CHAPTER 7
Sustainable airport infrastructure: balancing infrastructures 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 other 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 chapter 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 creation and on-going development of 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 of hard, soft and social infrastructures provides the necessary balance to the airport metropolis to ensure sustainable development. This chapter 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.*

Keywords: airports, physical infrastructure, social infrastructure, connectivity, sustainability.

Introduction

The importance of sustainability and infrastructure is clearly acute at the confluence of the airport and the city. The modern airport is an essential global connection for the social and economic interaction of cities that rely on aviation as a means to shuttle both people and goods in a 'same day service world'. Airports require well connected infrastructure links to the city and region to service this global interface. However, to make this truly sustainable, infrastructure needs to be viewed as more than just physical works that connect people. Rather, social infrastructure is a critical element that defines the capacity of the community to sustain a quality of life and healthy community. How well 'hard' and social infrastructure are connected impacts the overall sustainability of

the relationship. This is especially critical when the function of infrastructure changes in a society.

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 (Freestone, Williams, & Bowden, 2006). 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* (Kasarda, 2001) 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 have been referred as an 'airfront' which describes the wide range of commercial, industrial and transportation facilities required to service the new demands (Blanton, 2004). The airport metropolis becomes a hub that provides the city and region with a different context for markets and flow of goods. As Kasarda (2001) 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 chapter 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 defines the sustainability of the airport as critical infrastructure to the metropolis and the surrounding region.

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 the 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 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 (Graham, 2000; Graham & Marvin, 2001). 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 (Ferreira, Stevens, & Baker, 2006). 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 (Lagadec, 2004). 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 (Lehtonen, 2004).

Transport infrastructure, as a facilitator of access, is recognised as fundamental to the development of the new airport and the emerging airport metropolis (Kasarda, 2001). Access to and from the airport is important for a variety of users; those who 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. Critical to new definition is the unfettered role of access. As result, infrastructure is essential to 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 four years (estimated at $5 billion) 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 (Ferreira et al., 2006). 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 (Wells & Young, 2004). Evaluating 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.

Social infrastructure
It is widely accepted that hard or economic infrastructure is a critical tool to leverage economic gains from airports, their associated supporting industries, and surrounding 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 (SGS Economics and Planning, 2003). 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 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 of, or investment in, physical infrastructure (Wells & Young, 2004).

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 the Organisation for Economic Co-operation and Development (OECD) (2006) has proposed it is 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 (Swanson, 1996). That is, the social infrastructure capacity of many communities is shaped by their within community interaction as well as their interaction 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 whilst sustaining the sense of community.

Social infrastructure has resonance with the concept of social capital, a term that was introduced by Loury (1987) and found popularity with Bourdieu (1993) and Putnam (2000a). In essence social capital refers to the connections among individuals, the networks, common values and social norms that exist between people (Bourdieu, 1993). 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' (Putnam, 2000b). 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 (Putnam, 2000a; Woolcock, 1998). 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.

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 chapter 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, the development of enterprise as well as social and economic development. As Friedman (2000) noted, connectivity has a direct link to productivity.

As inherently social beings, connectivity is considered 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. ICTs 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 community's needs. Information technology also assists public action and social movements to organise to challenge actions that work against the best interest of the community (Friedman, 2000; Keast & Brown, 2002).

The existence of 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.

Connectivity and sustainability

Infrastructure sustainability

Infrastructure is inherently unsustainable, with built-in obsolescence, and direct environmental impacts from its construction. In addition, the building of large infrastructure projects often has significant distributional impacts with respect to social/environmental sustainability. For example, the construction of large dams and hydro electric plants in hinterland regions impacts watersheds, rivers and local communities. The benefits realised from these projects most often are distributional – where large urban areas are served by the energy created and delivered by the hydroelectric infrastructure. The hinterland region bears the impact of the urban demand for energy.

However, the paradox is that infrastructure is essential, despite its obsolescence and distributional/environmental impacts. A key element in the benefits supplied by infrastructure is connectivity, which in turn provides growth and distributional effects. Wong (1999, p. 281) notes "growth effects are the aggregate of benefits accumulated from the rise in economic output, productivity, employment and economic welfare…". Connectivity improves information flow, reduces time in travel, and reduces overall transaction costs. Within a social context, adequate infrastructure provides for general prosperity and health. At a general level, these elements within themselves can serve economic efficiency, less consumption of resources and a more sustainable society. As Graham and Marvin (1996) observe, modern urban systems are dependent on infrastructure networks to make their economic and social systems function effectively.

At an airport scale, the development of sustainable infrastructure hinges on similar elements that characterise other infrastructure megaprojects. The challenge is to ensure that localised impacts are mitigated and that the benefits of the airport are distributed at a regional scale. The airport and its connecting physical infrastructure should be judged on the basis of not only contribution to economy, but also with respect to social and environmental sustainability. Of course, this is a challenging balance between market and non-market values. There is an increasing environmental concern in developed countries about the continuing growth of air travel and the airports which make that possible. Climate change has become a main issue for debate. With more audible political and community discussion about the limits to growth, the need for demand management, and urging reconsideration of government policies that facilitate market demand for air travel, there are serious implications for the attendant growth and prosperity of development dependent on unconstrained air travel.

However, most large cities are connected to the global network for communication and trade. Global cities are now critical points in the global economy and are connected to

each other through links in trade and knowledge forming global city networks (Taylor, 2004). Airports are essential infrastructure agents for these global city networks. Thus, one of the tenets of sustainability is to balance the localised environmental and social impacts of this critical infrastructure with its wide-ranging benefits.

If connectivity is used as one organising element of sustainability then the provision of local connectivity in infrastructure should balance the global connectivity that the airport provides. What does sustainability mean in the context of connectivity within local and regional communities?

Social infrastructure sustainability
Conventionally urban planning around airport precincts has concentrated on physical architecture requirements. This has primarily addressed land use, transportation and communications networks as well as the provision of buildings and landscapes. There has been considerable emphasis in the literature on the importance of this 'hard infrastructure', including that within airport precincts, being developed to contribute to economic and environmental sustainability requirements (Lehtonen, 2004). More recently, operational sustainability has been added to the suite of indicators identified as necessary to preserve and strengthen the airport business/community (Upham & Mills, 2005). By contrast, sustainable social infrastructures, the fourth pillar of a forward oriented community, has been much less observable in the area where airport related infrastructure overlaps with local community. Social sustainability occurs when the social systems, processes, structures and relationships in a locality actively support the capacity of current and future generations to create liveable communities. That is, a socially sustainable community is one that has the ability to maintain, tap into and build on its own resources (physical, intellectual and social) to respond to current issues and prevent future problems. This resiliency is a core outcome of social infrastructure.

For a community to function and be sustainable, the basic needs of local community citizens must be met. It is contended that socially sustainable communities operate to the following principles: equity, diversity, quality of life, connectively and democracy (Barron & Gauntlett, 2002). The latter two principles – connectivity and democracy – are particularly important in the airport city concept given the role that airports play in linking local and global worlds.

Connectivity in the social infrastructure context is not just about being linked to knowledge and transport networks and other 'physical resources' or having social networks that can be used to help people to survive in a particular locale. Rather, it is about the ability of local citizens to be able to tap into the added benefits inherent in modern infrastructures such as high speed internet capacities. In social capital terms this is represented as the difference between just 'getting by' and 'getting on' (Woolcock, 1998). Connectivity is also concerned with designing the physical infrastructure to promote interaction between it and citizens. Central to this is a consideration of space and the location of facilities to better enable the access and utilisation of public facilities. Ideally such facilities would be designed to serve a dual purpose and encourage the active engagement of local and other citizens in terms of access and broader utilisation patterns. In this way, some facilities such as parks and open meeting places could serve both as an airport and local community resource. Dual usage extends the infrastructure purpose and the array of groups using the facilities and, in doing so, helps to embed local people within broader airport infrastructure development and planning processes.

Moreover, it affords opportunities for enhanced interaction between local and airport communities.

Similarly, transport infrastructure planning and delivery should take into account existing transport flows and work to retain the sense of community connection rather than inserting major traffic corridors which can fragment an area into a number of disconnected locations. Further, the location of hard infrastructure units should not disrupt the natural flows of human interaction or remove the 'space' for public congregation. A number of authors (Rowley as cited in Graham & Marvin, 2001) point to the problems inherent in public spaces being 'claimed' for private purposes. Such action serves to sever the connection of citizens from their location, isolating them behind infrastructure grids and traffic corridors. The creation of globally rather than 'glocally' oriented hard business infrastructure effectively limits public access and utilisation thus preventing the very connectivity that they were established to provide. This condition has been defined elsewhere as 'splintered urbanism' (Graham & Marvin, 2001), where hard infrastructure is introduced to a location and the benefits of this private or global infrastructure are filtered from local communities. The end effect it is argued is a growing disconnect between global and local infrastructure benefits which can rupture the social fabric of a region (Graham & Marvin, 2001).

The key point made here is that social sustainability requires attention to the development and protection of a number of layers of connectivity. Drawing on this enhanced level of local and global connectivity, social processes can be leveraged to better facilitate engagement with the area and its resources. An understanding and commitment to the centrality of people and their connections, both relational and resource oriented, as a key element of community ideally would be built into airport and broader regional planning.

Governance

Careful consideration of the governance arrangements for the point of intersection between the airport and its infrastructure and the local community is also important for sustained social outcomes and is closely associated with connectivity. Governance refers to the way in which society is ordered, how decisions are made and resources allocated (Lowndes & Skelcher, 1998). Although airports have internal governance arrangements that guide their operational sustainability goals, they are increasingly subject to other complex governance arrangements in which layers of government and other stakeholder groups, including citizens, now comprise the decision making arena. An emergent urban planning consideration has been the development of community stakeholder engagement processes to better inform local citizens of airport developments and increasingly to actively engage citizens in genuine dialogue regarding issues of mutual concern (Upham & Mills, 2005). Under these governance arrangements the primary focus is the sustainability of airport and related infrastructures.

Social sustainability builds on and extends this notion of stakeholder engagement and argues for a better alignment between the physical infrastructure and local conditions and needs. Such an approach does not seek to infiltrate the internal operation and decision making of the airport which rightfully remains the exclusive responsibility of management. Instead, debate is directed at enhancing the decision making involvement of local citizens about those developments that may impact both positively and negatively on the community locale. Critical to this process is the selection of

appropriate representative 'governance' structures, coupled with accountable and transparent decision making regimes.

Accordingly, social sustainability requires governance arrangements to be developed and implemented that actively engage with local citizens who reside within the airport infrastructure shadow and therefore should have 'voice' in terms of those infrastructure developments that directly impact on them. This does not lessen the airports' or other government actors' decision making sovereignty but rather allows for a nuanced approach to engagement based on democratic principles. Such an approach allows for an increasing intensity of engagement ranging from information, knowledge, dialogue and finally mutual decision making. However, getting to this level of governance sustainability will require a shift in thinking and practice for both airports and other institutions charged with the responsibility for sustained infrastructure development as well as a level of maturity from the local citizens. This maturity involves an understanding that while not all presenting issues will be positively resolved, the process enables a genuine dialogue and ensures that these issues are heard and taken into consideration. It is argued here that together connectivity and governance, if done well, offer a way for a more collective approach to infrastructure to be established and maintained that allows all actors in this domain to benefit now and in the future.

There is growing attention being directed to social sustainability as an important 'fourth pillar' for the long term benefit of airports and their related urban communities. The recent Brisbane Airport Master Plan provides an example of a planning approach that recognises the need to include social, economic, operational and environmental aspects to secure a sustained future (Brisbane Airport Corporation, 2009). Despite the acceptance of the fourth pillar approach, it is contended that the key benefit and challenge of sustainable development is the ability to successfully meld all four aspects to be able to leverage from the synergies that emerge from their intersection. It is critical that both the airport and local communities are able to work together to build and protect this emergent resource.

Conclusion

The existence of interconnected infrastructures that 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.

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 chapter 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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