Connecting Knowledge Brokers for SMEs Digital Transformation: a configurational study

DOMINIQUE LEPORE[*] ALESSANDRA COSTA[•] ANTONIO CRUPI[♠] LUCA MARINELLI[**]

Framing of the research. *Small and Medium-sized Enterprises (SMEs) struggle to adopt digital technologies that are necessary to survive and be competitive (Matt et al., 2020). To overcome this challenge, SMEs require tailored approaches based on cooperation with other actors, including institutions, academia and firms (Benitez et al., 2020). SMEs can obtain access to knowledge by connecting to regional innovation networks that include actors well linked to global knowledge sources (Kauffeld-Monz and Fritsch, 2013). Indeed, knowledge diffusion across regions can bring many benefits to SMEs that they would not be able to afford on their own (Fuller-love, 2009). Nevertheless, spending resources on regional networks does not always lead to positive outcomes for firms (Elvekrok et al., 2018). Thus, scholars have tried to understand the factors that underpin successful knowledge exchange. A particular area of research has focused on intermediary organizations acting as knowledge brokers across regional boundaries (Wink, 2018). These intermediaries can act as agents connecting two or more parties in innovation processes (Howells, 2006) and as gatekeepers able to establish extra-local linkages (Le Gallo and Plunket, 2020). Therefore, there is a need for further investigations to help policy-makers choose the right intermediary (Larty et al. 2017). This call becomes relevant in the emerging scenario of digital innovation hubs (DIHs). DIHs are structures that the European Commission recognizes as supporting the digital transformation of SMEs by connecting these firms to external stakeholders, such as research centres, universities, institutions, and other firms (Macias Aragonés et al. 2020). DIHs, acting as orchestrators, constitute one of the leading regionally focused European programs to facilitate Industry 4.0 in European regions within the Digital Single Market package. These intermediaries are knowledge brokers that through their activities and partnerships shape the digital transformation of SMEs (Crupi et al., 2020). The European Commission aims at creating a network of European DIHs. In fact, DIHs should be able to act as a doorway providing access to knowledge not available locally through the network of DIHs across Europe (Kalpaka et al. 2020). Based on this goal, it becomes necessary to investigate what are the characteristics that can explain the presence of a regular exchange of knowledge among DIHs.*

Purpose of the paper. *The paper aims to identify the conditions that can explain the exchange of knowledge among DIHs across regional borders. Thus, the objective of the paper is to support the creation of a network of DIHs that based on the continuous exchange of knowledge can effectively support the digital transformation of SMEs.*

Methodology. *We apply the Qualitative Comparative Analysis (QCA). Configurational methods integrate qualitative and quantitative approaches and are useful for building richer theories. Recent studies used a configurational perspective to individuate the condition or some useful combinations of conditions able to explain the presence of an outcome or the occurrence of a particular final state (Fiss, 2011). Among others, QCA is considered one of the approaches that helps bridge the division when difficult phenomena are being studied, as well as facilitating the analysis of small samples that do not acquire representativeness, or of relationships that do not adapt to statistical models (Fernández-Esquinas, 2021). The QCA does not demonstrate the existence and the magnitude of causal relationship among variables but allows to reduce a large number of causal conditions to a small set of configurations that contribute to a certain outcome across all cases. In this study, we use the fuzzy set qualitative comparative analysis (fsQCA), which extends the general Boolean functioning by introducing fuzzy set-membership scores, in contrast to the presence/absence categorization of the data (as in crisp set). Fuzzy membership scores range from 0 to 1 and can take any values between them according to the calibration method adopted (Ragin, 2006). The basic step in fsQCA is data calibration, which refers to the operationalization of collected data as membership scores within predefined sets, whose values range from 0 to 1. In this study, we refer to the direct calibration approach, so that we directly choose the fully in, intermediate and fully out thresholds. Our outcome variable refers to the regular exchange of knowledge among*

[*] Post-doctoral research fellow in *Applied Economics* - University of Macerata, Italy
e-mail: d.lepore@unimc.it

[•] Researcher in *Innovation Management* - University of Messina, Italy
e-mail: alessandra.costa@unime.it

[♠] Researcher in *Innovation Management* - University of Messina, Italy
e-mail: crupi.antonio@unime.it

[**] Researcher in *Management* - Polytechnic University of Marche, Italy
e-mail: l.marinelli@staff.univpm.it

DIHs, and instead of using a binary fuzzification, we adopt a three-scale variable: absence of knowledge exchange (0); only intra-regional exchanges (0.33) and extra-regional (1).

Since there is no specific literature explaining the conditions that could determine the presence of networks among knowledge brokers, the selection of conditions contributing to connections among DIHs is based on a literature review on knowledge management, innovation intermediaries and DIHs specifically. The literature review is combined with the expertise gained by the group of researchers from working in DIHs and collaborating in their research and training activities as well as on the insights gained from other experts on DIHs. The conditions selected include the following characteristics of DIHs:

i) structure. DIHs are defined as no-profit organizations supporting the digital transformation of SMEs. Cooke (1996) highlighted that not-for-profit organizations are excellent for setting up networks because they are trusted. The most common leading actors hosting or creating DIHs are public organizations (research transfer office or University) or governmental (innovation or development) agencies. Other leading actors are private accelerators or public-private partnerships for research, presenting organizational structures such as joint ventures, network organizations (formal or informal)and projects with multi-partners with formalized ending time (Hervas-Oliver et al., 2021). In this study, we follow Crupi et al. (2020) classification differentiating between industrial associations, academia, institutional and network-based structures, according to the analysis conducted on the Italian case.

ii) involvement in the regional S3 design. We differentiate between active and passive involvement based on the participation of the DIHs in designing the S3; Since DIHs have a strong regional dimension, there is a strong potential connection to policy initiatives, especially with reference to the S3 (Rissola and Sörvik, 2018). S3 is a place-based innovation policy concept to support regional prioritisation in innovative sectors, fields or technologies through the entrepreneurial discovery process, which is a bottom-up approach to reveal what a region does best in terms of its scientific and technological endowments (Foray et al., 2011). DIHs should be involved in the regional S3 through cross-fertilization of regional actors, industries and activities, not limited just to the entrepreneurial discovery process (Hervas-Oliver et al., 2021). Moreover, DIHs are pictured as collaborative enablers that allow the integration of Industry 4.0 plans into the S3 (Lepore and Spigarelli, 2020).

iii) presence of a technological focus. Specializing in a homogeneous set of ideas is both more efficient and less risky. Nevertheless, specializing implies increasingly exhausting existing recombinant possibilities, while brokerage generates new ones. Therefore, technology domains tend to grow faster when they specialize, but the more specialized they are, the more they require knowledge brokerage to develop (Carnabuci et al., 2009). As for DIHs, the European Commission is creating networks of DIHs based on a technological focus as means to support businesses in their digital transformation and promote cooperation among them. In this sense, the European Commission has launched a preparatory action to establish a framework for continuous collaboration and networking between DIH focusing on specific technological domains, like Artificial Intelligence (AI) and provide evidence and support for the preparation of relevant policy and future programmes. At the same time, other DIH networks are emerging at the national and European levels without a specific technological focus. Therefore, it is of interest to understand if having or not a technological focus can incentives the exchange of knowledge among DIHs.

iv) competencies of staff based on the presence of administrative, technical or mixed competences. There is an area of study that considers the weaknesses of intermediaries, which are due to a lack of expertise and qualified staff (Chandran et al., 2013). Intermediaries should be built up of people with a range of backgrounds and skills, which often includes postgraduate scientists, technologists, business project managers, and research analysts, who are skilled at merging commercial experience with technical knowledge (Malik, 2012). Even if there has been an increase in the numbers of such professionals, there has been little focus on their functions and development (Phipps and Morton, 2013). Given the variety of services offered by DIHs from seeking partners and financial resources to technological development, a mix of administrative and technological skills are expected to ensure that the DIH is able to seize external opportunities.

v) level of formality in managing relationships with other stakeholders. The benefits of informal networks are that information is transferred fast. In general, informal networks provide the chance for information and knowledge to flow in both vertical and horizontal directions, which contributes positively to the flexibility of the organization (Cross et al. 2002). Scholars have examined the role of formal and informal networks in the case of SMEs. Kingsley and Malecki (2004) found that small firms employ informal networks for distinct types of advice, including product development, competitive concerns, or labour matters. They also seem quite comfortable having a mix of informal and formal relationships with suppliers and customers.

vi) type of brokerage activities, including knowledge selection, exchange and appropriation. As reported by Crupi et al. (2020), DIHs can engage in three main types of knowledge brokering activities: knowledge selection by selecting potential stakeholders (e.g., firms, academia, investors) that can contribute towards the digital transformation of SMEs; knowledge exchange by connecting and translating knowledge flows between stakeholders and SMEs; knowledge appropriation following up the collaboration and market development of the collaboration established between stakeholders and SMEs. The positive and negative forms of six conditions were included in the necessity analysis. The analysis has been performed with R-package QCA (Dusa, 2019) through the Quine-McCluskey algorithm that provides three different solutions: a complex solution, a parsimonious solution and an intermediate one.

As a first step, fully operational DIHs registered in the European catalogue of DIHs were contacted with an e-mail to invite them to participate in the survey. A complex and intermediary solution based on a sample of thirty-eight DIHs

is discussed to provide recommendations on DIHs' development. Based on the results, interviews were conducted with significant cases of DIHs in order to interpret the findings.

Results. *Thirty-eight DIHs participated in the study by answering the online questionnaire that was sent by e-mail. The questionnaire was composed of multiple questions addressing the six conditions and open questions to allow DIHs to further integrate their answer sand report on the opportunities and challenges faced when collaborating with other DIHs. DIHs answering to the questionnaire are located in different European and Extra-European countries as follows: Austria (2), Croatia (1), Denmark (1), Finland (1), France (4), Germany (1), Greece (1), Ireland (1), Israel (1), Italy (7), Latvia (1), Lithuania (2), Netherland (2), Romania (1), Serbia (1), Slovenia (1), Spain (4), Sweden (2), Turkey (1), UK (2), Ukraine (1).*

The cases leading to the presence of extra-regional knowledge exchange are 11, while on the other hand absence of the outcome revealed 27 cases. Among the 27 cases, it must be considered that four DIHs exchange knowledge with other DIHs but only at the regional level. By applying the fsQCA, among all the 16 OR-configurations, the analysis reveals that none of the conditions alone is a necessary condition for the output "regular knowledge exchange among DIHs". This means that no single condition on its own leads to the output, implying that taking a configurational perspective is essential. We concentrate on the intermediate solution for our analysis because it is more suitable for theoretical interpretation (Fiss, 2011).

The intermediate solution can be considered as a complex solution reduced by the conditions that run counter to fundamental theoretical knowledge so that it takes advantage of the most plausible simplifying assumption. Based on this solution, we identify a set of pathways that can lead to extra-regional knowledge exchange among DIHs, with a consistency and coverage that comply with the criteria established by Ragin et al. (2008). The results contribute to a very interesting stream of literature that aims to understand the ratio behind the successful exchange of knowledge among DIHs. By considering all the different pathways, when focusing on the most positive configuration of all the conditions, the regular exchange of knowledge is enhanced for those DIHs that are actively engaged in the S3 and in all three types of knowledge brokerage activities. The active involvement in the S3 agrees with Miörner et al. (2019), according to whom S3 managers should proactively identify industry needs and fit their support to DIHs accordingly and work to make sure that DIHs contribute to integrating different parts of the regional innovation ecosystem. Among the cases, a deviant case is identified and is justified by being one of the few cases of DIHs belonging to an extra-European country. Indeed, structures acting as DIHs can apply to the European catalogue even if there are part of an Extra-European country. In deepening the analysis, DIHs state to know other DIHs based on previous relationships with their stakeholders (n.24). A group of DIHs has also used the European catalogue to search for other DIHs (n.15). DIHs also stress the need to collect and study not only best practices but also examine negative experiences of collaboration. Furthermore, exemplary cases of DIHs reported the need to foster informal networking activities among DIHs based on face-to-face meetings, underlining the negative impacts of the COVID-19 pandemic. Looking into the partnerships that DIHs have with other stakeholders, it is noted that when considering companies, universities and governments there are strong relations at the regional and national level. Instead, when considering the case of collaborations with other DIHs, the European and non-European collaborations are higher respect to national and regional ones. Matching the results gathered from the fsQCA and interviews conducted with selected DIHs we conceptualize the key dimensions to build a knowledge ecosystem of brokers that acts at the regional, national, European and Extra-European levels.

Research limitations. *The study encounters several limitations that should be addressed by future studies investigating the case of knowledge brokers enabling the digital transformation of SMEs. First, the conditions used in the QCA methodology were derived indirectly from the literature on knowledge management, innovation intermediaries and DIHs specifically, and from experts on DIHs. Therefore, this means that significant conditions may have been excluded. Second, the perspective used was only one of the knowledge brokers. Thus, interviews based on interpreting the configurations found should be complemented with the perspectives of SMEs, DIHs' stakeholders and policy-makers. In this way, it would be possible to provide a more comprehensive analysis of the phenomenon understanding the opportunities and the obstacles towards creating an active network of DIHs enabling the digital transformation of SMEs.*

Managerial implications. *The results provide a set of relevant implications for DIHs managers, SMEs, DIHs' stakeholders and policy-makers in line with the intention of the European Commission of building a network of European DIHs. Based on the results of the fsQCA as well as the interviews of DIHs, DIHs managers can become aware of the elements to focus on for redefining their objectives and activities in order to engage with other regional DIHs and encourage an effective and regular exchange of knowledge. Thanks to a strong network of DIHs, SMEs can have access to a wider degree of knowledge and experiences that can overcome the challenges faced in their digital transformation. Also, the stakeholders of DIHs can have the opportunity to engage with a broader range of stakeholders and overcome lock-in and path dependence issues. Finally, the paper provides innovative indications to policy-makers at the regional, national, European and Extra-European levels to structure programs and incentives that leverage the positive as well as negative experiences reported by DIHs. Indeed, the results of the sample highlighted the need of focusing not only on best practices but also on reporting negative experiences in DIHs collaboration in order to design effective managerial and policy strategies.*

Originality of the paper. *The paper contributes to the emerging literature on knowledge brokers focused on the digital transformation of SMEs. Specifically, the results provide a new theoretical and practical perspective on how to build and support networks of knowledge brokers across regions. The paper combines results from the fsQCA analysis*

with interviews with exemplary cases of DIHs to provide a broader interpretation of the configurations identified. Both qualitative and quantitative studies can further integrate the findings here provided by extending the sample and integrating the conditions selected.

Keywords: *digital transformation; digital innovation hub; innovation intermediaries; knowledge brokers; smart specialization strategies.*

References

BENITEZ G.B., AYALA N.F., FRANK A.G. (2020), "Industry 4.0 innovation ecosystems: An evolutionary perspective on value cocreation," *International Journal of Production Economics*, vol. 228, 107735.

CARNABUCI G., BRUGGEMAN J., "Social Forces", vol. 88, n. 2, pp. 607-641,

CHANDRAN V.G.R., SUNDRAM V.P.K.S., SANTHIDRAN S. (2013), "Innovation systems in Malaysia: a perspective of university-industry R&D collaboration", *AI & Society*, DOI 10.1007/s00146-013-0468-9

COOKE P. (1996), "The new wave of regional innovation networks: Analysis, characteristics and strategy", *Small Bus Econ*, vol. 8, pp. 159-171.

CROSS R., NOHRIA N., PARKER A. (2002), "Six myths about informal networks - and how to overcome them", *MIT Sloan Management Review*, vol. 43, n. 3, pp. 67-76.

CRUPI A., DEL SARTO N., DI MININ A., GREGORI G.L., LEPORE D., MARINELLI L., SPIGARELLI F. (2020), "The digital transformation of SMEs - a new knowledge broker called the digital innovation hub", *Journal of Knowledge Management*, vol. 24, n. 6, pp. 1263-1288.

DUSA A. (2019), *QCA with R. A Comprehensive Resource*, Cham, Switzerland: Springer International Publishing.

ELVEKROK I., VEFLEN N., NILSEN E.R., GAUSDA A.H. (2018), "Firm innovation benefits from regional triple-helix networks", *Regional Studies*, vol. 5, n. 9, pp. 1214-1224.

FERNÁNDEZ-ESQUINA , M.S. (2021), "The use of QCA in science, technology and innovation studies: a review of the literature and an empirical application to knowledge transfer", *Scientometrics*, vol. 126, pp. 6349-6382.

FIS P.C. (2011), "Building Better Causal Theories: A Fuzzy Set Approach to Typologies in Organization Research", *Academy of Management Journal*, vol. 54 n. 2, pp. 393-420.

FORAY D., DAVID P., HALL BH. (2011), "Smart specialization: from academic idea to political instrument, the surprising career of a concept and the difficulties involved in its implementation," *MTEI Working Paper*, École Polytechnique Fédérale de Lausanne.

FULLER-LOVE, N. (2009). "Formal and informal networks in small businesses in the media industry", *International Entrepreneurial Management*, vol. 5, pp. 271-284.

HERVAS-OLIVER J.L., GONZALEZ-ALCAIDE G., ROJAS-ALVARADO R., MONTO-MOMPO S. (2021), "Emerging regional innovation policies for industry 4.0: analyzing the digital innovation hub program in European regions", *Competitiveness Review*, vol. 31, n.1, pp. 106-129,

HOWELLS J. (2006), "Intermediation and the role of intermediaries in innovation," *Research Policy*, vol. 35 n. 5, pp. 715-728.

KALPAKA A., SÖRVIK J., TASIGIORGOU A. (2020), "Digital Innovation Hubs as policy instruments to boost digitalization of SMEs", Kalpaka, A., Rissola, G. (Eds.), Publications Office of the European Union.

KAUFFELD-MONZ M., FRITSCH M, (2013), "Who Are the Knowledge Brokers in Regional Systems of Innovation? A Multi-Actor Network Analysis", *Regional Studies*, vol. 47 n. 5, pp. 669-685

KINGSLEY G., MALECKI E.J. (2004), "Networking for Competitiveness", *Small Business Economics*, vol. 23, pp. 71-84,

LARTY J., JACK S., LOCKETT N. (2017), "Building regions: a resource-based view of a policy-led knowledge exchange network", *Regional Studies*, vol. 51 n.7.

LE GALLO J., PLUNKET A. (2020), "Regional gatekeepers, inventor networks and inventive performance: Spatial and organizational channels", *Research Policy*, vol. 49, n.5.

LEPORE D., SPIGARELLI F. (2020), "Integrating Industry 4.0 plans into regional innovation strategies", *Local Economy*, vol.35, n.5, pp. 496-510.

MACIAS ARAGONÉS M., DE LA VIÑA NIETO G., NIETO FAJARDO M., (2020), "Digital Innovation Hubs as a Tool for Boosting Biomass Valorisation in Regional Bioeconomies: Andalusian and South-East Irish Case Studies", *Journal of Open Innovation: Technology, Market, and Complexity* vol. 6 n. 4.

MALIK K. (2012), "Use of knowledge brokering services in the innovation process", In 2012 IEEE 6th International Conference on Management of Innovation and Technology, ICMI T 2012|IEEE Int. Conf. Manage. Innov. Technol., ICMIT (273-278). IEEE.

MATT D.T., MODRÁK V., ZSIFKOVITS H. (2020*), Industry 4.0 for SMEs. Challenges, Opportunities and Requirements*, Palgrave Macmillan.

MIÖRNER J., KALPAKA A., SÖRVIK J., WERNBERG J. (2019), "Exploring heterogeneous Digital Innovation Hubs in their context. A comparative case study of six (6) DIHs with links to S3, innovation systems and digitalisation on a regional scale", Rissola, G and Kalpaka, A. (Eds.), EUR 29851 EN, Publications Office of the European Union, Luxembourg, 2019, ISBN 978-92-76-11108-5, doi:10.2760/627437, JRC117976).

PHIPPS D., MORTON S. (2013), "Qualities of knowledge brokers: reflections from practice", *Evidence & Policy: A Journal of Research, Debate and Practice*, vol. 9, n. 2, pp. 255-265.

RAGIN C. (2008), "Redesigning Social Inquiry: Fuzzy Sets and Beyond", *University of Chicago Press*, Chicago. doi:10.7208/chicago/9780226702797.001.0001

RAGIN C. (2006). "Set Relations in Social Research: Evaluating Their. Consistency and Coverage", *Political Analysis*, vol.14, n. 3, pp. 291-310

RISSOLA G., SÖRVIK J. (2018), "Digital Innovation Hubs in Smart Specialisation Strategies", EUR 29374 EN, Publications Office of the European Union, Luxembourg, 2018, ISBN 978-92-79-94828-2,

WINK R. (2008), "Gatekeepers and Proximity in Science-driven Sector in Europe and Asia: The Case of Human Embryonic Stem Cell Research", *Regional Studies*, vol. 42, n.6, pp. 777-791.

Websites

AI DIH network, https://www.ai-dih-network.eu/