Regional Studies, Regional Science

ISSN: (Print) (Online) Journal homepage: https://www.tandfonline.com/loi/rsrs20

Enablers of successful innovation precincts

Christopher Bajada, Renu Agarwal, Katrina Skellern, Samantha Luff, Stephen Soco & Roy Green

To cite this article: Christopher Bajada, Renu Agarwal, Katrina Skellern, Samantha Luff, Stephen Soco & Roy Green (2022) Enablers of successful innovation precincts, Regional Studies, Regional Science, 9:1, 732-756, DOI: 10.1080/21681376.2022.2144427

To link to this article: https://doi.org/10.1080/21681376.2022.2144427

REGIONAL STUDIES, REGIONAL SCIENCE
2022, VOL. 9, NO. 1, 732–756
https://doi.org/10.1080/21681376.2022.2144427

Enablers of successful innovation precincts

Christopher Bajada [a], Renu Agarwal [b], Katrina Skellern [c], Samantha Luff[b], Stephen Soco[b] and Roy Green [d]

ABSTRACT

Governments worldwide are increasingly focused on promoting innovation activity to generate much needed economic growth. Innovation precincts are seen as providing the strategic opportunity to leapfrog economies and deliver a future competitive advantage. However, there are limited insights into how innovation activity in precincts takes place. In particular, the factors that enable successful innovation precincts, how they are measured and how their locations influence improved economic outcomes. This paper presents an analysis of the important enablers of innovation precincts, with a focus on measuring the relative importance of these enablers and their contribution to innovation and economic outcomes. A novel mixed-methods approach involving the use of a 'double-blind doubled-scoring' methodology and analytical hierarchy process (AHP) are applied to score and determine the relative importance of enablers of innovation precincts.

ARTICLE HISTORY

Received 7 April 2022; Accepted 18 October 2022

KEYWORDS

innovation precincts; innovation policy; innovation drivers; innovation cultivators; innovation infrastructure; innovation networking

1. INTRODUCTION

There is an emerging trend where firms from new and old industrial sectors are coming together to form clusters and districts with the intent of sharing knowledge, capabilities, technologies, networks, infrastructure and other elements to improve their individual and collective productivity and economic performance (Baptista & Swann, 1998; Sleuwaegen & Boiardi, 2014). Moonen and Clark (2017) argue that these physical locations (referred to here as innovation precincts[1]) have become the source of strategic economic planning for many advanced economies and at times also underpin governments' innovation policies. This paper uses an Australian context to identify and measure various enablers of innovation precincts across different geographical areas and levels of maturity. Consistent with the Australia government, this paper defines an innovation precinct as a hot spot of activity where innovation is cultivated through the interactions of research and commercial enterprise with the shared objective of producing innovative goods and services that ultimately increase economic growth and social well-

CONTACT Christopher Bajada chris.bajada@uts.edu.au
[a] Economics Discipline Group, UTS Business School, University of Technology Sydney, Sydney, NSW, Australia
[b] Management Discipline Group, UTS Business School, University of Technology Sydney, Sydney, NSW, Australia
[c] CBSI, UTS Business School, University of Technology Sydney, Sydney, NSW, Australia
[d] Special Advisor and Chair for UTS Innovation Council, University of Technology Sydney, Sydney, NSW, Australia
[e] Present affiliation: Customer and Community Services, City of Ryde, Sydney, NSW, Australia
Supplemental data for this article can be accessed here https://doi.org/10.1080/21681376.2022.2144427.

being (Cutler, 2009).[2] Each innovation precinct has its own unique strengths and characteristics attracting firms to collaborate for economic benefit. Such behaviour raises the need for establishing a coherent and structured approach to identifying and measuring enablers of innovation occurring at each precinct and how these generate economic benefits.

The literature suggests that innovation locations are influenced by a range of factors including the local conditions where the precinct is positioned (Isaksen, 2016), relevant policy stimuli (Roper et al., 2017) and infrastructure and demographical characteristics (Sleuwaegen & Boiardi, 2014). There is also a shortfall in research examining whether the association of innovation locations with these range of factors is capable of boosting innovation and economic growth (Fernandes et al., 2020). Research does point to the benefits of firms working together to produce innovative goods and services that contribute to technology and knowledge spillovers (Scherer, 1982), research and development (R&D) expenditure (Khanna & Yafeh, 2007) and scale up of operations (Cohen & Klepper, 1996). More recently Belenzon and Berkovitz (2010), using a novel dataset on ownership and patents, found a significant positive relationship between firms working together and corporate innovation (Innocenti et al., 2020). This effect is potentially amplified when chief executive officers (CEOs) are overconfident in their pursuit of innovation and, in doing so, are more likely to take the firm into a new technological direction (Galasso & Simcoe, 2011). This literature helps us understand the 'individual and silo level' enabling characteristics of innovation precincts and as such, many contributions to innovation research have focused on understanding these narrowly defined and individual groupings of success factors (Wagner & Storring, 2016).

This paper builds on these earlier studies of innovation enablers, specifically Katz and Wagner (2014), the European Commission (2019) and Moonen and Clark (2017), by identifying the various enablers within a precinct. What remains unknown is the relative importance of the various enablers that ultimately influence the success of innovation locations in the broader context of the innovation ecosystem. Moonen and Clark (2017) have emphasized that physical locations have become the source of strategic economic planning for advanced economies and at times also underpin governments' innovation policies. Overtime, various research has identified the need to better understand these enablers of innovation ecosystems. Breschi and Malerba (2001) suggested the need for additional research on the conditions and processes that foster the emergence of innovation locations. Tödtling and Trippl (2005) followed by arguing that a 'one size fits all' approach of identifying enablers of innovation locations is deficient and the strengths and weaknesses of locations need to be considered. Isaksen (2016) extended on this call by suggesting that a greater focus is needed on expanding the current knowledge of the enablers of innovation precincts as well as a better understanding of the role that decision-makers have in developing targeted policies that carefully address the gaps in local conditions within an innovation precinct, whether it be metropolitan or regional. More recently, Breznits (2021) argues that economic growth does not lie specifically with high-tech or high-end manufacturing as the modus operandi for innovation strategy, but instead requires localized communities to focus on their niche capabilities to contribute to the global production system, in a way that allows them to specialize their innovation efforts. By considering the gaps identified from extant literature, this paper addresses these issues through an analysis of the important enablers of innovation precincts in the context of location and specialization but with a focus on measuring the relative importance of these enablers and their contribution to innovation and economic outcomes. Attention is given to the level of precinct maturity to identify and measure enablers that contribute to their growth and better understand the opportunities, challenges, and conditions necessary to foster growth and longevity of these innovation precincts. Specifically, this paper introduces four broad innovation enablers – innovation drivers, innovation cultivators, innovation infrastructure and innovation networking – each with their own subcategory of enablers. Henceforth, this research study is underpinned by an empirical methodology using a

novel mixed-methods approach designed specifically for this purpose. It is developed by drawing on the various literary experiences of innovation precincts around the world combined with case study examples and data from Australian innovation precincts to undertake the empirical methodology.

The remainder of this paper is structured as follows. Section 2 presents an overview of innovation precincts and outlines the important enablers underpinning successful innovation precincts and their associated gaps. Section 3 describes a unique and novel empirical methodology used to calibrate the relative importance of enablers, while section 4 presents the results of this analysis. Section 5 discusses the implications and conclusions from these results.

2. INNOVATION PRECINCTS – A LITERATURE REVIEW

A significant part of the innovation literature addresses the role of innovation as a key indicator of economic development (Schumpeter, 1934). More recent empirical studies on innovation find that innovation as a result of R&D is the main engine of economic growth (Anselin et al., 2000; Teixeira & Fortuna, 2004; Canton et al., 2005; Batabyal & Nijkamp, 2013; Akinwale et al., 2012; Cinnirella & Streb, 2013, OECD, 2013; Howard et al., 2016). This builds on the earlier work of Nelson and Winter (1982) that examined innovation as a public good, and Romer's (1986) and Lucas's (1988) work on endogenous growth models that analyse productivity through the formation of human capital and innovation supported by R&D. In addition, considerable literature exists on innovation at the firm level. For example, working with consumers to improve product design as a means of increasing innovation outcomes (von Hippel, 2017; Gambardella et al., 2017; Kveton et al., 2018), increased level of education of workers (e.g., blue collar workers in manufacturing; D'Acunto, 2014), increased human capital by CEOs which promotes increased levels of innovation (Custodio et al., 2019), firm ownership structure (Ferreira et al., 2014) and supplier–customer geographical proximity on supplier innovation Chu et al., (2019) and social trust (Xie et al., 2021).

2.1. What we know about innovation precincts

To extend beyond the narrow firm-specific contributions to innovation requires a more focused analysis on clusters of innovative firms or innovation precincts. Appropriately defining an innovation precinct requires a detailed look at the participants, activities, economic and technological factors and the interrelationships within a particular location. These clustered locations of innovation activity take on various forms (OECD, 2009). Putnam et al. (1994) describe one such form as interrelated through alliances and other activities (buyer–seller or customer–seller transactions) that draw upon a common talent pool and technology. In the Australian context, Cutler (2009, p. 12) describes an innovation precinct 'as a hot spot of activity where innovation is cultivated through the interactions of research and commercial enterprise with the shared objective of producing innovative goods and services that ultimately increase economic growth and social well-being'. This definition has been adopted by the Australian government and adopted in this paper.

An innovation location typically works in proximity with the wider ecosystem, that is, the physical place, human actors and presence of people, and so an ecosystem cannot grow in isolation from the city's wider socio-technical conditions and systems (Hanna, 2016). In addition, Hanna (2016) describes innovative locations as being rooted within existing neighbourhoods or developed from industrial locations where firms and institutions share infrastructure and spaces. This contribution suggests that locations display the importance of connection and agglomeration benefits where proximity of people, knowledge, capability, technology and firms stimulate

productive dialogue and ideas-sharing. These slightly varied definitions are relevant only in as much as in the contexts from which they are drawn.

Whilst innovation studies provide frameworks for analysing key attributes for innovation precinct development, a major critique of these approaches has been that they are less effective in identifying which systematic attributes of a place are more responsive to stimulating innovation creation (Boschma et al., 2017) Critics argue that this perspective has failed to adequately account for the influence of space in reshaping traditional industries towards a more innovative trajectory (McCauley & Stephens, 2012; Bos et al., 2014). By engaging with economic geography and regional studies, innovation scholars have begun to address these spatial limitations and examine how and why innovation takes place in different geographical settings. This multidisciplinary approach illustrates the governance and policy challenges for translating locality specifics, particularly for emerging technologies and niche formations that are contingent on place specific factors (Hansen & Coenen, 2015; Ponds et al., 2007). Whilst these are important perspectives, focusing on the resource-based approach (Fernandes et al., 2020) through a systematic literature review, has identified four clusters within a regional innovation system, namely regional knowledge systems, regional institutional systems, regional R&D systems and regional network systems.

2.2. Identifying important enablers of innovation precincts

The European Innovation Scoreboard (EIS) and the Regional Innovation Scoreboard (RIS) (European Commission, 2019) both provide a performance assessment of innovation systems at a macro-level across 23 European Union (EU) member states (or the national/country level) and the regional identification gap by providing statistical facts across 238 regions (or the city level) of the 23 EU member states to measure a region's innovation performance.

On the other hand, Brookings Institute frameworks by Katz and Wagner (2014) and Wagner and Storring (2016) highlight five key characteristics that contribute to a successful innovation precinct, namely the presence of critical mass, competitive advantage, quality of place, diversity, inclusion, culture and collaboration. These characteristics can be described as the micro-environment forces that help define a locally specific innovation precinct.

Both micro- and macro-environment forces are relevant contextual factors for enabling innovation locations. However, micro-environment forces positioned in the context of 'place-making' are important considerations applicable to smaller scale and local innovation locations, such as precincts. In an Australian context, for example, the Australian Business Foundation (2011) found that the agglomeration of organizations resulted in better collaboration leading to a more prosperous location. The Australian Innovation System Report (Office of the Chief Economist, 2016; Department of Industry, 2017) introduced the National Innovation Map to identify the geographical spread of innovation to develop an improved understanding of the Australian innovation ecosystem. The National Innovation Map indicates that proximity to areas of dense economic activity can induce stronger competition between businesses, which in turn encourages innovation and resource efficiency. Proximity reduces transport and communication costs and increases the scope for differentiation and market experimentation in the pursuit of innovation-driven comparative advantage (Office of the Chief Economist, 2016). Such findings demonstrate the importance of networked and relational innovation to the Australian economy. It incorporates three fundamental elements as key: (1) networks of people and organizations; (2) innovation-related activities; and (3) an institutional and cultural environment conducive to collaboration (Coenen et al., 2015). This has, in turn, motivated researchers to investigate the conditions necessary to stimulate innovation activities in these innovation locations (Katz & Wagner, 2014) and consider a more nuanced set of indicators for understanding innovation performance.

However, what this literature does not compare is the level of innovation precinct success enabled by its proximity to either a metropolitan or regional (non-metropolitan) location

(i.e., remoteness). Distinguishing between differing geographical opportunities and challenges associated between metropolitan and regional locations is critical for the success of an innovation precinct due to its location to professional and community networks, events close to city locations and tacit knowledge in more remote and intimate locations, such that appropriate policies for developing different geographical regions can be uniquely identified and appropriately crafted. In addition, the literature does not indicate how differing levels of precinct maturity influence the enablers of innovation success and how these levels impact change over time. It will be important to distinguish between the maturity classifications of a precinct to enable policy support and programme delivery to be tailored to suit.

These various approaches highlight a gap in the literature, specifically the limited examples of measurable indicators and metrics to analyse innovation location activity and growth of the innovation precinct, and the absence of a coherent approach for classifying the enablers and characteristics of innovation precincts. For example, whilst larger scale studies such as the EIS take a national perspective on innovation activities and the RIS focuses on the regional level, both approaches are limited in their assessment of smaller place-based innovation activities occurring at a local precinct to enable these gaps in the literature to be addressed. On the other hand, the more focused studies such as that by Katz and Wagner (2014), which define the key characteristics within a smaller spatial scale, do not provide analysis on the relevant indicators that measure growth of innovation precincts. In the remainder of this section we address these gaps by drawing upon the innovation precinct literature and experiences from Australian innovation precincts to identify important enablers. As a first step, we group the literary attributes and cultural characteristics of successful precincts described in the literature into four building blocks that encapsulate these enablers. These groupings are presented as the building blocks for innovation precincts in Figure 1.

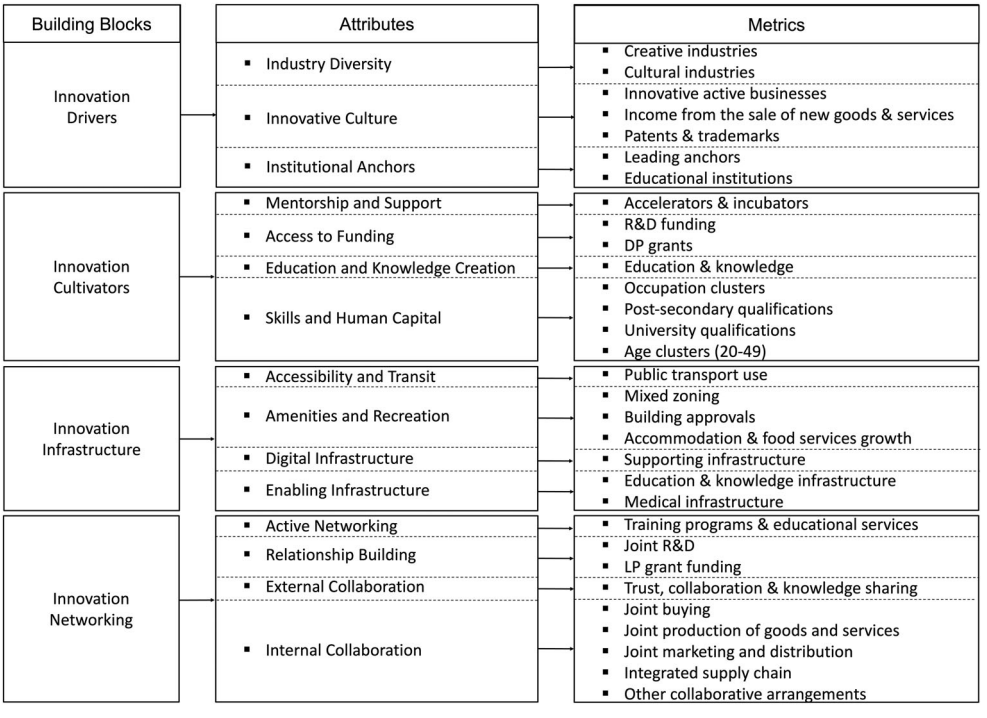

Figure 1. Building blocks of innovation precincts conceptual framework: building blocks, attributes and metrics.

The four building blocks consist of innovation drivers, innovation cultivators, innovation infrastructure and innovation networking. Each building block comprises several attributes, each of which in turn can be measured by available metrics also shown in Figure 1. The construction of these metrics will be discussed in more detail in section 3.

Innovation drivers motivate and develop innovation activity and incorporate a diversity of industry, innovative culture and institutional anchors (Moonen & Clark, 2017; Read, 2016; Hanna, 2016; Roig-Tierno et al., 2015; Engel, 2015; Sleuwaegen & Boiardi, 2014; Katz & Wagner, 2014; Florida et al., 2010; Buesa et al., 2010; Agrawal & Cockburn, 2003). Innovation cultivators support innovation through mentorship activity, access to funding programmes, education and knowledge creation, and the development of skills and human capital (Moonen & Clark, 2017; Read, 2016; Hanna, 2016; Sleuwaegen & Boiardi, 2014; Ghani et al., 2014; Chatterji et al., 2014; Agrawal et al., 2014). Innovation infrastructure facilitates innovation through accessibility and transit, amenities, and recreation, digital and enabling infrastructure (Moonen & Clark, 2017; Read, 2016; Hanna, 2016; Roig-Tierno et al., 2015; Katz & Wagner, 2014; Greater Sydney Commission, 2016; European Union, 2011). Innovation networking strengthens and advances innovation through active networking, relationship-building, external and internal collaboration (Read, 2016; Katz & Wagner, 2014; Connell & Probert, 2010; Wagner et al., 2017; Hassan et al., 2015).

The innovation drivers building block includes innovative organizations and capabilities that initiate innovative efforts and develop innovative products, services and opportunities within the precinct (Katz & Wagner, 2014; Microsoft Australia, 2015). This building block comprise three specific attributes: institutional anchors, industry diversity and innovative culture. The presence of innovative organizations and creative industries, including the support of anchor institutions, provides significant impetus for stimulating an innovative culture and leveraging funding opportunities (Schildt and Rubin, 2015; FNSGLC, 2017). The presence of firms from various industries can also build capacity to produce innovative outcomes that otherwise might not be possible from a single industry perspective (Moonen & Clark, 2017; Hanna, 2016). In addition, having an innovative culture within the precinct helps cultivate ideas involving firms from a diverse range of expertise that will lead to innovations that competitively positions the precinct in the market (Hewlett et al., 2013).

The innovation cultivators building block comprises the structures and activities that support innovative growth and ideas by accelerating innovation and building capability of individuals and firms within the precinct (Katz & Wagner, 2014; Hanna, 2016). The building block comprises four specific attributes: education and knowledge; mentorship and support, access to funding and skills; and human capital. This building block is characterized by the existing depth of knowledge and education that is essential in stimulating ideas to develop innovative products and services (OECD, 2016). Mentorship and support include incubators, accelerators, shared working spaces, high schools and community colleges that aim to enable skills to be developed (Moonen & Clark, 2017; Read, 2016). Access to funding ensures that financial resources are available to support the necessary investment in infrastructure and other capability-building requirements to achieve the objectives of the precinct (Schildt and Rubin, 2015; FNSGLC, 2017).

The innovation infrastructure building block includes the physical and institutional environment that enables innovation to take place (Howard Partners, 2016). The innovation infrastructure building block comprises three attributes: enabling infrastructure; accessibility and transit; and amenities and recreation and digital infrastructure. This building block identifies how the design of spaces, accessibility across spaces and amenities including support facilities, contributes to building innovation capability. This building block describes the infrastructure required to facilitate connectivity, collaboration and encourage an innovative culture. It comprises the important support services for residents and workers that unite the innovation community

with the wider economy, including assets across both public and private dimensions (Katz & Wagner, 2014). Research has suggested that the physical environment needs to be engineered to stimulate innovation, where the 'style' of an innovative environment – including buildings and their layout – can inspire innovation (Haner & Bakke, 2004). In addition, the supporting digital infrastructure including information technology (IT) ensures the connectivity of skills, capability and organizations to facilitate other drivers such as innovative culture, collaborative activities and mentorship including other support that helps grow the precinct (OECD, 2016).

The innovation networking building block defines the relationships and social ties across actors within and outside the precinct, as well as the activities that help create and strengthen connections, networks, and an open innovation culture throughout the precinct. As such, the innovation networking building block comprises four attributes: internal collaboration; external collaboration; active networking; and relationship building. This building block personifies the presence of strong networks facilitating trust between people or firms who are in close physical proximity and have a history of working professionally together (Yigitcanlar et al., 2008). Such relations can be formed during networking events in open spaces between buildings, learning institutions and open innovation centres (Katz & Wagner, 2014; Connell & Probert, 2010). These activities can generate an open innovation culture throughout the precinct, and in the process, sharpen and accelerate the advancement of ideas (Katz & Wagner, 2014; Hassan et al., 2015). These types of ties can be beneficial for innovation as they deter ideas from becoming locked-into different networks and extend knowledge, partnerships and links with new contacts (Hansen & Coenen, 2015).

2.2.1. *Context-specific factors: remoteness and maturity*

Context-specific factors could also have a bearing on the relative importance between the broad enablers of innovation precincts. These context specific factors include remoteness (defined as the geographical location of the precinct) and maturity (defined as the stage of development in the precinct life cycle).

2.2.2. *Remoteness: geographical location of the innovation precinct*

Wagner et al. (2017) argue that an innovation ecosystem cannot grow in isolation from the city's wider socio-technical conditions and systems. Therefore, it is important to examine the different spatial formats of innovation locations as important criteria for understanding the conditions necessary for enabling successful innovation precincts, for example, geographical location of a precinct. Distinguishing between differing geographical opportunities and challenges associated between metropolitan and regional locations is critical for the success of an innovation precinct. For example, according to the Australian Standard Geographical Classification System, there is a hierarchy of statistical areas, for example, 'metropolitan and regional', with the latter encompassing all areas outside Australia's major cities. Additionally, the general Statistical Spatial Framework, developed by the Australian Bureau of Statistics (ABS), provides Australia with a common approach to connecting people-centric (socio-economic) information to a location, and improves the accessibility and usability of this location-enabled information. Given this, precincts located further from metropolitan centres may not have the same network and event-attending advantages as compared with proximity with city-based locations. On the other hand, regional locations may benefit from relational and tacit proximity (ABS, 2016), henceforth we classify two categories of precincts namely, 'metropolitan' and 'regional'. In addition, having the right mix of amenities such as shared spaces and public infrastructure combined with a culture of taking risks and experimentation, are also regarded as essential conditions and enablers for innovation ecosystems (Microsoft Australia, 2015). These characteristics can significantly vary in quality and intensity in the context of the remoteness classification. In this study, each precinct is classified as either metropolitan or regional

(as defined by the Australian Standard Geographical Classification (ASGC) and as outlined in section 3).

2.2.3. *Maturity: development stage of the innovation precinct*

As highlighted by the innovation literature (Breschi & Malerba, 2001; Isaksen, 2016; Putnam et al., 1994), precincts develop and perform to different extents. Insights into the development level of a precinct can assist policymakers to categorize and adequately determine the needs and mechanisms required to further strengthen innovation precincts. The classification of precincts using a maturity scale also helps us to understand the relationship between attribute development and maturity status of precincts. We illustrate the effects of this maturity classification on the building blocks of innovation precincts in section 4. This maturity classification is important to ensure that policy design that supports innovation precinct development targets those attributes most important for emerging precincts to ensure that they mature to become thriving precincts. The maturity classifications in this study are grouped into three categories: planned, emerging and active precincts:

- Planned precincts are defined as precincts at their conceptual stages, typically limited or no data available, and for this reason not included into the analysis. Yet, we have retained the reference to planned precincts here because they remain part of the maturity scale and government policy can still contribute at this conceptual stage.
- An emerging precinct is defined as a working innovation location that is starting to scale up in its innovation activities. It has made progress in building local networks and collaborative ventures and has support and commitment from key stakeholders for expansion. A focus for emerging precincts is establishing appropriate governance to bring together key stakeholders to support the precinct's development. Precinct stakeholders can work together to increase the diversity of its participants to make the precinct more liveable, attract investment to boost its market advantage and to establish a recognizable brand and market identity to promote the growth of innovation precincts (NSW Innovation and Productivity Council, 2018).
- An active precinct is defined as having a recognized identity, a strong culture of collaboration and entrepreneurialism, access to venture capital investment and actively undertakes R&D to commercialize new products and services. It has good enabling infrastructure and a vibrant, mixed-use environment that attracts skilled workers and visitors. A focus for active precincts is to build on the existing brand and identity of the precinct to increase its scale and tap into global markets. The precinct is likely to have a formalized governance structure that coordinates efforts to attract new investment and partnerships, take advantage of opportunities as they arise and address any emerging challenges (NSW Innovation and Productivity Council, 2018).

3. METHODOLOGICAL APPROACH

A number of approaches for measuring innovation precinct success have been presented in the academic literature (see section 2). Metrics such as the number of patents, the value of R&D expenditure and the number of cultural industries as well as educational and research institutions in close proximity, are common ways used for gauging the success of an innovation precinct. These 'common ways' are more easily extractable from a set of publicly available national or metropolitan data sets such as those from the EIS or RIS analyses. However, these metrics are disparate, and their relative importance is not captured in this literature. To enable a more nuanced and micro level analysis of innovation precinct enablers, a richer methodological

approach is required that captures the 'ways of working' at a smaller precinct scale. This paper builds upon these ideas and metrics but presents a novel and a more comprehensive approach for evaluating the important enablers of an innovation precinct. In an Australian context, It does so by calibrating an overall precinct score based on the measurement of the attributes comprising each of the building blocks. These scores allow an evaluation of the relative importance of both the building blocks and the attributes within a precinct and to identify weaknesses within blocks that may not only improve the successful outcomes of a precinct but potentially their longevity. For example, a precinct strong in two attributes (institutional anchors and industry diversity) in the innovation drivers building block, may underperform as a precinct if it is weak in the attribute of innovation culture. By having metrics on each attribute and building block, each precinct can self-identify areas for improvement.[3]

To gauge which of the building blocks and attributes are the most important enablers for the growth of an innovation precinct, several metrics were used in the calculation. Each of the four building blocks were scored using individual measurement scores of the various attributes. In turn, each of these attributes were scored using the appropriate metrics. Therefore, it is possible not only to calibrate the relative importance of each attribute within each building block, but to also calibrate the relative importance of each of the four building blocks across an innovation precinct. These metrics provide an indicator on each attribute, in particular their level of development, likelihood of contributing to the success of a precinct and opportunities/barriers for each of the precincts.

The choice of metrics was informed by extant literature and in consultation with innovation precinct participants for each of the attributes. Most of the metrics were constructed using publicly available data and when no publicly available data for a metric was available, survey data using a scoring technique of factual discussion with innovation precinct stakeholders (incubator participants, start-up firms, established firms engaged within innovation precincts, innovation experts, universities, and relevant public sector agency) in an Australian context was used to close the gap. Table B1 in Appendix B in the online supplemental data lists each of the metrics, description and data sources. This approach comprised four steps and is summarized in the research design illustrated in Figure 2.

3.1 . Research design

The first step in the research design was to establish a theoretical grounding via a literary review (step 1 in Figure 2) followed by data collection (step 2 in Figure 2). The data-collection process included the development of a questionnaire and a scoring grid to collect and calibrate responses from in-depth interviews. A second survey for use in an Analytical Hierarchy Process (AHP) was also developed to rank the relative importance of each attribute. The next step involved conducting several robustness measures to ensure sufficient reliability in the attributes and building blocks before scoring the individual precincts (step 3 in Figure 2). Step four involved the final scoring of the attributes and building blocks.

To identify and score the sample of Australian innovation precincts, suitable quantitative metrics from publicly available data were used. The data were measured at the Statistical Area (SA2) level as defined by the ABS (2011). These statistical areas generally have a population of approximately 10,000 people.[4] The purpose for applying SA2 is to provide as small a measure of a geographical area that best represents a community that interacts together socially and economically (ABS, 2016). A large proportion of the data metrics were sourced from the ABS, either at the SA2 level or were converted to the equivalent statistical area using appropriate ABS concordance tables. Examples of key ABS data sources included 2011 Census place of work, Counts of Australian Businesses (8165.0), Innovation in Australian Business (8158.0) and Selected Characteristics of Australian Business (8167.0).

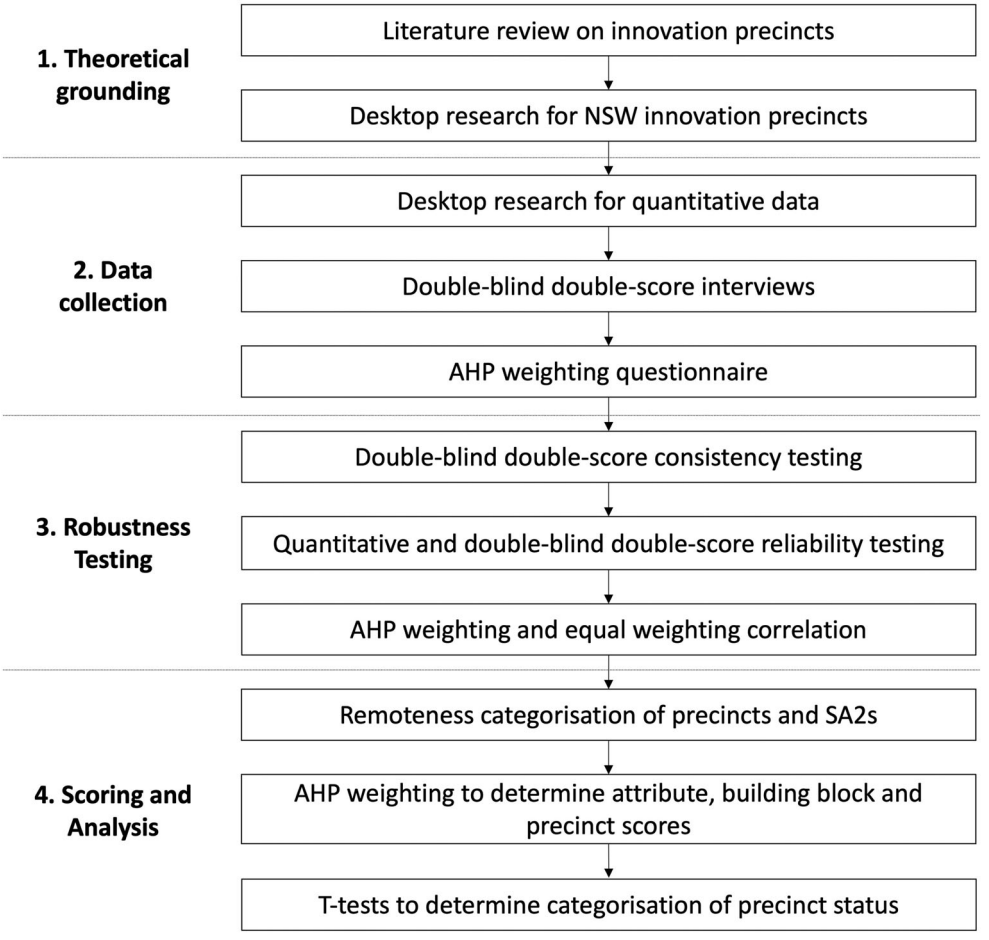

Figure 2. Research design.

While for several attributes the quantitative data at the regional level were available, they were not available for six attributes specifically, external collaboration, active networking, digital infrastructure, enabling infrastructure, mentorship and support, and education and knowledge creation. To address this gap, the study developed a scoring grid using a 'double-blind double-scoring' methodology (using 41 in-depth interviews) which was then used to construct quantitative estimates of these six attributes.[5] This approach, originally developed by McKinsey & Company, involves a conversation-style interview where responses to the questions are scored by the main interviewer followed by a second score given by an independent listener of the recording to ensure quality and for calibrating the results. At least 80% of the scoring grid was rescored by a second silent listener to assist in calibration and accuracy of the scoring (see Bloom & Van Reenen, 2007, for a detailed description of the approach). For the remaining attributes both quantitative metrics and scoring grid methods were used to provide some reliability to the use of public data.

The data were subsequently split by 'regional' or 'metropolitan' status using the ABS Remoteness category for areas. The metropolitan and regional classification is based on the ASGC and is a common method for defining spatial differentiation (ABS, 2011). The ABS (ASGC) remoteness areas was used to categorize innovation precincts as this allows for capital

Table 1. A 2 × 2 remoteness–maturity matrix by geographical location.

		Maturity		
		Active	**Emerging**	**Total**
Remoteness	Metropolitan	6	3	9
	Regional	2	3	5
	Total	8	6	

Table 2. Remoteness and maturity matrix by activity across industry sector.

		Maturity			Remoteness		
		Active	**Emerging**	**Total**	**Metropolitan**	**Regional**	**Total**
Industry sector	Innovation and Tech	1	5	6	2	4	6
	Education and Health	3		3	3		3
	Creative	1	1	2	2		2
	Manufacturing	2		2	1	1	2
	Finance	1		1	1		1
	Total	8	6		9	5	

city locations to be identified as either inner (more densely populated) or outer metropolitan (more sparsely populated) areas that are separated by a geographical boundary (often linked by distance from the capital city) where the population density changes, hence an important distinction for accommodating differences in population, labour force and infrastructure. More specifically metropolitan areas incorporated 'capital cities', while regional areas were further broken down into other metropolitan centres and inner regional. In total 21 precincts made up the full sample of precincts. A summary of the remoteness–maturity categorization and the focus of activity for the precincts used in this study is given in Tables 5 and 6. They illustrate that the representation of precincts in this study comprise both urban and regional areas as well as a cross-section of various industry sectors. Consequently, we propose a remoteness–maturity matrix comprising of remoteness and maturity characteristics for the active and emerging precincts which is given in Table 1. It illustrates that the sample of precincts under study is a relatively balanced mix between level of maturity and metropolitan/regional precincts.

In addition, as the emerging and active precincts included in the study are from various industry sectors, Table 2 presents the 2 × 2 remoteness–maturity matrix of remoteness and industry sector of the innovation precincts. The innovation and technology precincts make up a larger proportion of all precincts under study with a relatively similar mix of other industries namely, education and health, creative, manufacturing and finance.

Both the quantitative metrics and the scoring grid were normalized to produce a standardized score for all data types. To obtain a composite measure for each attribute, the normalized scoring grid metric and the quantitative metrics from publicly available data were each given 50% weighting, as detailed in Table 3. In some instances, an appropriate quantitative metric was not available to represent an attribute, hence the scoring grid metric contributed to 100% of the attribute's weighting, as also shown in Table 3.

3.2. Analytical hierarchy process (AHP)

To determine this relative importance, the AHP method was used (Saaty & Peniwati, 2013). It involves identifying the relative importance of multiple items (i.e., relative weights) through ordinal pairwise comparisons (Saaty, 2008). The AHP method has been widely used in

Table 3. Analytical hierarchy process (AHP) weighting.

AHP weighting applied to each building block (β)	Building blocks	AHP weighting applied to each attribute (α)	Attributes	% Split across the quantitative metrics and the scoring grid	Quantitative metrics
29.6%	Innovation drivers	45.6%	Industry diversity	50% 50%	2 quantitative metrics Scoring grid (double-blind double-scoring)
		30.7%	Innovative culture	50% 50%	3 quantitative metrics Scoring grid (double-blind double-scoring)
		23.7%	Institutional anchors	50% 50%	Quantitative metrics Scoring grid (double-blind double-scoring)
27.4%	Innovation networking	29.4%	Relationship building	50% 50%	2 quantitative metrics Scoring grid (double-blind double-scoring)
		26.6%	External collaboration	100%	Scoring grid (double-blind double-scoring) only
		25.7%	Active networking	100%	Scoring grid (double-blind double-scoring) only
		18.3%	Internal collaboration	50% 50%	5 quantitative metrics Scoring grid (double-blind double-scoring)
22.9%	Innovation infrastructure	28.8%	Accessibility and transit	50% 50%	Quantitative metric Scoring grid (double-blind double-scoring)
		25.7%	Amenities and recreation	50% 50%	3 quantitative metrics Scoring grid (double-blind double-scoring)
		23.3%	Digital infrastructure	100%	Scoring grid (double-blind double-scoring) only
		22.2%	Enabling infrastructure	100%	Scoring grid (double-blind double-scoring) only
20.1%	Innovation cultivators	31.2%	Access to funding	50% 50%	2 quantitative metrics Scoring grid (double-blind double-scoring)
		21.9%	Mentorship and support	100%	Scoring grid (double-blind double-scoring) only
		21.9%	Education and knowledge creation	100%	Scoring grid (double-blind double-scoring) only
		25.0%	Skills and human capital	50% 50%	4 quantitative metrics Scoring grid (double-blind double-scoring)

applications that relate to multicriteria decision-making, planning and resource allocation, and is a valuable analytical tool for the purposes of this study. It provides a non-linear framework for carrying out both deductive and inductive evaluation by taking numerous metrics into consideration. To determine the overall precinct performance, a structured questionnaire provided the data required for the construction of the weights used to provide a measure of the relative importance of the building blocks and the attributes. The AHP sample included 17 participants who ranged from senior corporate executives of anchor institutions, senior business developers managing the precincts or working for a precinct authority and senior executives of innovation development networks who are each highly knowledgeable about the innovation processes and the innovation activities taking place in their precincts. Respondents compared the importance score of the four building blocks and each of the attributes developed in a pairwise comparison matrix based on a 19-point scale developed by Saaty (1980).

To calculate the AHP weighting for each building block and attribute, the geometric mean (and inverse of the geometric mean) for each pairwise comparison was included in an AHP matrix, as shown in Tables A1–A5 in Appendix A in the online supplemental data. The AHP matrix was used to calculate a normalized score for each variable by taking the value of each cell and dividing it by the column sum of the AHP matrix. The row sum of the normalized score table provided the normalized score for each variable. As a proportion of the total value of the normalized scores, the weighting for each variable was then derived.

As illustrated in Figure 3, the innovation precinct score was calculated as follows:

$$\text{Precinct Score} = \beta_1 InnDrivers + \beta_2 InnNetworking + \beta_3 InnInfrastructure + \beta_4 InnCultivators \quad (1)$$

where each building block score is based on the corresponding weighting (β) derived from the AHP approach, as shown in Table A1 Appendix A. Each building block score is in turn based on the corresponding attributes and the relative weightings (α), once again based on the AHP process as calculated in Tables A2–A5 in Appendix A. For example, the innovation drivers (building block) score is obtained by taking the weighted average of the composite measures

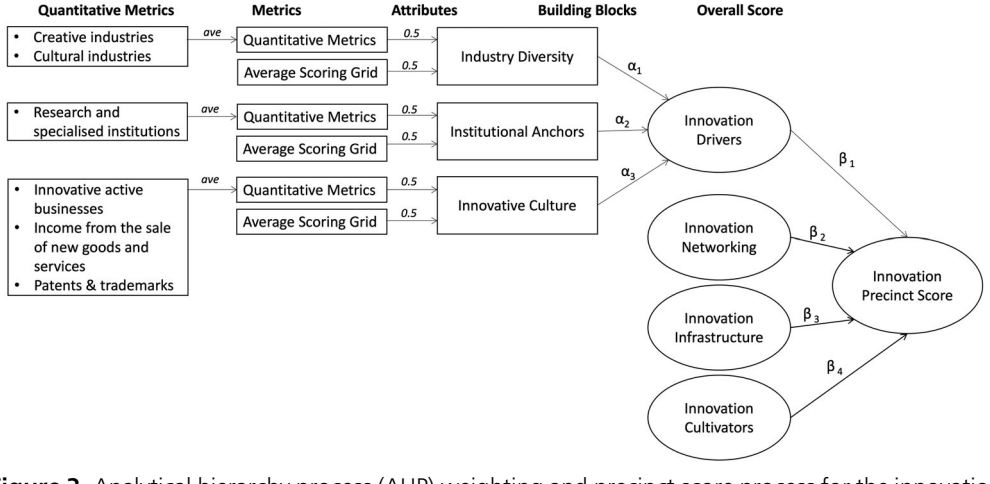

Figure 3. Analytical hierarchy process (AHP) weighting and precinct score process for the innovation drivers building block.
Note: The other three building blocks, namely innovation networking, innovation infrastructure and innovation cultivators, are also shown. The same general process has been adopted for these three building blocks.

for industry diversity (*IndDiv*), institutional anchors (*InstAnch*) and innovative culture (*InnCulture*), where α reflects the percentage of weighting. This is calculated as follows:

$$InnDrivers = \alpha_1 IndDiv + \alpha 2 InstAnch + \alpha_3 InnCulture \quad (2)$$

This calculation is illustrated in Figure 3 for the innovation drivers building block. For brevity, the other three building block calculations are not shown; however, they are calculated in a similar way as follows:

- A score for innovation networking is calculated by taking the weighted average of composite measures for relationship building (*RelBuild*), external collaboration (*ExtCol*), active networking (*ActNet*) and internal collaboration (*IntColl*):

$$InnNetworking = \alpha_4 RelBuild + \alpha_5 ExtCol + \alpha_6 ActNet + \alpha_7 IntCol \quad (3)$$

- A score for innovation infrastructure score is calculated as the weighted average of composite measures for accessibility and transit (*AccTransit)*, amenities and recreation (*AmenRec*), digital infrastructure (*DigInf*) and enabling infrastructure (*EnabInf*):

$$InnInfrastructure = \alpha_8 AccTransit + \alpha_9 AmenRec + \alpha_{10} DigInf + \alpha_{11} EnabInf \quad (4)$$

- A score for innovation cultivators score is calculated as the weighted average of composite measures for mentorship and support (*MentorSup*), access to funding (*AccFund*), education and knowledge creation (*EduKnow*) and skills and human capital (*SkillCap*):

$$InnCultivators = \alpha_{12} MentorSup + \alpha_{13} AccFund + \alpha_{14} EduKnow + \alpha_{15} SkillCap \quad (5)$$

The construction of the attribute scores is in turn calculated using the relevant metrics defined to measure the attribute for the three building blocks, and is summarized in Table B1 in Appendix B in the online supplemental data. Once each attribute score is constructed, the relevant building block score is calculated.

Table 3 provides the AHP weightings of the four building blocks and their attributes along with the quantitative and scoring grid metrics for each attribute. The relative importance (or weighting) of each building block and attribute calculated using the AHP method is shown as a percentage score. The weights derived using the AHP method facilitated a hierarchical scoring of the sample innovation precincts. The overall scoring provides insights into the presence (or strength) of each building block and attribute of a precinct.

3.3. Robustness testing

To ensure robustness of the results and to validate the research methodology used, three robustness tests were undertaken, as shown in Figure 4.

In the first instance, the precinct scores were determined by designating equal weighting to each set of attributes and building blocks. Upon determining the AHP weights, the precinct scores were calculated, this time applying the AHP results to each set of attributes and building blocks. Figure 5 illustrates a high level of correlation between the AHP weighted precinct scores and the equally weighted precinct scores.

To ensure the reliability of the quantitative and scoring grid metrics, three scenarios were tested using the AHP scoring process: (1) using only the scoring grid metrics; (2) using only the quantitative metrics; and (3) using both sets of metrics with equal weightings. The results for each scenario are shown in Table 4. For the most part, minor differences in the precinct score occurred between the three scenarios. The tests reflected that while the quantitative metrics provided useful comparable data across the different precincts, some data were limited, particularly

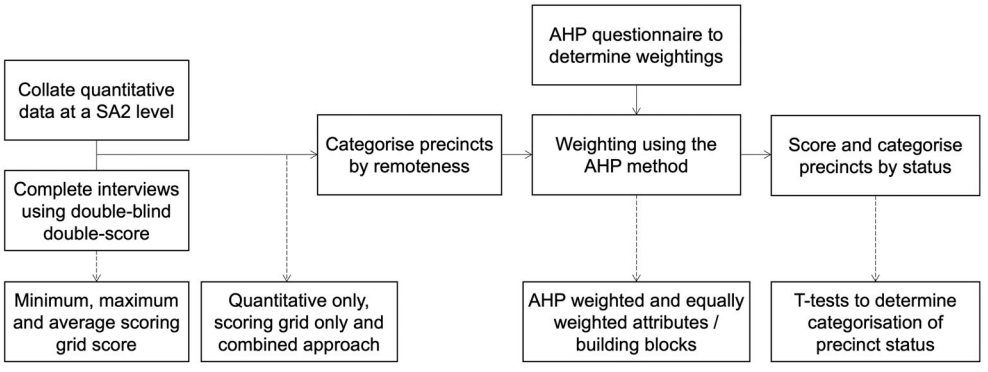

Figure 4. Robustness tests.

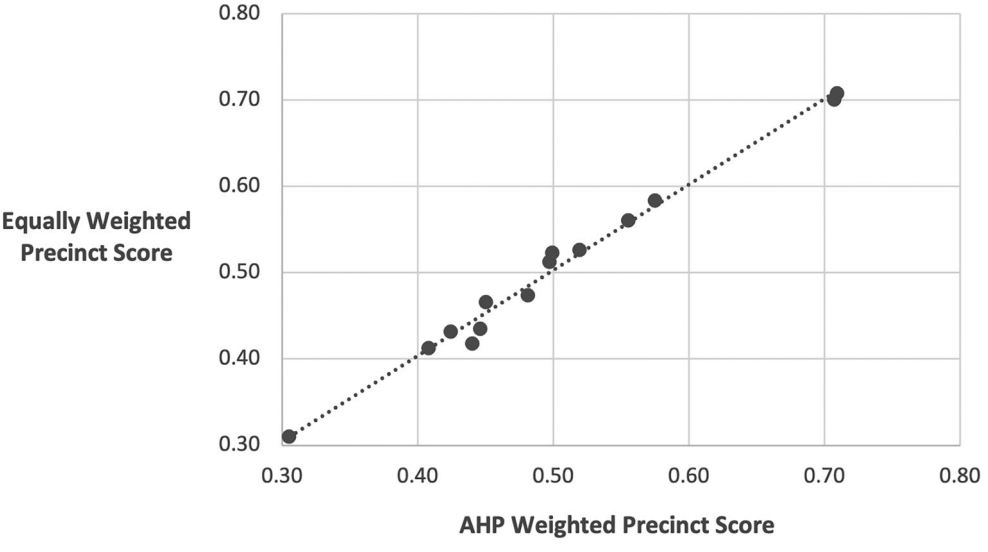

Figure 5. Overall precinct score comparison between analytical hierarchy process (AHP) weighting and equal weighting.

for regional precincts. Furthermore, appropriate quantitative metrics could not be sourced for a number of attributes. Hence, the reported scores incorporated both the scoring grid and quantitative metrics in the AHP scoring process.

The 'double-blind double-scoring' methodology also provided a way to evaluate the robustness of the scoring grid approach. As multiple interviews were completed for each precinct, the

Table 4. Combined and separate metrics scoring grid results.

Precinct	Combined approach	Scoring grid only	Quantitative metrics only
Metropolitan precincts			
Median score across four building blocks	0.497	0.584	0.276
Regional precincts			
Median score across four building blocks	0.450	0.497	0.237

Table 5. Average, maximum and minimum scoring grid results.

Precinct	Average	Maximum	Minimum
Metropolitan precincts			
Median score across four building blocks	0.497	0.583	0.422
Regional precincts			
Median score across four building blocks	0.45	0.551	0.354

variations in scores of the scoring grid were also tested by running three scenarios, taking the average, maximum and minimum scores for each attribute of each precinct. The average score provided the most consistent approach and resulted in precinct scores that were insignificantly different to the precinct scores from using the maximum and minimum. This process provided a confidence interval for each precinct's score, as shown in Table 5. However the score using the average scoring grid was used for reporting.

4. ANALYSIS AND KEY FINDINGS

This section presents the key findings when scoring the building blocks and attributes for a sample of Australian innovation precincts using the available cross-section data. These results provide a relative measure of the importance of building blocks and attributes as enablers for these precincts according to the two classifications outlined in section 3: namely (1) 'metropolitan' and 'regional' geographical classification and (2) 'active' versus 'emerging' status. Tracking these relative measures of the building blocks by repeating this methodology over time using longitudinal data would provide additional confidence in the relative rankings of the four building blocks to better guide policy and investment decisions.

The methodology for scoring the overall precinct is dependent on the individual attribute scores. The overall precinct score facilitates a classification of the precincts according to an 'active' or 'emerging' status, consistent with the earlier definition of these two classifications. To achieve and exceed best practice, each precinct must strengthen existing capabilities and address deficiencies in others. Figure 6 illustrates the minimum and maximum scores achieved by any one precinct across each of the four building blocks as well as the average score across all precincts. The variation in scores provides some insight into potential areas of improvement for specific precincts through additional resources (not necessarily financial) and highlights the importance of the specific building block as an enabler for that precinct. For example, the precinct scoring lowest on networking and collaboration (0.279) may warrant assistance to improve its access to markets, knowhow and other resources as enablers of precincts. Across all the building blocks, *innovation drivers* scored the highest on average, primarily because it was the most common of building blocks present across all innovation precincts. *Innovation infrastructure*, *innovation networking* and *innovation cultivators* building blocks followed next.

Figure 7 compares the *active*, *emerging, metropolitan and regional* precincts using the best score by attribute for each maturity category, respectively. As expected, the *emerging* precincts score consistently lower on average compared with the *active* precincts. However, there are similar patterns in the importance of attributes across active and emerging precincts. Despite emerging precincts scoring on average lower than the active precincts, the emerging precincts do score comparatively high on a number of attributes. The attributes that score highest for both active and emerging precincts include 'accessibility and transit', 'education and knowledge creation' and 'active networking'. The average score for 'active networking' across emerging precincts is high and close to the best-performing emerging precinct in the group. For example, the Armidale Agritech Precinct attracts a diverse mix of skills and talent in agriculture and

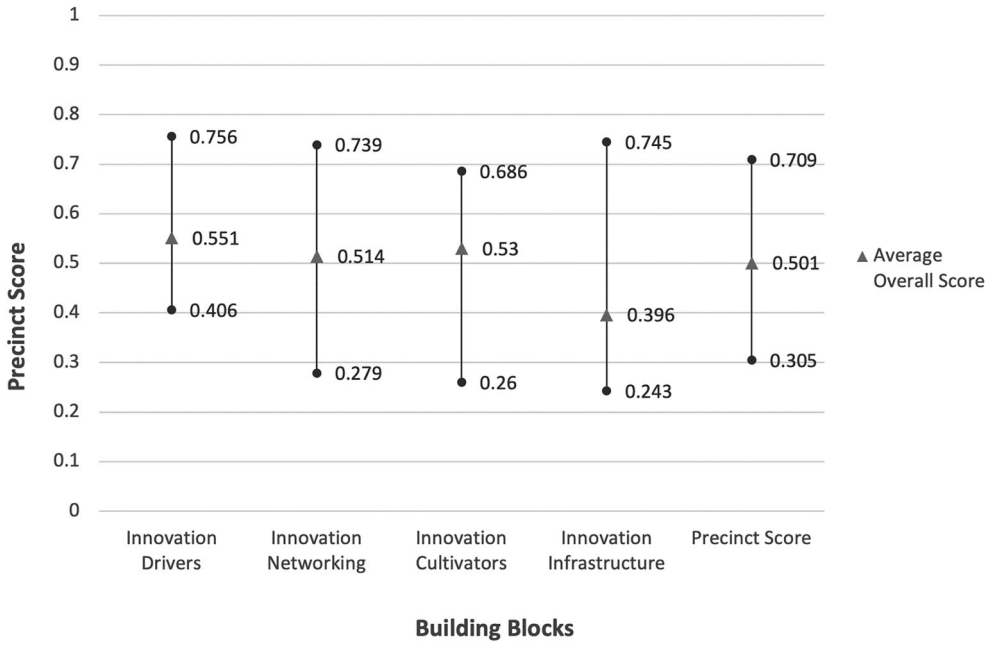

Figure 6. Scoring innovation precincts according to building blocks.

environmental science. The University of New England (UNE) Smart Region Incubator was launched in 2017 to enable small to medium-sized enterprises and entrepreneurs to connect regionally, nationally and internationally using communications technology supported by commercial expertise. There is close collaboration with several local farmers who worked with the UNE in commercializing technology. The Armidale Business Chamber organizes regular networking events and within the regional area, most business owners know each other. The business chamber coordinates 'Tech Fest' to attract other interested stakeholders from outside of the region to collaborate with local businesses. The UNE hosts national agribusiness events with Livestock Australia and the R&D corporations to share ideas from across the country.

These emerging precincts also do comparatively well on this attribute compared with the active precincts. The situation is different 'for accessibility and transit', where the average

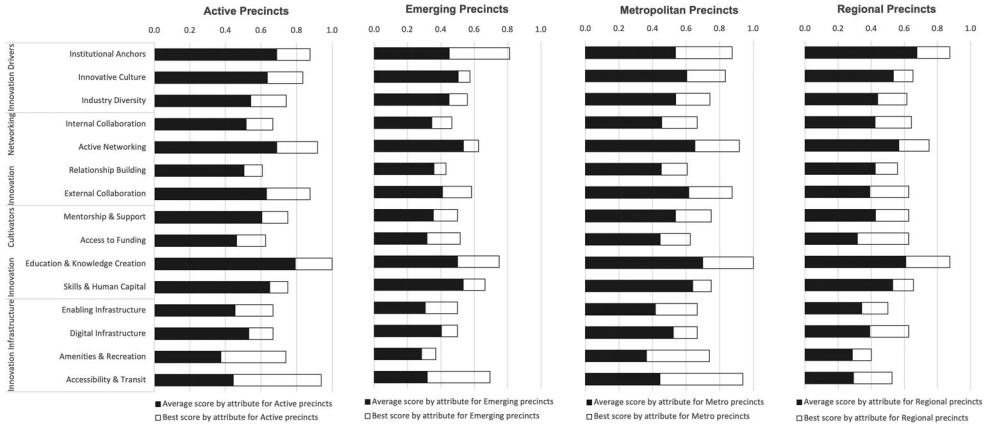

Figure 7. Best and average performing innovation precincts.

score for emerging precincts is quite low compared with the best-performing emerging precinct and lower still compared with the active precincts. On these two attributes alone, policymakers may focus on facilitating enablers that support improvements in accessibility and transit facilities around emerging precincts through infrastructure funding. Similar policy decisions can be made by benchmarking attribute scores across active and emerging precincts, where emerging precincts underperform on average.

Figure 7 also illustrates that for active precincts, the score for institutional anchors was considerably higher on average than for emerging precincts. This finding was mainly due to a consistent presence of an anchor institution in the various innovation precincts (Roig-Tierno et al., 2015; Engel, 2015; Katz & Wagner, 2014; Florida et al., 2010; Buesa et al., 2010; Agrawal & Cockburn, 2003). For example, the Westmead Health and Education Precinct hosts a strong presence of innovation leadership and business confluence built around the anchor institutions, Westmead Hospital and University of Sydney. This has created a dynamic precinct of over 350 complementary enterprises. An entrepreneurial culture is supported through the Westmead Research Hub, a collaboration of five organizations with expertise in medical research, health and education. Within the emerging precincts, at least one precinct scored as well as the best-performing active precincts on this score. However, on average most emerging precincts under-performed due to the absence of a strong anchor institution. Again, this is where coordinated enabling efforts on the part of policymakers could encourage appropriate anchor institutions to become involved in selected precincts.

Figure 7 also illustrates the attribute scores for each building block across 'regional' and 'metropolitan' innovation precincts. As expected, the *regional* precincts score consistently lower on average compared with the metropolitan precincts. However, there are similar patterns in the importance of attributes across metropolitan and regional precincts. Despite regional precincts scoring on average lower than the metropolitan precincts, the regional precincts do score comparatively high on several attributes. The attributes that score highest for both metropolitan and regional precincts include 'institutional anchors', active networking' and 'education and knowledge creation'. While 'accessibility and transit' scores high for metropolitan precincts (as might be expected), it scores low in regional precincts.

Figure 7 highlights that the regional innovation precinct scores are lower across the innovation infrastructure building block, suggesting a significant improvement is needed. It also highlights that the only attribute that scores above the average performance of all attributes for regional precincts is the institutional anchor attribute in innovation drivers building block. It also highlights that metropolitan innovation precincts generally score better for the innovation cultivators building block, particularly in access to funding and mentorship and support, the latter being due to the location of expert support. Once again, where significant underperformance is evident in relatively important attributes across regional innovation precincts, there is cause for government involvement that enable improvements to close the gap.

5. DISCUSSION AND CONCLUSIONS

This paper presents a methodology to measure the relative importance of enablers (building blocks and attributes) of successful innovation precincts. Particular attention was given to the '*active*' and '*emerging*' as well as '*metropolitan*' and '*regional*' classification of innovation precincts. By applying the novel mixed-methods approach using empirical data, this study identified several opportunities, challenges and conditions necessary to foster growth and longevity of innovation precincts as they contribute to improvements in national productivity and economic growth.

The four building blocks identified comprise of 15 attributes and 23 metrics, the measurement for which is the first contribution we make in line with the gap identified regarding measurement of characteristics of precincts (Fernandes et al., 2020). Further we also contribute

to designing a novel mixed-method approach which has been used to measure and calibrate the relative importance of the building blocks and attribute. This has facilitated the identification of opportunities and gaps across the building blocks that enable or limit the ongoing activities of these innovation precincts. These results highlight that supportive government policy needs to develop and nurture specialized capabilities located across different geographical areas, as noted by Breznits (2021), whilst also developing a tailored approach to understanding the building blocks and corresponding attributes that contribute to building a successful innovative ecosystem. We find that each innovation precinct has its own strengths, challenges and opportunities, particularly influenced by their location and development status, and likely additional context-specific factors (for future research) such as innovation focus. For example, Deegan et al. (2021) illustrate how different regional innovation system dynamics can influence the type and location of innovation partner and process selected. Important innovation partners for firms in networked RISs are local universities, R&D institutes and technology transfer agencies. In regionalized national RISs, firms cooperate primarily with actors outside the region in innovation processes, and often with science partners. A RIS is typically seen to consist of two subsystems underpinned by an institutional infrastructure. The subsystems contain a region's industry (firms, entrepreneurs, clusters, value chains) and the knowledge infrastructure of universities, R&D institutes, incubators, etc. (Deegan et al., 2021). By applying these dynamics, this study demonstrates how a regional and metropolitan innovation precinct can differ depending on the types of subsystems present and in terms of maturity level for an active or emerging status. International evidence (Moonen & Clark, 2017; Hanna, 2016; Wagner et al., 2017) suggests that if locations lack specific fundamental drivers and ingredients to activate an innovation precinct, it will struggle to reach its full potential, regardless of the external factors that may be in its favour. These fundamental drivers align with the findings of Deegan et al. (2021) and include, institutional infrastructure including formal regulations, legislation, and informal societal norms that may stimulate or hamper entrepreneurship, knowledge flow, and innovation cooperation between actors in the subsystems. The first is capability failures, which involve innovation system actors such as firms and knowledge and support organizations lacking appropriate competence to carry out or support innovation activity. The second is coordination failures. These include in specialized RISs, the risk of too much information, and knowledge exchange between a fixed set of actors only, which hinder the inflow of complementary and alternative ideas and competence. Third, institutional failures occur when formal institutions (laws, regulations, etc.) and informal institutions (norms and implicit 'rules of the game') hinder innovation. These system failures hinder RISs to efficiently support innovation activity in existing regional industries, while they do not necessarily stimulate the development of new regional industries.

From this analysis, a set of recommendations is possible. First, there is a need for coordinating activities within and across innovation precincts to facilitate and support innovation activity, productivity, and global competitiveness. Research findings strongly support the role of government as a facilitator in assisting to develop and cultivate activities to promote successful innovation precincts and to foster local leadership to guide action. Second, innovation networking is the second most important key innovation building block identified in this study, emphasizing the importance of relationships and collaboration for developing innovation precincts. Collaboration between different stakeholders including government, universities and businesses provide opportunities for greater alignment in goal setting. Third, innovation precincts vary in their individual needs, particularly given the varied location, development, and innovation focus. This implies that individual precincts should focus on developing further the strengths specific to that precinct. Finally, coordination by governments and local leaders should place the precincts unique needs, opportunities and characteristics at the forefront when determining policies for governance. Research findings highlight the role a precincts' development status plays on the level of partnerships, for example, whether a simple network for the purpose of

information sharing is most suitable for that precinct compared with an alternative stronger connected strategic alliance.

The findings of this study further emphasize the role of future research. While Active Australian precincts performed well overall in the External Collaboration attribute, further research could interrogate the types and forms of external collaboration activities that incentivise such engagement. Similarly, further effort is needed to understand the attributes of the innovation networking building block that contribute to shared knowledge amongst stakeholders and the role of tacit expertise in this essential attribute. Whilst this paper illustrates the importance of precinct leaders and the role of government in promoting a culture of collaboration and information sharing, this research could be further extended to identify the success factors and barriers that such leaders face in facilitating such activities. It can also guide appropriate public policy responses for developing innovation precincts and guide how public policies can be informed for developing strategies that specifically focus at the precinct (micro) level as opposed to the broader (macro) level (Roig-Tierno et al., 2017). Finally, the research methodology proposed can be improved by transitioning from cross-sectional data used in this study to a longitudinal analysis as time series data become more readily available. Future research that can track the evolution of these important enablers can more precisely guide government policy and investment decisions in supporting and promoting innovation precinct strategies. Furthermore, future research to operationalize other precinct attributes such as governance, leadership, branding and positioning would strengthen the innovation location and economic geography literature.

ACKNOWLEDGEMENT

The authors are grateful to the Department of Industry Skills and Regional Development, NSW Australia, for funding the research.

DISCLOSURE STATEMENT

No potential conflict of interest was reported by the authors.

FUNDING

This work was supported by the NSW Innovation and Productivity Council, NSW Department of Industry.

NOTES

[1] Various terms are used interchangeably to identify an innovation precinct, including *innovation cluster*, *innovation district*, *industrial district* and *innovation hub*.

[2] Several supporting grant programmes form part of the Australian government's strategy for building capabilities and coordinating skill development across Australian innovation precincts.

[3] With the growing interest in innovation precincts, an emphasis on improving and expanding data collection will continue. This will ensure that more precise measurement of the scores is possible as new and improved data sources become available.

[4] For very sparsely populated areas, the ABS limits the typical population size for SA2 to avoid combining very diverse geographical areas that make the data less meaningful.

[5] The interviews included (but were not limited to) questions on affordability of commercial spaces, transport infrastructure, governance and funding (i.e., role of government and

communication across land owners, etc.), regional needs compared with metropolitan and barriers/incentives to innovation activities taking place in the precinct.

ORCID

Christopher Bajada http://orcid.org/0000-0003-0590-1492
Renu Agarwal http://orcid.org/0000-0002-8493-7313
Katrina Skellern http://orcid.org/0000-0001-5914-8294
Roy Green http://orcid.org/0000-0001-5936-8203

REFERENCES

Abrahamson, E., & Fombrun, C. J. (1994). Macrocultures: Determinants and consequences. *The Academy of Management Review*, *19*(4), 728–755. https://doi.org/10.2307/258743

Agrawal, A., & Cockburn, I. (2003). The anchor tenant hypothesis: Exploring the role of large, local, R&D-intensive firms in regional innovation systems. *International Journal of Industrial Organization*, *21*(9), 1227–1253. https://doi.org/10.1016/S0167-7187(03)00081-X

Agrawal, A., Cockburn, I., Galasso, A., & Oettl, A. (2014). Why are some regions more innovative than others? The role of small firms in the presence of large labs. *Journal of Urban Economics*, *81*, 149–165. https://doi.org/10.1016/j.jue.2014.03.003

Akinwale, Y. O., Dada, A. D., Oluwadare, A. J., Jesuleye, O. A., & Siyanbola, W. O. (2012). Understanding the nexus of R&D, innovation and economic growth in Nigeria. *International Business Research*, *5*(11), 187–96.

Al-Ashaab, A., Flores, M., Doultsinou, A., & Magyar, A. (2011). A balanced scorecard for measuring the impact of industry–university collaboration. *Production Planning & Control*, *22*(5–6), 554–570. https://doi.org/10.1080/09537287.2010.536626

Anselin, L., Varga, A., & Acs, Z. (2000). Geographical spillovers and university research: A spatial econometric perspective. *Growth and Change*, *31*(4), 501–515.

Ankrah, S. N., Burgess, T. F., Grimshaw, P., & Shaw, N. E. (2013). Asking both university and industry actors about their engagement in knowledge transfer: What single-group studies of motives omit. *Technovation*, *33*(2–3), 50–65. https://doi.org/10.1016/j.technovation.2012.11.001

Athanassopoulou, N. (2017). Boosting innovation through SME–university collaborations, The manufacturer, London, viewed 4 December 2018, https://www.themanufacturer.com/articles/boosting-innovation-through-sme-university-collaborations/.

Athreye, S., & Cantwell, J. (2007). Creating competition? Globalisation and the emergence of new technology producers. *Research Policy*, *36*(2), 209–226. https://doi.org/10.1016/j.respol.2006.11.002

Australian Bureau of Statistics (ABS). (2011). Australian statistical geography standard, viewed 22nd July 2014, http://www.abs.gov.au/websitedbs/D3310114.nsf/home/Australian+Statistical+Geography+Standard+(ASGS).

Australian Bureau of Statistics (ABS). (2016). Australian statistical geography standard (ASGS): Volume 1 – 1270.0.55.001 – Main structure and greater capital city statistical areas, viewed 10th July 2019: https://www.abs.gov.au/ausstats/abs@.nsf/Lookup/by%20Subject/1270.0.55.001~July%202016~Main%20Features~Statistical%20Area%20Level%202%20(SA2)~10014.

Australian Business Foundation. (2011). Strategic serendipity. *Australian Business Foundation*.

Batabyal, A., & Nijkamp, P. (2013). Human capital use, innovation, patent protection, and economic growth in multiple regions. *Economics of Innovation and New Technology*, *22*(2), 113–26.

Balland, P. A., Boschma, R., & Frenken, K. (2015). Proximity and innovation: From statics to dynamics. *Regional Studies*, *49*(6), 907–920. https://doi.org/10.1080/00343404.2014.883598

Baptista, R., & Swann, P. (1998). Do firms in clusters innovate more? *Research Policy*, *27*(5), 525–540. https://doi.org/10.1016/S0048-7333(98)00065-1

Belenzon, S., & Berkovitz, T. (2010). Innovation in business groups. *Management Science*, *56*(3), 519–535. https://doi.org/10.1287/mnsc.1090.1107

Bell, S., Tracey, P., & Heide, J. (2009). The organization of regional clusters. *Academy of Management Review*, *34*(4), 623–642.

Bennett, R., & Robson, P. (2000). SME growth: The relationship with business advice and external collaboration. *Small Business Economics*, *15*(3), 193–208. https://doi.org/10.1023/A:1008129012953

Bloom, N., & Van Reenen, J. (2007). Measuring and explaining management practices across firms and countries. *The Quarterly Journal of Economics*, *122*(4), 1351–1408. https://doi.org/10.1162/qjec.2007.122.4.1351

Boschma, R., Coenen, L., Frenken, K., & Truffer, B. (2017). Towards a theory of regional diversification: combining insights from evolutionary economic geography and transition studies. *Regional Studies*, *51*(1), 31–45.

Bos, J. J., Brown, R. R., & Farrelly, M. A. (2014). Building networks and coalitions to promote transformational change: Insights from an Australian urban water planning case study. *Environmental Innovation and Societal Transitions*, *15*, 11–25.

Breschi, S., & Malerba, F. (2001). The geography of innovation and economic clustering: Some introductory notes. *Industrial and Corporate Change*, *10*(4), 817–833. https://doi.org/10.1093/icc/10.4.817

Breznits, D. (2021). *Innovation in real places: Strategies for prosperity in an unforgiving world*. Oxford University Press.

Buesa, M., Heijs, J., & Baumert, T. (2010). The determinants of regional innovation in Europe: A combined factorial and regression knowledge production function approach. *Research Policy*, *39*(6), 722–735. https://doi.org/10.1016/j.respol.2010.02.016

Camarinha-Matos, L., Afsarmanesh, H., Galeano, N., & Molina, A. (2009). Collaborative networked organizations – Concepts and practice in manufacturing enterprises. *Computers & Industrial Engineering*, *57*(1), 46–60. https://doi.org/10.1016/j.cie.2008.11.024

Canton, E., Minne, B., Nieuwenhuis, A., Smid, B., & van der Steeg, M. (2005). *Human capital, R&D and competition in macroeconomic analysis*. Working Paper 38. The Hague: ENEPRI.

Chatterji, A., Glaeser, E., & Kerr, W. (2014). Clusters of entrepreneurship and innovation. *Innovation Policy and the Economy*, *14*(1), 129–166. https://doi.org/10.1086/674023

Chu, Y., Tian, X., & Wang, W. (2019). Corporate innovation along the supply chain. *Management Science*, *65*(6), 2445–2466.

Cinnirella, F., & Streb, J. (2013). *The role of human capital and innovation in Prussian economic development*. Cesifo Working Paper 4391. Munich: Cesifo.

Cutler, T. (2009). *The role of precincts in innovation systems–a discussion paper*. White paper.

Cohen, W., & Klepper, S. (1996). A reprise of size and R&D. *Economic Journal*, *106*(437), 925–951. https://doi.org/10.2307/2235365

Collinson, E., & Quinn, L. (2002). The impact of collaboration between industry and academia on SME growth. *Journal of Marketing Management*, *18*(3–4), 415–434. https://doi.org/10.1362/0267257022872442

Connell, D., & Probert, J. (2010). Exploding the myths of UK innovation policy. *Centre for Business Research, University of Cambridge*.

Coenen, L., Moodysson, J., & Martin, H. (2015). Path renewal in old industrial regions: Possibilities and limitations for regional innovation policy. *Regional Studies*, *49*(5), 850–865.

Cooke, P. (2010). Regional innovation systems: Development opportunities from the 'green turn'. *Technology Analysis & Strategic Management*, *22*(7), 831–844. https://doi.org/10.1080/09537325.2010.511156

Custódio, C., Ferreira, M. A., & Matos, P. (2019). Do general managerial skills spur innovation? *Management Science*, *65*(2), 459–476.

D'Acunto, F. (2014). *Innovating to invest: The role of basic education*. Working paper, University of California, Berkeley.

Deegan, J., Solheim, M. C. W., Jakobsen, S.-E., & Isaksen, A. (2021). One coast, two systems: Regional innovation systems and entrepreneurial discovery in Western Norway. *Growth and Change*, *53*(2), 490–514. https://doi.org/10.1111/grow.12595

Dehghani, M., Denison, T., & Stillman, L. (2018). Shared collaborative spaces challenges in inter-organisational collaborative projects. In *PACIS,* 199.

Department of Industry. (2017). *Boosting Business Innovation*, NSW Government, viewed 1st August 2017. https://www.industry.nsw.gov.au/__data/assets/pdf_file/0006/95163/boosting-business-innovation-program-prospectus.pdf.

Engel, J. S. (2015). Global clusters of innovation: Lessons from Silicon Valley. *California Management Review*, *57*(2), 36–65. https://doi.org/10.1525/cmr.2015.57.2.36

European Commission. (2019). Regional innovation scorecard, viewed 10th August 2020. https://ec.europa.eu/growth/sites/growth/files/ris2019.pdf.

European Union. (2011). Regional policy for smart growth in Europe 2020. viewed 12 May 2017, http://ec.europa.eu/regional_policy/en/information/publications/guides/2011/regional-policy-for-smart-growth-in-europe-2020.

Ferreira, D., Manso, G., & Silva, A. C. (2014). Incentives to innovate and the decision to go public or private. *Review of Financial Studies*, *27*, 256–300.

Fernandes, C., Farinha, L., Ferreira, J. J., Asheim, B., & Rutten, R. (2020). Regional innovation systems: What can we learn from 25 years of scientific achievements? *Regional Studies 55*, 377–389. https://doi.org/10.1080/00343404.2020.1782878

Ferris, I. (2018). 'Brunel co-innovate journeys: Enabling SME/University Collaboration', Brunel University London, Brunel, viewed 7 December 2018, https://www.brunel.ac.uk/news-and-events/news/articles/Enabling-SME-university-collaboration.

Fitjar, R. D., & Rodríguez-Pose, A. (2013). Firm collaboration and modes of innovation in Norway. *Research Policy*, *42*(1), 128–138. https://doi.org/10.1016/j.respol.2012.05.009

Florida, R., Mellander, C., & Stolarick, K. M. (2010). Talent, technology and tolerance in Canadian regional development. *The Canadian Geographer/Le Géographe Canadien*, *54*(3), 277–304. https://doi.org/10.1111/j.1541-0064.2009.00293.x

FNSGLC. (2017). Anchored in place how funders are helping anchor institutions strengthen local Economies, Funders' Network for Smart Growth and Livable Communities viewed 2nd September 2020, https://www.fundersnetwork.org/wp-content/uploads/2017/07/Anchors-Report-8-16_digital.pdf.

Gambardella, A., Raasch, C., & von Hippel, E. (2017). The user innovation paradigm: Impacts on markets and welfare. *Management Science*, *63*(5), 1450–1468.

Galasso, A., & Simcoe, T. S. (2011). CEO overconfidence and innovation. *Management Science*, *57*(8), 1469–1484. https://doi.org/10.1287/mnsc.1110.1374

Ghani, E., Kerr, W. R., & O'Connell, S. (2014). Spatial determinants of entrepreneurship in India. *Regional Studies*, *48*(6), 1071–1089. https://doi.org/10.1080/00343404.2013.839869

Greater Sydney Commission. (2016). Towards our Greater Sydney 2056, viewed 1 August 2017, https://www.greater.sydney/towards-our-greater-sydney-2056.

Haner, U. E., & Bakke, J. W. (2004). On how work environments influence innovation—A case study from a large ICT Company. In *CD-ROM Proceedings of the XV Annual Conference of the International Society for Professional Innovation Management (ISPIM)*.

Hanna, K. (2016). Spaces to think. Innovation districts and the changing geography of London's knowledge economy. *Published by Centre for London*.

Hansen, T., & Coenen, L. (2015). The geography of sustainability transitions: Review, synthesis and reflections on an emergent research field. *Environmental Innovation and Societal Transitions*, *17*, 92–109.

Hassan, S., Bucifal, S., Drake, P., & Hendrickson, L. (2015). Australian geography of innovative entrepreneurship. *Research Paper*, *3*, 2015.

Hewlett, Marshall and Sherbin. (2013). Harvard business review, How diversity can drive innovation, viewed 2nd September 2020, https://hbr.org/2013/12/how-diversity-can-drive-innovation.

Howard Partners. (2016). Impact review of the Canberra Innovation Network (CBRIN), viewed 18 May 2017, http://cbrin.com.au/.

Howard, J., William, T., & Agarwal, R. (2016). Smart specialisation as an engagement framework for triple helix interactions. *The Triple Helix Association Magazine - Helice*, *5*(3/4), 18–29.

Hunter Research Foundation. (2017). Innovation in the Hunter, http://www.hrf.com.au/hunter-insights/innovation, viewed 1 August 2017.

Innocenti, N., Capone, F., & Lazzeretti, L. (2020). Knowledge networks and industrial structure for regional innovation: An analysis of patents collaborations in Italy. *Papers in Regional Science*, *99*(1), 55–72. https://doi.org/10.1111/pirs.12478

Isaksen, A. (2016). Cluster emergence: Combining pre-existing conditions and triggering factors. *Entrepreneurship & Regional Development*, *28*(9–10), 704–723. https://doi.org/10.1080/08985626.2016.1239762

Katz, B., & Wagner, J. (2014). *The rise of innovation districts: A new geography of innovation in America*. Brookings Institution.

Khanna, T., & Yafeh, Y. (2007). Business groups in emerging markets: Paragons or parasites? *Journal of Economic Literature*, *45*(2), 331–372. https://doi.org/10.1257/jel.45.2.331

Kveton, V., & Horak, P. (2018). The effect of public R&D subsidies on firms' competitiveness: Regional and sectoral specifics in emerging innovation systems. *Applied Geography*, *94*.

Laursen, K., Reichstein, T., & Salter, A. (2011). Exploring the effect of geographical proximity and university quality on university–industry collaboration in the United Kingdom. *Regional Studies*, *45*(4), 507–523. https://doi.org/10.1080/00343400903401618

Lee, S., Park, G., Yoon, B., & Park, J. (2010). *Open Innovation in SMEs – An Intermediated Network Model*, *39*.

Lucas, G. (1988). On the mechanics of economic development. *Journal of Monetary Economics*, *22*, 3–42.

Mares, P., Harrison, C., O'Toole, M., Oberklaid, M., & Hunter, J. (2013). Productive cities: Opportunity in a changing economy (No. 2013–5).

McCauley, S. M., & Stephens, J. C. (2012). Green energy clusters and socio-technical transitions: analysis of a sustainable energy cluster for regional economic development in Central Massachusetts, USA. *Sustainability Science*, *7*(2), 213–225.

Microsoft Australia. (2015). Accelerating Australia's innovation ecosystem.

Moonen, T., & Clark, G. (2017). The logic of innovation locations. *Catapult Future Cities*.

Nelson, R. R., & S. G. Winter. (1982). The Schumpeterian tradeoff revised. *American Economic Review*, *72*.

NSW Innovation and Productivity Council. (2018). NSW innovation precincts, lessons from international experience, viewed 12th March 2018, https://www.industry.nsw.gov.au/__data/assets/pdf_file/0011/172892/NSW-Innovation-Precincts.pdf.

OECD. (2009). Regions matter: *Economic recovery, innovation and sustainable growth*. Organisation for Economic Co-operation and Development. (source: https://www.oecd.org/cfe/regionaldevelopment/regionsmatteredonomicrecoveryinnovationandsustainablegrowth.htm)

OECD. (2013). Innovation-driven growth in Regions: The role of smart specialisation, viewed 12th August 2020, https://www.oecd.org/innovation/inno/smart-specialisation.pdf

OECD. (2016). Innovating education and educating for innovation, viewed 2nd September 2020, http://www.oecd.org/education/ceri/GEIS2016-Background-document.pdf.

OECD. (2018). Promoting innovation in established SMEs, Policy Note, SME Ministerial Conference, 1–8.

Office of the Chief Economist. (2016). *Australian innovation system report,* viewed 10 October 2017, https://industry.gov.au/Office-of-the-Chief-Economist/Publications/Documents/Australian-Innovation-System/2016-AIS-Report.pdf.

Organisation for Economic Co-operation and Development (OECD). (2013). Innovation-driven Growth in regions: The role of smart specialisation. OECD.

Partanen, J., Kauppila, O. P., Sepulveda, F., & Gabrielsson, M. (2018). Turning strategic network resources into performance: The mediating role of network identity of small and medium-sized enterprises. *Strategic Entrepreneurship Journal*, 1–20.

Peças, P., & Henriques, E. (2006). Best practices of collaboration between university and industrial SMEs. *Benchmarking: An International Journal*, *13*(1/2), 54–67. https://doi.org/10.1108/14635770610644574

Pouder, R., & St. John, C. H. (1996). Hot spots and blind spots: Geographical clusters of firms and innovation. *The Academy of Management Review*, *21*(4), 1192–1225. https://doi.org/10.2307/259168

Ponds, R., Van Oort, F., & Frenken, K. (2007, August). The geographical and institutional proximity of research collaboration. *Papers in Regions Science*, *86*(3), 423–443.

Putnam, R. D., Leonardi, R., & Nanetti, R.Y. (1994). *Making democracy work: Civic traditions in modern Italy*. Princeton university press.

Read, D. (2016). Case studies in innovation district planning and development.

Romer, P. M. (1986). Increasing returns and long run growth. *Journal of Political Economy*, *94*(5), 1002–37.

Roig-Tierno, N., Alcázar, J., & Ribeiro-Navarrete, S. (2015). Use of infrastructures to support innovative entrepreneurship and business growth. *Journal of Business Research*, *68*(11), 2290–2294. https://doi.org/10.1016/j.jbusres.2015.06.013

Roig-Tierno, N., Ribeiro-Soriano, D., & Mas-Verdú, F. (2017). Clustering and innovation: Firm-level strategising and policy. *Entrepreneurship & Regional Development*, *29*(7–8), 814–816. https://doi.org/10.1080/08985626.2017.1335958

Roper, S., Love, J. H., & Bonner, K. (2017). Firms' knowledge search and local knowledge externalities in innovation performance. *Research Policy*, *46*(1), 43–56. https://doi.org/10.1016/j.respol.2016.10.004

Saaty, T. L. (1980). *The Analytic Hierarchy process*. McGraw-Hill.

Saaty, T. L. (2008). Decision making with the Analytic Hierarchy process. *International Journal of Services Sciences*, *1*(1), 83. https://doi.org/10.1504/IJSSCI.2008.017590

Saaty, T. L., & Peniwati, K. (2013). *Group decision making: Drawing out and reconciling differences*. RWS publications.

Scherer, F. M. (1982). Inter-industry technology flows in the United States. *Research Policy*, *11*(4), 227–245. https://doi.org/10.1016/0048-7333(82)90011-7

Schumpeter, J. A. (1934). *The theory of economic development - An inquiry into profits, capital, credit, interest, and the business cycle*. Harvard Economic Studies

Schildt and Rubin. (2015). Leveraging anchor institutions for economic inclusion, viewed 2nd September 2020, https://www.policylink.org/sites/default/files/pl_brief_anchor_012315_a.pdf.

SGS Economics and Planning. (2018). From alleys to Valleys, creating innovation precincts through inclusive policy, viewed 8th March 2020, https://www.sgsep.com.au/assets/main/SGS-Economics-and-Planning-Innovation-Precincts.pdf.

Sleuwaegen, L., & Boiardi, P. (2014). Creativity and regional innovation: Evidence from EU regions. *Research Policy*, *43*(9), 1508–1522. https://doi.org/10.1016/j.respol.2014.03.014

Thune, T. (2010). The training of "Triple Helix Workers"? Doctoral students in University–Industry–Government collaborations. *Norwegian Institute for Studies in Innovation, Research and Education*, *48*, 463–483.

Teixeiara, A., & Fortuna, N. (2004). *Human capital, innovation capability and economic growth*. FEP Working Paper No. 131. Porto: Universidade do Porto.

Tödtling, F., & Trippl, M. (2005). One size fits all? Towards a differentiated regional innovation policy approach. *Research Policy*, *34*(8), 1203–1219. https://doi.org/10.1016/j.respol.2005.01.018

Vogel, J. (2012). *The two faces of R&D and human capital: Evidence from Western European Regions*. University of Oxford Working Paper 599. Oxford: University of Oxford.

Wagner, J., Davies, D., Storring, N., & Vey, J. S. (2017). 12 principles guiding innovation districts. *Metropolitan Revolution*.

Wagner, J., & Storring, N. (2016). *So you think you have an innovation district?* The Brookings Institution. http://www.brookings.edu/blogs/metropolitan-revolution/posts/2016/03/30-innovation-district-audit-wagner-storring.

Xie, F., Zhang, B., & Zhang, W. (2021). Trust, incomplete contracting, and corporate innovation. *Management Science, Articles in Advance*, 1–25.

Yigitcanlar, T., Velibeyoglu, K., & Martinez-Fernandez, C. (2008). Rising knowledge cities: the role of urban knowledge precincts. *Journal of Knowledge Management*, *12*(5), 8–20.