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Balancing Infrastructure for the Airport Metropolis

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Abstract—Ongoing financial, environmental and political adjustments, have shifted the role of large international airports. Many airports are expanding from a narrow concentration on operating as transportation centres to becoming economic hubs. By working together, airports and industry sectors can contribute to and facilitate not only economic prosperity, but create social advantage for local and regional areas in new ways.

This transformation of the function and orientation of airports has been termed the aerotropolis or airport metropolis, where the airport is recognised as an economic centre with land uses that link local and global markets. This paper contends that the conversion of an airport into a sustainable airport metropolis requires more than just industry clustering and the existence of hard physical infrastructure. Attention must also be directed to the social infrastructure within proximate areas and the maximisation of connectivity flows within and between infrastructure elements. It concludes that the establishment of an interactive and interdependent infrastructure trilogy provides the necessary balance to the airport metropolis to ensure sustainable development. This paper provides the start of an operating framework to integrate and harness the infrastructure trilogy to enable the achievement of optimal and sustainable social and economic advantage from airport cities.

I. INTRODUCTION

THE role, scale and meaning of major urban airports worldwide have changed over the past decade as a result of corporate and economic transformation. Modern airports are very different from traditional airports, and our current knowledge is insufficient for understanding the complex roles and relationships now associated with airports [1]. The airport can no longer be considered in isolation from the metropolis that it serves. Large international airports in Europe, North America and Asia have varied functions beyond airport traffic and operate as metropolitan hubs with a diverse range of land uses.

The evolution of the airport into an urban hub that impacts both the city and region has been termed the *aerotropolis* [2] or *airport metropolis*. While airports have become more

important to cities in recent decades, the airport metropolis concept asserts that airports themselves can invest in developments to guarantee that the airport is more than just a crucial piece of infrastructure, and is actually generating otherwise unattainable economic and social benefits. The airport metropolis becomes an economic generator that is a gateway to international destinations and markets that link regions on a global scale. This in turn, requires specific industry clustering and infrastructure to provide the necessary support for global competition. The districts around the airport has been referred as an “airfront” which describes the wide range of commercial, industrial and transportation facilities required to service the new demands [3]. The airport metropolis becomes a hub that provides the city and region with a different context for markets and flow of goods. As Kasarda [2] notes this type of global market is based on *speed* and *access* where the airport metropolis provides an unimpeded gateway for the flow of goods between the region and global markets. However, the movement of the airport from air transport to business hub is not without problems. In particular an overemphasis on the hard or physical infrastructure does not acknowledge the importance of social infrastructure and connectivity as essential elements to this new identity. We argue in this paper that the airport metropolis consists of three essential and interactive elements: the hard and soft infrastructures and connectivity. The dynamics between these elements sets a context that allows the airport to either succeed or fail in its new role.

II. PHYSICAL INFRASTRUCTURE

Many types of physical infrastructure have to be in place to enable airports to meet their new dual roles of transportation hub and regional economic facilitator. These hard or economic infrastructures include large scale installations that connect and service commercial, industrial, residential and cultural nodes of the region. Typical elements are roads, railways, utilities, ports, airports, freight and service interchanges, and of increasing importance; information and communication technology (ICT) - collectively, these provide the basis around which development is clustered and connected. Hard infrastructure provides the traditional network connectivity between the airport (the place where planes land and takeoff) and surrounding region.

Transport infrastructure and its service provision have played a part in the shaping of urban form since towns were established at crossroads and along ancient trade routes thousands of years ago. Urban growth has continued to evolve from transport induced innovation, as seen in the way

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seaports in the 18th Century, railways in the 19th Century and highways and freeways in the 20th Century are reflected in urban patterns. In addition, transport infrastructure has been the basis for nearly all models of urban progress, from the rail connections of Ebenezer Howard to the highways and the airports atop skyscrapers of Le Corbusier.

Airports are now established as an important component of the transport infrastructure of modern cities and have proven increasingly influential to their urban structure, form and development. The reciprocity of impacts between city and airport have evolved in the last 30 years as air travel has expanded, but recently have been amplified under the neo-liberal processes associated with economic and corporate transformation. Government and corporate strategies of economic development, commercialisation and privatisation applied to airports are giving rise to a new form of airport that is far more complex and interactive than the landing fields of the past.

Infrastructure networks of all kinds determine how a city is used, how it is acknowledged and how it is defined socially, technically and politically. They are often described as networks or systems, and as such, do not operate in isolation, nor do they have impacts in isolation, a change in one is always reflected and reverberated through others [4], [5]. The airport is dependent on various utility networks (power, water, sanitation, ICT) for its ongoing operation and at the same time is an integral part of a city's transport infrastructure network. In return, communities around airports also benefit by sharing in infrastructure provisions – airports are often viewed as ideal areas for real estate development partly because of the high quality of infrastructure provision.

Unrestricted access to and from an airport is critical. The resilience of a network to change, or impact, is an increasingly important focus of evaluation. The evaluation of the security of transport linkages is the capacity to identify, assess and respond to possible emergency, crisis, and disaster events with significant potential to disrupt the flow of goods and services. Airports require the assurance of continuity in supply chains and generic capacities to withstand disturbance, yet remain functional [6]. Strong evidence exists internationally that, as airport-related networks expand in size and interactive complexity, they become more vulnerable to catastrophic failure, which is often triggered by small and seemingly insignificant disturbances [7]. With limited access points to the airport by road, traffic incidents on key connecting roads can have a dramatic impact on access to the airport for air passengers. The regional commercial strategies of many airports are also recognised as having the potential to imperil airport access as transport connections are increasingly congested with retail and commercial traffic [8].

Transport infrastructure, as a facilitator of access, is recognised as fundamental to the development of the new airport and the emerging airport metropolis [2]. Access to and from the airport is important for a variety of users; those that

work within the airport site, both in the functioning of the airport and commercial and retail precincts; logistics organisations picking up and delivering freight; the travelling public and their associated entourages; and increasingly the public arriving at the airport as a destination for retail and commercial opportunities. Access, and its adequate maintenance, can only be understood through defining the critical package that binds together users, built environment, land use and transport infrastructure.

The concept of the airport metropolis as a dynamic node of the surrounding region expands the definition of the airport to a more synergistic growth node within the metropole; and as a result, the role of infrastructure becomes critical in the functioning of this new model.

The emerging airport is a large attractor/generator of trips, with time sensitive, high value and perishable attributes. If transport linkages allow the movement of people and goods further and faster, we are in essence increasing the airport catchments. This may have significant environmental impacts at both the local and regional levels, including the availability and value of land. The interface evaluation of transport linkages will allow an understanding of these network wide impacts by all stakeholders. The successful operation of the new airport hinges on the land based access and its critical relationships with the urban or regional periphery. World trade in services, information and knowledge has redefined the role of the region, and many regions now have access to world-scaled trade because of airport transportation hubs.

A primary interrelationship in the role of infrastructure for the new airport is that with land use. A better understanding of how changes in the transport networks influence the type of and the rate of change in, land use activity patterns in the region is required. For example major road projects in Brisbane, Queensland in the next 4 years (estimated at \$AUD5B) have the potential to impact directly on airport landside accessibility in terms of travel times and reliability of arrival times. The projects, which are currently in the planning stages, are already having an impact on location decisions of firms. The area in the vicinity of the airport has one of the fastest growing industrial activity nodes in the region [6]. Consideration of the airport and region requires broad strategic options where the interrelationships between transportation networks and land use activities are modelled through the use of a transportation demand approach used iteratively with appropriate economic development, land use and governance inputs.

Changes in the intensity of land use and infrastructure, may occur very quickly as a consequence of the external environment (e.g.: fuel costs, economic performance; etc.) although the planning and the provision of both happens over long time horizons. To meet the forecast demands of air transport and to facilitate efficient access to new on airport development, airports are considering a variety of infrastructure expansion strategies. Importantly, airports are considering more efficient use of existing facilities, to meet

demand, reduce costs and mitigate negative reaction from the surrounding communities to plans of expansion [9]. Evaluating of the efficient use and upgrading of current airport and regional infrastructure systems may only be viewed as an effective means to meet expected demand (while minimising impacts) when considered through the interdependencies of the airport metropolis interfaces. It requires a system approach to ensure that the impacts of; streamlining of facilities for more efficient arrival and departures; improving airport operations through information technology, or the review of management practices, are understood and effectively managed for the entire airport region.

III. SOCIAL INFRASTRUCTURE

While it is widely accepted that hard or economic infrastructure is a critical tool from which to leverage the economic gains from airports and their associated supporting industries to locales, the contribution of social infrastructure has largely been ignored or downplayed. Social infrastructure refers to the mix of factors or entities that provide a broader social and communal contribution to a setting or community [10]. Specifically, these include the basic community functions such as housing, education, health and support services provided by governments to maintain local quality of life and sustain society. Also contributing to the creation of a solid social foundation are those organisations that serve cultural, philanthropic and commercial purposes. Together these services work to underwrite social stability and provide a basis to facilitate within and across community engagement in order to address economic need. That is, social infrastructure provides a mechanism that enables citizens to connect with each other as well as accessing services.

Adding to the support provided by this suite of facilities is the array of initiatives that build communal sense, strength and capacity such as local events, festivals and the philanthropic and religious bodies. It has been argued that the quality of this total set of services and facilities (or their absence) and the level of resultant embedded community connections and capacity can directly influence the ability of a location to respond proactively to opportunities presented by other developments, despite the presence or investment in physical infrastructure [11].

Following this line, social infrastructure is more than the existence of social services and community activities, as valuable as these are to establishing a base sense of belonging and well-being. Underpinning social infrastructure and enabling it to fully enact and draw upon opportunities offered by both economic and social connections, is the notion of capacity. As [12] has proposed it the capacity and will of individuals and communities to provide or take advantage of opportunities that enhance their economic and social wellbeing.

Central to the creation of capacity is the ability to make informed decisions and act in the best interests of the

community. The ability to do this is influenced by the quality of the hard infrastructures such as buildings, transport and communication technologies and in particular with an even distribution of high speed broadband [13]. That is, the social infrastructure capacity of many communities is shaped by their within community interaction as well as with the airport infrastructures. Central to community capacity is the ability to tap into existing and new information sources and make informed choices that facilitate economic development while sustaining the sense of community.

Social infrastructure has resonance with the concept of social capital a terms that was introduced by Loury [14] and found popularity with Bourdieu [15] and Putnam [16]. In essence social capital refers to the connections among individuals, the networks, common values and social norms that exist between people [17]. Similar to social infrastructure social capital is considered to be a stock that can be drawn upon by individuals and communities to not only 'get by' but 'do better' [18]. As well as embedded social relations a number of other authors have pointed to the existence of residual knowledge, skills and learning ability, as also being indicative of social capital [19], [20]. In this way, communities that are able to tap into their social capital and social infrastructures are better able to make choices that facilitate economic development that is not at the cost of social cohesion and benefit.

It is not enough to focus on the basic services such as education, health care and housing – we must also take into account and facilitate and nurture the social connections and capacities of communities attached to airports to enable them to judiciously link into the opportunities made available through enhanced hard infrastructures.

IV. CONNECTIVITY

In the Airport Metropolis model, connectivity has been essentially delineated as consisting of hard infrastructure elements such as transport modes and communications networks that serve to link people and places. However, in this paper we argue that connectivity is considerably more than facilities and that a sole focus on the hard elements misses essential interdependencies. Connectivity provides a critical link to hard and soft infrastructures and enables them to operate more effectively in both their separate and collective domains.

Connectivity refers broadly to the capacity to be linked by road, rail, sea and airport or telecommunications technology rapidly, efficiently and economically. It is the mechanism that links people together and integrates hard infrastructures. The ability to optimally link a suite of infrastructures within any location to focus on delivering maximum outcomes, coupled with facilitating connections to broader areas determines the ability to innovate, enterprise and social and economic development. As Friedman [21] noted connectivity has a direct link to productivity.

As inherently social beings connectivity is a human necessity. People rely on interactions to build and maintain social bonds, access knowledge and mobilise resources. Information technology is the emergent 'backbone' of connectivity. However, it is a virtual connection and it is suggested here that hard connectivity still has a place in the airport metropolis in order to deliver passengers and freight to airplanes and goods and customers to the airport and surrounding business. It supplements the roles previously played by rail and road in economic expansion and social linkages. Continual advancements in information and telecommunication technologies which now allow for the simultaneous real time transfer of multiple data sets as well as transmission of audio, video and other images have changed the way organisations operate and reshape the way that people live and work. Information and communication technologies have enabled greater and more instantaneous access to information that was previously not available in the public domain. As a result citizens and interest groups now have a growing capacity to access, use and disseminate information for optimal decision making. This expansion of knowledge availability has also extended the set of decision makers and helps to build the capacity of the community and its leaders to make informed decisions relevant to the communities needs. Information technology also assists public action and social movements to organise to challenge actions that work against the best interest of the community [22], [23].

The existence infrastructures that are themselves connected and which in turn facilitate the connection of citizens to place and opportunity have the potential to deliver airport benefits beyond the airport metropolitan zone and more fully integrate communities into economic, cultural and social life.

Gaps between regional and local planning regulations and the master planning of airports are significant. Faced with increasing air traffic movements, some airports have lost flexibility in master planning because of poor integration between the local planning authorities and airport planning. Airport and urban plans acknowledge, but often ignore each other; they are frequently at odds. Despite very plausible arguments in favour of airport-centred development, already well underway in diverse global settings and forms, the assumptions and ramifications of the economic aspects of this trend are poorly understood. The consequences of the conflicts and gaps can include inadequate multi-modal interconnections, duplication of roads and rail lines, congestion, inefficient land use, piecemeal and unintegrated investments in infrastructure, diminished competitiveness, and draining legal challenges.

V. CONCLUSION

The existence of infrastructures that are themselves connected to and which in turn facilitate the connection of citizens to place and opportunity have the potential to deliver

airport benefits beyond the airport metropolitan zone and more fully integrate communities into economic, cultural and social life.

The interconnectedness of the airport to its surrounding region also poses hitherto unanswered questions to ways of mitigating and addressing the impact of landside activities on airside, and vice versa. Likewise, the nature of private-public relations with regard to infrastructure provision, maintenance and protection warrants detailed analysis [24].

Connectivity is suggested to be a useful concept to apply to emerging phenomena such as the airport metropolis because much of what determines the new role of this urban growth is defined by "connectedness" to other elements within the urban and regional fabric. Physical and social infrastructures are important in this endeavour and their connectedness is equally essential to understand. For example, hard infrastructure methods used to measure supply and demand (e.g. traffic modelling) may include social infrastructure, but it is often discounted in traditional analyses. Connectivity is an important concept to develop and is presently used as a means to understand the importance of the flows of information and knowledge within technology parks and knowledge precincts and the building of social capital within the urban environment. We argue in this paper that connectedness can be expanded to evaluate other contexts, such as land use planning or economic development, and supplement traditional analytical techniques. The challenge is to develop rigorous methods to integrate connectedness to hard and soft infrastructure and to add value to a comprehensive approach to understanding complex urban phenomena.

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