Spatial disruption and planning implication of the sharing economy: a study of smart work in Canberra, Australia

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Abstract: The advancement of the digital technology and the rise of the knowledge economy have facilitated a growing practice of smart work – working anywhere and anytime. This study approaches smart work as a form of the sharing economy, with a central concern on its spatial disruption to inform planning implication, based on a case study of Canberra, Australia. The analysis combines spatial clustering of smart workers at small community level with the practice and perception of smart work. The results suggest an emerging spatial disruption of smart work on both land use and space use, which implies a need for some new planning thinking for urban-suburban relationship, infrastructure provision, localised economic development, and spatial reconfiguration for communities and spaces. This study also suggests a cautious and critical approach to sustainability aspirations, which have in part elevated the recent enthusiasm in smart work and the broader sharing economy.

Keywords: sharing economy; smart work; knowledge economy; temporal-spatial flexibility; collaborative consumption; collaborative production; spatial disruption; consumption-production integration; sustainability; Canberra.

Reference to this paper should be made as follows: Hu, R. (2019) 'Spatial disruption and planning implication of the sharing economy: a study of smart work in Canberra, Australia', *Int. J. Knowledge-Based Development*, Vol. 10, No. 4, pp.315–337.

Biographical notes: Richard Hu's research cuts across urban design, urban science, and urban policy to investigate important contemporary issues concerning design excellence, global cities, urban competitiveness and sustainability, and place-based innovation in an environment of increasing uncertainty and change. His latest book is *Global Shanghai Remade: The Rise of Pudong New Area* (2019).

1 Introduction

This study unpacks the emerging spatial disruption of smart work to inform potential planning implication of its increasing practice and impact. It goes beyond the paradigm of 'collaborative consumption' (Hamari et al., 2015) to view smart work as a form of the sharing economy, and argues that smart work involves higher degree and complexity of temporal-spatial flexibility and consumption-production integration. The term 'smart

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work' builds upon the term 'telework' that has been in use for almost four decades (Nilles, 1976), but differentiates from it in significant ways. Despite various definitions, telework essentially refers to work undertaken in locations such as home or a remote place away from a traditional office environment (Alizadeh, 2009). Conceptually, telework has a strong relevance to the information and communication technology (ICT); smart work, however, has an explicit focus on being 'smart' in capturing a new way of working jointly facilitated by technological advancement and the knowledge economy.

Thus, this study situates the emergence of smart work in two broad contexts–the advancement of the digital technology and the rise of the knowledge economy–two interwoven and mutually facilitating processes (Pratchett et al., 2015). The exponential advancement of the ICT has revolutionised its application and accessibility: the newest round of the ICT development in the forms of user-centricity, mobility, and ubiquitousness has massively enhanced its use and efficiency (Deloitte Access Economics, 2011). This marks a fundamental spatial flexibility of smart work compared with telework, since the latter still has a strong locational attachment (Duxbury and Smart, 2011). The knowledge economy has been rising from the post-World War II decades in the transformation from industrial to post-industrial production. But its accelerated development since the 1990s has largely been driven by the advancement of the ICT (Hu, 2016). The ICT has significantly reduced the cost and enhanced the efficiency in the production, transmission, distribution, and use of knowledge and information. These knowledge activities often involve the practice of smart work. Hence, the technological advancement of the ICT and the rise of the knowledge economy have combined to lead to the temporal-spatial flexibility of smart work–working anywhere and anytime.

The above two broad contexts of smart work determine the selection of Canberra as the case study: Canberra has the highest level of digital access and the most knowledge-intensive economic base among Australian capital cities. This study combines secondary data from the Australian Census and primary data from an online survey to find out Canberra's digital access and knowledge capacity, spatial clustering of smart work, and practice and perception by smart workers. Drawing on these findings, this paper discusses the emerging spatial disruption and planning implication of smart work. It is organised as follows. After this introduction, Section 2 is a literature synthesis on smart work as a form of the sharing economy. Section 3 outlines the methods of the case study. Section 4 displays the results from the secondary and primary data analysis. Section 5 discusses spatial disruption and planning implication of smart work, and critically reviews the potential contribution of smart work to sustainability. The paper concludes with a summary of the study, limitations and suggestions on further research.

2 Smart work and the sharing economy

Both smart work and the sharing economy have attracted increasing research interest and policy debates, but the literature on them has been developing in parallel. The lack of a scholarly dialogue results from a gap in recognising the connections between the two important emerging urban phenomena; both are reshaping contemporary urban space and the way we approach it. This section reviews literature on each of them to identify themes and gaps, from which it further synthesises their conceptual links to argue for smart work as a sharing economy, with a particular focus on their nexus on a spatial dimension.

2.1 Smart work

Smart work provides a flexible style of working regardless of location and time (Wheatley, 2012). Work may be completed from home or at alternative locations such as cafés and libraries, which create a community atmosphere and increase connectivity (Wilmot et al., 2014). Smart work changes the spatial boundaries of work, breaking down the traditional barriers of how a workplace is operated, and allowing more flexible working conditions for employees and employers (Boell et al., 2013). Broadly speaking, smart work brings about benefits to individuals, business, and society, through reducing commute and alleviating traffic, diversifying work choices, enhancing business return, and providing localised economic opportunities. At the same time, it also faces challenges and problems, especially in employee performance and management relationship. Both pros and cons have been debated in research and policy discourses.

Traffic saving is a primary driver for advocating smart work. It has long been suggested that with improvement in technology like computers and phones, workers should be able to work from an office close to home instead of travelling into the central business district (CBD) of a congested city (Nilles, 1976). Smart work would reduce travel time and road congestion, not only for smart workers, but also for other road users during peak traffic periods (Access Economics, 2010). There are other associated benefits from reduced commute and traffic. The saving of time leads to a reduction in energy consumed (Graizobord, 2014), along with reductions in noise and pollution (Wilmot et al., 2014). Pressure on city infrastructure is reduced and there is less demand for governments to upgrade roads or increase public transport (Deloitte Access Economics, 2011). A decrease in traffic also leads to less accidents and lower insurance costs for other drivers, while smart workers have less fuel expenses and vehicle maintenance requirements (Deloitte Access Economics, 2011).

Smart work provides new opportunities for employees and employers that were not possible in the pre-digital age. Having more freedom with work can improve well-being and increase production (Bentley et al., 2013). Smart work opens up employment opportunities for disabled people and allows for greater equality within the workforce (Baker et al., 2006). Achieving a better work-life balance and improving family relationships are leading personal benefits from smart work (Graizobord, 2014). Women are more likely than men to undertake smart work to spend more time with family (Mokhtarian and Salomon, 1997). The more children employees have to take care of, the more likely they would be to complete work-related activities at home (Yen and Mahmassani, 1994). For business, smart work reduces the size of the office, saving fixed costs on real estates and utilities (Boell et al., 2013). Allowing access to smart work improves the options to attract talent. It removes the geographic barrier between home and work, and helps widen the talent pool available for recruitment possibilities (Deloitte Access Economics, 2011). Smart work also increases business resilience during events that impact the movement of people, such as transport strikes, natural disasters, and extreme weather events (Deloitte Access Economics, 2011). Smart work increases motivation and loyalty from employees too (Alvesson, 2000). Through being a workplace of smart work, businesses can raise their corporate image by being viewed as an organisation that is modern, sustainable, and supportive (Pyöriä, 2011). This can attract more interest from investors and workers due to the flexible working conditions and arrangement.

Smart work enables a spatial proximity of home and work to drive the local community development. Spatial distribution of population and employment impacts commuting patterns, and has generated many contemporary urban and planning challenges, such as congestion, sprawl, and sustainability (Regional Development of Australia, 2013). Smart work provides a new opportunity for local economic development, since working from home makes it easier to access services at local commercial centres (Wilmot et al., 2014). Smart work further provides the option to increase employment numbers in regional areas where employment prospects are less likely than in urban centres (Pyöriä, 2011). Smart work allows the flexibility for residents to choose their desired locations to live. Being allowed to smart work means that the location of their workplace does not become a factor if they choose to move their place of residence. This is likely to move knowledge workers out of urban areas and into the outer city areas where land is cheaper (Alizadeh, 2013). The flexibility of residential locations means that urban patterns become decentralised with suburban employment increased (Alizadeh, 2013). This tends to create more economic development opportunities in the traditional dormitory suburbs and provides new opportunities for the outer communities to counter the magnet effect of CBDs that have concentrated jobs and opportunities.

Despite its widely recognised benefits, however, smart work has several major barriers and challenges, which limit its potential as a new mode of work. Not having a physical presence in the office can lead to less consideration from the organisation for promotion or advancing in a career (Pyöriä, 2011). The lack of face-to-face interactions with managers may also lead to mistrust with managers and colleagues; working at home limits the opportunity to gather learning from spontaneous events or gaining tacit knowledge; and if a problem occurs, smart workers will have less technical assistance available (Pérez et al., 2002). While smart work removes time commuting to work, it does risk longer hours being used for work (Deloitte Access Economics, 2011). There are risks for family conflict due to being distracted from family responsibilities for work (Davis, 2002). Work materials at home may lead smart workers to constantly think about getting more work completed, even during leisure moments spent with family (Tremblay and Thomsin, 2012). This could be so especially during periods when an individual might feel behind schedule on work.

The vast body of literature on smart work has examined its advantages and disadvantages for almost four decades along with digital technological advancement and its wider practice. But the perspectives employed remain largely the same: economic productivity and saving, organisational management, and work-life interface. What is missing is a due attention to its spatial impact on land use and space use. The spatial dimension of smart work is of increasing prominence and importance, with the rapid technological progress in ubiquitous access to information that is enabling ‘working anywhere’. This spatial flexibility of smart work embodies a strong attribute of ‘sharing’– sharing space with other activities and urban functions within the same space. The ‘sharing’ in smart work naturally builds up a conceptual relationship with the sharing economy in the first instance, although there are more conceptual connections between them as discussed later.

2.2 The sharing economy

The sharing economy is essentially about the collaborative consumption through the sharing of unused services and products (Hamari et al., 2015). The ‘sharing’ concept is

not necessarily new in that our conventional understanding of economics is exactly about transacting or 'sharing'. However, its recent surge has benefitted from improved information technology that keeps users in instant contact, and it started growing rapidly in the aftermath of the global financial crisis 2008 (Andersson et al., 2013). Through online collaboration, online consumption, and social connections, users access the sharing economy to loan a service to another individual for a limited time (Hamari et al., 2015). The global financial crisis 2008 questioned the ideas of economic ownership and materialism, and began pushing for more sustainable use of resources (Andersson et al., 2013). The growth of the sharing economy has renewed a belief in the importance of community, advancement in technologies with peer-to-peer network, environmental concerns, and the global recession (Botsman and Rogers, 2010).

Despite providing pathways towards sustainability, the sharing economy has caused controversy by disrupting mainstream consumerism (Heinrichs, 2013), and challenging the traditional way governments regulate business and plan communities. Airbnb's hotel-like services are in areas that are not traditional locations for hotels to be placed for tourists (Zervas et al., 2016). The ride sharing service by Uber is similar to a taxi company, but is used through an application and the companies are built by social networking (Cohen and Kietzmann, 2014). Problems exist within the sharing economy because companies evade regulations through their certain business models (Schor and Fitzmaurice, 2015), and people working in the sharing economy are not employed by the business and are independent (Ranchordás, 2015). Thus, there is a complication for regulators on whether they should limit the growth of the sharing economy and enforce laws and rules to limit its advantage over competitors, or encourage the sharing and consider it an innovation (Ranchordás, 2015).

Urban form has played a role in the recent popularity of the sharing economy through mixed land uses, increased density and higher land prices (Agyeman et al., 2013). The most notable sharing economy forms are transport sharing and space sharing. The early bike sharing failed in Amsterdam in the 1960s, but later it was successful in Copenhagen in the 1990s (Shaheen et al., 2010). Car sharing is a latecomer, but has gained rapid popularity with much quicker and deeper impact than bike sharing. Studies have identified some correlations between car ownership and sharing, and urban form. Car ownership makes less sense in dense urban centres, where services are within close distance and roads are usually more congested (Belk, 2014). Peer-to-peer car sharing activities are attractive options for commuters in low-density residential neighbourhoods, where car use is frequent and preferred over public transport options (Hampshire and Gaiites, 2011). Shared transport works as a complement to public transport modes, decreasing car ownership, enhancing urban mobility, saving costs, and contributing to sustainability (Shared-Use Mobility Center, 2016). Users of ride sourcing activities tend to drive less, sell their cars, or delay purchasing new ones (Martin et al., 2010). In addition, there is a social-demographic dimension of sharing cars. The shared modes are more accessible to younger people than the elderly residents due to technology literacy and physical mobility (Li et al., 2016). But, elderly residents are more likely to live in the fringes, where usually have limited access to public transport options.

Like transport sharing, space sharing has also generated interest and controversy over regulation, planning, and zoning. Airbnb rivals the hospitality industry with hotels being located usually in commercial centres and well regulated, while spaces for Airbnb are in

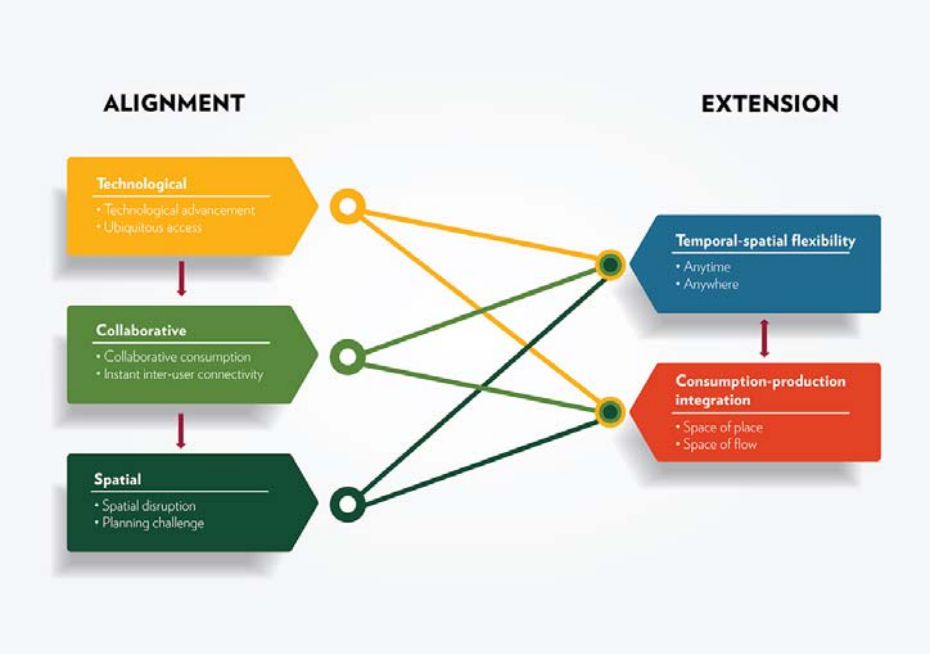
the suburbs or quiet residential areas (Geron, 2013). Zervas et al. (2016) find that the Airbnb service has increased tourism and encouraged users to travel more, and is more flexible to peak demand, particularly in cities that feature a high seasonal demand of tourists. Providing unused spaces for tourists in residential neighbourhoods also brings economic benefits to local commercial services through attending local attractions, restaurants, and shops (Abelsohn, 2014). On the other hand, Airbnb has caused controversy in various cities through violating planning zones and avoiding regulation (Gurran and Phibbs, 2017). It disrupts planning controls and generates problems on land use zoning for many residential areas where commercial activities are prohibited, including hotels (Davidson and Infranca, 2016). In practice, cities differ in responding to the new mode of space sharing. In New York, penalties have been applied to Airbnb hosts for breaking planning controls and the legal requirements of their property (Abelsohn, 2014). Seoul, however, has encouraged elderly residents to share spaces with younger people to build connections between generations and save space (Dlugosz, 2014).

The growing body of literature on the sharing economy, like the smart work literature, has also focused on a dichotomy of pros and cons of it. But the sharing economy literature incorporates an explicit spatial dimension into its analysis and critique, which is insufficiently addressed in the smart work literature, however. On the other hand, the sharing economy has been conceptualised as 'collaborative assumption' on the basis of its early stage of development that mostly involved 'sharing' of the unused products or services. This conceptualisation is proving insufficient in capturing the increasing practice of 'collaborative production' through 'sharing', where smart work right fits into. The gaps in the scholarship on smart work and the sharing economy, and their complementarity, creates a conceptual cross-fertilisation of them as outlined below.

2.3 Smart work as a sharing economy: conceptual alignment and extension

How does smart work fit into the sharing economy? Synthesising the literature reveals both conceptual alignments and extensions between them, as illustrated in Figure 1. Smart work is aligned to the sharing economy through three common attributes. The first attribute is technological. The advancement of the digital technology and resultant ubiquitous access to information and service platform has significantly improved the connectivity between smart workers, or the users of the sharing economy. The second attribute is collaborative. Collaborative consumption defines the sharing economy. For this attribute, co-working space is the most representative of the sharing economy among many forms of smart work. Related to the first attribute, instant inter-user connectivity makes seamless collaboration between them possible. The third attribute is spatial. Urban form plays a role in the practice of smart work and other forms of the sharing economy, such as transport sharing and space sharing. They all have various degrees of spatial impacts, creating new contexts for urban management and regulations, and challenging modern planning tools of land use and zoning. These three attributes form a progressive relationship, in which the technological advancement has enabled the collaboration, which has further generated the spatial impacts.

Figure 1 Smart work as a sharing economy (see online version for colours)



On the basis of the three common attributes, smart work extends the sharing economy through two distinctive attributes: temporal-spatial flexibility and consumption-production integration, which are in a mutually supportive relationship. For one, the temporal-spatial flexibility is reflected by 'working anytime and anywhere', which blurs the conventional division of working hours and non-working hours, and the division between working space and other space uses, such as living and consumption. For the other, the consumption-production integration goes beyond collaborative consumption to incorporate a production component into the conceptualisation of the sharing economy. To explain this, Manuel Castells' (2000) concepts of 'space of place' and 'space of flow' provide useful lenses. Let's start with co-working, which is the most aligned to the sharing economy's collaborative consumption. But co-working involves not only collaborative consumption, but also collaborative production: co-working enables an emergent collaborative production in the form of 'working alone together' through networking within a given space (Spinuzzi, 2012). In this sense, co-working integrates consumption and production in a 'space of place', since co-working space is still an office-like space, which is 'shared'. However, smart work is more than co-working; it is about 'workplace mobility' (Pajević and Shearmur, 2017). 'Working anywhere' liberates smart workers from collaborating in a space of place only. The spatial flexibility involves collaborative consumption with different users or with different land/space uses. At the same time, it involves collaborative production with workers elsewhere, through creating and sharing a 'space of flow', which is only possible in the contemporary contexts of digital technology and the knowledge economy as argued in the beginning. These attributes of temporal-spatial flexibility and consumption-production integration of smart work builds upon and extends the foundational attributes – technological, collaborative, and spatial – of the sharing economy, an evolving concept itself.

3 Methods

Underpinned by the above framework of smart work's alignment to and extension from the sharing economy, this study investigates its emerging spatial disruption and planning implication. It is based on a case study of Canberra, Australia, undertaken through three major steps. They involved collection of secondary data from Australian Census 2011 and 2001, and primary data from an online survey.

In step 1 Canberra was situated in Australia's national context to understand its digital access and knowledge capacity, which form the basis for smart work. Canberra was compared with the other Australian capital cities in terms of household with broadband internet access and populations with tertiary qualifications, using data from Australian Census. Australia is a highly urbanised society with high concentration of residents in the capital cities, which are vastly spread along the coastlines of the continent except for Canberra (Figure 2). Occupying only 1% of the nation's land area, the eight capital cities accommodated 66% of national population, and 63% of national employment according to Australian Census 2011 (Table 1). For the digital access, this study measured the percentage of households with broadband internet access as in 2011. For the knowledge capacity, this study used location quotient (LQ), a technique that calculates the concentration of population with tertiary qualifications in each of these cities with reference to Australian nation, and its time series changes in 2001–2011, to measure the knowledge base of Canberra compared with other capital cities. Three variables of the knowledge population–LQ in 2011, LQ change in 2001–2011, and employment share in 2011–were plotted for the eight Australian capital cities to illustrate Canberra's knowledge capacity in the national context. On the basis of measuring the digital access and the knowledge capacity in step 1, steps 2 and 3 further unpacked smart work in Canberra.

Step 2 mapped the spatial distribution of smart workers in Canberra. Geographically, the study area extended outside the Australian Capital Territory (ACT) to cover its surrounding region in New South Wales (NSW), since Canberra's urban functions and economic activities cross the administrative borders: many people live outside the ACT, but work inside the ACT, or vice versa. The ACT and its surrounding region include 15 Statistical Area Level 3 (SA3), and 146 Statistical Area Level 2 (SA2), which are delineated by the Australian Statistical Geography Standard (ASGS) 2011, in total. The smart workers were then calculated according to three variables collected from the Census 2011:

1 employment in high-skilled occupations at either Managers or Professional levels classified by the Australian and New Zealand Standard Classification of Occupations (ANZSCO) 2006

2 employment location was outside of the SA3 of residence location

3 working at home on the day of the 2011 Census.

They were selected from Census as proxies of smart workers out of these considerations: variable 1 is used to capture knowledge workers whose work requires certain degree of skills and knowledge, variables 2 and 3 are used to capture the knowledge workers who need to commute to work but work from home instead. The LQ technique was used to calculate the concentration of smart workers at the SA2 level, a small community level, with reference to the whole ACT and surrounding region. They were mapped out using

Esri ArcGIS to illustrate spatial distribution and identify clusters. It should be noted that there are limitations in the Census data by focusing on smart workers working at home instead of commuting. They do not capture people whose employment location is close to residence, that is, within the same SA3. Further, smart work includes, but is not limited to, working at home. However, working from home is the most appropriate proxy available in the Census data; it is already used in a similar study (Matthew et al., 2015). Considering these limitations, a survey was used in step 3 to capture smart workers working anywhere including home.

Figure 2 Geographical locations of Australian capital cities (see online version for colours)

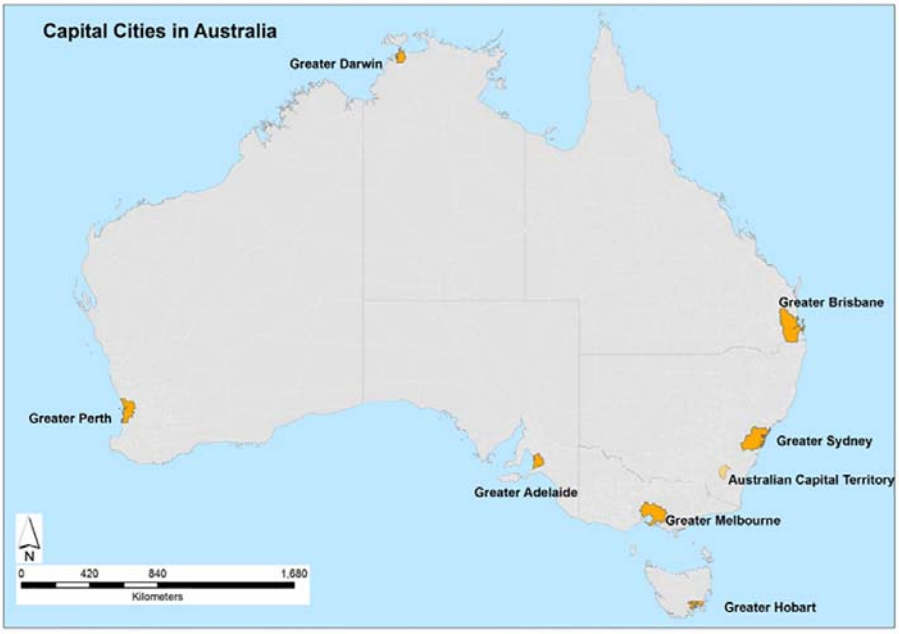


Table 1 Australian capital cities

Capital Cities	*Population*	*Employment*	*Land area* (km²)
Australian Capital Territory	356,586	207,901	2358
Greater Adelaide	1,225,234	523,354	3258
Greater Brisbane	2,065,998	925,387	15,826
Greater Darwin	120,586	56,666	3164
Greater Hobart	211,655	92,277	1696
Greater Melbourne	3,999,980	1,756,402	9991
Greater Perth	1,728,865	751,804	6418
Greater Sydney	4,391,673	1,874,115	12,368
Total of Capital Cities	14,100,577	6,187,906	55,077
Australia	21,507,719	9,807,530	7,692,000
Share of Capital Cities in Australia	66%	63%	1%

Data source: Australian Census 2011

Step 3 investigated the practice and perception of smart work that could not be reflected in the Census data. A survey was designed to ask about to what extent smart work has been accepted, practised, and what are the major benefits and barriers. Given the focal inquiry on smart work, the survey was distributed online among the ACT Government, the Commonwealth Department of Finance, and the business sector. The survey was open for responses in October and November 2014. The first batch of 110 responses was used for this study.

4 Results

4.1 Digital access and knowledge capacity in Canberra

Canberra is leading the other Australian capital cities in the two contextual factors that underpin the practice of smart work: digital access and the knowledge economy. As in 2011, Canberra had the highest digital access, and the most intensive knowledge capacity. Canberra was the only Australian capital city where more than 80% of households accessed broadband internet (Figure 3). Canberra had the highest concentration as well as the largest proportion of people with tertiary qualifications (Figure 4). The LQ of Canberra's knowledge population was 2.4, the only Australian capital city with an LQ value of more than 2; the share of Canberra's knowledge population was 20.16%, the only Australian capital city with a share of more than 20%. Though the LQ change of knowledge people in Canberra was slightly ahead of Darwin only in 2001–2011, this was largely attributed to its comparatively high LQ values in both years. The values of the three variables (LQ in 2011, LQ change in 2001–2011, and knowledge population share in 2011) for the eight capital cities plotted in Figure 4 are provided in the Appendix. Overall, all Australian capital cities increased their concentration of knowledge capacity in the first decade of the 21st century, reflecting a national transition towards a knowledge economy.

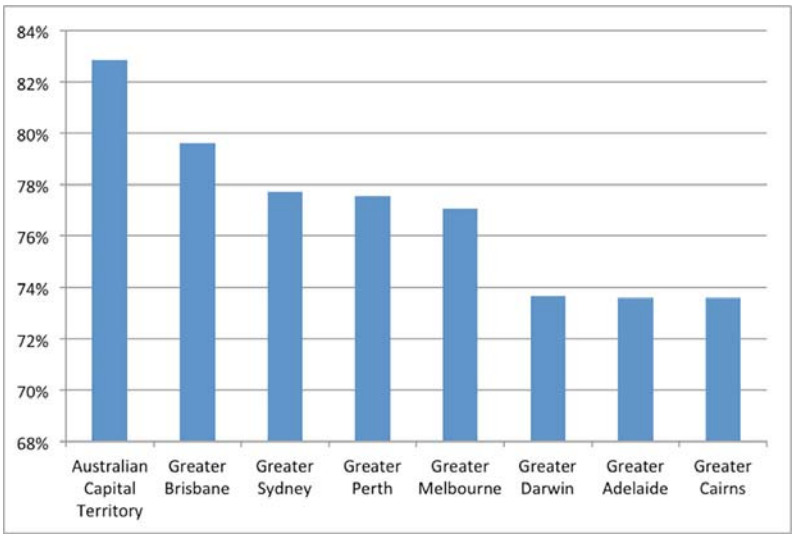
The knowledge economy brings new opportunities for smaller cities. Although size still matters, its importance is much less than it was for cities with industrial or manufacturing economic base (Pratchett et al., 2017). Globally, there are many cities or areas that are known for being innovation and knowledge hubs, such as San Hose with Silicon Valley, Tel Aviv, and Austin. However, their sizes are obscured by mega metropolises. In Australia, Canberra is the smallest capital city according to several traditional city measures – population, employment, and economic scale. However, it stands out in measures that focus on the intensity of knowledge capacity (Hu, 2015a).

4.2 Spatial patterns of smart work in Canberra and surrounding region

Several patterns are observed from the spatial distribution of smart workers in Canberra and surrounding region. Within the ACT, there are three spatial clusters: Gungahlin, Weston Creek, and Tuggeranong (Figure 5, highlighted in dashed circles); outside the ACT, two spatial clusters exist in the neighbouring regions of Queanbeyan and Yass in NSW (Figure 6, highlighted in dashed circles). A regional perspective is necessary to apprehend smart workers in Canberra, since its labour market and many socio-economic activities interact across the ACT-NSW borders. The ASGS 2011 delineates Canberra-Queanbeyan as one Significant Urban Area (SUA) according to urban functions and

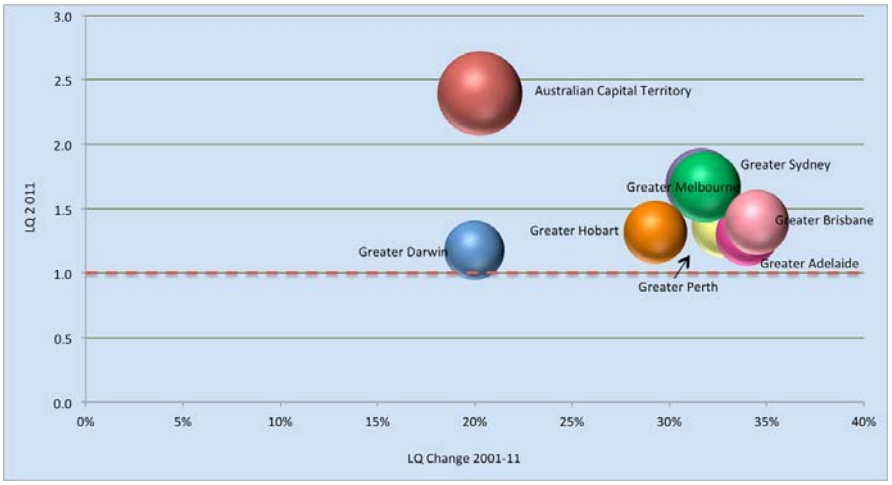
labour markets instead of administrative boundaries. Not surprisingly, these spatial clusters of smart workers are in the fringes, away from major employment centres, given the way the data was collected to reflect the need of commuting between the worker's employment location and residence. However, these clusters are not in residential areas only; they tend to be located around suburban town centres. This is especially so in Gungahlin Town Centre and its surrounding area that has the highest level of concentrated smart workers across the Canberra region.

Figure 3 Digital access in Australian capital cities (see online version for colours)



Data source: Australian Census 2011

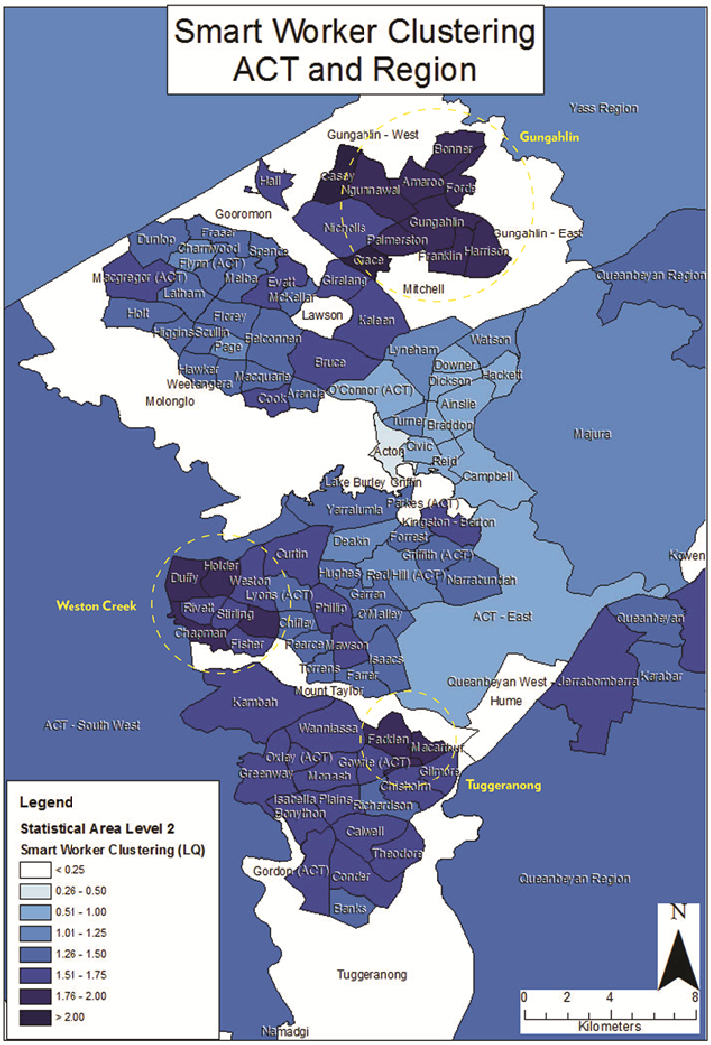
Figure 4 Knowledge capacity of Canberra and Australian capital cities, 2001–2011 (see online version for colours)



An LQ value of more than 1 marked by the dashed line represents a level of concentration above the national average.

Data source: Australian Census 2001 and 2011

Figure 5 Smart worker clustering in ACT (see online version for colours)



4.3 Smart work practice and perception in Canberra

The survey results attest smart work as a common practice in Canberra temporally and spatially: 63% of respondents ever worked outside of normal working hours; 43% of respondents ever worked away from office. The regularity of smart work was mostly on a daily base, or weekly base. One open-text question was asked about the types of tasks that the respondents felt the most productive through smart work. A word cloud calculation of the text answers reveals that the tasks are predominantly knowledge-based activities, such as writing, research, reports, reading, emails, documents, and meetings (Figure 7). Some of these results are counterintuitive. People tend to assume that

smart work is more applicable to codified knowledge activities that can be easily facilitated by digital technology, while tacit knowledge activities require higher degree of face-to-face communication (Johnson et al., 2002). However, the open-text answers indicate that 88% of tasks are codified knowledge-based (e.g., reading, writing, emails), and 54% of them are tacit knowledge-based (e.g., research, thinking, meeting). Smart work is then conducive to generating both codified knowledge and tacit knowledge, although the former has a higher response rate than the latter. Further, the aspiration for smart work is very high: 81% of respondents express a willingness to participate if smart work opportunity is available.

Figure 6 Smart worker clustering in ACT's surrounding region (see online version for colours)

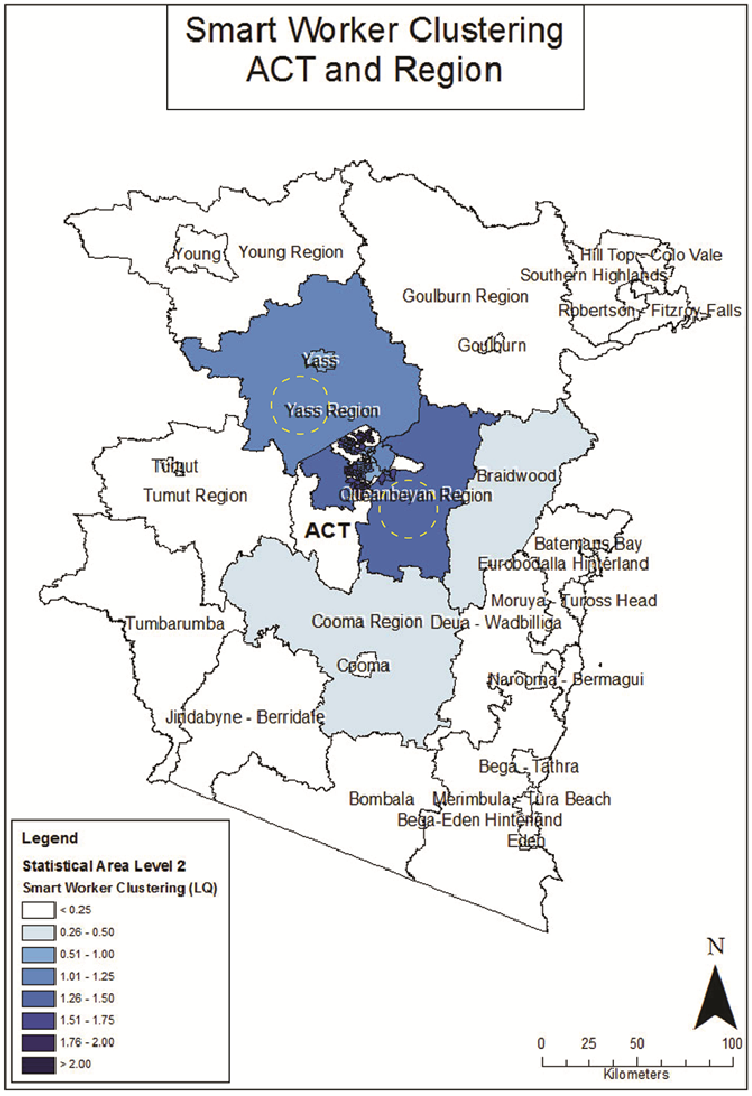
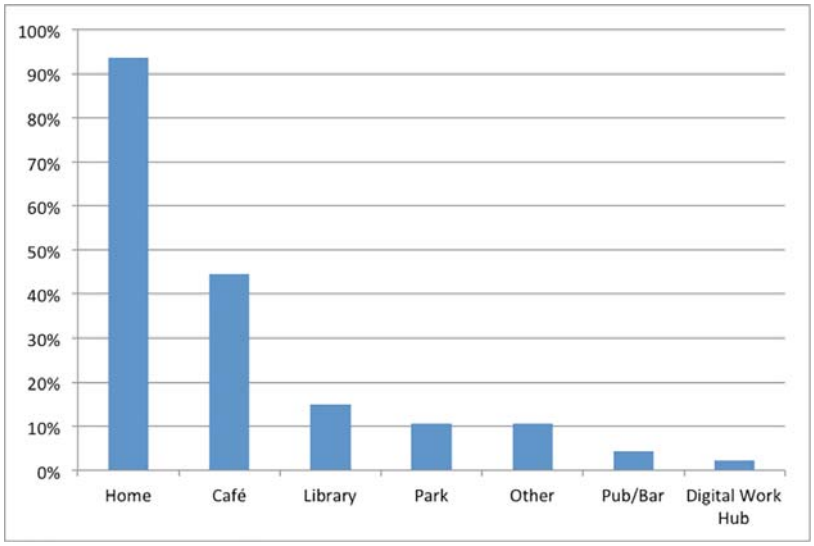


Figure 7 Productive smart work tasks (see online version for colours)

The locations of smart work include both private and public places, with their conventional space uses being transformed to incorporate work activities (Figure 8). The most common place is still home. A distant second place is café, which is becoming an important part of 'the third place' other than home and office. Library, as the third place of smart work, is shifting its space use for education and community service to a flexible working space. Park is incorporating smart work into its uses of public space mainly for leisure, entertainment, and social interaction. Digital work hub, dedicated co-working space, has the lowest participation rate, however. This is probably due to a lack of provision and availability in the ACT region at the moment. The demand for and shortage of digital work hubs point out a need to plan and develop more of them, especially in the suburban and regional town centres where smart workers cluster.

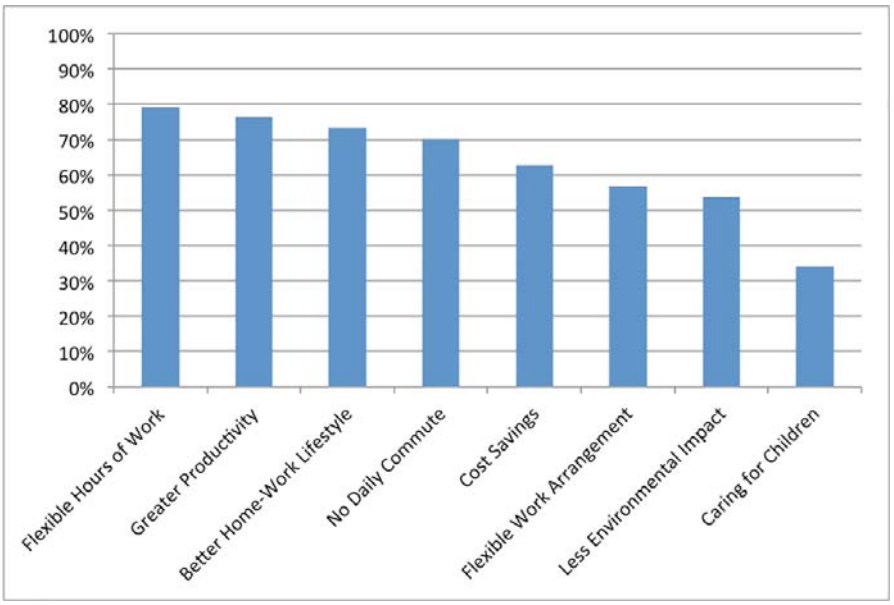
Figure 8 Locations for smart work (N = 110) (see online version for colours)



Respondents indicate both converging and diverging views on the pros and cons of smart work. There are three broad benefits of smart work: flexibility, productivity, and saving (Figure 9). These benefits are broadly aligned to the three dimensions of sustainability: economic dimension in productivity, and cost saving; social dimension in lifestyle, work-life balance, and family commitment; and environmental dimension in reducing commute and thus environmental impact. Of the benefits perceived, flexibility is of primary

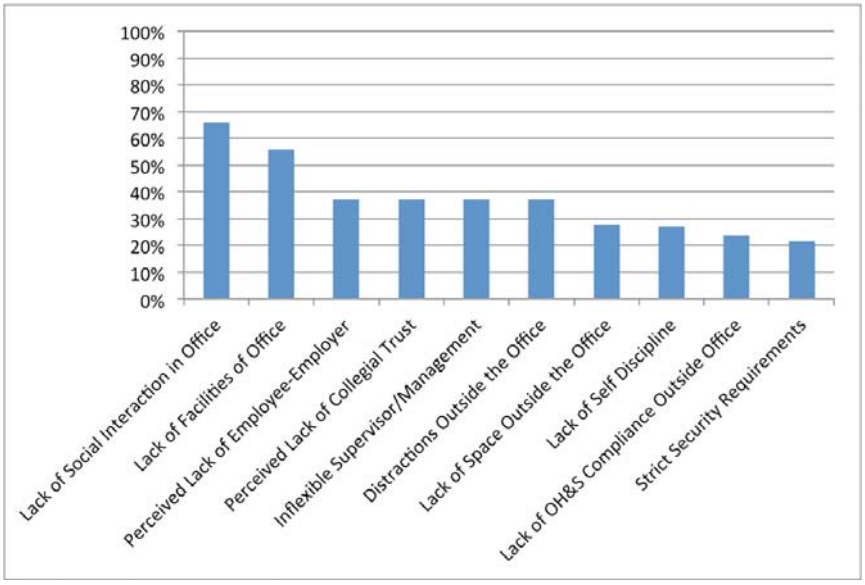
importance, which incorporates temporal flexibility, spatial flexibility, as well as organisation and management flexibility. This flexibility marks a fundamental difference of the new economy of knowledge and innovation, or the post-industrial economy, from the traditional industrial economy (Blakely, 2001).

Figure 9 Benefits of smart work (N = 110) (see online version for colours)



The barriers of smart work fall into three broad categories: working relationship, working facilities, and self-management (Figure 10). First, working outside of office generates two types of problematic working relationships. One is the lack of social interaction in office, may it be inter-personal or work-related discussion. This is important for organisational culture and productivity. Smart work is applicable to both codified knowledge and tacit knowledge as identified above. But there are occasions when face-to-face interaction is indispensable, especially for tacit knowledge; face-to-face interaction is more effective for creating tacit knowledge than digital communication (Storper and Venables, 2004). The other derives from the pathway dependence of organisational culture and management approach that were rooted in the pre-knowledge economy. Being absent from office and team generates distrust and marginalisation if the organisational culture is not established for smart work yet (Pyöriä, 2011). In addition, working in non-office environment involves security and confidentiality of business, and occupational health and security (OH&S) that need to be solved technically and legally. The second broad barrier is the lack of ready facilities and space outside of office. As stated above, this barrier calls for more digital work hubs to accommodate smart work. The third barrier is personal. Working outside of an organisational space challenges self-management and disciple and thus impacts focus and productivity. Applicability of and adaptability to smart work differs by individuals.

Figure 10 Barriers of smart work (N = 110) (see online version for colours)



5 Discussion

Discussion on the empirical results of smart work in Canberra draws upon the conceptualisation of smart work as a sharing economy argued earlier: smart work shares defining attributes of the sharing economy and extends its conceptual boundary. The discussion takes a spatial perspective. It first discusses the spatial disruption of smart work through 'sharing' land use and space use, then it discusses planning implication of the new spatial use patterns. The discussion finishes with a critical revisit to the sustainability tenet in the sharing economy discourse.

5.1 Spatial disruption

The study of Canberra illustrates that smart work, among other things, involves a 'sharing' of land use and space use. It is in land use and space use that smart work presents some forms of emerging spatial disruption at macro and micro spatial levels respectively. At a macro level, smart work clusters in or near suburban centres surrounded by residential zones. This locational characteristic of smart work is similar to other forms of the sharing economy like Airnbn and Uber (Geron, 2013; Hampshire and Gaiites, 2011). However, smart work has a higher degree of spatial mobility while Airnbn has spatial attachment to residential areas, and Uber to the areas with low density and less accessibility to public transport. The spatial dominance of smart work at home in Canberra could be in part attributed to the constraints of digital technology access elsewhere (e.g., public space), lack of digital work hubs, and organisational management and culture. The spatial patterns of smart work are very likely to change in the future with these constraints lifted to further reach its potential of 'working anywhere'.

At a micro level, smart work encroaches into spaces that are not traditionally for work-related activities. Working from home is not new itself; what differentiates the current phase of smart work is its increasing practice and acceptance (Bloom et al., 2014). Further, smart work encroaches into what is called 'the third place' other than home and office, such as café, restaurants, pubs, libraries, park, and public transport. This disruptive effect involves spatial reconfiguration not only of non-workspace for work activities, but also of workspace for non-work activities. Consequently, we see special allocation of space for smart workers in Starbucks; we also see the living and leisure spaces in offices of Google. The widespread of smart work blurs the conventional division between space uses (Blakely and Hu, 2019). At this emerging stage, the most felt impact is on blurring the division between working and living through working at home (Pratchett et al., 2015). This blurring is also increasingly felt in the 'domestication' of commercial space, through bringing creativity and comfort into office design to make it 'homey'. These emerging spatial disruption of smart work, at both macro and micro levels, well fit into the argument for 'post-functionalist cities': cities are no longer based only on predetermined and designed functions since the boundaries between traditional urban functions have become blurred, different functions co-exist in the same spaces, and new functionalities emerge as people take space into new uses (Marino and Lapintie, 2017).

5.2 Planning implication

The emerging and anticipated spatial disruption of smart work informs a revisit to the urban-suburban relationship and a rethinking of spatial configuration of community and place. The conventional dichotomy of the urban and the suburban is largely built upon the locational separation of working and living, and are linked through commuting and transport infrastructure. Smart work provides a new lens to examine infrastructure provision and urban and suburban development. Integrating digital infrastructure with transport infrastructure in a mutually supportive manner to grow suburban and regional communities requires effective policy discussions and implementations (Alizadeh and Sipe, 2016). Combination of both physical and virtual connectivity contributes to a city or region's competitiveness in a globalised knowledge economy (Hu et al., 2013). Economically, suburbanised employment generates a commercial floor space demand and associated economic opportunities for local communities, in addition to savings of time and cost (Pratchett et al., 2015). Similar localised economic opportunities are observed in other forms of the sharing economy like Airnbn (Abelsohn, 2014), though they do not function in similar ways to smart work.

At a regional level, smart work has triggered an increasing interest in and demand for digital work hubs within Australia and across the world (Regional Development Australia, 2013). The locational preference is the regional centres that have certain distance from the CBD through public transport or roads, but are comparatively easy to access for surrounding communities. In July 2014, the NSW Government announced five regional centres (Rouse Hill, Oran Park, Penrith, Gosford, and Wyong) for digital work hubs across the Greater Sydney region, which all fit these criteria of locational preferences. This study of Canberra identifies a smart work cluster in Gungahlin, which is linked to the Civic area through a light rail system completed in 2019. Indeed, the local community in Gungahlin has advocated for a digital work hub for years (Peake, 2015). Or, the digital work hubs are not necessarily suburban, but co-working spaces dedicated

to knowledge-based, creative, digital, and sharing economy, with a propinquity to the so-called 'creative cluster' (Mariotti et al., 2017). It is envisaged that more such digital work hubs or co-working spaces will be proposed and developed in light of the broader social and political interests in smart cities and communities in Australia and across the globe.

Smart work implies a new spatial configuration approach to communities and spaces where they take place. Although the functionalist division of urban spaces into the basic functions of housing, work, leisure, and mobility has been criticised since the 1980s, it still dominates land use planning today (Marino and Lapintie, 2017). A new thinking informed by smart work needs to be appreciated by the planning and design professions first, and then gradually translated into practice. For such a community, commercial spaces and facilities within walking distance are necessary to cater for the need of smart workers at home, including café, hot desks, meeting rooms, printing, and postage, in a similar, if not exactly the same, way to they are in the office areas. This thinking requires a change from planning a community of 'residential' land use only; it also requires a change from designing home of 'living' space use only. However, the traditional land use planning regime remains an impediment to the planning of such communities (Alizadeh and Sipe, 2013). Simply from a home design perspective, converted or adapted studio space at home is common now, but it is not a common approach well established in the design profession yet. The standardised home design remains living-centric, unless it is a customised design, or required by the owner to incorporate or increase flexible workspace. A futurist approach to community planning and home design needs to be employed to respond to and anticipate the increasing practice of smart work and its requirement for spatial reconfiguration. To put these implications in a broader context of transitioning from a 'functionalist' to a 'post-functionalist' city: most of the current planning approaches and instruments are still based upon the concept of the functional city; the post-functionalist city still serves major functions for society, but its spaces are increasingly multifunctional, mixed, and changing (Marino and Lapintie, 2017).

5.3 A new pathway to sustainability?

The most profound planning implication of smart work and the broader sharing economy is that it seems to point out a new direction of addressing the contemporary challenge of sustainability (Heinrichs, 2013). This expectation justifies the increasing aspiration for the practice and debates of the sharing economy (Schor, 2014). This is exactly where planners and policy makers need to be cautious about the very nature of smart work, and the extent of its potential contribution to sustainability. Over-simplistic or over-optimistic judgement on the association between smart work and sustainability would mislead planning and development towards undesired outcomes. If sustainability is understood in its broad sense of incorporating the triple dimensions of economy, environment, and society (World Commission on Environment and Development, 1987), clearly smart work demonstrates benefits that are generally aligned to the three dimensions as found by this study earlier.

However, the understanding of the benefits of smart work is one dimensional, focusing on either economic productivity, or environmental friendliness, or work-life balance. The key lies in integrating them into one nexus of sustainability. The triple dimensions of sustainability embody more contradictions than synergies (Hansmann et al., 2012). Thus, the challenge is how to fix the contradiction to achieve a balance in contemporary planning for sustainability (Hu, 2015b). Applying smart work to the

wicked problem of sustainability, it remains unclear to what extent smart work is likely to contribute to fixing the contradictions to achieve a balance of economic growth, environmental friendliness, and social inclusion. So far, the sustainability opportunity from the sharing economy is more an aspiration than a reality, with limited and mixed evidence in coupling economic return with ecological impact and social capital (Schor, 2014). As found in this study, the practice of smart work has always involved pros and cons. Increased productivity and reduced environmental impact are often achieved at the cost of longer working hours and encroachment into private life (Tremblay and Thomsin, 2012). The move forward or backward of smart work largely depends on whether its benefits prevail over its drawbacks, or vice versa. The presumed sustainability opportunity requires a good understanding of its mechanism, sophisticated policy design, and effective implementation. It is worth exploring, but requires more time and practice to uncover and test.

6 Conclusion, limitation and further research

This study bridges smart work and the sharing economy, which have been developing in parallel in the literature. It fuses the two concepts through complementing and filling each other's gaps: the sharing economy injects a spatial dimension and 'sharing' element into approaches to smart work, and smart work brings 'collaborative production' to supplement the 'collaborative consumption' that has defined the sharing economy. This conceptual cross-fertilisation creates a framework underpinning smart work as a sharing economy: they are aligned in terms of digital facilitation, collaborative consumption, and spatial disruption, but smart work extends the 'sharing' by higher degree and complexity of temporal-spatial flexibility, and consumption-production integration. This framework is applied to analysing, interpreting, and discussing the empirical results of smart work in Canberra with a central concern on spatial disruption and planning implication.

Through 'sharing' land use and space use, smart work is presenting an emerging form of spatial disruption at macro and micro levels. At the macro level, smart work challenges traditional land uses and zoning by bringing work and work-related activities into the residential areas and other land use precincts such as retail and amenity. At the micro level, smart work blurs the spatial divisions between working and living, and other space uses including education, entertainment, and public space. This disruption is enabled by the extended 'sharing' of the smart work characterised by temporal-spatial flexibility, and consumption-production integration. This emerging spatial disruption informs a new thinking to the orthodox planning approaches, which had been rooted in an industrial age, to adapt to the new mode of urban activities and functions in a post-industrial age characterised by the digital technology and the knowledge economy. The planning implication of the sharing economy, as suggested by the spatial disruption of smart work, informs a re-imagining of land use and space use to incorporate increasingly flexible spatial patterns involving urban-suburban relationship, infrastructure provision, localised economic development, and community planning and space design.

This preliminary study intends to trigger continued intellectual exploration and policy debates on smart work aligned to the evolving sharing economy. It has limitations in data availability and collection, which suggest areas for further research. The proxy of 'working at home' in Census does not fully capture smart workers; this explains why an online survey was undertaken to supplement Census data. Further empirical research may

include a comprehensive household and workplace survey, undertaken among targeted smart work groups, coupled with interviews with representative smart workers. Insights drawn from these width and depth of data collection will further test the arguments of this study.

Acknowledgements

I wish to acknowledge the research assistance provided by Joseph Sutton, Sajeda Tuli, and Lucas Carmody. Coco Liu assisted with the figures.

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Appendix: Knowledge base and change in Australian capital cities

Capital Cities	*LQ 2011*	*LQ Change* 2001–2011 (%)	*Population Share 2011* (%)
Australian Capital Territory	2.40	20.27	27.67
Greater Adelaide	1.30	34.00	14.99
Greater Brisbane	1.39	34.49	16.10
Greater Darwin	1.18	19.97	13.60
Greater Hobart	1.32	29.28	15.24
Greater Melbourne	1.67	31.84	19.24
Greater Perth	1.37	32.80	15.85
Greater Sydney	1.69	31.61	19.49

Data source: Australian Census 2001 and 2011