knowledge flows, the significance of business relations, the role of public authorities' support, as well as the processes of cooperation and competition. Harnessing the grounded theory method (GTM) in its hybrid form (e.g. combining the rigorous systemizing with spontaneous grounding: Glaser & Strauss, 1967; Strauss & Corbin, 1990) implied, that the original questions served as the basis for the emergence of new issues (apparently critical with respect to the provision of IC in I4.0 cluster). These topics, in fact, depict the nature of IC and constitute the main findings of this explorative study. This paper is structured as follows: first, it offers a brief literature review, and presents the key concepts of the analysis. Next, it outlines the adopted qualitative method. The discussion of cluster importance as a provider of IC for advancing the digital transformation and drawing on the HAv case, conducted in the spirit of grounded theory method, is carried out in section three. The final part concludes with a summary, outlining the limitations, and making suggestions for future studies. This research can contribute to the still scarce and patchy literature on clusters and I4.0, e.g. the one combining business and entrepreneurship studies, with regional development or economic geography.

1. Literature review—the main elements of the conceptual framework

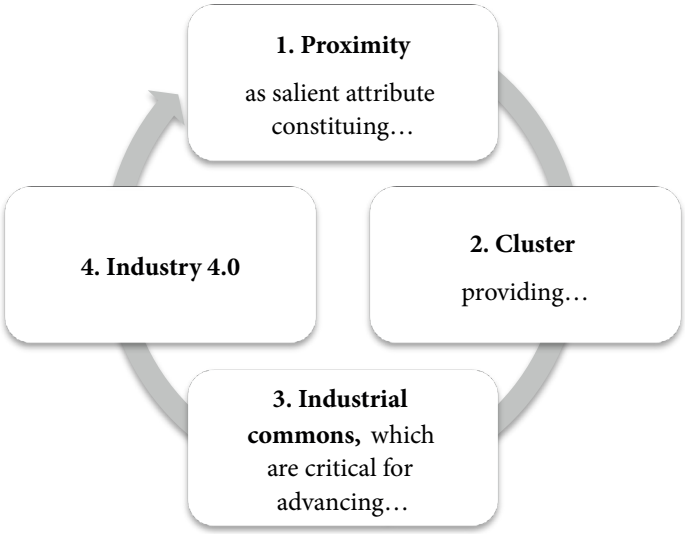
Clusters are hybrid forms of reciprocal trading and mutual contracting, located between hierarchies and markets (Maskell & Lorenzen, 2003). As geographic concentration of interconnected firms, suppliers, service providers, and other related institutions, they are supposed to provide multiple externalities and economic benefits leading to synergies, allowing higher efficiency, innovativeness, and competitiveness (Ketels, 2004; Porter, 2000). These well recognised advantages build upon the cluster core attributes, such as the critical mass of specialised firms, which are geographically concentrated. Proximity is widely regarded as a multi-dimensional facilitator of knowledge generation, dissemination and a region's development (Boschma, 2005; Lis, 2019; Cooke, Uranga, & Etxebarria, 1997). Hence all kinds of proximity, e.g. besides the physical, the cognitive; social; as well as organisational proximity enable the creation and exchange of knowledge (Uzzi, 1997; Boschma, 2005), and impact upon the innovativeness. Industry 4.0 is often portrayed as a radical innovation—as disruptive innovation in production processes, transforming the markets and business models. Knowledge environment can be regarded as one of the three main sources of clusters' attractiveness, along with pecuniary agglomeration economies enhancing effectiveness, and thus, improving profitability and the institutional setting, possibly reducing uncertainty and transaction costs, and providing a favourable business environment.

Available findings confirm a growing multiplicity in the local economy. MAKERS experts define the know-how nuclei, as sets of firms and competences embedded in a place, and part of 'industrial DNA', and establish the expansion of these nuclei, which illustrates the spawning of new specialisations and the diffusion of new knowledge-intensive business services' (KIBS) providers. The multiplicity of nuclei of specialisation acts as an open knowledge laboratory, where new varieties of materials, instruments, organisational solutions, and products, are continuously experimented with, selected, and conserved. Processes of territorial co-location and knowledge transfer between manufacturing SMEs and KIBS in Europe, can be confirmed (Lafuente, Vaillant, & Vendrell-Herrero, 2017). It is, hence, of utmost importance to understand the role of critical factors, such as collaborative partnerships between KIBS and product firms. Such companies usually tend to concentrate on what they know, e.g. production, whilst leaving to others, the enhancement of their products, thanks to the adoption of integrated solutions. The relevance of proximity in such circumstances, cannot be over-estimated. Various forms of proximity such as: social, physical (spatial distance), cognitive, or technological proximity, might be distinguished as facilitators of knowledge creation and exchange (Davids & Frenken, 2018; Lagendijk & Lorentzen, 2007; Parrino, 2015), supporting also, the smooth flow of goods and other spill-over processes. The need to co-locate several linked activities is amplified in digital economy business models, if complementary resources are needed "locally" to make an upstream, digital technology—exploitable and profitable. Business models, involving digital resources, lead to more complex entry mode choices, because complementary resources are often not "off the shelf" inputs with a fixed purpose, but must be customised/co-developed in some knowledge melding (Verbeke, 2018).

The term Industry 4.0 stands for disruptive innovation in production systems (Schmidt et al., 2015; Schuh, Potente, Wesch-Potente, Weber, & Prote, 2014). It also fits into the high-tech strategies of many advanced economies, and is seen as the state sponsored vision of smart manufacturing. I4.0 will revolutionise the organisation, the governance of global value chains, and will modify the way value is created and captured. New business models will follow (Strange & Zucchella, 2017; Philbeck & Davis, 2019). MAKERS experts advocate a modified approach to I4.0, when compared with the German and European Parliament attitude, where Industry 4.0 is defined as the organisation of production processes, based on technology and devices autonomously communicating with each other along the value chain. I4.0 stands for the mature process of network connectivity and data processing. A broader understanding of Industry 4.0 encapsulates more than just greater efficiency and productivity—it is the game changing formulation of Economy 4.0.

Discussion of industrial commons (IC) as a component of geographic cluster attractiveness, as proposed in this paper, also indirectly addresses the call made

by Cantwell and Salmon (2018), to re-combine technology fields and geographic locations, e.g. examine them in tandem, when thinking about knowledge complexity in the new industrial revolution (NIR). Janssen & Frenken (2019), argue that future innovation and industrial policy should be all about cross-specialisation, aiming at reaping the benefits of unrelated varieties. This, however, can be facilitated by interfaces based on common themes, technologies (like I4.0), and needs platforms / intermediaries, e.g. the form in which to materialise. It seems that (open, ready to flexibly adopt new orientation) clusters may well offer such a potentially conducive environment (be platform / intermediary) for this purpose—for experimenting with bolder industrial expansion. Hence, industrial commons should refer to more than one industry, to baseline knowledge, common for more than one sector. The ultimate goal of the provision of such public goods, such as IC, should be regional development, its adaptability, or renewal. Industrial commons might be regarded as a specific category of cluster commons (Sölvell, 2015), and could be understood as meeting places and bridges, which facilitate the spill-overs among cluster members (Morgulis-Yakushev & Sölvell, 2017). Pisano and Shih (2009) define IC as encompassing knowledge, skills, institutions, and a broader R&D environment; as a bundle of regional and industrial idiosyncratic assets, being a form of public good, and regarded as a critical pillar for innovation and competitiveness. IC are rooted in firms, and usually, are also firmly geographically embedded (Pisano & Shih, 2012; Bailey & de Propis, 2014; Buciuni, & Pisano, 2015). In a sense, they epitomise the concept of proximity—as they integrate the cognitive industrial similarities with geographical closeness. The concept of IC may also be perceived as building on the triple helix idea, purporting clusters, which assumes the co-existence of academia, administration, and industry. IC can stand for the resources available in district areas (Barzotto, Corò, & Volpe, 2017); goods whose use is difficult to exclude from potential beneficiaries, and which are characterised by some rivalry. These, however, as the "tragedy of commons" foresees, can lead to an imbalance arising from their under-/over-exploitation, and in consequence, to their rapid disappearance (Barzotto et al., 2017). At the same time, fresh outside input, for instance, thanks to the arrival of MNEs can boost the IC's regeneration. These commons, or more broadly, the regional economic context, can act as a springboard in external knowledge networks (Huggins, Izushi, & Prokop, 2019). The more advanced the commons in a given region, the better they are equipped to tap into foreign advanced regions and their sources. As IC are seen in terms of local externalities, it is worth drawing on studies by Capozza, Salomone and Somma (2018), which show that both localisation economies and diversification economies determine how favourable the regional ecosystem is, for emergence and development of innovative firms. Scheme 1 outlines the main elements discussed in this paper, and can facilitate the orientation in the text, and its perception. In a simplified version it depicts the underlying relationships.



Scheme 1. Main components of the analysis
Source: Own elaboration.

As proposed in this paper, cluster (2), whose attractiveness builds upon various forms of proximity (1), can provide industrial commons (3) which are critical for the advancement of Industry 4.0 (4). This framework constitutes the departure point for further analysis. To sum up, this explorative study aims at unearthing the nature of these interdependencies, by focusing on one of the leading German clusters. Results obtained, although limited to the concept of industrial commons, not only shed light on the cluster's role in advancing I4.0, but can also offer some lessons of how to shape the transformative place--based policy, e.g. adopt clusters, as vehicles for business digital transformation. However, given the limited transferability of the results of this case study, it can rather identify certain crucial aspects which should be taken into account, than offer concrete guidelines. These, nevertheless, might be particularly important for new market and transitional economies, which already are, or will be, soon facing the challenges of implementing the fourth industrial revolution. These "HAv lessons learned" are presented in the final section.

Despite the growing interest in the exploration of business digital transformation (Weresa, 2019), there seems to be a research gap, with regard to the spatial dimension of this process (Castelo-Branco, Cruz-Jesus, & Oliveira, 2019; Gereffi, De Marchi, & Di Maria, 2017). The research on I4.0, in relation to clusters, is only emerging (Hervas-Oliver, Estelles-Miguel, Mallol-Gasch, & Boix-Palomero, 2019; Hervas-Oliver, 2019). Likewise, the empirically grounded insight on the nature of industrial commons, provided in one of the leading German clusters, can contribute to the extant knowledge on "cluster effects" (Puig, 2019).

2. Methodology

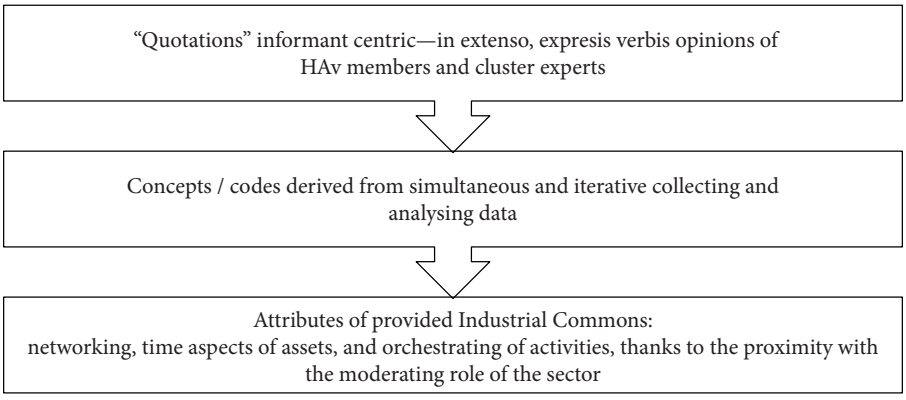
In order to investigate the idiosyncrasies of the Industry 4.0 cluster, this paper employs the grounded theory method (Gligor, Esmark, & Gölgeci, 2016; Corbin & Strauss, 2008; Marschan-Piekkari & Welch, 2011; Piekkari, Welch, & Paavilainen, 2009). In particular, it relies on the case study research method. Such an approach is well-suited for contemporary and complex phenomena to be studied within their real-life settings (Welch, Piekkari, Plakoyiannaki, & Paavilainen-Mäntymäki, 2011; Welch & Paavilainen-Mäntymäki, 2014; Dubé & Paré, 2003), which is true for the ongoing I4.0 transformation. The adopted methodology can be seen as the most suitable one for research on phenomena, which does not have any specific conceptual base (Benbasat, Goldstein, & Mead, 1987). In that way, it may help develop new formats for studying the peculiarities of the functioning of Industry 4.0 clusters (Eisenhardt, 1989). The deployed case-based approach allows identifying conceptual 'building blocks' (Eisenhardt & Graebner, 2007), and learning about new and context-specific processes (Dominguez & Mayrhofer 2017; Zaeferian, Eng, & Tasavori, 2016). It provides insight and knowledge, which could not have been gained otherwise (Martineau & Pastoriza, 2016).

This paper adopts a hybrid version of GTM (merging the Glaser classic concept with Strauss & Corbin approach). It features so called "theoretical sensitization", which seems inevitable for properly conducting the qualitative case study. While trying to balance these two streams, this paper aims at unpacking the nature of IC in I4.0 cluster, with the concrete questions asked during the interviews (on the role of knowledge flows, the importance of business relations, or significance of state support) serving only the exploratory purposes allowing new issues to emerge. The underlying iterative process of data collecting, coding, comparing and contrasting of the gathered insight is depicted on Scheme 2 and 3.

Hamburg Aviation cluster (HAv) has been chosen for the analysis as it officially represents the Industry 4.0 German clusters, identified by the Cluster Platform Deutschland. It is a winner of German prestigious Leading-Edge Cluster Competition (Cantner, Graf, & Töpfer, 2015) and honoured with various awards (including the Gold label of ECEI). Interviews with cluster representatives were conducted in Spring, 2019. Talks took the form of guided conversations, rather than structured interviews (Buxbaum-Conradi, 2018). Interviewers were asked among others: if they see HAv as genuinely I4.0 cluster; which technologies of I4.0 are applied/used by their companies; if they agree that cluster can facilitate digital transformation as it provides the conducive knowledge environment (skills, infrastructure, etc.); if they share the opinion that classic agglomeration benefits (local labour market as well as customer ties and supplier linkages) are crucial for advancing digital transformation or if they agree that institutions and professional policy support available in

cluster can facilitate the development of Industry 4.0? The concrete questions were oriented towards the listener, and were supposed to stimulate narration. Semi-structured interviews offer the interviewees enough space to reveal their subjective perspectives and interpretations, without being under certain pressure from prior structural thoughts of the interviewer. Those interviewed, were representatives of the HAV office—the team of managers involved in co-ordination of cluster activities, Hamburg City—the Ministry of Economy, research institutions, and managers or CEOs of various companies, mainly small and medium-sized, often start-ups active in consulting, training, manufacturing, and design, as well as scholars researchers from Helmut Schmidt University. The sample of firms is pretty heterogeneous as it encompasses producers of aircraft components, propulsion system, aeroplane engines, or integrated solutions for mobility, as well as providers of fabrication services. The twenty-six interviewers were anonymized and classified as: cluster representatives, cluster experts, cluster companies, cluster officials, cluster scholars (respectively seven CR; four CE; twelve CC; two CS, one CO). Though, it should be noted that in many cases, these functions overlapped, e.g., with researchers also involved in running a company or serving in official cluster institutions as experts. Some also switched sides, which made them valuable informants, especially with regard to the cluster.

As the research follows the GTM, the main findings derived from the gradual iterative process of data collecting and analysing (Scheme 2). Guided by the procedure proposed by Gioia, Corley and Hamilton (2013), in an initial step, first-order (informant-centric) constructs—quotations—were developed. Secondly, these citations were grouped into second-order constructs: codes. In the third stage, they were systemised and distilled into the attributes of the main category of the analysis.



Scheme 2. Steps of the adopted procedure for exploring the provision of IC in HAv
Source: Own proposal.

The topic of this research (I4.0 & cluster) reflects a phenomenon which is new, with little prior research, and no pre-determined theoretical assumptions. Hence, the selection of case was broadly designed to provide the flexibility to capture, document, and conceptualise the phenomenon, lacking in plausible existing theory and empirical evidence (Fletcher & Plakoyiannaki, 2011). As it is, however, difficult for an academic researcher to write a phenomenon-based study that makes absolutely no reference to prior theory, this presented case selection refers to concepts from prior literature, but not the previously identified relationships between them. Such an approach constitutes a potential grey area, in relation to the distinction between purely theory-driven and phenomenon-driven selection of the case study (Fletcher, Zhao, Plakoyiannaki, & Buck, 2018).

On a final note, it should be added that this study reflects the principles of relational research design, which aims to generate abstract and transferable findings, but must take into account, contingent conditions of a given setting (Bathelt & Glückler, 2018). It stresses context, path dependence, and contingency. Relational theories can be characterised as "middle range theories"—close enough to an empirical case, to ensure richness and authenticity, yet, at the same time, abstract enough to develop transferable theories.

3. Hamburg Aviation Cluster—findings and interpretations of the nature of industrial commons

HAV is considered as the third largest aerospace cluster in the world, after Seattle hosting Boeing and Toulouse with the Airbus Headquarters (Buxbaum-Conradi, 2018). Hamburg Aviation is a cluster, in terms of spatial agglomeration of related sectors, but also in terms of cluster organisation, and it is also a metropolitan region—one of the most advanced of the German Bundesländer. HAv's three major players are: Airbus, Lufthansa Technik, and Hamburg Airport, accompanied by more than 300 SMEs, with a total of more than 40,000 highly qualified personnel. These entities cover the whole value chain of aviation and complete life cycle of an aircraft: from the development, manufacturing, and assembly, to the air transportation system, maintenance, repair, and overhaul, to final recycling. In 2008, Hamburg Aviation won the title of Leading-Edge Cluster (LEC), and is since benefitting from wide-ranging research support (Cantner et al., 2015; Rothgang et al., 2017). In 2014, it received the GOLD Label for Cluster Management Excellence by the European Commission, thereby ranking as one of the 'Top 40 clusters in Europe'. "European Cluster Excellence Initiative medals—brown, silver, and gold—can serve as a proof of excellence in management. It shows the role played by managers, but indirectly, is related to the performance of the region as such, so Hamburg municipality strives to have all 8 clusters with at least, one brown award" (CO1). As revealed by the

study of Cantner and others (2015), thanks to the LEC, the funding accessibility of prominent actors has improved, which enabled small and more peripheral actors to co-operate with the more prominent ones. This was particularly visible in HAv, with the largest mobilisation effect, where during the process of cluster formation, the openness for new co-operation between established firms, such as "Airbus" or "Lufthansa Technik" increased. Interviews with local SMEs conducted by Cantner and others (2015), confirmed that it was much easier to meet these large companies on an eye-to-eye basis. Besides, the funding resulted in more local embeddedness as HAv tend to localise, with an increased share of linkages, into the cluster region, and this led to intensification of linkages and increased network density.

As such the metropolitan region of Hamburg is plugged into the global network of mainly civil aerospace manufacturing, via the anchor company, Airbus (Buxbaum-Conradi, 2018). Whereas central functions and the programme management of the planes A330/340, A380 and A350XWB are located in France, the programme management for the A320 and the A320 neo product families is situated in Germany. As one member put it, "HAv is funded by the Ministry, or actually better said, it is an investment of the Ministry and Hamburg state. It is seen as tool for innovation policy, an instrument to manage the regional development" (CS1).

3.1. Major players in the proximity

HAv's strength can be attributed chiefly to the concentration of various entities; their networking with the largest players: Airbus, Lufthansa Technik, and Hamburg airport, along with their competencies in specific areas. Critical for the HAv pool of local industrial commons are institutions. Hanse Aerospace e.V., can be regarded as a voice for SMEs in the region (https://www.hanse-aerospace.net/). HECAS, Hanseatic Engineering & Consulting Association e.V., is an association comprising engineering and business consultant service providers (https://www.hecas-ev.de). BDLI (Bundesverband der Deutschen Luft- und Raumfahrtindustrie) the German Aerospace Industries Association with more than 230 companies, is the primary industry representative for the aerospace sector in the whole of Germany (https://www.bdli.de/en). DLR (Deutsches Zentrum für Luft- und Raumfahrt) the German Aerospace Centre, offers extensive R&D work in areas of aeronautics, space, energy, transport, digitalisation, and security, and plays a part in national and international joint projects. HCAT, Hamburg Centre for Aviation Training, aims to safeguard the highly qualified workforce for the regional aerospace industry (https://www.hcatplus.de). By conducting common projects, it aims to buttress the capabilities, especially of SMEs, in terms of a sustainable human resource development. The mission aims at structured change of digitisation. The task of HCAT+ is to integrate the SMEs, technologies, and educational institutions, to foster a long-

term development of skills in the metropolitan region. Besides DigiNet.Air, HCAT+ runs projects dedicated to training the trainers (Train-The-Trainer: Cabin Experts Meet Academia (TTT-Cabin)), allowing for vocational orientation (Bo Luftfahrt—Berufsorientierung in der Luftfahrtindustrie), or enabling smooth transition for engineering (StudyING). ZAL (Zentrum for Angewandte Luftfahrtforschung GmbH) Hamburg's Centre of Applied Aeronautical Research, founded in 2016, is the technological R&D network of the civil aviation industry in the Hamburg Metropolitan Region (https://www.zal.aero/home/). In two large hangars, ZAL provides numerous stations to develop new technologies in the formula of open space, even forcing collaboration by interior design (e.g. big tables instead of single separate ones). There is, e.g., a laboratory for testing more comfortable and quiet flying, with an acoustics room adorned with eggshell walls aimed at reducing the engine noise. ZAL covers technologies critical for the better comfort of flying, as well as those aiming at improved design, as it, meanwhile, tests a special light system reducing jet lag problems on long-haul flights. ZAL bundles the technological competence of the region in the ZAL Tech Centre. Located in HH-Finkenwerder, in close proximity to the Airbus site, with a working area of more than 26,000 square metres, it provides offices, laboratories, and sophisticated research and testing infrastructure. "It happened once, as side effects, actually, of this co-sharing of ZAL's offices, that engineers came together and developed a new solution, which brought them in fact, prestigious awards (CS1)." This exemplifies the importance of facilitating the sharing of knowledge and providing co-operation possibilities.

Besides these dedicated bodies, there are four universities, which are committed to teaching and research in the field of aviation, as well as the city of Hamburg and the BWVI (Behörde für Wirtschaft, Verkehr und Innovation). HAv epitomises the triple helix format, as it meets the necessary criteria of co-operation among academia, business, and public authorities. "Cluster is not just the critical mass of companies, agglomeration, or simple geographical concentration. You really cannot separate and prioritise them, all three are critical for successful cluster, they should be co-existing (CO1)."

However, not all initiatives seem to be welcomed by some cluster members. "Some activities may seem like goals of their own, and the decisions as though they are self-objective. I would not say that the policy impact is a positive one (CE3)." The Integrated Design Lab (IDL), set up by the Institute of Air Transportation Systems (DLR), with the aim of tackling the challenges of collaboration in R&D (https://www.dlr.de/lk/en/), was created, nearly ten years ago, with financial support from the city. It provides space, for mainly SMEs, to smooth the co-operation (adjustable furniture, big screen, new digital tools to distant communication) and flexibly accommodate various needs. Its function to enhance the collaboration among small companies, however, has been somehow taken over by the newly established ZAL, which is actually a cluster of its own, with many companies collocated in one building.

Hamburg also hosts one of three Airbus' BizLabs (ABL), located in Toulouse and Bangalore (ABL, 2017). These are the global aerospace business accelerators where aviation-oriented start-ups and Airbus engineers meet to turn innovative ideas into business (Redlich, Moritz, & Wulfsberg, 2019). Despite being an "anchor tenant", credited with many benefits for the local economy, it turns out that Airbus is also surrounded by much scepticism. The suspicion towards Airbus has been high, due to its restrictive non-disclosure agreements, and the perception that, if it participates in multilateral R&D projects, it claims the intellectual property. "Firms compete with each other, there is much suspicion, fuelled by the dominance of one large player—Airbus (CS2)." This situation may resemble the case of Cosentino in the Spanish marble cluster (Aznar-Sanchez & Carretero-Gómez, 2016), and exemplifies the profile of Lazerson's and Lorenzoni's (2008) 'leading firm', who focuses on building distribution and marketing capabilities in global markets, whilst shifting a share of production outside the local districts, rather than acting as the 'knowledge integrator', who attempts to connect global markets with local clusters, and is deeply focused on building local manufacturing capabilities through collaboration with, and investment in, local suppliers. This difference can, according to Buciuni & Pisano (2015), explain why different supply chain strategies may impact upon cluster performance. "Intellectual property issues are always in the background; you cannot escape them. That is why it matters so much to know each other, to have the trust relations built over years: that is something you cannot replace or substitute (CO1)."

3.2. Moderating role of the sector

Actually, all HAv representatives stressed the uniqueness of aviation industry, understood in terms of high entry barriers and political dimension reflected in Airbus being a European political integration project, and with regard to I4.0, with less penetration of digital technologies than might be expected. The peculiarity of the aviation sector and importance of a few large players, globally, is also reflected in the composition of HAv, dominated by Airbus. "In aerospace, we are catching up, we are far behind the automotive industry, which is much more automated. Here, manual work and humans still matter; it is impossible to completely replace the work of people (CE4)." This industrial uniqueness can result in some rigidity, particularly for new ventures and young firms. "We are a start-up company, still in the seed phase, and we try to generate traction in the market. We need to scale up, but aerospace and the aviation industry is a slowly specific area, which is not very good for agile firms as our company (CC2)." Adoption of I4.0 solution varies. "We are part of an international enterprise, and have in Hamburg, a main office, dealing with management, developing, design, and administrative issues, but we are not using I4.0 there (CC7)." "We are producing engines for Airbus, my section not directly, but the company as

such, is using some digital technologies. We are all implementing a new portal, which will co-ordinate across the whole company all of its activities (CC10)."

Production of new models and the inception of new programmes (e.g. Airbus with A380), require usually more collaboration, as experimenting relies more on tacit knowledge. Hence, as argued, with new initiatives, it seems easier to co-operate. The peculiarity of aviation, which is, in that case, also linked to the Airbus as a major player, implies that most suppliers simultaneously provide for the civil and military sections of this company. This results in heightened security standards, requirement of more confidentiality, and often an unwillingness to share knowledge, or to collaborate with partners. Thus, the HAv office and related institutions like ZAL, Fraunhofer Institute for 3D printing, or Mittelstand 4.0—one of several nation-wide centres—see their role in raising awareness among SMEs of the digital transformation and providing the extra push to move towards I4.0. ZAL offers a neutral (not controlled by one partner) networking platform for mainly SMEs, which is a key element for advancing I4.0. So, small firms should not fear losing their independence vis-à-vis a large player. How it plays out in reality brings, however, a mixed assessment.

In the eyes of HAv representatives, Industry 4.0 seems to be a common thread of various initiatives undertaken. It is in the back of minds and activities of cluster members, seen as an inevitable challenge, and as a chance. Actually, only some of the I4.0 technologies are, in fact, applied. "We are using some technologies of I4.0 but not all of them, so we adopt I4.0 to some degree (AI RGB picture detections, visualisation, in future perhaps, VR) (CC1)." It is perceived that this implementation should come naturally from the needs of firms, themselves; "you look for the technologies and choose what suits you (CC1)." In some opinions, this digital distant communication (part of digital transformation) is a threat to clusters; a threat which is unavoidable. Initiatives such as eFactory can be regarded as an exemplification of this tendency (https://www.efactory-project.eu). The European Connected Factory Platform for Agile Manufacturing—eFactory—is a federated ecosystem and a digital platform that interlinks up various stakeholders from digital manufacturing. It enables the use of innovative functionalities, experimenting with disruptive approaches, and developing new solutions. Such initiatives, though, may seem to be undermining the importance of clusters as geographical collocations of firms but they are, in fact, employed and managed by clusters' entities—in HAv's case by Hansa Aerospace, implying certain complementarity. It can also imply the gradual evolution of traditional clusters towards entrepreneurial ecosystems. They, however, differ from classic clusters, in terms of: organisation of resources around start-ups, and the scale-up of new ventures; dominant networking and competition patterns (horizontal networking, vertical competition); and prevailing forms of knowledge spill-overs, emphasising the pursuit of entrepreneurial opportunity and scale-up through radical business model innovation (Autio, Nambisan, Thomas, & Wright, 2018).

3.3. Networking—(un)articulated proximity

In the opinion of most cluster members, business networks are critical, and co-operation with complementary firms matters most. They argue, that the most important benefits of membership are the linkages to potential customers. Proximity is a central issue, as it generates trust, which is the base for co-operation. "We are all humans, so we need these inner feelings. Knowing each other is critical for co-operation, and being part of a cluster enables this. (…), you always have the feeling you are speaking to someone you already know (CC1)." Frequent face-to-face contact reduces mistrust "by seeing and talking in person with these people, you gain the trust, which enables collaboration (CC1)." Spatial closeness is important for some firms, as with those who deliver the engines, also due to classic transportation costs. To foster contacts, "a cluster should also try to align the university landscape better, but it is also clear that every company needs to find their right way (CC6)." Companies which seek cluster support are usually medium-sized, and need help to improve their business situation. Large firms have a good standing on the market, own relations, and have a direct interface to the customers. Despite these owned strengths, cluster membership advantages can materialise for them, for instance, in the research area. "On the research side, the situation is slightly different because research activities are driven by official funding; it is something which comes along with cluster activities. Hence, in order to work in R&D activities, it might be interesting to be part of the club (CC7)."

Cluster firms value the possibility of observation, which comes with HAv membership. As they admit, participating in workshops is important—not in terms of solving a certain problem, but rather as a chance to see what others are doing, see their approach, avoid their mistakes, or learn their ideas, in order not "to re-invent the wheel". SMEs have the possibility to meet big industry players, and talk to them on a face-to-face level. Even if many of these small firms have some employees, who have good connections, and have worked in the aviation industry for years, they admit that they would never be able to generate such a network, like the one they enjoy in Hamburg Aviation. "Fruitful discussion is a base for a future project—I don't know if I would have been invited, if I had not been a member of a cluster (CC1)." "We belong to HAv, and have membership to Hansa aerospace for two reasons—the exhibition where Hansa Aerospace has fairly good contacts, and because our deliveries are interiors for aircraft and the centre of gravity in aviation is here in Hamburg (CC6)." Cluster membership can facilitate the digital transformation, as thanks to cluster networks, members can learn from each other, however, as stressed by one firm: "if we really need something more in terms of artificial intelligence, real technical know-how and expertise, agile programming, actual tech, we'd rather get in touch with each other's start-ups, who are sitting here in a shared office in ZAL (CC2)."

HAv members almost unanimously agree, that networking is critical, and HAv is doing a tremendous job to facilitate this. "The new things agile companies are doing within their own organisations, HAv has on its agenda, and aims at enhancing the creativity and entrepreneurship (CE3)." This also enhances the exchange of knowledge, particularly if one considers knowledge not in a narrow sense, but in a broader way, as tacit or sticky knowledge, which requires face-to-face contact, possibly thanks to proximity.

3.4. The past and the future of the key assets

What stands out in the provision of HAv's pool of industrial commons, are besides the classic economies of scope or scale typical for clusters, the economies of time. This is because of the consequences of past developments, and a strong focus on building future competences for aviation. The case of modularisation and standardisation of Airbus—the main HAv player—as described by Buxbaum-Conradi (2018), best exemplifies this. If local firms wish to continue producing for Airbus network, they must connect to the codification schemes, via accreditation and certification. This can allow them to forge further contracts with other big companies in the aerospace industry. Now, many local firms feel excluded from the production network. They are (suddenly) confronted with formal codes that are developed by very distant epistemic communities, and enforced by prime contractors as the dominant demanders of this formalised knowledge. This has resulted in profound relational changes in the Airbus production network that became visible in Hamburg in the disembedding of production relations, and an increasing network distance of local suppliers to Airbus, despite their geographical proximity and long-term established relationships. Additionally, as stressed by one member, "China and Russia are working on their own programmes similar to A320 (most sold airplane ever), which are due in 2021. We know China is a very automated and digitalised country. So, although they are creating them from scratch, they may have advantages over Airbus, which has relied on old technologies and design (CC3)." This might suggest again the time dimension and path dependency aspect in cluster performance. This past legacy might be a burden to some extent, causing rather incremental change, which is not so swift and radical as China or Russia can afford. As it seems, adapting "old" is much harder than getting a new production system or design.

Despite overall positive assessment of cluster role by its members, critical voices, particularly on the experts' side, are also raised. Their abstention from HAv, is a concrete example, but it rather indicates the general tendency to overestimate the power of clusters. Whereas clusters may have fancy websites, organise various useful events, and provide value for their members, they often work only as long as there is funding, or for a new field, which requires more co-operation. Once funding ends, projects often die, and the whole endeav-

our is not sustainable, which could simply mean a large waste of public money (Ludwig, 2019). The role of cluster institution in these processes, might also be over-rated. Time tells how successful many of these initiatives have been, but one has to bear in mind, that HAv is unique, as the aviation sector it represents, has an integral defence component resulting in obvious state involvement. The co-learning initiatives undertaken in Hamburg, seem to be an answer to the calls of adequate managing of local learning (Brinkhoff, Suwala, & Kulke, 2016). It aims at offering the enabling context / protected enabling space where the creation of '*ba*' stimulates linkages among a variety of knowledge organisations. '*Ba*' is defined as physical, social, cultural, mental, economic, or virtual spaces or platforms, which enable knowledge creation, and can exist at different levels (Nonaka, 2008; Nonaka & Takeuchi, 1995). It takes time to build expertise, to learn from mistakes, to know the problems, and know the consequences of them "It takes years to reach high quality" (CC10).

Predicting and shaping future skills takes place in different dimensions, and cluster management provides multiple possibilities. Proximity enables workers to change jobs between companies, and in fact, can strengthen the local labour market. "The brain drain is there, but it is something in net positive. Some companies lose workforce, others gain, but it means adaptability to adverse shocks (CO1)." The importance of "people" and "talents" as one of the major trends, including action areas such as lifelong learning, attracting talents, developing new curricula, or training for today's and the future's needs, can be found in a new strategy (55th HAv Forum, June, 2019). This reflects the ongoing often disruptive processes taking place in the aviation industry.

3.5. Enhancing the proximity by cultivating the commons

The HAv case demonstrates the need to develop the commons, to buttress the multi-dimensional proximity by highlighting these elements which are shared, and by eliminating all what divides. A previous study dedicated to HAv, revealed the importance of communication and identity building as a *sine qua non* condition for members' engagement (Hintze, 2018; Putnam, & Nicotera, 2009). Community and a feeling of belonging are crucial for cluster success. The Cluster brand requires the ownership of all stakeholders. Identity is like a quality label, with which cluster members can easily associate (Morgulis-Yakushev & Sölvell, 2017). It builds upon proximity, and reversely, strengthens it. Developing identity is a process, which takes time, needs routines, establishing some culture of co-operation, as uncertainty breaks only over a year. The search for commons is visible, literally, in actions aimed at better cross-clustering collaboration.

Inter-sectoral, intra-regional, collaborative learning is creating a *cluster-space* (Fromhold-Eisebith, 2017), and can aim at: coping with cluster support from one initiative to another, combining simply together the support meas-

ures available in different initiatives, and combining agency towards outside or truly cross-cluster, internal, networking happenings at different levels in different configurations. It appears that the activities undertaken in Hamburg, in particular, the bridging (cross-clustering) promote such evolution, and fit into the advanced type of cross-cluster, internal networking.

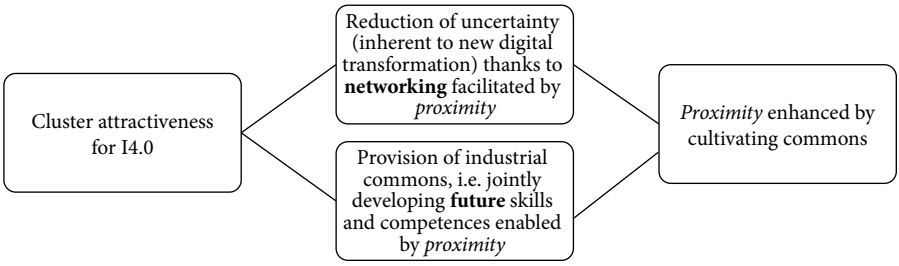
The findings of the field study point out the importance of co-operation, competition, and the role of cluster organisation, as within the sphere of the co-ordinator. Indeed, advances in digitalisation and the rise of I4.0 with more interconnectedness and interdependence of technologies and business organisations, make the co-ordination—conceptualised with co-operation and competition as the three basic types of strategic interactions—more relevant than ever before (Pietrewicz, 2019).

Conclusions, recommendations, limitations, and future studies

Provision of industrial commons critical for advancing the I4.0 in clusters, must build up the multi-faceted proximity, and further require the actions towards strengthening this proximity. IC is being developed in HAv, by gradual and incremental accumulation of main triple helix components; by stimulating the critical mass of knowledge, business / industry activity, and policy framework orchestrating the cluster members. Besides collecting components, safeguarding the effective relations among them remains critical, hence, the activities such as organisation of fairs, or exhibitions. As it appears, the higher the proximity, the easier it happens.

Although HAv belongs to I4.0 German clusters, interviewees seem cautious as to whether it is indeed the case. They point out that Industry 4.0 is in the background of the HAv mission and factor of change. The Cluster aims at raising the awareness on the digital transformation's related challenges, and seeks to facilitate the critical skills developments, thus, the approach of HAv towards I4.0, might be described as soft and prospective. It is further clear that understanding of I4.0 varies among members, although, they are regarded mostly as representing advanced technologies. Actions so far concentrate mainly on improving the knowledge about I4.0. The peculiarities of the aviation industry should be stressed and taken into account. This sector is much less susceptible to automation or digitised integration than the automotive industry. The provision of industrial commons, e.g. the bundling of knowledge, business, and policy is embodied in the profile of HAv institutions (e.g. ZAL)—which are aiming at being an interface, a networking industry, and a science; business, research, and policy, are duly strengthened by simultaneous membership of institutions in each other, or by the co-ordinating role they play (ZAL for re-

search, HECAS & Hansa Aerospace for supply chain, and HCAT+ for education). Business relations and networking more than the knowledge exchange, matter mostly for cluster members, in particular SMEs (Ferreira, Raposo, Rutten, & Varga, 2013). Access to large players—being the centre of gravity—is also relevant in the eyes of many small members. Future skills feature high on the cluster agenda. Yet, past developments, in particular, the previously destroyed industrial fabric, which is too hard to be reinstated, impact upon the current provision of IC. In fact, finding the commons and strengthening the "proximity"—that what binds—is the main task for cluster organisation. It aims at offering the enabling context (space), stimulating linkages among a variety of organisations.



Scheme 3. Cluster role for I4.0 advancement—IC and proximity
Source: Own proposal.

Certain cautious scepticism towards the "cluster" has been mentioned in some conversations conducted in HAv. Nevertheless, especially for SMEs, it continues to provide high added value. Membership is hence not questioned at all, as the advantages offered here matter much.

In the future, as indicated by some respondents, "cluster" (generally as a concept) will defend its position regardless of the threat of IT-facilitated possibility of distance collaboration. But to remain an attractive location, it must evolve—not only adopt new trends but also shape them ("future of skills") and assimilate more diversity (as the latest cluster literature finds).

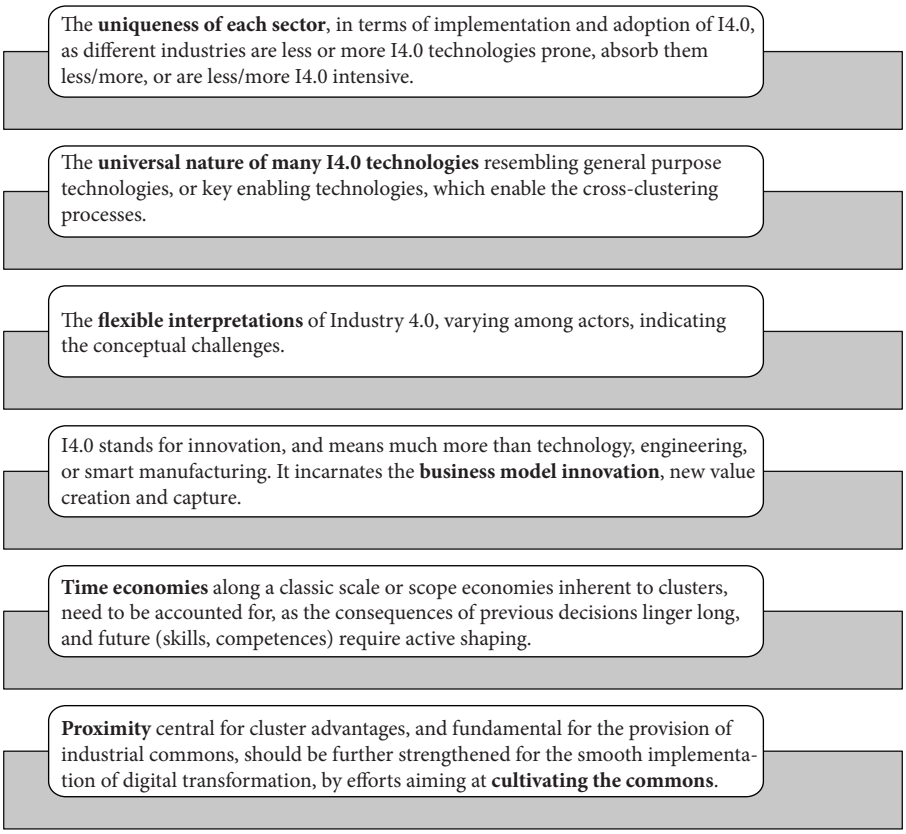
The studied case indicates the endless benefits of clustering in the I4.0 era; nevertheless, it also highlights the necessary efforts to cultivate the (cluster industrial) commons and care for members "networking".

The main limitation of this study lies in its qualitative approach and the narrow sampling (Vanninen, Kuivalainen, & Ciravegna, 2016), that makes its conclusions more suggestive than conclusive. The single-case study method used, has its inherent weaknesses, such as difficulty in generalising and possible bias in interpreting interview transcriptions (Richardson, Yamin, & Sinkovics, 2012). Single case studies can create, first of all, an internal validity. The transferability to other cases, e.g. the external validity is difficult to assess, because the HAv

cluster as an 'aviation, large company-dominated' cluster, is quite specific in its nature. HAv is unique in many ways—it is located in a metropolitan region, vibrant, and one of the richest cities in the EU. At the same time, a Federal state in the German administrative system, it is heavily biased towards the largest player, e.g. the Airbus company; the industry as such, is also specific in terms of life cycle, or entry barriers and costs. Hence, the generalisation of results might be limited. One of the challenges faced is deciding what to show and what to tell (Pratt, 2009). Focusing on showing the data, can make the paper seem overly descriptive, while focusing on talking about the data, can make the conceptual framework suggested seem unsubstantiated.

Future studies should obviously aim at comparing the results of the HAV case, with other advanced or I4.0 clusters. They should dwell more on the various dimensions of proximity (Yamamura & Lassalle, 2019). Furthermore, they should take up and further explore the management problem of asymmetry of relations (the need of networking), which requires deeper appreciation for the nature of the power relationships and is key to understanding how clusters function (Bathelt & Taylor, 2002). Despite the above discussed advantages, which are provided by clusters for the advancement of I4.0, the deeper question of possible barriers hindering the digital transformation, such as the ones related to path-dependence, some inertia, or managerial causation (opposite to managerial effectuation) need to be investigated, and if necessary, also properly addressed (Laudien & Daxböck, 2016). Although, in light of available data (a dominant 'wait and see' approach to emulate success in other companies—Bradley, Loucks, Macaulay, Noronha, & Wade, 2015) and the fact that business is not characterised by endless reaction speed, firms tend to adopt a co-evolutionary gradual approach (Voigt, 2008), which also features in clusters. Future studies should address the challenges—previously identified in the literature—associated with the richness of knowledge interactions, and understood as knowledge flows, diffusion, spill-overs, mobility, monitoring, transfer, exchange, or sourcing (Micek, 2016).

Cluster and I4.0 are world-wide phenomena and processes having a profound impact on innovativeness and competitiveness everywhere, though, in particular, in developed economies. Given the explorative nature of this study, it is only possible to provide indicative suggestions (Laplume, Petersen, & Pearce, 2016). Though, some of the findings may provide interesting insight and practical suggestions for other similar initiatives in other countries, including Central and Eastern Europe ones, with their transition economies. Clusters, as the German case shows, can be implemented as an efficient vehicle for place based transformative policy. Hence, the results obtained could offer some guidelines for all involved, in shaping the regional aspects of digital transformation, and responsible for technology and innovation policies, such as the Polish Platform of Industry 4.0. However, instead of producing concrete advice, this study can rather draw attention to certain aspects, as listed on scheme 4.



Scheme 4. HAv key lessons learned for conducting cluster-based policy in digital transformation—aspects deserving attention
Source: Own elaboration.

Lessons learned from this case with regard to provision of industrial commons, might help to avoid or reduce some hidden traps of implementing I4.0.

Digital transformation's natural outcome is the emergence of superstar firms which is causing even more market imbalances and poses challenge for policymakers. Likewise, the problem of adequate scale-up and threat of pilot purgatory (Garms, Jansen, Schmitz, Hallerstede, & Tschiesner, 2019). Hence, harnessing properly the clusters advantages—the chance to learn from each other thanks to the networking and reduced imbalances—as the HAv case shows, could not be overestimated (Labhard, McAdam, Petroulakis, & Vivian, 2019).

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