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Rosli, A. and Cacciolatti, L.

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**The Role of Universities in the Development of the Local Knowledge
Base: Supporting Innovation Ecosystems through Skills Development
and Entrepreneurship**

Ainurul Rosli
Dept. of Globalisation, Entrepreneurship and Strategy
Brunel University
London, United Kingdom
ainurul.rosli@brunel.ac.uk

Luca Cacciolatti*
School of Organisations, Economy, and Society
University of Westminster
London, United Kingdom
l.cacciolatti@westminster.ac.uk

*Corresponding author

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Abstract

Regional competitiveness can be achieved by different setups in the regional innovation system (RIS). Overall, the predominant model emulated by many countries in the world is the liberal, industry-driven model of Silicon Valley. From a Triple Helix perspective, the Silicon Valley model adds value to the innovation ecosystem by leveraging on the weight of private initiative. However, other actors in the Triple Helix can also play an important role in contributing to thriving innovation systems. We present two case studies based on the UK experience, outlining the role that universities play in supporting the development of the local knowledge base to build resilient and sustainable innovation systems. The former case shows how the Triple Helix model can contribute to regional competitiveness through governmental coordination (in the Northern Powerhouse case) and shift into a Quadruple Helix model by enhancing inclusivity. The latter shows how regional competitiveness can be achieved by leveraging on the coordinating role of the local centres of knowledge (in the Midlands Engine case). Key elements to the success of these two different models of coordination are the upgrading of regional learning capabilities and the workforce upskilling. The policy implications deriving from this study suggest policymakers could shape the role of the centres of knowledge in the coordination of regional efforts to apply Knowledge Based Development (KBD) solutions to the development of RIS: (i) a partnering role might be most appropriate to initiatives based on a Quadruple Helix approach and (ii) stronger leadership as primus inter pares may be more suited for initiatives based on a Triple Helix approach.

Keywords: *Knowledge Base Development, Regional Competitiveness, Innovation Ecosystems, Communities Engagement, Quadruple Helix Model, Triple Helix Model.*

1.0 Introduction

After the success of innovation ecosystems such as Silicon Valley, which have been built on the initiative and creativity of entrepreneurs in a liberal-market fashion (Fogarty and Amit, 1999; Ooms et al., 2015), we wonder whether such success can be replicated in countries where the socio-political and economic setup differs from the pure liberalism that characterises the USA. Critical to the establishment of functional regional innovation systems (RIS) is the coordinating role of an actor, whose role is to establish the trajectories and regimes for the development of technological innovation (Asheim and Coenen 2006; Musiolik et al., 2020). However, the concept of RIS is often limited by the definition of geographic boundaries (Asheim, 2007). The expansion of telecommunication technologies and the growth of the internet have blurred these boundaries, changing the inter-organisational collaborative dimensions that underpin the successful development of innovation.

Different models emerged to complement (and not to antagonise) our understanding of RIS. Amongst these, two models, in particular, have proved particularly useful to explain the complexities of innovation ecosystems: the Triple Helix and the Quadruple Helix Models (Hasche et al., 2019; Carayannis & Campbell, (2009); Etzkowitz & Leydesdorff, 2000). The former maintains that our understanding of the complexities of the production of innovation is facilitated by the coordination that takes place amongst the three main actors who operate in a specific regional context. These actors are the government (that determines the rules by which the regulatory environment affects all other actors), the industry (which embodies the market force), and the centres of knowledge (universities, national key laboratories, and national institutes, that lead on knowledge creation and dissemination (Etzkowitz, & Leydesdorff, 2000). While this model is widely acknowledged as being useful to explain many of the main innovation

systems complexities, the latter model - the Quadruple Helix Model - also adds a fourth actor, the citizen (who embodies the reception of social value), to account for the need for inclusivity in a truly sustainable socio-economic system (Hasche et al., 2019; Carayannis et al., 2018).

These two models have been applied in different world regions and, given the variety of political and economic policy approaches in different areas of the world we cannot assume that the liberal model of innovation of Silicon Valley is necessarily an easy recipe to replicate elsewhere (Audretsch, 2019; Ooms et al., 2015). These models seem to be characterised by the emerging leadership of different actors in different socio-economic settings. In some cases, universities play a leading role in shaping the RIS due to their power to create and disseminate knowledge (O'Shea et al., 2007; Etzkowitz & Leydesdorff, 2000). In this paper, we study the role that universities play in supporting the development of the local knowledge base to build resilient and sustainable innovation systems.

We build a Knowledge Base Development (KBD) model for regional competitiveness based on the collaborative coordination offered by the centres of knowledge and based on the principles of the Triple and Quadruple Helix models. We provide evidence for the successful implementation of policies that support the creation of local systems of innovation, thus to corroborate our proposed model we use two British case studies, i.e. the Northern Powerhouse and the Midlands Engines, and provide evidence for these initiatives' different coordination mechanisms, which differ from the USA liberal model and which contrast the current belief that predominantly industry-led initiatives can stimulate local regional development (Ooms et al., 2015; Lynch et al., 2009).

In the case of Silicon Valley, the coordination of the system is led by private firms (Etzkowitz, 2019). However, in the first British case presented, the coordination of the innovation system lies with the State, while in the second case it lies with the centres of knowledge, demonstrating the importance of the context in devising policies geared towards the enhancement of local competitiveness. This paper contributes to current research in innovation studies by providing a better understanding of the development of RIS through an enhancement of the local knowledge base and the leverage provided by the local entrepreneurial activity. This paper also offers some useful considerations for the development of strong inter-linkages amongst government, universities, industry, and the wider society presented as implications for policymakers and universities.

The paper is structured as follows: sections 2 and 3 and sub-sections present the theoretical basis to build the conceptual model, section 4 and sub-sections explain the methodology, section 5 and sub-sections present the case study analysis, section 6 presents the conclusions and implications.

2.0 Building the Foundations: the Shift from the Triple to the Quadruple Helix Model of Innovation.

RIS around the world proved to develop in light of the diverse socio-economic and political realities in different nations and regions. For instance, Sweden has 'Robotdalen' a smart specialisation initiative led by hybrid autonomous organisations that connect various stakeholders with the users and the civil society (Höglund & Linton 2018; Hasche et al., 2019). On the other hand, Italian industrial districts focus on rising connectivity to global-knowledge resources managed by foreign entities (Berman et al., 2020). These examples reflect different aims and mechanisms to

develop and strengthen the existing local knowledge base and to create a structure whereby new products and services can be taken to market. In this regard, policymakers need to identify the models that are more likely to work within their region, avoiding a like-for-like copycat of the policies from world regions that present socio-economic differences.

What appears to play a major role in RIS effectiveness is a policy focus on facilitating cross-sectoral coordination and RIS players' co-creation (Arnkil et al., 2010; McAdam & Debackere, 2018). The Triple Helix model presents the advantage to facilitate better coordination amongst the actors and to enhance the quality of innovation through collaborative work. Nevertheless, it only helps to frame a complex RIS reality under a simple lens (Galvao et al., 2019), but not keep into account the ever-increasing need for a sustainable approach to innovation and the need to add value to society at large (Kinnear & Ogden, 2014). Furthermore, the Triple Helix focus on technological innovation does not leave much room for the exploration of applications aimed at social welfare improvement.

To address this lack of sustainability in the way the development of RIS is approached, the Quadruple Helix model puts particular emphasis on a new actor: the citizen. The inclusion of the civil society puts the basis for the need for a stronger co-creation approach to RIS development and the creation of value-adding innovation (Carayannis et al., 2012; Kim et al., 2012; Leydesdorff, 2013; Plewa et al., 2013). This concept builds on the ideas of co-creation and co-evolution and borrows some methodologies from the Open Innovation Model (Chesbrough & Garman, 2009). The inclusion of citizens in a model that explains RIS development and sustainability has important implications for our understanding of local competitiveness and a sustainable approach to innovation, e.g., an increased focus on social innovation (Jalonen, 2013).

Whether the role of citizens in the co-creation of policy solutions is observed by different perspectives such as RIS (Asheim & Coenen, 2005), innovation networks (von Hippel, 2007), or ecosystems (Carayannis & Campbell, 2009) the need for their involvement in society-centred policy designs is undeniable (Jalonen, 2013) as they sets the direction for innovation that adds value to people's lives. The inclusion of citizens as actors in the establishment of the local innovation system necessarily causes a major shift of focus from technology development and technology management: the processes of technology creation are concentrated in firms and their networks of stakeholders. For instance, the growth of the geographical innovation network of the video game industry in southern Sweden was attributed to a knowledge sourcing network of video game developers (Chaminade et al., 2020) while a smart city initiative in Barcelona integrated all the information generated by smart services into a single urban mobility platform in partnership with Cisco (Zygiaris, 2013). These technology creation processes, when designed by private organisations, are aimed to facilitate the commercial exploitation of knowledge through patenting and the commercialisation of inventions, pushing towards the management of innovation.

On the contrary, the main target for an inclusive RIS that involves the region's citizens is the overall innovativeness and an enhanced scientific and technological development with high impact solutions for the social welfare (which may happen through inventions commercialisation too), through a process of knowledge transfer and collaborative learning. This sets the ground for sustainable development of the local knowledge base. However, for a shift to happen RIS can leverage on two major actors: the centres of knowledge (e.g., universities, research institutes, national key laboratories) and entrepreneurs. This is particularly true when the link between innovation ecosystems and entrepreneurial ecosystems is commonly known, as they

often exist in symbiosis (Carayannis et al., 2018). While there is a plethora of studies supporting the linkage between entrepreneurship and innovation ecosystems (Autio et al., 2014; Spigel, 2017), the depth of the role universities play in the regional Knowledge-based Development (KBD) is still underexplored by current innovation literature. In what follows we explore the role of universities in facilitating RIS stability and in shaping the trajectory of KDB which leads to enhanced regional competitiveness.

2.1 Universities' Support of RIS: The Strategic Focus in Knowledge-based Economies

The KBD approach to innovation stresses the importance of knowledge creation, knowledge dissemination, and knowledge exchange and transfer (Rosli and Rossi, 2006). Universities, through their knowledge-centre role, have been offering local communities, cities, and regions a variety of multidimensional development opportunities to cultivate and share knowledge, foster innovation, and pursue regional growth (Carrillo et al., 2014). The past two decades have seen how universities operated as centres of knowledge by taking up the role of instigators of a KBD philosophy (Marozau et al., 2016).

When looking into the research done on universities and their symbiotic role in knowledge-based economies, most studies focus on how universities can add value to local economies through university-enterprises collaborations, and how universities are increasingly seen as a central asset to the formation of knowledge-cities, i.e. cities that act as clusters of knowledge creation and dissemination. Literature highlights how universities play an important role in innovation ecosystems through the development of human capital and advancement of technology and are recently expected to

participate as economic development partners with industry and local, state, and national governments (Heaton, Siegel, and Teece, 2019). By keeping into account the pivotal role of local-level economic, societal, spatial, and institutional development strategies, universities able to facilitate knowledge creation and dissemination, as well as collaborations aimed at knowledge transfer and co-creation through KBD policy development (Edvardsson et al., 2016).

When looking at how to build capabilities and capacity in Triple Helix shaped innovation systems, current research mostly focuses on a broad overview of the higher education systems in specific countries (i) shedding light on the differing roles of new public and private universities (Gunasekara, 2006; Kitagawa et al., 2016), from the evolution of ivory towers to entrepreneurial universities (Haeussler & Colyvas, 2011; Rosli & Rossi, 2016; Rossi & Rosli, 2015) (ii) highlighting the changing role of universities at training personnel in learning organisations (Kruss et al., 2012), and (iii) including co-location effects when universities attract scientists and creative people to work collaboratively in a local cluster (Goldstein & Glaser, 2012).

It is no doubt that universities' role in generating knowledge through research and the dissemination of that knowledge through the provision of education and knowledge exchange activities can be fulfilled in a variety of ways, e.g., collaborative and contract research, training, contacts via alumni or professional organizations, patents and licensing (Bekkers & Freitas, 2008; D'Este & Patel, 2007). By capitalising on the numerous interactions with citizens' economic life and the involvement with community stakeholders, universities provide an important supporting role for local firms in their pursuit of the development of technological solutions that can be commercialised, and for local entrepreneurs.

3.0 Institutional Triggers of Collaboration and Actors' Involvement: A Triple and Quadruple Helix Frame to Universities Coordinating Role

Universities' engagement with the actors in the RIS has to keep into consideration both the role played by the institutional initiator of regional or local KBD projects (whether KBD is part of a national or local policy) and the level of actors' involvement foreseen by the policy. The rise of a market-oriented education and the increase of knowledge exchange activities between the education sector and the industry (Gunasekara, 2006; Rosli & Rossi, 2016) has reinforced the need for universities to revise their scope and the approach to their operations, pushing academics to come out of their ivory towers to start interacting more with the industry. This change of scope of activities has been moving universities from unidirectional interactions with the society (i.e. university transferring their intellectual output to the industry for instance) to bidirectional interactions instead (Rossi & Rosli, 2015), as a configuration of outputs that depend on skills development and the local entrepreneurship agenda, based on the needs of the local economy and the local entrepreneurial ecosystem.

Although recent reviews of KBD literature highlighted a focus on the benefits of KBD policy implementation, its impact, and the raising challenges of knowledge-based economies (Kolehmainen et al., 2016; Kruss et al., 2012; Yigitcanlar, 2017), more discussion is needed about effective ways to build the local knowledge base. Thus, the main challenge consists in bridging the gap between universities' adaptation to changing educational market setup and addressing the needs of the local business community in the areas in which universities are located. When looking into building capabilities and capacity in Quadruple Helix shaped innovation systems, innovation takes place within RIS which are strongly related to entrepreneurial ecosystems. In Advanced Industrialised Countries (AICs) attention fades away from the generic firm

and moves towards the formation of a sustainable ecosystem for entrepreneurship development, whereby the entrepreneur is nurtured through adequate training, fosters innovation, adds value to society through social innovation and social entrepreneurship initiatives, and is ultimately supported by increased political attention and funds (Autio et al., 2014; Bramwell & Wolfe, 2008).

Yet, universities around the world have access to different institutional resources and present different research and teaching profiles. Thus, the one-size-fits-all logic does not work to transfer innovation and entrepreneurship ecosystem development models from a local context to another like-for-like (Kitagawa et al., 2016; Rossi & Rosli, 2015; Spigel, 2017). The adoption of this type of university management and operations models and their implementation may add further pressure to the diverse organisational structures and cultures within universities, hampering them in embracing change (Bramwell & Wolfe, 2008). For example, in investigating the dynamics of KBD in regional universities, Nord (2002) highlighted that universities are important to provide new access to higher education at the local level and broaden professional education and training, but also to assist regional economic growth and diversification with industry-university collaboration on knowledge transfer projects.

Furthermore, universities help to foster new social and cultural development opportunities. However, Nord (2002) also suggested that different models are adopted by different countries given the different priority attributed to universities. For instance, the North American university model focuses on access to higher education and short-term economic growth, whilst the Nordic (North European) model provides equal emphasis on education and industrial engagement. On the other hand, the Soviet model focuses on providing new access to higher education and on broadening professional education and training to local firms rather than engaging with knowledge transfer

activities. These example highlights that universities play a pivotal role in fostering collaboration capabilities amongst multiple stakeholders. Hence, universities play an increasingly important role in leading the coordination of these networks, and in facilitating the development of collaboration capabilities in different stakeholders, to facilitate knowledge creation and diffusion. But can universities fulfil their leadership role in such complex, multi-stakeholder, multi-disciplinary collaborative networks? The next section of this paper will discuss how universities interact with local business communities and how they support skills development and entrepreneurship in local economies.

3.1 Universities Engagement with the Local Business Community: Roles, Collaboration Capabilities, and Skills Development

A strong knowledge base is fundamental to develop the local economy and the transfer of knowledge generated in universities and research institutes to the industry is critical when addressing regional growth issues. To build regional innovation capacity is an aim of most national innovation programmes in those countries that see innovation as a driving force for the socio-economic development of the nation. In order to generate innovation capacity, there is a need to establish efficient and effective RIS. Thus, the country needs to develop innovation capabilities (Li, 2009).

Universities play a pivotal role in fostering collaboration capabilities amongst multiple stakeholders. Innovation capabilities are strictly linked with the actors' ability to collaborate typically of the Triple and the Quadruple Helix models. Collaboration is a necessity in increasingly complex RIS, thus stakeholders in an effective innovation and entrepreneurial ecosystem have no choice other than developing strong collaboration capabilities if they want to succeed in their endeavours. As pointed out

by Zhao et al. (2015) 'to improve innovation capabilities at the regional level it is necessary to: Stimulate the initiative of innovation actors (private and public), coordinate the relationship amongst innovation actors, and promote regional collaborations fostering innovation (Liu & White, 2001). Other than capabilities building, RIS also play another important role: efficient regional innovation systems are important to build innovation capacity in a Country (Tsai, 2009) but the combination of resources (innovation input) and know-how within collaboration frames that allow innovation actors benefit from innovation outputs is a complex process.

Thus, policies aimed at enhancing collaboration amongst the different stakeholders of the RIS should leverage on capitalising on strong links with the government, the markets, and the other actors collaborating on innovations (Broekel, 2012), to establish effective multi-stakeholders' collaborations, which enhance innovation capabilities and knowledge diffusion through knowledge transfer (Autant-Bernard et al., 2013).

The Government should contribute to providing regional innovation stakeholders with institutional support, e.g., policies supportive of KBD, to enhance innovation collaborations through policy making. Some of the concrete steps done by governments to provide such support include the provision of infrastructures at the regional level, financial capital for intra-regional and inter-regional investments, talent management through the creation of institutes or schools to train highly specialised scientists and engineers, as well as overall higher education and high-tech projects funding (Barretta & Busco, 2011). This is often achieved by encouraging collaboration amongst enterprises, government, and universities with the wider society in mind (Bozeman, 2000).

Thus, collaborative research programmes in science and technology, as well as more commercially tuned programmes aimed at improving the industry with products and

processes that can reach the market in a short period have a significant impact on the strengthening of networks that breed innovation (Boardman & Corley, 2008).

3.2 Universities as Gravitational Centres for Network Coordination and Skills Development

Universities can contribute to fulfil their leadership role in such complex, multi-stakeholders, multi-disciplinary collaborative networks by coordinating the network, contributing to research results generation and by developing the future workforce for their stakeholders. While research-wise it is widely acknowledged the role universities play in innovation ecosystems, which are 'characterized as knowledge ecosystems where local universities and public research organizations play a central role in advancing technological innovation within the system' (Clarysse et al., 2014). When we look at universities' role in coordinating the network, we suddenly realise that universities play a leadership role by:

- (i) Acting as 'anchors of creativity' that sustain the virtuous cycles of talent attraction and retention (Gertler & Vinodrai, 2005);
- (ii) Supporting the need for regional focus, by developing distinctive and original areas of specialisation. These areas of specialisation contribute to select and prioritise different fields or areas of knowledge where a cluster of activities can be performed (Morgan, 2017);
- (iii) Helping to identify the need to develop research and innovation that is fundamental to industrial development and those scientific areas that provide greater economic impact, e.g. by supporting R&D at a regional level through research, workforce training and education (Arbo & Benneworth, 2007);

When we look at universities' role in developing job skills in the future workforce, we realise that universities are key players in attracting talents for research and potential high players amongst the students they attract for their undergraduate and graduate training, and amongst those students that once trained access the job market. Amongst the skills frequently required are critical thinking, analytical skills, and planning skills. In a recent study on job skills development for the 4th industrial revolution and industry 4.0 Cacciolatti et al. (2017) highlighted that 'these skills are sought by employers because they are critical to the success of the tasks undertaken in the following frequently advertised duties: planning, drive efficiencies, lower production/distribution costs, problem-solving. Employers are searching for individuals who possess critical, analytical, and planning abilities that can be applied to specific contexts' (p. 149).

Furthermore, amongst highly sought skills that universities more recently started to provide we find skills related to entrepreneurship as these skills are often associated with the ability to generate more radical innovation: 'there is an overwhelming and convincing literature concluding that new and small firms play a disproportionately large role in forwarding radical innovations. The reasons are allotted several factors such as internal organization structures in large incumbents, so called business stealing effects, and individual and cognitive traits, to mention a few' (Braunerhjelm et al., 2018). More enterprising universities that develop entrepreneurial skills in students can facilitate knowledge exchange amongst network members attracting more innovative firms from the local business community. This can help address issues of potential economic relevance through the identification and distribution of potential opportunities for technological improvements.

Finally, universities that develop skills in the future workforce help to foster human capital formation for the future knowledge needs of the region's new industries as well

as the traditional ones, which are pushed more and more to adapt to an increasingly more technological world. Universities can provide them with highly skilled, talented graduates. How can collaborations be implemented to support the collective? In what follows we will discuss two main models of innovation collaboration experimented in northern England.

===== INSERT FIGURE 1 ABOUT HERE =====

4.0 Methodology

The data, collected on a continuous basis from 2014 to 2018, comprised observations, artefacts, archival data, and interviews with different actors of the innovation systems under examination. A thematic analysis was adopted to triangulate the vast amount of data collected for the study, which generated some main nodes and trees of analysis that linked the different concepts explained in the conceptual model presented in Figure 1. The face validity of the initial findings was corroborated by proposing an overview of the nodes and trees to three innovation experts from Academia, three representatives of the industrial world, and two policymakers at the local government level. In what follows we present the findings and analyse the dynamics leading to regional competitiveness through a KDB approach to innovation systems development.

4.1 The Strength of the Collective: Two English Cases of Collaboration Models to Foster Innovation and Entrepreneurial Ecosystems

In this section, we showcase the two case studies to illustrate two distinct models used in England to leverage multi-stakeholders' collaboration to develop effective

innovation and entrepreneurial ecosystems. We analyse the two cases following the model illustrated in Figure 1, highlighting how the different inception (institutional trigger) and the strategic focus, coupled with different collaborative approaches, can lead to regional competitiveness. By identifying the activities and resources and their coordination mechanism we show the coordination role of the centres of knowledge. We compare the two cases in table 1 and 2. The first model, the Northern Powerhouse, is an example of the application of a Quadruple Helix model to innovation systems, whereas the second model, the Midlands Engine, is an example of the application of a Triple Helix model to innovation systems. In the former case, the centres of knowledge play a supportive coordination role as partners to the initiative but subordinated to a consultative and directive multi-stakeholders' council. In the latter case, the centres of knowledge play a directive role as leaders, or *primus inter pares*, in the collaboration effort. These models are suitable to develop ecosystems that can satisfy current institutional complexities in the British RIS.

Cases background information. These two cases are characterised by a first model that focuses on developing collaborative efforts across different stakeholders, so to boost the local economy by ensuring that investment decisions are made by the locals; this is illustrated in the Northern Powerhouse example. The second model focuses on building a brand built on grassroots support, working collaboratively to build a collective identity, and it is illustrated in the Midlands Engine case.

These two initiatives ran almost simultaneously: the Northern Powerhouse in 2014 and the Midlands Engine in 2015. They were introduced by the conservative government (aka the Tories) in England at that time. These initiatives were designed to support growth and innovation across England. The multi-stakeholders' engagement

and collaboration approach adopted in these two projects in support of KBD make unique experiments out of the Northern Powerhouse and Midlands Engine.

The approach is based on the development of collaborative capabilities across the Quadruple Helix actors and the creation of support structures based on geographical and economic proximity that transcend current administrative constraints in the geographical setup of the UK regional divisions.

These case studies provide an answer to the following question: How can the UK local governments continue to keep the country moving forward on innovation while improving regional connectivity? How can the leading role of centre of knowledge contribute to the development of regional competitiveness? These UK-based experiments enable the combination of different stakeholders' skills more effectively, the creation of strong collaborative networks in which members can pursue the development of technical and soft skills that, when combined they can provide the best solutions to their clients' problems across Northern England.

The geopolitical context. England is one of the countries of the United Kingdom, along with Wales, Scotland, and Northern Ireland. The standard regional division of England comprises 9 administrative regions in total Greater London, South East, South West, West Midlands, West, North, North East, Yorkshire, and the Humber, East Midlands, and East of England.

The geo-political context. England is one of the countries of the United Kingdom, along with Wales, Scotland and Northern Ireland. The standard regional division of England comprise 9 administrative regions in total¹, yet their overall economic performance differs greatly from one region to another. The overall English economy

¹ Greater London, South East, South West, West Midlands, West, North, North East, Yorkshire and the Humber, East Midlands and East of England.

has overtime become too dependent on (and mostly dominated by) London and the South East, whilst the rest of the country is performing below its potential (Rowthorn, 2010). Numerous different initiatives have been designed and implemented to stimulate innovation and the economy in general in other regions, but various policies seem to have had limited outcomes with no long-lasting impact (Martin et al., 2016).

With the Northern Powerhouse and the Midlands Engine, the government managed to stimulate the creation of two models that proved beneficial in fostering KBD and innovation at local level. In both initiatives, universities act as 'anchor institutions' (or main points of reference) and play an important role for businesses, volunteers and society at large to collaborate better together. Table 1 shows the rationale underpinning these initiatives.

===== INSERT TABLE 1 ABOUT HERE =====

The British Government realized that more support was needed if they wanted to encourage universities to develop long-lasting collaborations between universities and their local councils. This University-State collaboration helped to improve services to local firms and boosted economic development with the launch of what was named the 'Leading Places Project', funded by the Higher Education Funding Council for England (HEFCE)².

The Leading Places Programme, currently active, consists of a pilot programme to build and transfer best practices in collaborative leadership among combined or local authorities, universities, and other local anchor institutions. It emphasises the role of the universities as 'local anchor-institutions' to work together to help drive growth, re-design public services, and strengthen civic participation. The next table illustrates the

² HEFCE is a non-governmental public body in the United Kingdom, responsible for the distribution of funding for higher education to universities and further education colleges in England since 1992.

main differences between the Northern Powerhouse model and the Midlands Engine in terms of resources allocation and management, as well as coordination type. A detailed presentation of the cases follows.

===== INSERT TABLE 2 ABOUT HERE =====

5.0 Case analysis

5.1 Case 1: The Northern Powerhouse

The idea of the Northern Powerhouse was first introduced in June 2014 as part of the government's industrial strategy in an attempt to gear the 15m people populating the North of England into a collective force that could: (i) increase the impact of the local economy on the overall UK economy, and (ii) counterbalance strategically the excessive economic power of London and the South East of England (Department for Communities and Local Government, 2017; Lee, 2017). This was part of the devolution agenda of the government to decentralise policy control and decentralise power away from Westminster to empower local regions and people (HM Treasury, 2017)

In a speech introducing the Northern Powerhouse in Manchester on 23 June 2014, the Chancellor of the Exchequer George Osborne stated: *“The cities of the north are individually strong, but collectively not strong enough. The whole is less than the sum of its parts. So the powerhouse of London dominates more and more. And that’s not healthy for our economy. It’s not good for our country. We need a Northern Powerhouse too. Not one city, but a collection of northern cities - sufficiently close to each other that combined they can take on the world”*. (George Osborne MP, 23rd June 2014). Figure 2 summarises the Quadruple Helix model.

5.1.1 The inception

The concept behind the idea of the Northern Powerhouse is not looking only at one city in the North of England but at a collection of northern cities sufficiently close to each other to be able to work closely together with significant implications for the national economy (Haughton et al., 2016). Some of the concrete policy initiatives welcoming with new enthusiasm the support for the North of England include the introduction of 'The Cities and Local Government Devolution Bill' in May 2015. This bill details the 'Combined Authority' status for a broader range of local authorities beyond the major cities, enabling them to work closely with the government to broker a bespoke devolution settlement (House of Lords, 2015), and de facto spreading the power amongst authorities while decentralising the power from Westminster (London). (See Figure 2)

This initiative involves a great deal of stakeholders' and resource coordination across cities and regions. The implementation of this strategy in terms of policy development and financial administration division was possible via place-based budgeting and an overarching investment strategy aimed at bridging administrative local differences amongst local authorities. All of this only works if policy design is being made based on local data and first-hand evidence of local characteristics, to support informed and responsive decision-making. Since this project bridges traditional administrative divisions, the Northern powerhouse includes Liverpool, Manchester, Leeds, Sheffield, Hull, and the North East (Nurse, 2015).

As previously said, universities were given a pivoting role to play in the leadership of this initiative and had to contribute to the success of the Northern Powerhouse initiative. The Northern Powerhouse is constituted by 23 universities, 6 of which rank in the top 20 UK universities for research excellence. More importantly, each of them

is an anchor institution of its community and plays a significant role indirectly contributing to the collaborative process and by bringing together stakeholders across a wide range of regional objectives. They lead to collaboration by taking charge of the creation and management of a network that gives all parties a unique perspective on the complex challenges to be faced together.

This collective yet multi-city-based approach allows the universities in the northern region to join more than 130 strong businesses and organisations supporting the central Government vision for a super-connected, globally competitive northern economy. This includes collaboration with 11 local enterprise partnerships (LEPs), which are voluntary partnerships between local authorities and businesses to help determine local economic priorities and lead economic growth and job creation within the local area. Each partner comes together with its specific local agenda but with common, shared priorities.

Northern universities are rejuvenating local areas as part of their role in delivering a deep, transformational impact on society. This collaborative arrangement in their relationships with businesses and the public sector not only add value to the initiative but also reduce the duplication of the work of other actors across different cities. For instance, Small and Medium Sized Enterprises (SMEs) are also able 'to plug into the public service supply chain' through this collaboration (Tomaney, 2016, p. 2), hence competing openly with larger firms to become official suppliers of the public administration. Another example of societal impact is the creation of various collaborative grass-roots educational programmes developing new skillsets in the local workforce. Educational initiatives do not only help local SMEs but foster the socio-economic development of various communities. Thus, the links between universities and local industry offer an opportunity for growth and this includes providing a greater

number of better-trained graduates so that they can build a career in the same city or region where they were educated or where their families and affections reside.

Furthermore, there is close collaboration among the 8 research-intensive universities of Durham, Lancaster, Leeds, Liverpool, Manchester, Newcastle, Sheffield, and York. These 'N8' collectively contribute to give jobs to 119,000 employees and have an aggregated turnover of £12bn contributing to regional wealth, provide help to more than 31,000 businesses, and create more than £6.6 billion gross value added (GVA) to the region as stipulated in the N8 2016 report (Bramley & Berry, 2018).

5.1.2 Areas of Collaborative Focus for Knowledge based Development

These universities combine their technical knowledge, expertise, and know-how to deliver the economy of tomorrow by identifying and coordinating powerful research teams and collaborations across the North of England. Four areas allow universities to develop and support the Knowledge Base Development for the region:

Education and skills. Universities act as 'net importers' of science and technology graduates that contribute to the growth of the locality. This includes co-investment by local businesses that act as employers to access the skills they need to acquire and grow for their operations. The local population needs to see that the collaboration is successful and that offers a way to develop adaptable skills for the future, for the workforce and firms to achieve their potential. For example, the Northern powerhouse consists of 17 enterprise supporting businesses across the North and include various investments initiatives such as the £15m worth 'National Institute for Smart Data Innovation' in Newcastle and the £11m worth 'Technology Incubators' in Manchester, Leeds, and Sheffield, or the £235m funding to support the 'Henry Royce Institute' in Manchester, which builds on the North's strengths in advanced materials research and

innovation. All these initiatives involve a collaborative arrangement between the government and various industry partners, local universities, SMEs, and local communities.

Infrastructures and Assets. Universities play also an important role in investing in the critical local infrastructures that drive growth. Knowledge hubs and co-location spaces for collaborative co-working help to bring together the different stakeholders of the North that otherwise would not communicate with each other. Yet, in the Northern Powerhouse, they work collaboratively using the evidence of best practice to deliver an agreed plan and clarify the priorities for infrastructure development at the local level. The current focus of the stakeholders on developing four major pan-northern centres of scientific excellence help to attract major companies and inward investment based on these strengths. Example of investment includes the Smart Ticketing System for public transport across the North and the 35-acres Olympic Legacy Park in the East-end of Sheffield, which is envisaged to create 1,000 high-value jobs and already attracted investment of leading companies such as Toshiba and Westfield Health.

Regional Competitiveness. Universities also play a role in capitalising on the collective northern strengths in each prime capability (Health Innovation, Energy, Advanced Manufacturing/Materials, and Digital). To achieve this, the initiatives connect and bring employers and civic leaders together, to pool the abundance of talent across the North, and to develop projects with experts in the universities). Collaborative projects with university experts help to drive higher levels of productivity, innovation, and enterprise across the northern economy. An example of investment includes £14m for the creation of the Advanced Wellbeing Research Centre in Sheffield, which is aimed at becoming the most advanced research and development centre for physical activity, health, and wellbeing in the world.

Leadership and Strength in the Collective. The Northern Powerhouse partnership programme – whose membership spans from infrastructure specialists, start-ups, PR agencies to banks and universities – gathers a new network of leaders who strongly believe in the potential to grow the northern economy and are committed to delivering this growth. This network of leaders allows all parties not only to share their thoughts and ideas but also to compete to invest, drive local areas regeneration, and benefiting all communities in terms of social innovation and social entrepreneurship. For instance, the celebrative event Hull City of Culture 2017 is but an example of the promotion of the Northern Powerhouse's cultural offer. Other examples include other town initiatives such as Newcastle and Gateshead hosting annually the Great Exhibition of the North, in which culture, society, innovation, and business merges to create the critical mass to raise the visibility of the North and strengthen the local economy in the eyes of the remaining English regions: Since 2010, the North-South gap divide in the private sector job creation has almost disappeared (Northern Powerhouse Partnership, 2017), thanks to this initiative.

5.2 Case 2: The Midlands Engine

The Midlands Engine is a government initiative aimed to build a collective identity for local stakeholders in central England (aka the Midlands) while releasing untapped growth across the region and present the Midlands as a competitive and compelling place for investment, attractive to both home and overseas companies. This initiative involves a coalition of local authorities, combined authorities (i.e. association of council leaders across several localities), Local Enterprise Partnerships (LEP), universities, and businesses across the region and groups them into a voluntary regional partnership.

Such a partnership is designed as part of the government's industrial strategy that has emerged following a call for increased localism (Bryson, 2016).

Amongst major aims of this initiative in the Midlands is the need to tackle the significant transport challenges as the Midlands' population is considerably more spread out than most of the other regions of England, making it more expensive for goods, people, and ideas to move around, thus stifling innovation (Department for Communities and Local Government, 2017). Figure 2 summarises the Triple Helix model approach.

5.2.1 The Inception

In a similar fashion to the Northern Powerhouse, this partnership focuses on pooling collective excellence across cities and towns in the region to take advantage of their geographical location, in this case at the centre of the UK. This partnership is about the concept of additionality (i.e. building upon current strengths rather than coming out with new ideas or programmes, and focusing on complementarity to make current projects greater), and it complements the work done with current investments and activities by the government. This initiative enhances local KBD and the local economy by improving collaboration across different stakeholders to boost added value and scale up economic activity from within the Midlands (Murphy & Rossiter, 2016). This initiative includes 11 cities, several important market towns, and a range of economically important rural areas. Since the region's economy is fragmented into small, poorly connected areas, modernising digital infrastructure is paramount for the success of the local innovation and entrepreneurial ecosystems.

"I believe we are now ready to very clearly and very loudly speak with one united voice on the world's stage – The Midlands is the beating heart of UK manufacturing,

we are the beating heart of the country and the home to global iconic businesses, we are a magnet for investment and we can deliver results which can drive forward the UK economy". (Sir John Peace – Midlands Engine Chairman).

Universities play a crucial role in the success of the Midlands Engine initiative, with 20 universities in total that are active with research, and also closely engage with local communities. The delivery of the first Science and Innovation Audit for the region was initiated by the Midlands Innovation Group of universities – which include Aston, Birmingham, Leicester, Loughborough, Nottingham, and Warwick universities – and thus played a critical role in supporting the delivery of the government strategy through the development of a science and innovation assessment tool.

The Midlands Innovation Group focuses on world-class research and industry partnership, build on the historical strengths of the Midlands and act as a global beacon of excellence, such as the Energy Research Accelerator (ERA), which brings together Midlands Innovation and the British Geological Survey in a cross-disciplinary hub of technology research and talents.

Furthermore, there are further close collaborations among 7 other enterprising universities, i.e., De Montfort University Leicester (DMU), Birmingham City University, Coventry University, University of Derby, University of Lincoln, Nottingham Trent University, and the University of Wolverhampton. These Midlands Enterprise Universities work loosely together through shared resources to create a unique pool of skills, research, expertise, and facilities. They co-locate with local businesses and local authorities to share the resource in a sustainable way and help to reduce the skills gap in the workforce. They help to provide jobs to boost economic growth across the East and West Midlands. More importantly, they deliver focused

support to many local SMEs, particularly by identifying and integrating SMEs with other larger corporations and by embedding them in the universities' supply chains.

5.2.2 Areas of Collaborative Focus for Knowledge based Development

These universities work closely with the region's 10 other Local Enterprise Partnerships. Thus, Midlands Enterprise Universities also aim to attract inward investment and build a regional tourism offer. They manage to achieve that by focusing on five areas of collaboration to support KBD for the Midlands Engine. These areas of focus are:

Trade and Investment. The focus for trade and investment is to drive business retention and inward investment, together with safeguarding employment. Universities work closely with the government on trade missions for sectors that have a strong foundation in the Midlands, which is renowned for its manufacturing base. Trade missions geared towards attracting investments and opening up trading opportunities include the mission to New Delhi for the automotive sector in March 2017, and trade mission to Dubai and China for the building and construction sector in 2016.

Transport. Universities play an important role in supporting industry partners and civic leaders altogether, fostering better connectivity for the region in the future. This includes being part of the investors investing in critical local infrastructures such as local buses and trams connectivity network. Through partnerships with LEPs and local businesses, universities in the Midlands work towards better-integrated new facilities for students and businesses, including working closely with local government companies responsible for integrated transport systems across the Midlands. This provides some ground for cross-fertilisation in multi-stakeholders' collaborations that span across different industrial sectors.

Business Support. Midlands Enterprise Universities has key strengths, expertise, and resources to support and facilitate entrepreneurship and enterprise development. For instance, Midlands Enterprise Universities launched the MEU Enterprise Network, which addresses engagement challenges between universities and businesses, and which provides stakeholders with a platform to network, share their expertise and perspectives, and work collaboratively together to solve problems. Collectively, they incubated more than 500 businesses and helping many more to innovate. The £250million Midlands Engine Investment Fund announced in the March (2016 Budget) run by the British Business Bank and ten Midlands' Local Enterprise Partnerships (LEPs) aimed to support the growth ambitions of its 780,000 smaller businesses (Midlands Connect, 2017), particularly about new product development, process innovation, and new market identification.

Research and Innovation. Midlands universities join their interdisciplinary research together with the unique strengths of the industry to drive innovation and skills development for economic growth. Midlands Innovation Universities not only create a stronger network of science parks and innovation centres, such as Midlands Innovation-led Energy Research Accelerator and regional science parks but also ensure that the research irradiates from these centres to the rest of the region, to encourage stakeholders to work more closely together to innovate in Midlands priority sectors, such as the automotive and mechanical engineering.

Skills Development. Midlands Enterprise aims to develop a comprehensive, demand-led approach for job skills development, particularly focusing on Midlands priority sectors, i.e., manufacturing and engineering. Both university networks undertake a review of best practices relating to employment and job skills and develop programmes to encourage multi-stakeholders' connectivity. For example, the Student Placements for

Entrepreneurs in Education (SPEED programme) aims at upskilling students and make them more entrepreneurial. This is achieved by involving them in a series of connected challenges to build self-awareness and grow entrepreneurial skills. Another example of concrete policy implementation is the Knowledge Exchange Network Programme (KEEN): a West Midlands university-industry collaboration scheme that involves academics and SMEs. In this scheme academics and SMEs jointly recruit and supervise an associate (i.e., a recent graduate) and s/he is tasked with working within a business and must deliver some projects achievable that bear strategic value for the involved enterprise (Rosli & Rossi, 2016).

Figure 2 shows a representation of the two case analyses based on the conceptual model proposed.

===== INSERT FIGURE 2 ABOUT HERE =====

===== INSERT TABLE 3 ABOUT HERE =====

6.0 Discussion and Conclusions

Echoing the regional innovation system (RIS) literature, which pays attention to the local knowledge base (O'Shea et al., 2007; Etzkowitz & Leydesdorff, 2000), this study sets out to explore the role that universities play in supporting the development of the local knowledge base to build resilient and sustainable innovation systems. Our findings enabled us to build a Knowledge Base Development (KBD) model for regional competitiveness based on the collaborative coordination offered by some centres of

knowledge and based on the principles of the Triple and Quadruple Helix models. Contrary to the optimism towards the importance of private initiative in the industry-driven model of Silicon Valley (Audretsch, 2019).), our findings also showed two important insights that can help explain the role of the centres of knowledge in the coordination of regional efforts towards KBD solutions for innovation and entrepreneurial ecosystems: (i) a more inclusive, socialist partnering role is more appropriate to initiatives based on a Quadruple Helix approach and (ii) stronger leadership as *primus inter pares* may be more suited for initiatives based on a Triple Helix approach democratic regions.

Our model illustrated with two case studies (Northern Power House and Midlands Engine) how universities support innovation ecosystems through skills development and entrepreneurship, taking into account the different mechanisms that can benefit the inclusion of society and citizens as important stakeholders in the innovation co-creation process. Our study key differentiation of focus: to support the boosting of the local economy vs expanding capacity-based activities on core competencies. These two developmental tactics can lead to different outcomes in supporting regional competitiveness.

Moreover, mirroring studies focusing on the development of job skills in the future workforce (Cacciolatti, Lee & Molinero 2017), our model sheds light on how universities (both through leading and partnering role) can act as ‘net importers’ in contributing to the growth of the local economy and to the enhancement of the capabilities in the innovation ecosystem. Our study raises an important implication on the effectiveness of innovation ecosystems, and the importance of policymakers to rely on the inter-linkages amongst the Triple/Quadruple Helix (Etzkowitz & Leydesdorff,

2000). Universities play an important pivotal role by contributing to the coordination of these collaboration initiatives and contribute to the definition of a broad innovation search trajectory, by providing coordination in the 'recombinations of existing knowledge, technologies, and other resources' (Davis & Eisenhardt, 2011:162). Changing institutional forces shape universities and the entrepreneurial ecosystem they operate with, yet there is scope for universities' involvement in RIS through their engagement with the local business community, by playing the role of the gravitational centre for innovation networks coordination and skills development.

By understanding how universities as hubs of knowledge engage with local communities and the RIS, policymakers can rely on the university to play an important role in the coordination of collaborative projects, in fostering collaboration capabilities amongst multiple stakeholders, as well as their contribution to the upgrade of the knowledge base of an ecosystem given their educational role. Indeed, our findings support Heaton et al.'s (2019) call for more embeddedness of government policies with the rest of the KBD ecosystem.

Learning from the two case studies, the Northern Powerhouse and the Midlands Engines; can help policymakers to take into consideration the knowledge-based development and how it could be shaped into the coordination of regional efforts to apply KBD solutions to the development of RIS: a partnering role might be most appropriate to initiatives based on a Quadruple Helix model whereas stronger leadership as *primus inter pares* may be more suited for initiatives based on a Triple Helix model.

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Table 1: Northern Powerhouse and Midlands Engine Models Comparison based on the Cacciolatti-Rosli KBD Model: Underpinning Rationale.

Models Characteristics	Northern Powerhouse	Midlands Engine
<i>Underpinning Rationale</i>		
<i>Strategic Focus</i>	To boost the local economy by ensuring investment decision are made by the locals. The focus is (i)	To build a regional brand based on (i) grassroots support and associated with (ii) the idea of excellence in

	devolution and (ii) local growth.	automotive and engineering manufacturing. The focus is industry specific.
<i>Inception</i>	Government initiated. Based on the importance for the government to work with local stakeholders to remove key barriers to productivity in the region.	Local government initiated. Based on a rationale of additionality.
<i>Regional Competitiveness</i>	Investment opportunities recognised across the world as a great place to invest and attract investments. Focus on attracting talented entrepreneurs and businesses.	Vision of becoming international through trade agreements with major Countries such as India, China and the Emirates. Complementary branding and promotional activity focused on knowledge-based industries.
<i>Innovation Ecosystem Collaborative Approach</i>	Open Innovation Type – Open invitation amongst local businesses; external (non-local) partners as supporters.	Triple Helix Type

Source: Authors' own.

Table 2: Northern Powerhouse and Midlands Engine Models Comparison based on the Cacciolatti-Rosli KBD Model; Resources and Coordination

Models Characteristics	Northern Powerhouse	Midlands Engine
<i>Resources</i>		
<i>Infrastructures and Assets</i>	Agglomeration-as-connectivity.	Shaping great places by promoting the Midlands as a great place to live, visit, learn and work.

<i>Investment</i>	Major investment in key city-regions, and for other cities and regions to share best practice.	Generate added value and scale up.
<i>Transport Logistics</i>	“It is the geographic closeness of four of the core cities (Leeds, Liverpool, Manchester and Sheffield) that creates the key ‘powerhouse’ potential in the North” (NPP, 2017).	Midlands connect: Take Advantage of the location at the heart of the UK. Significant transport challenges as the Midlands’ population are considerably more spread out than most of other regions of England.
Coordination		
<i>Auditing</i>	Drawing heavily on an OECD study of ‘lagging regions’ across the developed world (OECD, 2012).	The delivery of the first Science and Innovation Audit for the region was initiated by the Midlands Innovation Group of universities.
<i>Role of citizens</i>	People’s Powerhouse and Youth Council of the North has uncovered a deeper desire by the side of northern citizens to debate and to share their own vision of a good life in the North.	Council Combined Authority model: Joint consultation involving Midlands metropolitan district councils, local businesses and a Citizens’ Panel.
<i>Collective Focus</i>	North’s ‘collective intelligence’ based on system of learning. Formation of a Northern Innovation Council, bringing together leading universities, employers and local authorities.	Increasing multi-stakeholders’ collaboration and identifying specific and unique strengths capitalising on the activities developed by firms in towns, cities and rural communities in the Midlands.

Source: Authors’ own.

Table 3: Northern Powerhouse and Midlands Engine Models Comparison based on the Cacciolatti-Rosli KBD Model: Activities.

Models Characteristics	Northern Powerhouse	Midlands Engine
Activities		
<i>Education and Skills</i>	Universities act as ‘net importers’ of science and technology graduates that contribute to the growth of the local economy and	Comprehensive, demand-led approach for skills development: Initially

	to the enhancement of the capabilities in the innovation ecosystem.	focused on manufacturing and engineering. Employer-led skills pathways.
<i>Research and Innovation</i>	The N8 Research Partnership.	The Midlands Innovation Group focuses on world-class research and industry partnership.
<i>Business Support</i>	17 enterprise zone supporting businesses across the North; The North as an entrepreneurial region/place.	Midlands Enterprise Universities supporting small businesses by encouraging them to be part of their supply and service chains. Support of larger businesses by providing opportunities for new business development.

Source: Authors' own.

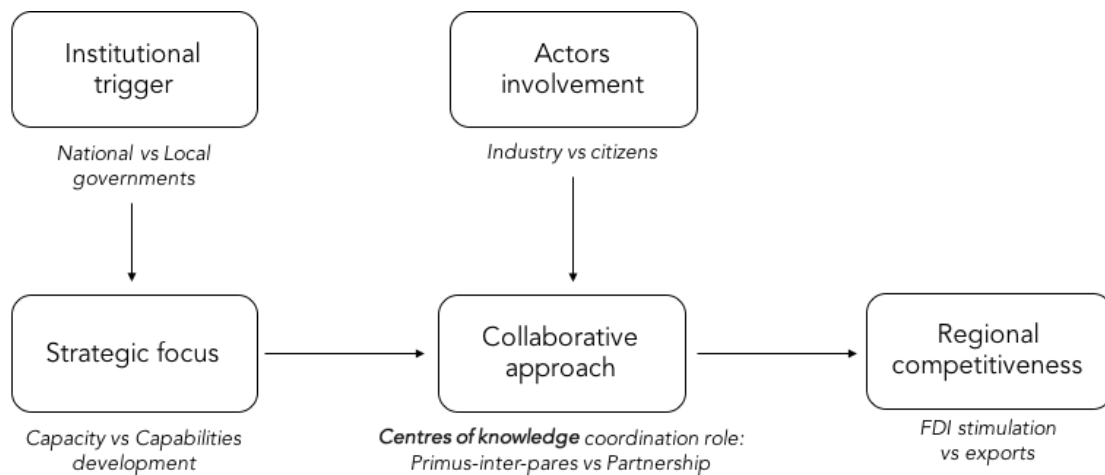


Figure 1: Cacciolatti-Rosli KBD model for regional competitiveness based on knowledge centres' collaborative coordination.

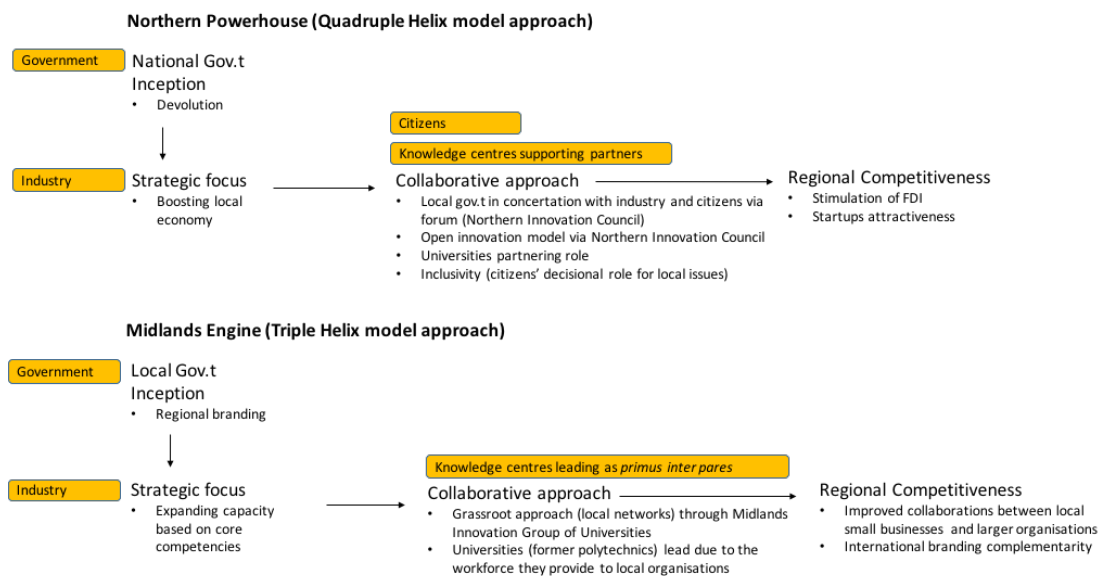


Figure 2: Case studies analysis based on the Cacciolatti-Rosli KBD model for regional competitiveness based on knowledge centres collaborative coordination.