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Infrastructure Asset Management: The Challenges and Approaches

TOO, Eric G.¹

Abstract: Infrastructure organisations such as airport, seaport, rail and road are operating in an increasingly challenging business environment as a result of globalisation, privatisation and deregulation. These organisations must ensure that their main resource i.e. their infrastructure assets are well managed in order to support their business operations. Brisbane Airport is used as a case study to understand the challenges faced in the management of infrastructure assets as well as the approaches used to overcome them. The findings can be useful in helping asset managers to identify the resources they should seek to manipulate in order to make improvement to their activities and contribute to the overall performance of their organisation.

Key words: Asset Management, Infrastructure, Process

1. INTRODUCTION

Building and operating infrastructures consumes a large amount of resources. The provision and development of infrastructure assets typically requires long lead times; significant planning; and the involvement of many stakeholders to ensure that the community is appropriately consulted, and needs are prioritised within the funding constraints (van der Mandele et al. 2006). These organisations need to maximise the investments they have made in their existing infrastructure assets in order to reduce their capital and operating expenditures and improve the organisation's overall performance.

Recent years has seen most of the industrialised world facing many challenges in the development and management of infrastructure assets. Some of these challenges include the need to accommodate continuing growth to support the economic and social developments of the nation (Kessides 2004; Stevens et al. 2006), ageing infrastructure (Hardwicke 2005), inadequate funding commitments for renewal and replacement (Hardwicke 2005), short term focus of planning and political processes (Hardwicke 2005), limited infrastructure information (Hardwicke 2005), continuing integration of economies and systems through the increased globalisation and trade in goods, services and information (Stevens et al. 2006), and the need to satisfy multiple stakeholder demands (Nutt 2004; van der Mandele et al. 2006).

In view of these challenges, recent years have seen a shift in government and public sector agencies towards a management culture that focuses on customer needs, accountability of results, and competition between public and private bodies for contracts to deliver services that achieves cost recovery and value (Manning 2002). The strive to improve effectiveness and overall operating performance requires clear understanding of how to manage infrastructure asset portfolio in a way that allows their current performance to improve while also investing in new assets to meet future needs. Consequently, organisations that manage infrastructure assets are driven to provide services in the most cost effective manner. The aim of this paper is to explore some of the challenges faced in the management of infrastructure asset and the

approaches that can be adopted in order to improve the performance of these valuable assets. Following this introduction, next section will describe the methods adopted in this paper. This is followed by the detailed examination of the case study to identify the challenges and approaches adopted in each of the core processes. Finally, it concludes the paper with some suggestions for practitioner asset managers responsible for managing infrastructure assets.

2. METHODS

Kennedy (2007) confirmed that the asset management process itself is a life cycle process and believed good asset management processes were essential. In general, infrastructure organisations will have many processes as are necessary to carry out the natural business activities defined by the life cycle of the infrastructure assets. However, many scholars acknowledge that not all business processes can be a source of competitive advantage. For example, Kaplan & Norton (2004) suggested that managers must identify and focus on the critical few internal processes that have the greatest impact on strategy and can create value to the organisations. Too (2008) identified 5 core processes in the effective management of infrastructure assets namely capacity management, options evaluation, procurement & delivery, maintenance management and asset information management. Hence, this study adopts the core processes identified by Too (2008) to explore the challenges and approaches using an in-depth case study of airport infrastructure asset management.

The data is obtained from discussions with senior managers responsible for the management of infrastructure assets and analysis of documents obtained from the organisations. Thus, the interviews are organised around two interrelated research questions: (1) what are the challenges in infrastructure asset management? and (2) What are the approaches that can be adopted to overcome these challenges? The interview transcripts were linked to other internal and external documents. Particularly, the interview data was supported, cross checked and compared with data from a broad range of sources such as organisation policies and procedures; organisation charts; master and development plans; minutes of meetings, progress reports and memoranda; consultant reports such as economic reports, traffic reports, environmental reports, aviation reports, etc.; and government

¹Lecturer, School of Urban Development, Queensland University of Technology, Brisbane, QLD 4001, Australia, PH: +61 7 31389257, Email: e.too@qut.edu.au

reports. All these documents were reviewed to corroborate and augment the evidence gathered from interviews.

3. THE CASE: BRISBANE AIRPORT CORPORATION (BAC)

BAC is the long-term lessee and operator of Brisbane Airport. It is a proprietary company limited by shares. Since privatisation, the airport has grown from a government-owned entity to a stakeholder-focused, commercially driven company widely known for its vision. It has won the Australian Airport of the Year and was named Major Australian Airport of the Year at the prestigious Australian Airports Association annual awards. The award recognises BAC's heavy investment in world-class aviation and passenger infrastructure and strategic growth of Airport from a city airport into Airport City.

BAC focuses on the strategic delivery of services and products for airline customers and their passengers. The key infrastructure assets managed by BAC include the runways, taxiways, and all the assets on the Domestic and International Terminals buildings such as baggage handling system, the check bag screening, aero-bridges, building fabrics, hydraulics, chillers, and all the HVAC system, electrical systems and communication systems, associated access roads and commercial properties.

3.1 Capacity Management

BAC's vision is to develop the Brisbane airport into a premier gateway as well as a centre of regional economic growth generating prosperity for the people of South-East Queensland (BAC 2009). To achieve this vision, BAC plans to invest \$2.0 billion worth of infrastructure over the next 20 years. Specifically, BAC plan to undertake significant development works to invest in new infrastructure as well as improving and upgrading of existing infrastructure. These include the development of the airfield (runways and taxiways), terminals (building and aprons) and supporting facilities and infrastructure within its lease area. The heavy investment required of this scheme reinforces the importance of the capacity management process.

3.1.1 The Challenges

The key indicators of airport growth are passenger traffic and aircraft movement. By analysing the trends and projection of growth, BAC can determine the capacity they need from runway, gates, check-in, baggage handling, circulating space and other terminal assets. These projected capacities can then be analysed and compared with existing capacity to decide on the best ways to provide the necessary needed capacity.

To ensure that future capacity is met to support the airport operation, BAC has to manage their capacity in such a way that they can optimise their existing capacity relative to demand and to justify and deliver timely key infrastructure (BAC 2008). The importance of delivering timely infrastructure is explained by a manager, "the great challenge is getting as close to just right or just in time."

Besides getting the timing right in infrastructure provision, they also need to ensure that they provide the right infrastructure. For example, the development of newer aircraft such as the A380 may indicate an opportunity to provide infrastructure that can

serve these type of aircrafts. If the provision of enhancement to the existing infrastructure is not made, the opportunity may be miss to attract airlines to fly in. However, getting the right and just in time infrastructure is difficult because of the constantly changing trends and factors that affect airport business. This difficulty is shared by a manager, "identification of what is the right time and what is the right increase is difficult."

The challenge is accentuated by the fact that there is a long lead-time to build infrastructure. The issue they faced is how to provide a justification as to the need to invest now due to the long lead time to develop these infrastructure. As noted by a manager, "these assets cannot be built overnight and it takes years from planning to delivery." In addition, airport infrastructure is designed to last a long time and not mobile. Hence, once it is built it has to be fully utilised in order not become a stranded asset. For example, a manager noted, "you cannot just pick up the runway, if there is excess capacity and put it somewhere else ... they are not moveable and we have to try to utilise it."

Airport capacity is also constrained by surface transport capacity. For example, BAC is currently embark on major construction works of the \$220 million Northern Access Road Project, which will ultimately provide a second major access and egress point for Brisbane Airport. This is necessary to support the expansion of the \$340 million international terminal and the \$600 million upgrading of domestic terminal currently under planning. In other words, such a surface transport system must be compatible with airside operations and airport efficiency as shared by a manager, "... because we are tied to the other part of the systems over which we have no control, for example, passenger number and aircraft movement have a direct relationship with ground traffic but capacity can be constrained by land-side traffic."

In sum, a key challenge in the infrastructure capacity planning and management at the airport is determining the right timing and right increase of infrastructure provision given the uncertainties of future demands. In addition, the need to manage the various stakeholders involved in asset provision is constantly an issue.

3.1.2 The Approaches

Infrastructure capacity analyses at the airport are done based on peak demand, both for the passenger traffic and aircraft movement. Managing capacity based on peak demand is important for an airport because any bottleneck can affect the efficiency and reputation of the airport. Based on the peak periods, the aircraft movements can be determined to assess whether sufficient runway capacity is provided to enable continue growth of air traffic.

To reduce the uncertainty in growth projection of these demands, BAC strives to collect as much information as possible with regards to the likely changes in the trends in the airline industry and aviation industry. For example, through discussions with airlines and the review of the Airbus Industries and Boeing forecasts and orders, it is expected that B767 size aircraft will be replaced by the B787 or A350 aircraft or even the newer and bigger aircraft such as A380 introduced in 2008. This suggests that the runway and terminal building need to be developed to provide a very high level of useability that can accommodate the operations of such larger aircraft. This is reflected in BAC latest expanded international terminal that have included the provisions

of dual aero bridges for super wide-bodied aircraft such as the A380. In addition, Emirates airlines opened its new first class lounge in the expanded terminal, complete with direct access to a state-of-the-art gate with A380 compatibility - the first lounge of its kind outside Dubai. Hence, through discussions with the airlines, BAC can be more prepared to provide the right infrastructure to accommodate the trends in the airline industry such as the trend of a growing proportion of low-cost airlines. The need to collect more information is succinctly noted by a manager, "I think we need to have the right information available ... with the right information in the right manner, the manager will be able to understand when an asset is needed."

Internally, airport operations can yield much information concerning the ability to cope of current infrastructure assets. BAC constantly communicates with their internal operations with regards to the ability of existing infrastructure to support their business operations. A manager noted, "our operation department will feedback on capacity of current assets and the capacity going forward ... we know when the terminal is struggling ... passenger throughput starts to slow as you reach capacity ... we set standards that a passenger should progress through the terminal within a certain time period ... when these standards are not met, we know where we are."

To address community concerns, BAC has been involving the community and stakeholder engagement in its capacity planning process. BAC develops a proactive approach to community and stakeholder engagement by initiating and supporting a range of committees to ensure the relevant community and stakeholder interests are kept informed of airport activities and plans. For example, BAC has established the Technical Group on Noise Management and Moreton Bay Sand Extraction Study Steering Committee. BAC is also an active participant on numerous industry and professional associations ensuring currency on industry issues and trends. These include the Australia TradeCoast's Marketing Working Group and Infrastructure Working Group. BAC believes that such stakeholder engagement form part of their capacity planning helps build relationships and provide valuable feedback to assist in delivering its vision to create Australia's premier airport city (BAC 2003).

3.2 Option Evaluation Process

BAC has identified specific objectives in the development and operation of their infrastructure. Besides meeting future capacity needs, BAC has identified the following development objectives (BAC 2009):

- Facilitation of safe passenger, freight and aircraft movement
- Sound environmental management
- Accessibility and land use
- Improvement of quality of services
- Sound business management

In the evaluation of asset options, it is important that these objectives be used as a reference point to ensure the options finally chosen would indeed support the achievement of these objectives.

3.2.1 The Challenges

Once a need is established, all major projects at BAC go through a series of evaluations through the Major Development Plan (MDP). The MDP document contains a series of evaluations to assess the various alternative options.

In evaluating the development of airport infrastructure, safety including flight safety, airside security and public safety are always given the highest priority at all times. For example, the runway must meet all the regulations on the safety aspects such there must be a minimum clearance 0.5m is two runways are developed next to each other. There is also a need to undertake a technical evaluation to ensure that the requirements, as set out by all statutory contexts, are complied with. Regulation compliance issues are non negotiable in airport infrastructure. Only after the minimum requirement of regulations are complied with can the evaluation concentrate on development of infrastructure features to achieve service excellence.

To ensure the proposed infrastructure serves its role in improving the quality of services, BAC must ensure that the proposed infrastructure provides convenient, cost efficient and high quality service for passengers, airlines, general aviation and tenants. From the environmental perspective, BAC must also evaluate the proposal based on how they can responsibly manage other environmental issues associated with airport infrastructure development. In fact, any new development has to comply with '2004 Airport Environment Strategy', which was prepared to enable BAC to comply with statutory and other requirements.

Hence, the main challenge in asset evaluation is best summed up by a manager as follows, "we need to do a balancing act ... there are obviously many evaluations to be considered but ultimately it depends on the value to the organisation."

3.2.2 The Approaches

The evaluation of the most appropriate infrastructure assets to meet the BAC objectives involves the balancing of conflicting objectives. To this end, the BAC approach is to form a team for each major development project such as the proposed parallel runway. The team consists of experts from various disciplines working together to evaluate each of the criteria to ensure a balanced outcome is achieved. They have different groups of people to evaluate different aspects ranging from environmental looking at lighting and cooling issues, safety looking at the regulations, security working with Police and Custom, the operation looking at passenger comfort and flow rate, maintenance looking at the maintenance aspects.

A senior manager coordinates the team so that all the inputs from various experts and specialists are properly considered and consolidated. He will take input from the various divisions in the form of comments on documentation. He will also coordinate the various inputs from these specialists from various departments to make sure the overall objectives are met. The importance of having a team consisting of experts from various disciplines working together to evaluate the asset is to ensure the optimal outcome is achieved.

In summary, BAC adopts a special project team comprised of experts from various divisions to ensure a balanced and comprehensive asset evaluation of all factors involved in order to minimise the risk of choosing the wrong options.

3.3 Procurement & Delivery Process

BAC outsources all their procurement of infrastructure asset through competitive tendering. In addition, BAC uses external consultants to draft, design and prepare the specifications. The design and specifications prepared by the consultants are used as a basis for calling for competitive tender in accordance with BAC in-house normal corporate governance. The main reason is that airport infrastructure are specialised assets and there is no in-house expertise. In view of this, the BAC approach to procurement is to achieve effective use of their external providers (BAC 2008) as noted by a manager, “we try to achieve effective use of our external providers ... it is a cost and quality driven issue.”

3.3.1 The Challenges

In relying on external providers for the design, procurement and delivery of most infrastructure assets, one of the key challenges faced is to ensure the availability of good and competent service providers. These providers need to have the experience of working within the airport setting and understand the compliance issues within the airport as noted by a manager interviewed, “the provider must know the place well and know the compliance issues at the airport.”

The importance of having competent providers is to ensure that the external providers can deliver the infrastructure within the constraint of the airport setting and especially its compliance issues. However, it is always difficult to engage good external providers who have experience in the airport setting. This is made worse during tight market conditions as noted by a manager, “in the tight market, it is difficult to find good provider”

In this regard, while outsourcing almost the entire asset procurement and delivery process, the achievement of the asset goals critically hinges upon the performance of the external service providers.

3.3.2 The Approaches

The heavy reliance on external service providers changes BAC’s role to that of a service quality manager in the procurement and delivery process. To assure the achievement of the desired outcomes, BAC recognises the need to have good documentation as a strategy to prevent uncertainty and dispute. A good contract clearly defines what is needed from the external providers and if there is any ambiguity, it can be easily identified. To ensure the documentation includes all critical performance indicators, key stakeholders are consulted during the preparation process to make sure that nothing is omitted.

Another quality assurance measure undertaken by BAC, as a result of its reliance on outsourcing, is that only external providers that have a good track record and performance are invited for tender. The performance of these external providers are stored in BAC’s approved contractor database. The database contains information on their past performance such as safety, relationships with stakeholders, consistency of performance, etc. The database is built up by assessing the performance of the contractors after each project. The performance of each provider were rated against criteria such as safety, consistent performance, and the stakeholder relationship management outcomes.

Having established a list of good performers of external providers, BAC seeks to maintain a good relationship with them. Good relationships with external providers are important to develop trust and ensuring effective collaboration. This can reduce the management effort of monitoring and inspection.

In summary, asset procurement and delivery is considered a non-core activity at BAC and therefore a major part of this function is outsourced. This necessitates the putting in place of extensive quality assurance measures to maintain a high asset procurement performance.

3.4 Maintenance Management Process

Maintenance management is deemed to be an important process to BAC because public perception and passenger experience is extremely delicate. This is succinctly explained by a manager, “we have to make sure that the asset is available whenever it is required ... in an airport, it is about presentation and public opinion ... they want a good experience in the airport.”

3.4.1 The Challenges

The main goal of maintenance management at BAC is to ensure optimum asset performance. To achieve the efficiency and effectiveness, maintenance planning is vital. Inspection and condition monitoring forms a large part of the maintenance planning at BAC. One of the key challenges is to reduce the time taken to carry out such inspection. BAC needs to plan the inspections and maintenance activities around the operations so as not to undermine operations at any time. This is especially important when the demand for assets is high and the amount of time for maintenance is reduced. For example, a manager noted, “we now have aircraft leaving until 1:30 am and we have our first arrival at 4:00am ... so the available window for maintenance of these assets has been significantly reduced.”

To capture critical maintenance works, BAC conducts scenario planning to assess possible asset failures and the effect on business continuity. However, the accuracy of such scenario planning is dependent on having good historical data, For example, a manager noted, “to ensure we are able to plan well, there is much data capture, and the analysis of those data ... only with a history you can then have trend analysis.”

Besides data, the other key challenge is the ability to analyse these data and make informed judgements. These analyses require the skill and judgement of a maintenance planner as explained by a manager, “people skills are important in the analysis ... you need the right technical people who know the asset and how it will operate and what effect is of the asset on the business operations.” In other words, BAC needs to have experienced personnel who know and understand well both the asset and its relation to operations. The maintenance personnel also need to have regular communication with the operations personnel to understand how maintenance can be planned so as not to disrupt operations. This sentiment is stated by one of the managers interviewed, “these managers, with their experience and understanding of our assets and operations needs, are key to ensure that we make the right judgement and assessment.”

Hence, the key challenge encountered is the shortage of skilled and experienced personnel that can conduct visual

inspections and make expert judgement on the conditions of an asset. In addition, the subjectivity of judgement can cause inconsistency problems and when an asset will fail.

3.4.2 The Approaches

BAC pays a lot of attention to preventative maintenance in their maintenance planning. They do so by examining the manufacturers' manual and performance history of the assets to capture the type of maintenance to be done, which is stored in their computerised maintenance management system. They also ensure that all the regulations and standards are adhered to.

BAC also conducts a lot of inspections to monitor the conditions of their assets. The purpose of these inspections is to plan an appropriate maintenance programme that will ensure the competent function of the assets. Monitoring of asset conditions is done through scheduled inspections and analysis of past history. The results of these inspections are fed into the computerized maintenance management system. It appears then that technology may be the way forward for monitoring the condition of the assets without disrupting business continuity. In fact, BAC has increasingly realised the benefits of technologies in monitoring the condition of the assets. For example, they are at the moment developing their capability to adopt more automation by setting up a research and innovation group to explore new technologies available. They also attend forums on new product demonstrations, and benchmark against the best airports around the world such as Schipol, Changi, Sydney and Melbourne.

BAC has also formed strategic partnership with institute of higher learning to investigate and conduct research. For example, BAC supports the QUT's Chair in Aviation Innovation and is involved in research, education and training. BAC also works with major technology providers to form strategic partnerships to develop the appropriate technology and explore solutions. In summary, BAC believes that they can overcome the challenges encountered in maintenance management through the use of technologies.

3.5 Asset Information Management Process

Asset information management is essential for the management of infrastructure assets at BAC as it provides important information for optimal decision-making. This information has to be stored in an IT database as noted by a manager, "obviously the IT database is the only way to be able to get an accurate reflective history of your assets."

3.5.1 The Challenges

BAC use their IT system, a database to record all their infrastructure assets and its capabilities. These assets include runway, taxiway, terminal assets, etc. The information captured in the system includes lifecycle cost, maintenance history, performance history, asset information and asset conditions, the traffic growth forecast and aircraft movement data.

The interviews revealed that at the moment, the information is used mainly for decision-making concerning the maintenance of their assets such as maintenance planning and scheduling condition inspection. This suggests that the capability of the IT

system is not fully exploited. One of the key challenges faced is the lack of clear policy and direction on how the data collected is used resulting in inappropriate data being collected. This noted by a manager, "we have a whole network that is connected with a lot of systems hanging on the network ... but there was no clear policy and no clear direction on integration"

Further, without clear direction, different data is being collected by different departments in accordance to usefulness in each individual department without considering the need for data sharing and resulting in a lack of integration. A manager noted, "integration of information is important ... at the moment, different parts of our company are handling different types of information." The issue is made worse with new staff who bring with them the knowledge and the introduction of new systems that they have used before in the past. The result is a suite of systems that may overlap in their capabilities but which lack compatibility and integration.

In summary, the key challenge faced by BAC is the lack of integration of their data and one manager aptly sums this up, "it is all about integration, about information management and consistency across the network ... only then you can manage your systems in a good way so that you can optimise it properly."

3.5.2 The Approaches

To achieve an integrated asset information management system, there is a need to have a clear policy on what and how the system is to be used. A team has been formed to reinvigorate the computer management system. A team has recently taken over the IT system so that they can work with other asset managers, utilities, engineering managers, security, environmental, and operations managers. The team works towards one goal, that is, so the IT system is targeted at working for the business. They have started examining the fundamental business process so that appropriate and consistent data can be collected and used. A manager commented, "to utilise an IT system, business process is key ... a business manager need to understand the potential of an IT system and similarly the IT people need to be familiar with the business process."

To capitalise on the system, there must be a clear sense of what data should be fed into the system. Through the team, appropriate data structures can be worked out as explained by a manager, "we now have to go through the process of culling a lot of data that we won't be using and to put in the necessary data so that we can make better decisions"

With the reinvigoration of the IT system, BAC anticipates that cultural change management is crucial to ensure the success. They noted that it is important in changing the employee's culture so that they can understand what the benefits are and know what information is going in and know what information are needed. It was also observed that regular training and support from top management is used to build the confident of all personnel using the system. This is shared by another manager, "as we use it and supplement with training, people are getting more familiar and confident ... by using it, everybody understand why it is required as it gives clarity why a certain decision is made ... that makes people more comfortable with it."

4. CONCLUSIONS

This paper illustrated the diverse challenges faced by Brisbane Airport Corporation in their core processes involved in management of infrastructure assets to support their business operations. The challenges and approaches identified to overcome these challenges are summarized in Table 1 below.

Table 1: Summary of Challenges and Approaches

Core Process	Challenges	Approaches
Capacity Management	<ul style="list-style-type: none"> • Identification of right timing and right increase of infrastructure provision • Managing stakeholders involved in asset provision 	<ul style="list-style-type: none"> • Peak demand analysis • Collect up-to-date information through discussion with airlines and internal operations • Works with various authorities • Communicate with stakeholders through Master Plan, Forums, Working groups
Options Evaluation	<ul style="list-style-type: none"> • To achieve a balance between the conflicting objectives 	<ul style="list-style-type: none"> • Use team of experts from various divisions working together to ensure a balanced outcome
Procurement & Delivery	<ul style="list-style-type: none"> • Ensuring performance of external service providers 	<ul style="list-style-type: none"> • Documentation to monitor performance • Develop a strong relationship with established providers
Maintenance Management	<ul style="list-style-type: none"> • Expedited inspection • Develop innovative tools and techniques to monitor condition of assets 	<ul style="list-style-type: none"> • Use of technology • Update knowledge of latest technology through research and innovation group • Partnership to develop technology
Asset Information Management	<ul style="list-style-type: none"> • Lack of defined use for data • Lack of systems integration • Consolidation of systems 	<ul style="list-style-type: none"> • Set up task force to address integration issues • Providing training and management support • Cultural change management

The challenges and approaches in this paper were identified based on generic strategic infrastructure asset management processes proposed by Too (2008). These are broad strategic core processes that are necessary to contribute to the attainment of asset management goals. However, there is scope for further research to support or reject the core processes proposed. This is necessary, as the pressure on critical infrastructure continues to build within developed economies around the world at an exponential rate requiring improved management processes to achieve optimal solutions.

Despite the above limitation, however, the lessons learnt from this case study, do provide guidance for infrastructure organisation to concentrate their investment of their limited resources in developing only the appropriate capabilities to overcome these challenges in order to survive in an increasingly competitive environment. The improved asset performance will be able to send a powerful signal to senior management of the strategic importance of the asset management function in contributing to the business goals of the organisation.

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