

Infrastructure for knowledge productivity: TOD's in Kansai and Western Australia

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Abstract

The efficient mobilisation and productivity of local knowledge resources is becoming increasingly important for national productivity and industrial competitive advantage. Spatial and place qualities of urban design provide a logical platform to do this by strengthening local social capital and offering access to quality services, people and knowledge flows. The provision of quality infrastructure and amenities has become a means for cities to attract high-value human capital to enhance the knowledge development capacity of social networks. Research is only beginning to understand the relationship between urban density, local capital development and economic wealth, and how quality elements of hard and soft urban infrastructure translate into productivity advantages for a city.

Based on empirical research, this paper argues that urban planning and design can positively contribute to sustainable national economic health and work productivity by strengthening local knowledge resources and networks. It identifies five key hard and soft infrastructure types impacting a region's capacity to facilitate knowledge development and innovation. The hard infrastructure components of Kansai, Japan and Perth, Western Australia transit-oriented developments are examined for their capacity as spaces to facilitate human flows for vibrancy and knowledge transfer. This paper finds that the human movement, interaction and vibrancy generated by the planning in Kansai are more likely to deliver New Economy policy objectives of high knowledge productivity and innovation. It concludes that more research is needed to understand the economic benefits of investing in such urban infrastructure and amenities and how it can facilitate Australian national innovation and productivity agendas.

1. Introduction

It is generally accepted that knowledge and innovation enrich inputs across all industries, enhancing overall national productivity, competitive advantage and industrial performance (Goldberg, 2006; OECD, 2007). The increasingly importance of knowledge appears to be reflected in the way we use our cities. Some have observed that advances in transport, technology and communication are enabling production processes to be located away from those who develop, commercialise or control it, but draw those who create, apply and commercialise knowledge and innovation closer to knowledge and creativity sources (Edvinsson, 2006; Florida & Tinagli, 2004; Glaeser & Kohlhase, 2003). How local urban form might facilitate national economic growth and wealth to provide a platform for knowledge development and innovation is little understood.

This is due in part to difficulties in understanding a changing set of economic drivers which challenge predictions of future national growth patterns and appropriate policy responses (APEC, 2003; OECD, 2001, 2003). Various country-appropriate technology, R&D and knowledge development policies and priorities have emerged globally, some aimed at increasing national competitiveness, productivity and wealth and others at reducing domestic income and regional disparities (ABS, 2002; Council of Competitiveness, 2007; Dahlman & Aubert, 2001). Enhancing labour productivity is a critical component of such policies, given its capacity to value-add to resources, reduce costs and raise profitability and wages (APEC, 2000, 2004). This paper asserts that urban planning which leverages knowledge creation, dissemination, development and organisation will supplement such policies supporting greater levels of national innovation and productivity than otherwise attainable. Economic sustainability into the next century implies city planning consider how human flows (defined in this paper as corridors of human movement), vibrancy and interaction affect innovation and knowledge-based activities. This paper proposes such urban planning enriches a city's knowledge capacity, and should be included in knowledge productivity and innovation policy discussions.

The next section discusses urban density and amenities in the context of enhancing productivity and economic wealth. The third section examines the role of hard and soft amenities and infrastructure, outlining five key considerations for innovative cities. The fourth section explores how hard

infrastructure has influenced human flows and interaction within train station developments in Western Australia and Kansai, Japan. The final section concludes that urban form appears to impact human flow, vibrancy and interaction levels, making some spaces better at fulfilling innovation and knowledge development priorities than others.

2. Urban Density versus Amenities

The complex nature of urban economics has sparked debate as to whether density or quality amenities and infrastructure have the greater influence over growing regional wealth and income differentials (Adamson *et al.*, 2004; Graham, 2007; Venables, 2007). Density is often a key planning tool as population and industry density are assumed to drive city economies. However, with significant negative socio-economic externalities (pollution, congestion, crime, etc) (Carlino & Hunt 2007; Glaeser *et al.*, 2001), simply increasing densities without regard to amenities does not work either in civic or industrial realms. Indeed, some have argued that: 1) advantages of dominant clustered industries may be offset by disadvantaged industries generating little (if any) overall productivity gains (Glaeser *et al.*, 2001); and, 2) civic engagement is negatively correlated to density (but positively to amenities) - implying urban sprawl is *not* a barrier to human interaction and has *not* damaged social fabric (Glaeser & Gottlieb, 2006). Given the importance of clustered industry and civic engagement to social capital formation and knowledge resources, such findings raise questions regarding the role urban form (as the distribution of residential, commercial, amenities, infrastructure (etc) in an urban environment) plays in facilitating innovation.

Various studies investigating a city's optimal density point have found that amenity levels and infrastructure constrain innovation capacity (Arnott, 2004; Behrens & Murata, 2009; Bettencourt *et al.*, 2007). Kanemoto *et al.* (1996) suggested that the point at which city density optimises innovation is determined by a unique set of fixed hard and soft urban infrastructure which spatially constrains economic activity and social capital formation. Rappaport (2006) purported that it is restricted by variations in city amenity levels (ie, infrastructure enhancing quality of life).

This paper takes the position that the spatial relationship between an appropriate mix of infrastructure and amenities will positively impact on a development's capacity to facilitate innovation by

Infrastructure for knowledge productivity: TOD's in Kansai and Western Australia supporting greater density and human activity levels. The following section presents a literature overview of amenity and infrastructure types conducive to innovation and knowledge development. These will be used to assess the innovative capacity of the case study regions.

3. Infrastructure and Innovation

The complex nature of consumer choice and its relationship to hard and soft infrastructure has made practical application of policies seeking to capitalise on quality human capital difficult; and often even well-planned cities fall short of expected economic outcomes. Amenity-rich cities have grown faster than the poorly-endowed, implying that quality of life in more highly-oriented consumer locations is more attractive to human capital (Glaeser *et al.*, 2001). This is supported by observations of the faster growth of metropolitan areas with higher levels of recreation and leisure (even in downturns), where location attractiveness appeared measured by distance from such areas. Indeed, distance to a CBD was found to have little relevance to demographic and economic growth patterns (Carlino and Saiz, 2008). The attraction and retention of quality human capital and strengthening of social networks, particularly in outer urban areas, is critical for regions vying for a comparative global advantage in knowledge and innovation.

Breschi and Lissoni (2006) found *social* proximity (professional ties, social networks) contributed to knowledge spillovers more than geographical proximity. Others suggest a local milieu is required for knowledge development due to the highly location-specific nature of knowledge spillovers (Baldwin *et al.*, 2007) and the strong correlation between local social infrastructure and business innovation capacity (Ruef, 2002). Lobo and Strumsky (2008) observed serendipitous meeting and exchanges between inventors of different metropolitan areas sparked higher levels of invention and creativity, and that increased formal networking (eg, business association activities) impeded the formation of new avenues for innovation.

Indeed, the local dimension of knowledge is challenging many to consider spatial flows, amenity levels and place qualities between suburban communities and CBD's. Local urban spaces which provide opportunities for knowledge spillovers can seed regional knowledge development to become key innovation assets. For example, *flows* and *accessibility* of knowledge *nodes* and *linkages* are

perceived by some as more appropriate for innovative cities than traditional *zones* and *proximity* (Bertolini & Dijst, 2003; Van Winden & Van den Berg, 2004). Studies exploring urban design spatial elements and place quality as a local platform for socially-inclusive networks found that place quality may not only contribute to social capital (important for knowledge development), but indicate capacity for its formation. Urban planning cognisant of the interaction of space, place and social capital seed diverse network connections and enrich social capital (Hanna *et al.*, 2009).

Five key soft (human) and hard (built form) infrastructure components for innovation have emerged in a review of literature focused on the optimisation knowledge development and innovation (Table 1).

Table 1: Hard and Soft Infrastructure: Facilitators of Innovation

	Soft Amenities/infrastructure examples (level of)	Hard Amenities/infrastructure examples (pedestrian accessibility of)
1. Connectivity	<ul style="list-style-type: none"> • ICT usage • Pedestrian-friendly commuting mode • Mobility and knowledge cross-pollination (journey-to-work data/overseas visitors) 	<ul style="list-style-type: none"> • Wifi access points • Transport infrastructure • Amenities • No. of intersections in given area • Public meeting places (parks, cafes)
2. Education & skills	<ul style="list-style-type: none"> • Education • Students to population • International students/academics • PhD students/researchers • industry/government/ community network • Knowledge workers 	<ul style="list-style-type: none"> • University/ /R&D centre • Technical college • Library
3. Creativity & cultural vibrancy	<ul style="list-style-type: none"> • Creative industry • Youth (18-30 year olds) • Entrepreneurial activity • Patents to population / employment 	<ul style="list-style-type: none"> • Arts, culture or historic districts • Amenities • Development density
4. Industry & business network	<ul style="list-style-type: none"> • Industrial clustering • New firm formation, patent applications, regional productivity • Regional export (relevance to global community) 	<ul style="list-style-type: none"> • Mixed-use development • Airport/port • Business district/industry park
5. Diversity	<ul style="list-style-type: none"> • Employment participation rate • Cultural/religious diversity • Low-skilled service sector • Housing choice 	<ul style="list-style-type: none"> • Access points to natural amenities (weather, water, crime rate) • General amenities (bars, night clubs, good schools, golf courses, etc) • Creative amenities (ethnic restaurants, cafes, bookstores, health clubs) • Landmarks (Tourism, public squares, commercial)

Empirical links between innovation, regional productivity and economic prosperity to each component (discussed below) offer insight into how infrastructure can influence human spatial movement, vibrancy and interaction.

3.1 Connectivity

The serendipitous flow and accessibility of new ideas and connections is vital for innovative cities (Lobo & Strumsky 2008), and achieved by human connectivity and mobility on all levels. Virtual Information and Communications Technology (ICT) and physical (face-to-face) aspects are redefining spatial distance as intimate pedestrian-oriented spaces are highly compatible to the electronic world (Salingaros, 2003). ICT has the capacity to transfer information instantly between persons regardless of location, while complex locally-embedded tacit knowledge is only available through the face-to-face connectivity of local spaces. Innovative cities require a well-organised system for the flow of both. The capacity to transfer information and tacit knowledge through virtual and physical connectivity is a key infrastructure consideration maximising worker productivity and economic growth in innovative cities.

Virtual connectivity in the form of ICT has spatially compressed global and local spheres. It has been instrumental in the rapid progress of innovation and global growth, decreasing knowledge access costs, increasing information pools and diffusion of ideas. For example, regional changes in ICT usage between 1998~2002 were mirrored by changes in the temporary migration of global labour. ICT infrastructure improvements appear to have narrowed regional income and productivity gaps. Indeed, USA productivity has grown 1% higher since 1995 (1.2% per annum) than predicted. ICT development is a key policy direction in APEC (APEC, 2000, 2002, 2004) and OECD countries. It has increased GDP more than other similar investments placing some OECD economies on higher productivity and growth paths (OECD, 2001).

Physical connectivity relates to the capacity of hard and soft infrastructure to embed global human flows into the local sphere. Power and Lundmark (2004) argued the global flow of highly-qualified people is highest in growing innovative clusters, acting as a pipeline for knowledge transfer and new influences. Salingaros (2003) proposed that organic geometric urban design (transport,

communications, pedestrian, etc) facilitates human flows and social capital building by optimising connectivity and mobility and restoring vibrancy and pedestrian functions of the *human* city. Indeed, studies espouse the value of public transport in raising productivity and economic prosperity (Gospodini, 2005; Kantor, 2008). Public transport is claimed to be most compatible with the fast adoption and creation of new innovation by effectively compressing space and time, addressing issues such as lack of time, human connectivity and firm clustering. As such, it is argued to be more efficient than cars at keeping the physical flow of ideas and knowledge abreast of the speed of information transfer (Graham, 2007; Knox, 2006).

3.2. High Education and Skills

Since the 1990's, human capital (eg, education and skills) has been a prime driver of productivity disparities and economic growth (OECD, 2001, 2003). On the soft infrastructure side, education and skills enhance industry knowledge capabilities on all levels (creation, dissemination and application) (APEC 2003), enabling more successful entrepreneurial activity (Glaeser, 2007), better global connectivity (Lopez-Rodriguez *et al.*, 2007), higher labour participation rates and national productivity levels (Australian Government Productivity Commission 2007). One extra year of average education was estimated to increase total factor productivity by 2.8% in US cities (Gottlieb & Fogarty 2003) and between 11-13% in Chinese cities (Liu, 2007). It is argued that more educated and skilled cities develop faster being more *economically productive* than aesthetically attractive, and more adaptive to economic shocks. Such findings suggest a pivotal role for human capital accumulation in sustainable regional prosperity and economic development (Glaeser & Saiz, 2003).

Studies highlight the capacity for higher education to augment regional innovation and industrial activities (Goddard, 2007; OECD, 2007), and regional socio-economic wealth variations based on opportunities to access quality education (OECD, 2001; Vintila, 2003). As hard infrastructure, universities, in particular, add creative vibrancy being producers of human capital, employers of knowledge workers and gatekeepers of information and communication. They are central to the global connectivity of knowledge workers and the knowledge exchange process as part of the local industrial

structure and international movement of students, researchers and academic professionals (Martinez-Fernandez *et al.*, 2006; Martinez-Fernandez & Sharpe, 2007).

3.3. High Creativity and Cultural Vibrancy

This paper uses creative and cultural elements interchangeably (Hansen *et al.*, 2005), given their equal contribution to the information society as sub-sets of knowledge-intense or knowledge-based industries (Garnham, 2005; Wu, 2005).

Florida (2002b) argued creativity and talent are vital to regional economic growth and competitiveness. Even though Florida's strong urban focus, statistical generalisations and narrow definitions of creative occupations generate measurement discrepancies limiting the application and robustness of his work (Ley, 2003; Luciani, 2006), research continues to support creativity as a major contributor to sustainable economic development, innovation and regional prosperity (Lee & Choi, 2008; Wojan *et al.*, 2007). Furthermore, despite inconsistent data and analysis (Kelly & O'Hagan, 2007), many researchers concur that firstly, social connections and then, city amenities (eg, aesthetic quality and natural environment) are more important than either occupation or industry (Hansen & Niedomysl, 2008; Marlet & van Woerkens, 2005; Wenting *et al.*, 2008).

Planning amenities and infrastructure to leverage creative and cultural elements can encourage urban vibrancy and human interaction. Studies have shown that the sense of vibrancy generated by the presence of creative persons in the daily urban environment can generate a multiplier effect for regional incomes (Markusen & King, 2003). Thus, government policy targeting creative soft (creative occupations) and hard (local art, music venues, cafes, entertainment complexes, etc) infrastructure will have a profound impact on human interaction and, therefore potentially, regional innovation capacity.

3.4. Strong Industry and Business Networks

The competitive advantage theory of industrial clustering (Marshall, 1890) remains a strong basis for contemporary research despite fundamental economic shifts over the last one hundred years (Baldwin *et al.*, 2007; Ciccone, 2006). Maskell and Malmberg (1999) contended that learning and knowledge creation by a firm is supported by clustering both in proximity and an institutional sense. Thus, industry and business networks are created through hard infrastructure, in the co-location of business

(eg, science parks, concentrated commercial services of CBD), and soft infrastructure, in the complex web of formal and informal business dealings (eg, conferences, networking, lobbying, daily trade).

With clustering now driven by high-quality labour pools rather than material inputs, network drivers and mechanisms of innovation are only loosely understood.

The positive externalities of localised clustering widely associated with Porter (APEC, 2004; Porter 2000) are under academic debate. Some believe that economic benefits are in the form of a *local* specialised creative workforce (ie, informal local knowledge spillovers and social networks) (Isaksen, 2004; Lobo & Strumsky, 2008; Neff, 2005) and *local* R and D inputs (eg, human capital) and competitive markets (Bettencourt *et al.*, 2007). While others advocate *national/global* linkages and networks (Maskell *et al.*, 2006; McDonald *et al.*, 2007; Simmie, 2004; Wolfe & Gertler, 2004) and a *national/global* mobile labour force (ie, network of social and professional ideas, knowledge and skills) (Power & Lundmark, 2004; Wenting *et al.*, 2008). What all have in common is an understanding of the positive impact of industrial and business networks on innovation, economic development and regional prosperity. City and infrastructure planning which is cognisant of the need to facilitate business and industrial networks and flows will more readily capitalise on soft infrastructure components (eg, human capital, business networks). Such urban environments will more easily convert new business opportunities and networks for regional competitive advantage.

3.5. Diversity

Diversity of human capital (soft infrastructure), across a broad set of disciplines and diversity in urban product (hard infrastructure), catering to various needs, are also assets for innovative cities. In the hard infrastructure context, diversity in natural and constructed amenities is strongly linked to economic competitiveness (Ren, 2004) given its positive contribution of networking opportunities (Marlet & van Woerkens, 2005) and that different population groups are drawn to different amenities (Clark, 2004). In the soft infrastructure context, the ability to attract skilled migrants is a source of natural competitive advantage as the global exchange of talent fuels regional knowledge pools (APEC, 2004; Duranton & Puga, 2001; Saint-Paul, 2004). Indeed, Adamson *et al.*, (2004) found policies enhancing cultural diversity and quality-of-life to attract high-capital workers by improving amenities, benefit

competitive advantage more than tax breaks and subsidies to firms. For example, Saxenian (2002) noted skilled migrant workers were high-value assets of Silicon Valley, where they started hundreds of technology companies, ensuring regional economic robustness. Lower social barriers and a tolerance for new ideas appear to make culturally diverse environments highly correlated with: (1) innovation levels and university-graduated immigrants (Hunt & Gauthier-Loiselle, 2009); (2) diverse amenity levels and high growth regions (Glaeser *et al.*, 2001); and, (3) cultural diversity and various measures of income, creativity and economic development (Boschma & Fritsch, 2007; Florida *et al.*, 2008; Thomas & Darnton, 2006).

However, the benefits of cultural diversity are often unevenly distributed with a wage premium for the skilled as (Ottaviano & Peri, 2006) and wage reduction for the low-skilled (Borjas, 2003; Card, 2001). The resulting socio-economic disparities between these two sectors present persistent challenges for cities interested in pursuing knowledge-oriented policies. Urban physical form and function becomes a critical tool for creating non-exclusionary community spaces. Cities which optimise diversity of amenities in, and the type of, human capital attracted to local spaces will be best equipped to combat social exclusion and provide stimulating environments for innovation.

4. TODs in Kansai and WA

4.1 Site selection and methodology

Perth City's Northwest Corridor in Western Australia (Local Government Areas of Wanneroo and Joondalup, hereafter, 'PNWC') and Kobe City in Kansai, Japan were chosen as suitable for a study of the impact different planning approaches may have on innovative outcomes. Both have regional knowledge economy visions, and urban planning is viewed in local government documents as a tool to strengthen knowledge resources and outcomes. Though in PNWC, it appears to have no clear role in economic development outside of a retail strategy, and in Kobe is directed by the high-tech and knowledge development ordinance of the national government (Martinus, 2008). Both have similar positions in their respective regional urban hierarchies competing against the larger economic and urban centres of Perth, in PNWC case, and Osaka, in Kobe case (Figure 1 & 2).

Figure 1: Position of Joondalup and Clarkson in relation to Perth City

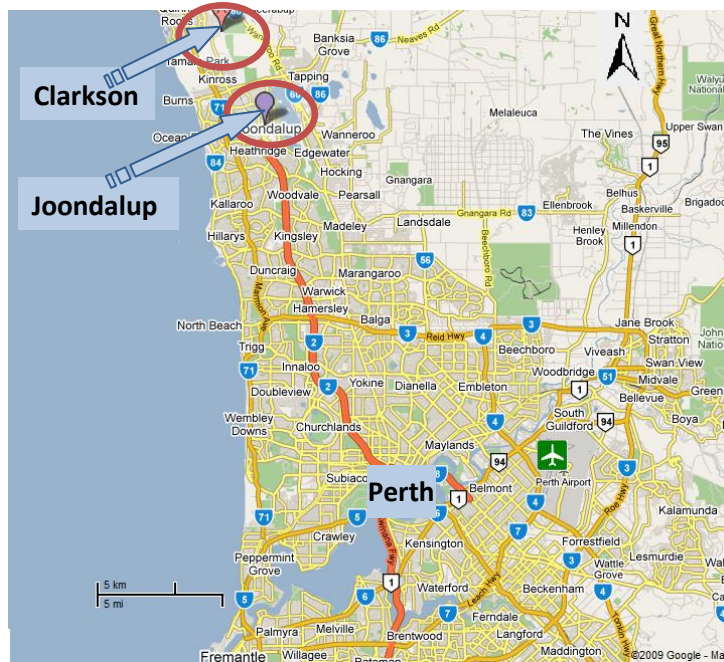
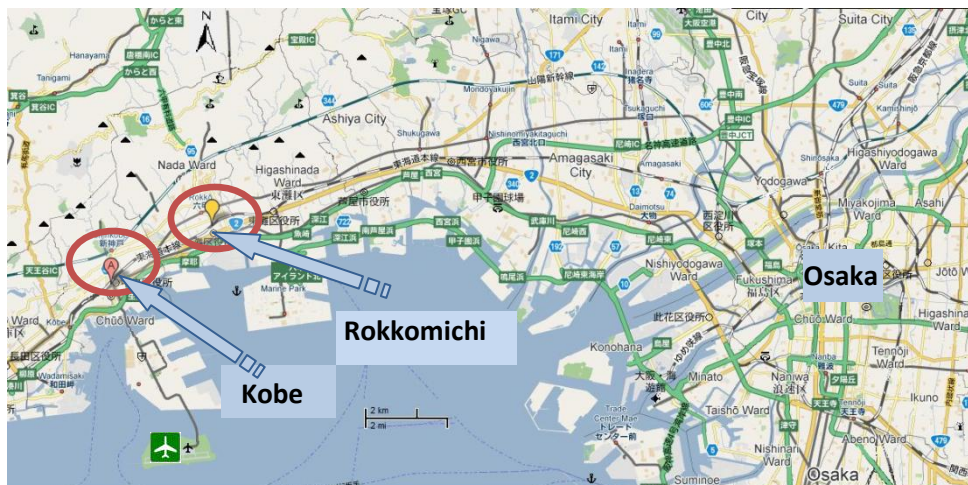


Figure 2: Position of Sannomiya and Rokkomichi in relation to Osaka City



Source: Adapted from Google Maps (2009)

This paper reports the initial findings of a study of urban planning supportive of knowledge economy priorities. As argued in Section 2, amenities and infrastructure are assumed more important than density. Greater population densities will result in more human reticulation following flow lines which are influenced by a given set of fixed infrastructure and amenities. Observing the existence and spatial distribution of key amenities and infrastructure (rather than exact numbers), as well as major human flow lines (hereinafter, HFLs), provide insight into a city's unique socio-economic imprint of human activity. Population increases will intensify, but not significantly alter, these patterns of activity. This

enables cross-country or cross-regional comparisons between locations similarly placed on the urban hierarchy irrespective of real urban densities. As such a study of transit-oriented developments (TODs) in the respective CBD and suburban areas of PNWC (Joondalup and Clarkson) and Kobe (Sannomiya and Rokkomichi) which examines patterns of pedestrian flows and activity, not intensities, will be largely independent of Kansai and WA urban density differences.

This study defines TODs as vibrant socially-inclusive hubs of mixed-use transport, affordable medium-density housing and small business developments (DPI, 2005). The layered transport, residential and business function of TODs aligns with other studies speculating on the role of railway stations as both a *place* (containing opportunities for social and economic human exchange and networking through a range of shopping, tourism, business activities) and *node* (mere transportation access point) (Oosten, 2000; Peek *et al.*, 2006). It is argued that urban form which layers human activities and amenities optimises the quality and diversity of human capital flows, providing locations where chance meetings may lead to productive human interactions (Bertolini, 1999). In addition to the local socio-economic *place* function of TODs in general, the case study TODs were purposely selected as the most-pedestrian-oriented location in each study region which best fulfilled the key components for innovation (Table 1).

Using Google maps, general categories of amenities and infrastructure types (generated from Table 1 components) were assessed as either present (✓) with a value of 1 or not (✗) with a value of 0 (Table 2). This allowed *place* and *node* values within and surrounding each station to be estimated. A *Node* is identified by the absence of socio-economic opportunities, and the degree of *place* by the number of natural and constructed amenities and infrastructure within an 80metre and an 80metre to 1kilometre radii taken from a *central point* (public open space) just outside each TOD. The 1km radius was chosen as consistent with studies of the limiting size of pedestrian cities (Salingaros, 2003) and TODs (DPI, 2005).

A higher total value indicates a higher *place* function and a lower total value reflects a stronger *node* function. The limited socio-economic amenities inside PNWC stations (Joondalup having 1 and Clarkson 2 out of a possible 17) point to a stronger node function than Kobe stations (Sannomiya

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Table 2: TODs node (inside station) and place (80m & 1km radii) functions

Amenity/infrastructure categories	Sannomiya (CBD)			Joondalup (CBD)			Rokkomichi (suburban)			Clarkson (suburban)		
	Place		Node	Place		Node	Place		Node	Place		Node
	80m-1km radius	80m radius		80m-1km radius	80m radius		80m-1km radius	80m radius		80m-1km radius	80m radius	
1. Transport options	✓	✓	✓	✓	✓	✗	✓	✓	✓	✓	✓	✓
2. Community open space	✓	✓	✗	✓	✗	✗	✓	✗	✗	✓	✗	✗
3. Kiosk, 24h mart	✓	✓	✓	✓	✗	✓	✓	✓	✓	✓	✗	✓
4. Small Retail	✓	✓	✓	✓	✗	✗	✓	✓	✓	✓	✓	✗
5. Major Retail	✓	✗	✓	✓	✗	✗	✓	✗	✗	✗	✗	✗
6. Supermarket	✓	✗	✗	✓	✗	✗	✓	✗	✗	✗	✗	✗
7. Personal/business services	✓	✓	✓	✓	✓	✗	✓	✓	✗	✗	✓	✗
8. Public wireless hotspots (cafes, etc)	✓	✓	✗	✓	✗	✗	✓	✓	✗	✗	✗	✗
9. Entertainment (cinema)	✓	✓	✓	✓	✗	✗	✓	✗	✓	✗	✗	✗
10. Restaurants, cafes	✓	✓	✓	✓	✗	✗	✓	✓	✓	✓	✓	✗
11. Hotels, accommodation	✓	✗	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗
12. Sporting facilities	✓	✗	✗	✓	✗	✗	✓	✗	✗	✗	✗	✗
13. Cultural, tourist, historical sites	✓	✗	✗	✗	✗	✗	✓	✗	✗	✗	✗	✗
14. Community library	✓	✗	✗	✓	✗	✗	✓	✗	✗	✗	✗	✗
15. University, technical colleges	✓	✗	✗	✓	✗	✗	✓	✗	✗	✗	✗	✗
16. Learning centre	✓	✗	✗	✓	✗	✗	✓	✗	✗	✗	✗	✗
17. High school	✓	✗	✗	✗	✗	✗	✓	✗	✗	✗	✗	✗
Total	17	8		15	2		16	6		5	4	
NB: Higher value indicate higher socio-economic <i>place</i> function & lower values reflect stronger transport <i>node</i> function	25/34		8/17	17/34		1/17	22/34		5/17	9/34		2/17

Infrastructure for knowledge productivity: TOD's in Kansai and Western Australia having 8 and Rokkomichi 6 out of a possible 17). This is also reflected in place indicators, as both PNWC TODs (Joondalup is 17 and Clarkson 9 out of a possible 34) score more weakly in both the 80m and 80m-1km radii than Kobe TODs (Sannomiya having 25 and Rokkomichi 22 out of a possible 34). Clarkson's overall results suggest a high node function.

Assessing a locations' innovative capacity needs an understanding of human flows as well as *place* function. Using Google Maps to identify spatial distribution of key amenities and infrastructure, daily human movements around each TOD were observed by the researcher in a series of site visits over 1992-2009, including living and working in Kobe (4 years) and PNWC (over 10 years). The remainder of this section documents general regional planning approaches and observations of major HFLs to discuss this capacity.

4.2 Kansai, Japan

Japan is a heavily populated, highly-urbanized and successful transit-oriented, knowledge economy (Lin, 2007; Sorensen, 2004). Reflected in business practices and government policy, national economic wealth revolves on the capacity of its cities to mobilise human capital. The national government has used urban planning policy to deliver national strategic industrial and economic priorities which reflects the assumption that private developers are motivated by profits, and local governments by tax revenues (Jacobs, 2002). This resulted in strategic regional industrial infrastructure development to attract and concentrate business, enabling post-war rapid economic growth, despite human capital being Japan's primary natural resource (Sorensen, 2004). Tripling real per capita income in the 1960's and averaging 3% to 5% growth in the 1970's, Japan progressed from primarily a heavy industry economy post-war to its large-scale manufacturing economy today. City populations mirrored industrial changes with mass migration to metropolitan production centres (Fujitaa & Tabuchi, 1997; Gilman, 2001).

Declining international competitiveness forced its transition to knowledge-based, high-tech and service industries. By the 1980's, its cities reflected the need for virtual and physical global mobility, with a high integration between 'infrastructure, architecture and public spaces' producing a 'three-dimensional generative framework organized around infrastructure' (Lin 2007: 87). In the 1990's, high quality and aesthetically pleasing living environments were considered vital for community

development and to attract and retain knowledge workers. Japan's cities adapted to knowledge economy requirements relatively easily, being a product of 'the strong visions of those advocating soft infrastructure development, human flows and interactions in local commercial zones of layered activities and functions within a highly pedestrian-oriented transport network' (Martinus 2008: 12). Such as visionary architect and city planner Kenzo Tange who rejected contemporary 1940 'white box' planning by studying Greek agoras and forums to better understand the *vital force* of cities. Tange suggested that the growing role of information meant public spaces were an essential, part of the metaphysical cities' 'urban core'. He believed that 'urban and architectural space' was not 'created by the separation of physical objects' but was 'a truly active and binding force' attracting structures (Tange, 1985). As a result, Japanese urban planning placed a high value on human movement through the urban spaces created by surrounding buildings and infrastructure.

Defined by their architecture, social and consumption patterns (daily human flows and physical movement; culture including entertainment, eating, socialising), Japanese cities are shaped by consumption and anchored by high rates of public transport use (Bertolini & Dijst, 2003). For example, 56.7% of Tokyo's population uses public transport, Osaka 59.5% (in Kansai), Paris 24.1%, London 17.1%, Sydney 13.6% and New York 9% (Wendell Cox Consultancy, 2003). The dense residential, leisure and business services mix of Japanese rail developments fit the TOD definition. Indeed, Japanese cities have had fully integrated land-use and transport planning for decades before Calthorpe (1992) popularised the term TOD. Japanese railway stations are often owned and developed by intensely competitive large private multinational conglomerates with a vested interest in creating economic and social vibrancy to attract users (Peek *et al.*, 2006). Both Japanese case study stations are such sites.

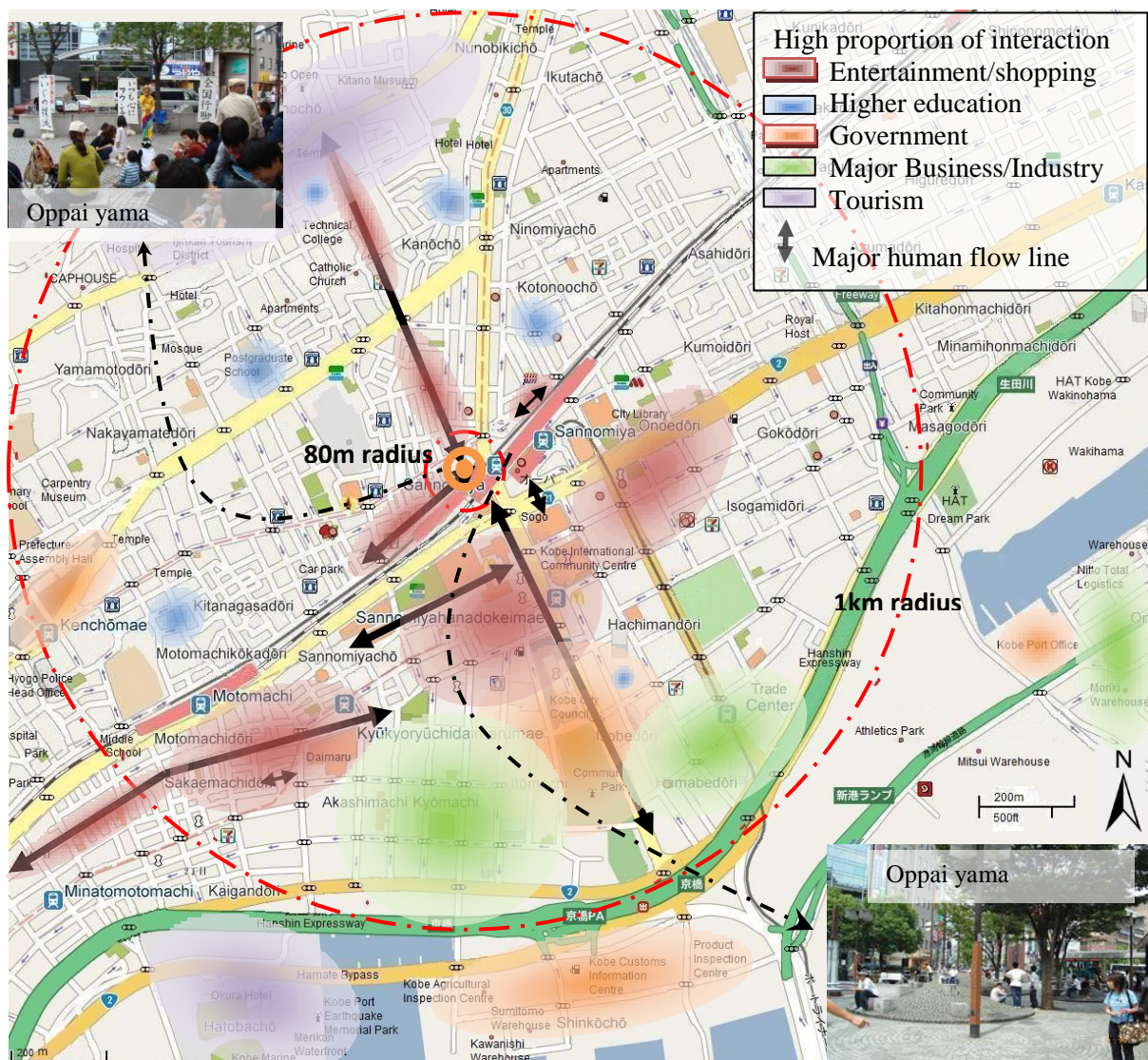
Sannomiya Station is centrally located in the major regional transport, education, entertainment, shopping and administrative hub of Kobe (Figure 3). Surrounding land is primarily for roads, daily pedestrian, business and social functions with car parks in walking distance. The size of the station affords alternative public open spaces within the 80m radius, including the *central point* for this study outside the Hankyu line. This modest open space scattered with stone and metal seating appears to 'capture' pedestrians before migrating to various destinations, with the congregation of friends, club

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meetings, business people, street entertainers, and even strangely-dressed youth. It is surrounded by shops, banking facilities, learning centres, twenty-four hour mini-marts, bookstores and eateries (fast food, ice creamery, restaurants and bars). Human movement away from here flows along energy corridors of commercial activity, pedestrian traffic is pushed towards major activity centres of tourism, administration and industry, as well as various other education, tourism and commerce points distributed throughout residential areas. HFLs are long, some travelling the full 1km radius of the study site.

Figure 3: Socio-economic neighbourhood of Sannomiya



Source: Adapted from Google Maps (2009)

JR Rokkomichi is located in a suburban shopping and business district. The *central point* for this study is the north-side brick plaza facing primarily retail and food speciality stores (Figure 4). HFLs are fewer than those of Sannomiya CBD, but similarly follow energy routes of commerce leading to

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destination points of more shopping, industry and transport; with further education administration and commerce distributed throughout residential areas. HFLs are long, some travelling the full 1km radius, such that HFLs from neighbouring Hankyu Rokko station (outside area of this study) easily reach Kobe University. HFLs to the south follow a similar pattern alongside a large community park designed to 'enhance the social infrastructure of the city' (CNAPPC, 2001) and towards a large shopping complex and industrial areas.

Figure 4: Socio-economic neighbourhood of Rokkomichi



Source: Adapted from Google Maps (2009)

The mix of business and social generated by the amenities and infrastructure surrounding both Kobe stations create an urban 'buzz' or vibrancy. The five infrastructure types of Table 1 appear well-

Infrastructure for knowledge productivity: TOD's in Kansai and Western Australia represented through the spread of amenities and infrastructure of Table 2. The infrastructure immediately surrounding each station is primarily for pedestrians (car parks are a short walk away). Streets lined with various commercial, education, retail, food and entertainment (shaded red) push movement from each station to local destinations of tourism, cultural, school, shopping, etc, creating long HFLs. Urban vibrancy appears to be generated through these concentration flows, and a high level of mixed-use (ie, residential/commercial) suggests high social inclusion. In short, the strong place value across the five infrastructure components (Table 2) combined with observations of HFLs and urban vibrancy indicate that both Kobe stations display urban characteristics highly supportive of activities relating to knowledge development and innovation.

4.3 Northwest Corridor, Perth

Perth's car-based urban planning compounds feelings of social exclusion, particularly for those living in poorly endowed outer metropolitan areas. The growing income and community participation disparities between inner and outer metropolitan Perth have prompted State and local governments to promote the benefits of better telecommunications and transport infrastructure. However, strategies to decentralise employment and economic activities away from Perth CBD and along transport corridors to address social disadvantage have added to urban sprawl (Curtis, 2006). The *Liveable Neighbourhoods* guidelines (WAPC, 2004a) advocated strengthening community networks by creating pedestrian-friendly urban villages of 400 metres radius. However, the guidelines did not 'acknowledge diverse and complex individual work/life travel itineraries' (Curtis, 2006), and has been prone to misinterpretations which have not generated the pedestrian-friendly environments (it) was designed for (Miller, 2008).

Despite evidence that many new economy cities are also highly transit-oriented (Scheurer *et al.*, 2005), public transport in Perth struggles with patronage, capturing approximately 6% of total metropolitan Perth trips (Curtis, 2006). Indeed, research into why people to choose to live in Perth TODs, revealed housing affordability was a greater factor than proximity to public transport (Holling *et al.*, 2007).

Perhaps WA's limited statutory land use requirements for sustainable regional economic outcomes around train stations or in poorly-served transit areas (Curtis & Perkins, 2006) has contributed to a

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lack of vibrancy in these areas. Economic development appears to be viewed as the natural outcome of the regulated approval of allocated commercial and retail space rather than targeting specific economic outcomes through urban planning. A TOD retail strategy, as the ‘analytical framework for assessing the scope and scale of development potential of activity nodes’ (Pracsys, 2007), does not outline its impact on or stipulate a required contribution to regional economic priorities.

Consistent with Perth’s Network Cities approach (WAPC, 2004b), the rail stations at Joondalup and Clarkson were developed, respectively, as a strategic urban transport hub and a local TOD (DPI, 2005). Given PNWC’s predicted future growth and knowledge-based priority outcomes, both can contribute to the social and business networks of WA’s knowledge-related industries.

Figure 5: Socio-economic neighbourhood of Joondalup



Source: Adapted from Google Maps (2009)

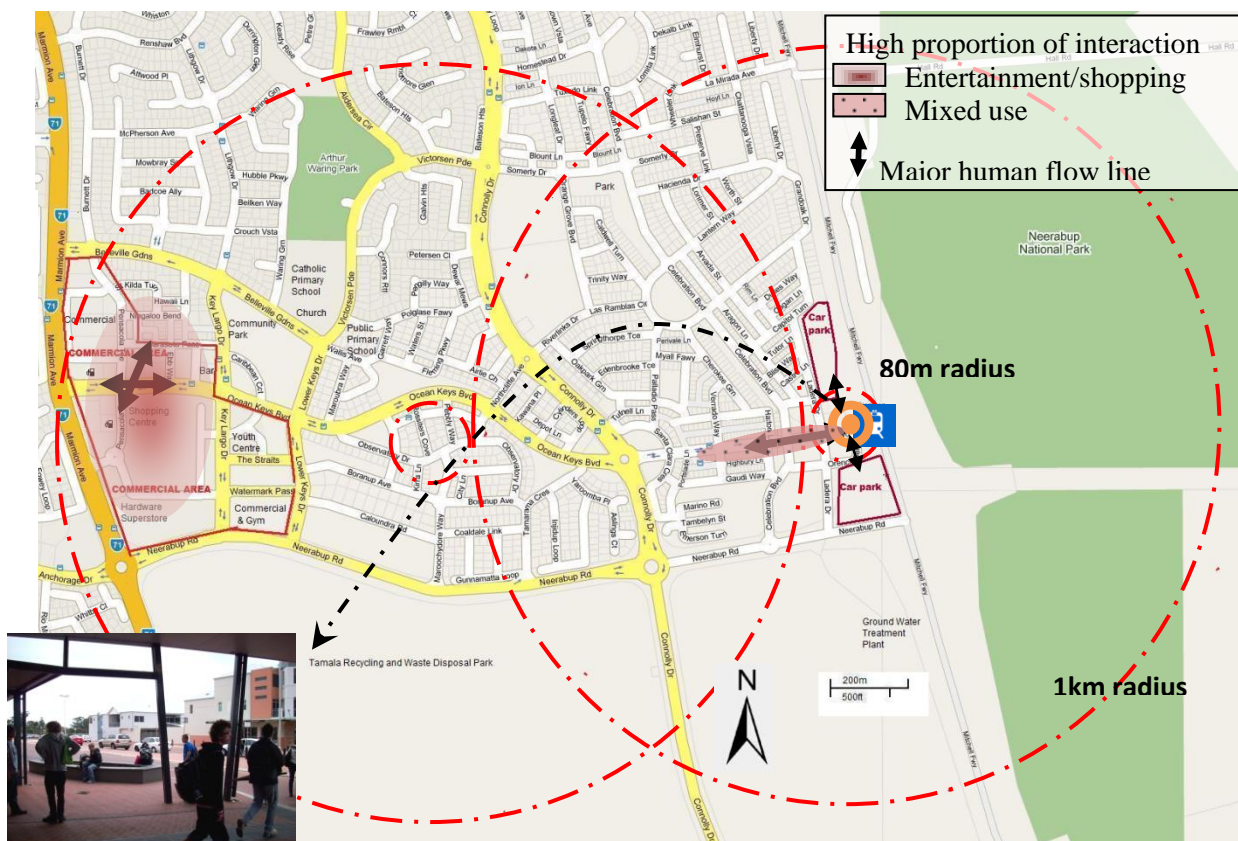
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Joondalup city centre is divided into five precincts - business, shopping, retail, administration and education (Hill, 2005), much of which is within 1km radius of the Joondalup Station. As a result, there is only limited mixed-use planning (residential/commerce) (Figure 5). The station itself sits on the southern edge of the CBD. The station is surrounded on three sides by access roads and car parking and on a fourth by a major retail shopping complex. Between the station and shopping complex lies a grassed/bricked space (with seating) (*central point*), where observations of short HFLs suggest that it acts as a passage into the retail complex. In general, the planning immediately surrounding the station appears to facilitate quick dispersal and absorption of users primarily into adjoining car parks.

The HFL between the station and Joondalup Learning Precinct (containing Edith Cowan University, WA Police Academy and West Coast Institute of Training) is longer, with students moving through a car park and over a busy road. A pedestrian-oriented commercial district on its north side generates only short HFLs. As such, the HFLs represent a significant loss of urban vibrancy and social capital development.

Figure 6: Socio-economic neighbourhood of Clarkson



Source: Adapted from Google Maps (2009)

Relatively new and still under development, the Clarkson TOD has a nature reserve to the east, and car parks, medium-density housing and businesses to the west (Figure 6). Users were observed to either walk to car parks or wait for alternative transport in an open space (*central point*) immediately outside the station (divided in two by a bus access road). Its planned pedestrian focus appears to target those living or working in its immediate vicinity as there is little walking integration with nearby major destinations points, such as beaches (about 4kms away), major shopping and employment (about 2kms away). A short boulevard of shops and town houses generates a short HFL, which will likely extend slightly once the development matures. This becomes a road flanked by residential lots, leading from the station exit for over 2kms to a local vibrant hub of various retail (large and small retail stores, furniture, etc), entertainment (cafes, restaurant, bars) and services (business, library, banking, sporting centres, auto/bike repairs, music studios, etc). There is no significant human flow between these locations.

Both PNWC stations generate low levels of pedestrian flow despite being located nearby vibrant retail precincts. The short distance between the Joondalup station and retail complex creates only short flows, and the long distance of primarily housing lots between the Clarkson station and local commercial precinct creates no flows above those expected in a normal suburban setting. Planning decisions that have contributed to car dependency (the provision of large car parks and wide roads) on prime land surrounding the train station creates pedestrian movements which are not spatially concentrated, thereby discouraging vibrancy and potential human interactions. The results from Table 2 and observations of human flows indicate that the urban form around each station may inhibit the kind of social interactions needed for economic efficiency in knowledge development and innovation. Such urban form is likely to detract from efforts to facilitate PNWC knowledge vision through policies to increase vibrancy, social capital, knowledge transfer and innovative outcomes.

5. Conclusion

Based on growing empirical evidence of hard and soft infrastructure's contribution to economic efficiency and robustness, this paper proposes that some urban spaces are more conducive to knowledge development than others. Hard infrastructure creates urban spaces with a unique socio-

economic imprint of human flows, vibrancy and interaction. Urban form which incorporates key elements for innovation (connectivity, education and skills, creativity and culture, business clustering and diversity) facilitates a broad scope for social capital building and knowledge transfer which enhances a region's innovative potential.

The results suggest that the railway stations studied have different capacities for human movement and interaction. TODs in car-dominated PNWC were found to have relatively low levels (with Clarkson having almost none) of the infrastructure types conducive to innovation, and limited human flows and vibrancy in the 1km radius of the stations. Its urban form appears to facilitate quick dispersal of people to adjoining transport or buildings, providing limited opportunity to leverage soft infrastructure assets for vibrancy and interaction. Conversely, TODs in pedestrian-oriented Kobe appeared to have greater levels of the infrastructure types conducive to innovation with longer, more vibrant human flow lines. Urban planning appears to use retail and commerce to naturally reticulate human movement towards major destination points, such as business, education, tourism, and shopping. This paper concludes that the human flow, interaction and vibrancy elements of Kobe TODs are more likely to strengthen local social capital, and therefore facilitate New Economy policy objectives of high knowledge productivity and innovation.

Unprecedented globalisation and technological advancements are demanding the mobilisation of local knowledge resources in response to issues of sustainable national economic competitiveness. Ignoring the potential impact of urban planning and city design on knowledge productivity and innovation is short-sighted. These disciplines define the local hard infrastructure framework demarcating the spatial limitations of soft infrastructure components, such as social capital, human movement and knowledge spillovers. Urban form that impedes human interaction is likely to require more government intervention and human resources to overcome inefficiencies in community participation and social inclusion. In contrast, urban form that enhances social capital tends to have better living and more accessible environments for all residents irrespective of socio-economic standing or aspiration. The high human connectivity of the latter can improve the efficiency of knowledge exchange and innovation systems, with accumulative effects at the regional or national levels for any given urban system.

Innovation is a highly complex process, and socio-economic barriers are inefficient in the New Economy. By understanding the knowledge development capacity and implications of well-constructed urban spaces, urban planning and city design can enhance the efficiency of innovative and knowledge productivity. More research is needed to understand the economic benefits of investing in such urban infrastructure and amenities, and how this can enhance Australian national innovation and productivity agendas.

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