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Rising knowledge cities: the role of urban knowledge precincts

Tan Yigitcanlar, Koray Velibeyoglu and Cristina Martinez-Fernandez

Tan Yigitcanlar is a Senior Lecturer at the School of Urban Development, Queensland University of Technology, Brisbane, Australia. Koray Velibeyoglu is a Lecturer in the Department of City and Regional Planning, Izmir Institute of Technology, Izmir, Turkey. Cristina Martinez-Fernandez is a Researcher at the Urban Research Centre, University of Western Sydney, Sydney, Australia.

Abstract

Purpose – The paper seeks to investigate the changing and challenging spatial nature of the rising knowledge cities' knowledge precincts.

Design/methodology/approach – The paper reviews the literature on recent knowledge precinct developments within the frame of innovation and urban economic competitiveness. The methodology develops a typological investigation and searches for useful insights for better understanding the fundamentals of knowledge precincts. The study exemplifies cases from Australia as well as other global best practices.

Findings – The paper sheds light on the contemporary knowledge production of rising knowledge cities, and points out the changing spatial agglomeration of knowledge-intensive industries and the formation of new types of knowledge precincts as the spatial core of knowledge-based urban development.

Originality/value – The paper provides an in-depth discussion on the changing spatial concepts of knowledge precincts and their vital role for the knowledge-based urban development of cities.

Keywords Knowledge management, Urban areas, Australia

Paper type Research paper

Introduction

Advanced economies are presently being radically altered by dynamic processes of economic and spatial restructuring within the frame of the new knowledge economy. In this context, ''knowledge-based urban development'' (KBUD) has become an important mechanism for the development of knowledge cities. KBUD is extensively seen as a potentially beneficial set of instruments which may improve the welfare and competitiveness of cities (Yigitcanlar et al., 2008a). The knowledge economy can currently be observed only in small parts of the world; however, its effect is worldwide. Since knowledge is addressed as a key driver in urban development, many cities all around the world are in fierce competition to attract talent and innovation by adopting various policy measures and incentives for promoting the knowledge city concept. Therefore the buzz concepts of being clever, smart, skilful, creative, networked, connected, and competitive have become some of the key ingredients of KBUD. Within this frame ''knowledge precincts'' have been endorsed as the engines of KBUD for cities that choose knowledge production as a key goal in their development strategy.

This paper aims to contribute to ongoing knowledge-based development and KBUD-related discussions that are becoming more popular in the academic and professional literature (see Yigitcanlar et al., 2008a, b). This is a follow up study of Yigitcanlar et al.'s (2007) work on ''attracting and retaining knowledge workers in knowledge cities'', which chiefly elaborated the question of ''what a knowledge worker wants when not at work'' (Yigitcanlar et al., 2007). In this study the focus is shifted from knowledge workers' social and living environments to their working (and in some cases also living) environments, namely knowledge precincts.

The specific focus of the study is therefore ''knowledge precinct development as the spatial core of KBUD''. The paper seeks to investigate the changing spatial nature of knowledge precincts in the urban context of competing knowledge cities with particular reference to emerging Australian knowledge cities. This paper reviews the current literature on recent knowledge precinct developments within the context of innovation and urban economic competitiveness. The methodology develops a typological investigation and explores useful insights for better understanding the changing spatial concepts of knowledge precincts. The study also exemplifies cases from Australia since the knowledge precinct concept is quite popular in the agenda of Australian cities and therefore deserves deeper investigation.

Knowledge economy and knowledge-based urban development

During the last two decades a global, knowledge-based, and technology-driven economy has emerged – the so-called ''knowledge economy'', also variously labeled the ''knowledge-based economy'', the ''new economy'', and the ''creative economy'' (Baum *et al.*, 2007). In this new economy, knowledge-related activities, including creativity as a tacit knowledge form, have become central for creating employment and wealth, and sustaining economic growth (Ofori, 2003; Howells, 2002). This implies the view of environmental and cultural assets of the cities and communities as economic resources (Landry, 2000). It also emphasizes knowledge work and knowledge workers as vital parts of a new emergent mode of production in the current knowledge economy (Florida, 2005; Henderson, 2005). Yigitcanlar *et al.*'s (2007) recent study elaborates the question of attracting and retaining knowledge and creative workers in the knowledge economy by addressing the needs and desires of knowledge workers in the contemporary urban context. The authors develop a typology of different groups of knowledge workers in their preferred urban environments. For example, while scientists and engineers mostly prefer quality of university and R&D milieu, artistic/creative people place creative milieu with a variety of entertainment options and urban diversity at the core of their preferences. By departing from an anthropological point of view, the authors explore the needs and desires of a knowledge worker and draw a base for understanding the urban and cultural needs of knowledge workers when they are not at work. The findings of this study indicate that a typical knowledge worker wants an intense twenty-first century urban environment to see the perfected human body, picturesque spaces for human display, to be part of a new community of strangers – defined by aggregation in action, a transport-rich environment, places rich in time. Above all, the study points out the crucial importance of knowledge workers' desires and attitudes in the shaping of successful knowledge precincts and rising knowledge cities.

The economy of a knowledge city creates high value-added products using research, technology, and brainpower. In the knowledge city, the private and the public sectors value knowledge, spend money on supporting its discovery and dissemination and, ultimately, harness it to create goods and services (Carrillo, 2006). Although many city initiatives call themselves knowledge cities, currently there are only a few cities around the world (e.g. Barcelona, Boston, Delft, Munich, Singapore, and Stockholm) that have earned that label. Many other cities aspire to the status of a knowledge city through urban development programs that target KBUD (Ergazakis *et al.*, 2004). Examples include Brisbane, Dubai, Melbourne, Monterrey, and Shanghai. The top-tier knowledge cities specialize in a few sectors only, but set ambitious goals for each, and they also develop their knowledge-based policies carefully.

To date, the (re)structuring of most of the cities has proceeded organically, in essence as a dependent and derivative effect of global market forces. Urban and regional planning has responded slowly, and sometimes not at all, to the challenges and opportunities of the global knowledge city. Almost a decade into the new century the economic success of the knowledge-intensive development policies in a number of cities and nations have led urbanists to think of whether similar policies could be applicable for the knowledge-based planning of city-regions (Knight, 1995). In recent years, urban planning has consolidated its interest in the paradigm of post-modern social production under the rubric of KBUD (Carrillo, 2004; Corey and Wilson, 2006). The concept of KBUD has started to gain acceptance among urban scholars. Parallel to this recognition, KBUD has become an emerging area of

research interest which transcends the interests of planners, economists, geographers, and social scientists. Despite this growing interest KBUD still remains in its infancy (see Yigitcanlar *et al.*, 2008a, c).

Planning sees KBUD as a new form of urban development for the twenty-first century that could potentially bring both economic prosperity and sustainable socio-spatial order to the contemporary city. The goal of KBUD is a knowledge city purposefully designed to encourage the production and circulation of abstract work (Cheng *et al.*, 2004). KBUD can be regarded as a vision/strategy to nourish the transformation and renewal of cities into knowledge cities and their economies into knowledge economies. It is not about strict government control on development; rather, it is the initiation and provision of a knowledge incubation environment (e.g. incentives, knowledge and urban infrastructures, quality of life) jointly by the public and private sectors and academia for entrepreneurs (e.g. knowledge enterprises, knowledge workers, artists).

KBUD is a powerful strategy for economic growth and the post-industrial development of cities and nations to participate in the knowledge economy (Yigitcanlar *et al.*, 2008a). It is a strategic management approach, applicable to purposeful urban human organizations in general (Carrillo, 2002). Relatively recent and growing literature indicates that KBUD has three purposes. The first is that it is an economic development strategy that codifies technical knowledge for the innovation of products and services, market knowledge for understanding changes in consumer choices and tastes, financial knowledge to measure the inputs and outputs of production and development processes, and human knowledge in the form of skills and creativity, within an economic model (Lever, 2002). The second is that it indicates the intention to increase the skills and knowledge of residents as a means for human and social development (Gonzalez *et al.*, 2005). The third is to build a strong spatial relationship between urban development clusters. Broad KBUD policies include:

■ developing capital systems (i.e. human, social, intellectual);

■ distributing instrumental capital;

■ developing and adopting the state of art technologies;

■ providing hard and soft infrastructures; and

■ providing quality life and place (Carrillo, 2002; Yigitcanlar *et al.*, 2008a).

Following the realization of the necessity and importance of KBUD, knowledge precinct development, as the spatial nexus of KBUD, has become a significant part of the strategic vision attempts of the rising knowledge cities.

Understanding the spatial formation of new knowledge precinct developments

Creativity and knowledge production are dominantly urban phenomena that require a certain scale and intensity of knowledge infrastructure as well as vibrant urban life with a full mix of diversity and tolerance (Florida, 2005). Knowledge production is also dependent on a large pool of talented labor power and consumption, which is critical to form a functional urban region that is suitable for knowledge precinct development. In such a landscape, cities concentrate on extensive global networks as intense mediums of exchange for knowledge precincts to flourish (Van den Berg *et al.*, 2004). Additionally, knowledge workers, primary sources of knowledge precincts, prefer inspiring cities with a thriving cultural life, an international orientation, and high levels of social and cultural diversity (Baum *et al.*, 2007). A big city with evidence of world city formation accommodates high quality

"**Advanced economies are presently being radically altered by dynamic processes of economic and spatial restructuring within the frame of the new knowledge economy.**"

urban services (i.e. high quality residential areas, cultural districts, recreational facilities, connectivity to global air transport networks and so on) and a diversified economic base including extensive supplier and distribution networks and specialized services. Examples of the new generation of urban knowledge precincts, such as One-North Singapore, 22@bcn Barcelona, and Brisbane Kelvin Grove Urban Village, could be referred to to support this tendency.

Knowledge precincts can be regarded as the spatial nexus of KBUD, which chiefly involves the clustering of R&D activities, high-tech manufacturing of knowledge-intensive industrial and business sectors linked by mixed-use environment including housing, business, education and leisure within an urban-like setting. The working definition of such areas differs from country to country (i.e. high-tech cluster, knowledge/innovation cluster, knowledge/innovation hub, digital village), more or less indicating a clustering of high-tech enterprises with a commercial mix of urban life and culture, predominantly within central urban locations.

According to Searle and Pritchard (2008), concentrations of knowledge sectors within particular urban areas may take a number of different forms that can be distinguished within three major types of knowledge clusters (potential knowledge precinct zones). The first type is the clustering of knowledge-intensive service sector activities (KISA) around corporate head offices and related activities of the increasing number of transnational corporations (Martinez-Fernandez and Miles, 2006; Martinez-Fernandez and Martinez-Solano, 2006). These KISA clusters operate in tandem with clusters of high-order financial services. Since trust and tacit knowledge transfer have prime importance for finance and business service operations, they reinforce the clustering in traditional core locations in global cities. Searle and Pritchard's second type is largely based on high-tech production, predominantly as ICT or biotechnology. The champion of this model is the famous Silicon Valley, mainly a knowledge network that encompassed both regional learning institutions (Stanford University and the universities of Northern California) and for-profit industry research teams. Innovations produced in the knowledge network were adopted and developed economically by proximate industries operating in an environment of flexible development. Such high-tech clusters are most commonly around suburban areas with a campus-like atmosphere for reasons of image and the amenity preferences of their knowledge workers (Castells and Hall, 1994). Their third type refers to creative industry clusters largely based on cultural knowledge generation like movie-making, popular music and related areas. Although ICT-based social networking and business opportunities are important, tacit knowledge and face-to-face communication are at the core of such type of clusters. Urban knowledge precincts frequently combine the characteristics of those basic knowledge cluster types mentioned briefly above. For example, when ICT clusters contain a combination of the first and second types, advertising and multimedia clusters combine elements of the first and third types, as well as the second in the case of multimedia (Searle and Pritchard, 2008). The distinctive feature in the formation of new generation knowledge precincts here is the value of ''urbanity'' that is depicted in the remainder of the section.

Precinct formation is actually an urban phenomenon; in urban planning and design the term ''precinct'' is defined as an urban area with the distinctive character comprising its internal closure and mobility (i.e. recreation precinct, residential precinct, education precinct, entertainment precinct) (Cullen, 1971). Lynch (1960) describes an urban ''district'' as similar to the precinct, mainly referring to a medium-to-large section of the city with perceived internal homogeneity and distinguished by some identity or character. Therefore the term ''knowledge precinct'' is rather place-centered and refers to a distinct part of a city with a recognizable identity to which knowledge gives its unique character. In this sense, the knowledge precinct can be regarded as the locus of different types of knowledge clusters in which ''geographic scale are not pre-determined and may be local or national/international – or both depending on the industry and its global construction'' (Searle and Pritchard, 2008, p. 186).

New generation knowledge precinct formation brought up the question of ''what is so unique in knowledge precinct developments that adds a *value* in providing an attractive investment

area?'' This important question can be addressed by investigating five major themes (see Table I) that give useful insights on the new *loci* of knowledge precincts in the urban contexts of rising knowledge cities.

Living and working

New generation knowledge precinct developments are located mostly around ''mixed-use environments'', with the aim of collecting the benefits of blurring the boundaries of living and working facilities (Cunha and Selada, 2007). As mixed-use projects, they achieve a critical mass of technology enterprises and knowledge workers. Modern urban settings, however, have been traditionally designed according to fixed zoning planning principles, where each area has a specific and exclusive function in the organization of the whole urban system. Advances in networked infrastructures, basically throughout the ICTs, major urban functions and activities (i.e. work, education, recreation, shopping) have been blurred almost in any place in the new post-modern urban scene – flexible, decontextualized, enclaved, and fragmented (Page and Phillips, 2003). Knowledge precincts resist traditional planning approaches because they are so changeable and subject to many external forces. In this context, new generation precinct developments consider the importance of giving room for living, working, learning and playing within their boundaries (i.e. Crossroads Copenhagen, Helsinki Digital Village). Another important issue is declining ''housing affordability'' being a significant barrier to the development of KBUD strategies (Yates *et al.*, 2005). New generation city-scale knowledge precinct projects purposefully aim to integrate different types of knowledge clusters, particularly creative ones, with mixed-use living environments. Generally they are deliberately located at the intersection of the technology, urban design and real estate development domains, which carries great business and real estate value.

Table I Common themes and values of new knowledge precinct developments		
Themes	*Values*	*Examples*
1. *Living and working* (mixed-use environments)	*Business, real estate value*: real-estate and technology capitals are very active in shaping knowledge precincts (i.e. Nokia in Helsinki). Hence, commercial success has a great value. This means the end of rigid separation of working and living environments of so-called knowledge workers	Helsinki Digital Village, Brisbane Kelvin Grove Urban Village
2. *Centrality* (proximity, clustering, premium access to different infrastructures, services, and amenities, place quality)	*Economic value, development value*: Formation of knowledge precincts has become a new urban policy tool for the revitalization of environmentally degraded former industrial sites or inner city urban districts	Helsinki Digital Village, 22@bcn Barcelona
3. *Branding* (symbol for branding a city as a knowledge city)	*Symbolic value, design value*: a regeneration strategy for creating successful knowledge cities or formation of new niche markets. Marking the name of the emerging knowledge city with a landmark development	22@bcn Barcelona, Taipei 101
4. *Learning and playing* (interactive environments, living laboratories, experience of place)	*Learning value, experimental value*: urban playfield of cutting-edge technological innovation and creativity, places of interaction, knowledge hubs-such as universities	Copenhagen Crossroads, Zaragoza Digital Mile
5. *Connectivity* (social networking, places of interaction, pedestrian orientation, face-to-face contact)	*Social value*: face-to-face contact, tacit knowledge transfer, place identity	One-North Singapore, Kelvin Grove Urban Village Brisbane

Centrality

Knowledge precincts today have great economic and development value that pragmatically requires premium access to networked infrastructures – such as scientific, financial, technical, and educational infrastructures – in increasingly central urban locations. Since spatial proximity helps to generate and transfer knowledge more effectively, firms in such precincts prefer to locate in close proximity to vibrant urban life and amenities. New knowledge precinct developments have tended to be located in the centers of cities (Audretsch, 1998). Traditional suburbs, in this sense, imply the separation of work, retail and residential activity and have a number of negative consequences for attracting and retaining knowledge workers (Baum *et al.*, 2007). Recent knowledge precinct developments follow the trend of revitalizing dilapidated inner city areas and turning them into knowledge precincts. Helsinki Digital Village is established around a former industrial site within an inner city district in Helsinki, where the first industrialization in Finland was begun. In Helsinki, like many other cases worldwide, science and technology have been at the service of city-wide urban renewal strategies. 22@bcn in Barcelona has followed a similar path of inner city regeneration in a former industrial quarter: ''Poblenou district [where the 22@bcn area is now located] originates from the beginning of the 19th century, when several textile factories were placed in this area [. . .] [and then] became well-known as the 'Catalan Manchester' due to its industrial concentration'' (Clua and Albet, 2008, p. 136).

Branding

In today's knowledge economy and culture, image making has become a central basis for successful competition. In this sense, knowledge precinct development has a great *symbolic value* and it brands a particular area with a distinguishing identity. Many cities in knowledge economies worldwide apply innovative strategies, including forming new niche markets through the development of knowledge precincts, for transforming themselves successfully into knowledge cities. 22@bcn in Barcelona, for example, is a recent effort of city's long-standing urban regeneration policy under the rubric of Barcelona's model that gave rise to the city's ''city of knowledge'' vision. The brand 22@ symbolizes the industrial past of 22a Poblenou and the knowledge-based 22@. This brand is an effective marketing of the idea and the project and creates a powerful coalition between professionals, technicians, land promoters, neighborhood associations, councilors of the municipality, and so forth (Clua and Albet, 2008). As exemplified in the Barcelona model, specifically in 22@bcn, new knowledge precinct development has great *design value* (i.e. Agbar Tower, designed by the famous French architect Jean Nouvel, is now the gateway to the 22@bcn) that brought a major physical transformation to the city and an explicit discourse of a vision of a knowledge-producing Barcelona. Taipei 101 is a good example of branding and vertical knowledge precinct development. The precinct, located in the highest building in the world, provides space for high-tech firms by occupying half of the building's space. The combination of technology applied to architecture and design and the focus on providing a creative environment in which to work, shop and relax without leaving the building creates an exclusive working environment and ''the place'' where high-tech companies prefer to be located.

Learning and playing

Research-intensive knowledge producers, R&D institutes and universities, as ''knowledge hubs'', can be considered as the core of the formation of new knowledge precinct developments where the *learning value* has the prime importance (Marceau *et al.*, 2005; Turpin and Martinez-Fernandez, 2006). Crossroads Copenhagen, for example, has special foci on research, experimentation, and testing that have created a distinctive university-centered knowledge precinct development. Another important asset in the development of a new knowledge precinct is a sense of playfulness and experimentation that promotes creativity and innovation. The Milla Digital (Digital Mile) knowledge precinct in Zaragoza has great *experimental value* in this sense, aiming to attract the right players to create a true innovation ecosystem. Digital Mile is home to new technological experiments (i.e. memory paving, a digital water wall and a sonic forest) within the organization of Expo Zaragoza 2008 (Massachusetts Institute of Technology, 2005).

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Connectivity

Connectivity can typically be interpreted as the seamless and interlinked option for communication among interested parties. In terms of knowledge precincts this can be done by creating a medium for communication that maximizes the chance of social contacts. In contrast to the previous generation of science and technology parks, it is the case of Singapore's One-North that the entire knowledge community precinct is intentionally designed to offer seamless connectivity not only at the level of business but also at the individual level. One-North's mixed-use environment is a conscious effort of selecting different technology clusters (Biopolis, Fusionpolis, Infopolis, Vista Xchange) interconnected throughout the precinct. Its design is intended to foster the face-to-face interactions important for sustaining the innovation ecology of the knowledge economy (Baum *et al.*, 2007). In the One-North case, *social value* lies in the creation of such an ecology that allows social networking and places of interaction for tacit knowledge transfer among social enterprises and citizen entrepreneurship.

Considerations for knowledge precinct developments in Australia

The KBUD process in Australia comprises strategic urban management actions aimed at developing knowledge precincts for the global competition of major Australian cities. Knowledge precinct developments across urban Australia provide a strong potential for these cities by producing codified and tacit knowledge, supporting the shift towards the knowledge economy and boosting economic-social-human capitals within their (sub)urban settings (Yigitcanlar *et al.*, 2008c). Among the Australian cities, Sydney and Melbourne are one step ahead in domestic competition since they have long been linked, one way or another, to the global system. The international links of Australia's third largest city – Brisbane – are more recent. Nevertheless, as the metropolitan heart of Queensland Brisbane has recently adopted the ''Smart State'' and ''Smart City'' strategies, targeting the knowledge-based development of the city and the state (Queensland Government, 2005; Yigitcanlar and Velibeyoglu, 2008). Now Brisbane is part of the competition to become Australia's first globally recognized knowledge city. Perth and Adelaide also want to reap the benefits that such recognition would bring.

Australia is a vast continent with more than two-thirds of its land being of a remote or rural nature. The population is concentrated in a few large metropolitan regions (Sydney, Melbourne, Brisbane, Perth and Adelaide). The geography of knowledge follows population concentrations in both dense metropolitan regions and in regional centers. Technology Precinct Bentley WA, La Trobe Research and Development Precinct VIC, Queensland University of Technology Kelvin Grove Urban Village QLD, and Adelaide University Research Precinct SA are among the better known of the 30-plus knowledge precincts in Australia. There are also some notable examples in remote areas, such as the Desert Knowledge Co-operative Research Centre (CRC), based in Alice Springs and covering most of Western Australia and the Northern Territory, and the Commonwealth Scientific and Industrial Research Organisation (CSIRO) research concentration in Narrabri, Northern NSW at the Australia Telescope National Facility and the Australian Cotton Research Institute (ACRI).

The Australian knowledge precinct policy dates back to as early as the 1980s (Joseph, 1997). There is not, however, a clear understanding of what a ''knowledge precinct'' actually needs to include to generate the highly innovative knowledge flows and innovation outputs

produced by the famous Silicon Valley. On the one hand, there is the issue of having high-tech designed buildings in closed precincts where separation from the rest of the suburb is evident through gates and security enforcement (i.e. Griffith University Knowledge Precinct, Gold Coast), and on the other hand, there is the open urban space where the ''living space'' is integrated with the working space (a model similar to the old European university cities such as Salamanca or Cambridge where scientists, students and business ''walk into each other's spaces'') (i.e. Queensland University of Technology Kelvin Grove Urban Village, Brisbane). Both concepts imply a very different planning system, and the strategies for residential, recreational and commercial development and land use would also be very different.

The highly urbanized form of Australian regions and the notable coastal urban growth, together with the demands for a knowledge economy, sets up questions about the organization or reorganization of knowledge and its effects in Australian regions. In Australia, it is often important for firms and organizations to locate close to universities, research institutes, CRCs or CSIRO to maximize their access to information concerning products and services developed by local knowledge-intensive institutions (Yigitcanlar and Martinez-Fernandez, 2007). This is also important for knowledge institutions, so that the knowledge they generate is used and transformed into new knowledge.

Recent research suggests that innovative activities, especially in producer services and the creative industries, are concentrated in knowledge precincts in globally linked cities (Yusuf et al., 2003). Within this context, the external links of firms in a knowledge precinct play a critical role in innovation and knowledge production. This brings the question of proximity to the discussion as most knowledge travels through networks and, in fact, some knowledge producers might be closer to users at the other end of the planet than to those next door within the same building or precinct. This means that geographical proximity does not automatically imply that the different parts of the local/regional innovation system will generate, share, transform and adopt knowledge. Strategic planning and policy measures might be needed to ensure that knowledge circulates through the urban system, creating new opportunities for players who otherwise would not have access to specialized information, skills or technology (Yigitcanlar and Martinez-Fernandez, 2007). An example of isolated systems in closer proximity is Australian knowledge-intensive mining sites in remote communities. These mining sites are innovation-intensive locations where service providers and staff of the mining company built new capabilities day to day. Despite this high concentration of knowledge and problem-solving skills, few of these innovation processes are leaked to the businesses and organizations of the hosting towns. In the long-term the disconnection of these two innovation systems leaves the mining town in a weak position to face the future beyond mining operations resulting, in most cases, in a shrinkage of the population and of economic prosperity.

Knowledge precincts represent a regional economic system constituted by economic actors whose success and survival depend on their capabilities to create new knowledge and then innovation (Petruzzelli et al., 2007). The intensity of the knowledge produced and transmitted makes the knowledge precinct a ''system of activities'', and while the boundaries are not limited at the geographical level, the organization at the core of the precinct does need to be in geographical proximity (Acs, 2002). In this regard, in North Ryde in Sydney there is both a strong presence of public research institutions, with Macquarie University and the CSIRO, and also a concentration of ICT companies (a prospective knowledge precinct) (Searle and Pritchard, 2004).

The development of knowledge precincts needs to consider the three main functions of knowledge:

1. generation (e.g. research);

2. transmission (e.g. knowledge workers, graduates); and

3. transfer (e.g. commercialization and industry application) of knowledge.

The way these three elements are combined is dictated by the talent involved and the environments where this talent results in innovation. For example, Western Sydney is the third largest economy in Australia and a global manufacturing hub of activity and commercialization, and three elements can be targeted for the successful knowledge-based development of Western Sydney:

1. the type of knowledge workers to be attracted;

2. the type of industries rich in KISA; and

3. the type of knowledge-based occupations of major revenue in terms of knowledge (Yigitcanlar and Martinez-Fernandez, 2007).
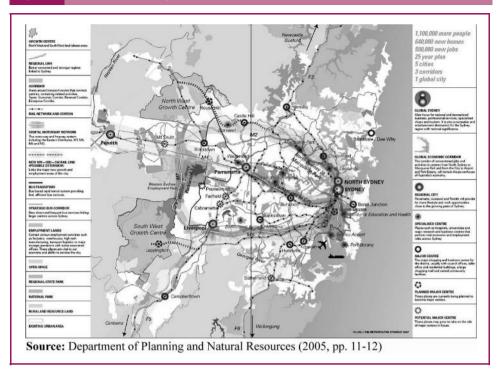
A possible typology is presented in Table II.

Porter (1998) points out that knowledge clusters cannot be ''created'', but rather they are ''stimulated'' through the right environmental conditions such as the support of knowledge-intensive and networking activities in strong knowledge industry sectors. Following Porter's point, many cities worldwide have been trying to provide the best environmental conditions to stimulate such KBUD. An innovation policy study analyzed Sydney in terms of its knowledge environment and concentrations, and this study has formed the bases of important policy documentation for the Sydney Metropolitan Strategy (Department of Planning and Natural Resources, 2005) where pockets of knowledge were identified across the Greater Sydney Region. Organizations identified include university campuses, CSIRO units, hospital and medical research units and CRCs' headquarters. There are clear concentrations of knowledge producing institutions in the Eastern and central suburbs of Sydney and in Ryde (see Figure 1).

The organization of knowledge in Australia's most global city, Sydney (Melbourne and Brisbane would follow similar patterns), is such that the central business district acts as a magnet attracting knowledge workers and knowledge institutions. As illustrated in Figure 1, the right environmental conditions seems to be provided at Sydney's global arc (the knowledge corridor including CBD and the airport). The same statement is not valid for Western Sydney as only a few knowledge institutions are located in the far West side of the Sydney corridor despite the growing population in Western Sydney, and therefore this creates a disadvantage in accessing knowledge for both a significant part of the population and for important contributing industries to the state of NSW and the nation (Yigitcanlar and Martinez-Fernandez, 2007). Traditional macro-economic strategies such as fiscal and labor force policies and international trade are important, but perhaps it can be argued that if the geography of knowledge precincts, producers and users matters for the knowledge-based development of Australian cities and in attracting talent, then knowledge strategies need to be linked to the development and planning priorities in the local area or region so that support policies can be designed more effectively.

Table II	A regional knowledge guide for knowledge precincts	
Knowledge workers	Rich knowledge-intensive service activity environments	Knowledge-based occupations
Information and communication technologies	Business services	Engineering and building
Business and financial services	Banking	Scientific
Managers (general and specialists)	Finance	Business and information
Technical workers	Insurance	Craft and trades
Scientists	Marketing	General management
Engineers	Education	
	Health	
Source: Martinez-Fernandez and Sharpe (2007, p. 53)		

Figure 1 Sydney's knowledge hub locations

Source: Department of Planning and Natural Resources (2005, pp. 11-12)

Concluding remarks: some reflections on the success of knowledge precincts

In this paper we emphasize knowledge precincts as the spatial nexus of KBUD, where the main promise of KBUD is a secure economy in a human setting – in short, sustainable urban and economic development. Velibeyoglu's (2001) research on ''technopoles of global information economy'' finds that knowledge precincts are evolved from science and technology, innovation and business parks, and the articulation of the technopolis concept over a long period of time. In addition to this, Searle and Pritchard's (2008) analysis of the three most common types of knowledge precincts proves that the evolution is not yet complete. Early knowledge precincts continued the mission of innovation parks by being solely oriented towards economic activity (e.g. Desert Knowledge Precinct, Australia), while more recent ones, or ''new generation'' knowledge precincts, are identified by having a more integrated and mixed land use pattern and a focus including residential and recreational uses within the precinct (e.g. One-North, Singapore). The latter forms a better model for the knowledge-based development of the twenty-first century's rising knowledge cities.

The important question many policy-makers face today is ''whether knowledge precinct development is a panacea of our most recent obsession of knowledge city formation'', or in other words, ''whether urban policy and management strategies can promote knowledge precinct development, and if so, how this should be done?''. We suggest the following several key points mainly considering KBUD's three purposes – i.e. economic development strategy, human and social development, and spatial relationship between urban development clusters – should be considered for the successful development of knowledge precincts.

First, there is a danger in successfully fulfilling the economic development purpose of KBUD for knowledge precincts by focusing on a particular type of technology or picking a winning knowledge base occupation. For instance, government regulations favoring certain knowledge fields can hamper other forms of new knowledge, resulting in a decline in knowledge attraction and, perhaps, urging scientists to emigrate. Policies oriented towards strengthening innovation systems therefore need to look not just at supporting the ''favorite knowledge industry of the month'', but also knowledge that might be more basic, fundamental and from which commercialization outcomes might not be clear at the present moment.

Second, to fulfill the human and social development purpose of KBUD, building networked infrastructures (both hard and soft) of a knowledge precinct with state-of-the-art offices surrounded by research centers or industry incubators is not enough to form a knowledge society and foster knowledge and commercial innovations unless a functional understanding of the dynamics of knowledge (generation, transmission and transfer) forms part of the equation. For example, universities today are magnets of specialized knowledge, and much knowledge migrates with the scientific and research staff of universities; this alone is a strategic tool for policy aimed at bringing knowledge into a city or region as supporting a knowledge society and scientific workers, and facilitating their participation in urban and regional networks would facilitate the circulation of knowledge. It is then necessary to ensure that this knowledge mixes, matches and expands through participation in networks. Policy-makers also need to be aware of the science and technology conditions operating in our globalized world today. There is increasing competition from other regions to attract scientists and industry talent; knowledge carriers are often targeted by other players to move institutions and knowledge bases.

Third, to fulfill the strong spatial relationship purpose of KBUD, planning policies and commercial strategies can certainly be structured to directly enhance the relevance of knowledge produced in a knowledge precinct, but the conditions for a high intensity of knowledge traffic are much more complicated than, for instance, the strategic use of land. A different set of skills is needed to develop knowledge networks where ideas can be trialed and discussed. Government policies, also at the local level, have a critical role to play in fostering the conditions and spatial relationships of urban development clusters, where accessibility, connectivity, integrity and intellectual vitality are made up of intensive collaboration networks that attract and retain knowledge carriers (agents, firms and workers). In part this responds to the view that local institutions, businesses and organizations are partners in fostering local development and are part of the local innovation system where they are embedded.

Lastly, we recommended that future research on the topics and issues addressed in this paper be conducted within the strategic context of KBUD research. The analysis of ''knowledge hubs'' and their elements and processes is still in its early infancy, and to extract lessons and conclusions that can be replicated into small scale ''knowledge precincts'' needs further exploration. Additional empirical research should focus on knowledge precincts and their contribution to the knowledge-based development of rising knowledge cities and urban-regions.

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Corresponding author

Tan Yigitcanlar can be contacted at: tan.yigitcanlar@ qut.edu.au

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