A PLANNING SUPPORT SYSTEM FOR AIRPORT CITY DEVELOPMENT

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ABSTRACT

Many airports around the world are diversifying their land use strategies to integrate non-aeronautical development. These airports embrace the "airport city" concept to develop a wide range of commercial and light industrial land uses to support airport revenues. The consequences of this changing urban form are profound for both airport and municipal planners alike and present numerous challenges with regard to integration of airport and regional planning. While several tools exist for regional planning and airport operational planning, no holistic airport landside and regional planning tool exist. What is required is a planning support system that can integrate the sometimes conflicting stakeholder interests into one common goal for the airport and the surrounding region. This paper presents a planning support system and evaluates its application to a case study involving Brisbane Airport and the South East Queensland region in Australia.

Keywords: Spatial Decision Support Systems, Planning Support Systems, Land Use Planning, Airport Planning.

1 INTRODUCTION

In recent years, the airport city has become the benchmark development strategy for modern airports (Kasarda, 2008). Consequentially, an airport can no longer be considered in isolation to the surrounding area and more importantly the surrounding area cannot be planned without due consideration from the airport. It would appear that while many airports have embraced this type of development strategy, many of the municipalities surrounding them have not. Traditionally, airport planners plan airports and urban planners plan cities and never the twain shall meet. With the advent of the airport city, the need for an integrated approach to airport and regional planning has never been greater. This polarisation between urban planners and airport planners is preventing many airports making a successful transition from airport to airport city. While some of the land adjacent to airports are planned with due consideration of airport development strategies, arguably others are not. Recognising the greater spatial influence of an airport city over a traditional airport is the first step to better understanding the planning problem facing current airport and urban planners. Many airports owners are struggling with their surrounding municipalities as they strive to embrace the airport city model.

To make matters worse, airports often operate under different planning regimes to the municipality surrounding them; this can hinder cooperative planning of the land uses immediately adjacent to airports. Without adequate coordination between the airport master plan and the municipality community plan, divergent strategic visions for the region can occur.

Australia's major airports have been operating with this mixed planning regime for over a decade with varying degrees of success. In fact 22 Australian airports are regulated under the federal government's Airports Act 1996 (Commonwealth of Australia, 1996) while the land adjacent to them is regulated under both local and state planning laws. The main area of concern for the local governments surrounding these airports has been their lack of involvement in the landside development process at these airports. Rightly or wrongly, a lack of compatibility between airport development and community plans was a major theme in recent issue paper submissions (Freestone and Baker, 2009). Consequently, the Australian Government, via the recent National Aviation Policy White Paper (NAPWP) has called for "improved planning at Australia's airports to facilitate

better integration and coordination with off-airport planning". The NAPWP requires the establishment of Planning Coordination Forums for large airports to safeguard ongoing engagement between the airport, the Commonwealth, and state, territory and local governments (Commonwealth of Australia, 2009).

The Australian Government's call for Planning Coordination Forums fits well with Healey's collaborative planning theory (Healey, 1997). If the main airport planning stakeholders come together early in the planning cycle then the chances of developing a shared vision of the airport and its surrounding area increases dramatically. As this group comes together, it will need a tool to help support this collaborative planning process. This paper presents such a tool in the form of a planning support system (PSS). Planning support systems have been emerging over the last decade. A PSS goes beyond simple geographic information system functionality and is well suited to collaborative planning. In particularly a PSS has the ability to express the technical modelling outcomes in terms familiar to planners (Brommelstroet and Bertolini, 2008).

While PSS are great aids for planning decision makers, it is important to note that any planning decisions should be made as part of a structured decision making framework. Our research utilises a policy analysis framework as described by Wijnen et al. (2008) and Walker (2000). This paper is mainly concerned with the PSS implementation and readers should review Wijnen et al., (2008) for more information on the policy analysis framework.

The paper is structured as follows: first an overview of the airport city, airport planning in Australia, and PSS techniques are discussed as background information for the reader. Secondly, methods utilised to develop and evaluate the PSS are outlined. Finally, this is followed by a discussion of the results and the implications of this research.

2 BACKGROUND

This section will examine the airport city and the airport planning environment in Australia. Finally, it will address the current research into PSS.

2.1 The Airport City

An airport city is the ultimate transit oriented development (TOD) strategy. It is best described as an airport centric city. The airport is at the heart of the city and is serviced by good access links from all modes of transport. The airport city is an interchange with access to global, regional and local markets. An airport city is spatially much larger than a traditional airport. In fact, an airport city extends beyond the airport boundary and incorporates surrounding land not owned or controlled by the airport. Finally, an airport city is not limited to aeronautical activities and has a broad spectrum of non-aeronautical activities (Stevens, 2006, Kasarda, 1996). Although the airport city concept was first described by Conway (1980) almost three decades ago, it has only recently been adopted as an industry standard.

The privatisation and corporatisation of airports has had the greatest influence on the land use composition of the modern airport and in turn the surrounding region. Privately controlled airports have more flexibility than their public owned predecessors. This means that modern airports have been operated and developed to maximise investor return with little interference from government. Therefore as a consequence of the privatisation of airports, planning efforts have focused on increasing an airport's competitive advantage over other airports (de Neufville and Odoni, 2002).

The airport city is a way to commercially exploit an airport's vacant land reserves to provide new revenue streams for airport operators. On airport developments like car parks, office precincts, retail outlets and freight hubs have replaced much of the traditional green buffers on airport land. Indeed revenue from non-aeronautical development (i.e., terminal concessionaires, car parking, investment

property, commercial land developments, and sale of assets) has at many airports worldwide surpassed the revenues generated from aeronautical activity (Wells & Young, 2004).

Increasingly, the development of business and technology parks and retail complexes is a preferred commercial strategy at airports where suitable land assets exist, and where landside access infrastructure will allow such development. Although it may be recognised that even without accounting for accessibility, a growing number of airport business parks are gaining popularity as an airport commercial strategy (SGS Economics and Planning, 2003).

Airport city developments also draw on the non-travelling public to generate an increasing proportion of commercial revenue. These developments are often identifiable beyond the airport's boundary as regional commercial investors see the benefits of locating near the developing airport city. This has important implications for the municipality responsible for planning the area surrounding the airport. Little attention has been given to these districts surrounding airports, and few town planning authorities understand how to plan development to best leverage this economic resource, and how it may fit into broader transportation and regional land use planning (Blanton, 2004).

Finally and perhaps more importantly given the current global economic downturn, the airport city should provide greater resilience through its diverse revenue streams. This could provide a significant difference to the overall profitability of an airport which is operating in a climate where airlines are going out of business daily.

2.2 Airport and Regional Planning: The Australian Context

Balancing land use compatibility with airport operation is the role of airport land use planning and its importance was recognised in the 1930s (Bednarek, 2000). The term compatibility should refer to both on-airport land use, in the form of airport master planning, and the land uses beyond the airport's boundary, often represented in local town and regional community planning.

As mentioned earlier, 22 Australian airports were privatised (under a 99-year lease agreement) in 1996. This privatisation of Australia's major airports lead to increased non-aeronautical development on airport property (Walker and Stevens, 2008). This type of development has not gone unnoticed (or unchallenged) by the airport's neighbours. In the last decade, this regulatory planning difference has caused numerous challenges and debate between airport, local and regional planners.

The recent National Aviation Policy White Paper (NAPWP) (Commonwealth of Australia, 2009) calls for improved planning at Australia's airports to facilitate better integration and coordination with off-airport planning. To aid this policy the government supports the establishment of a Planning Coordination Forums for each main capital city airport (i.e., Adelaide Airport, Brisbane Airport, Canberra Airport, Darwin Airport, Hobart Airport, Melbourne Airport, Perth Airport, and Sydney Airport). The NAPWP describes the Planning Coordination Forums as follows:

> " *…. the Planning Coordination Forum will act as the vehicle to lead constructive ongoing dialogue on matters such as Master Plans, the airport's program for proposed on-airport developments, regional planning initiatives, off-airport development approvals, and significant ground transport developments that could affect the airport and its connections. The Government anticipates that the proposed Planning Coordination Forums will build on rather than replace existing mechanisms. The Planning Coordination Forums will create a mechanism to consider the implications of metropolitan planning issues for the airport at a more strategic level and ensure that airports are considered as part of longer term strategies."*

The Planning Coordination Forums will comprise airport planners, state planners, local planners and possibly expert advisors. At this stage the Australian governments is remaining flexible on the conduct and makeup of the Planning Coordination Forums. The NAPWP states that each Planning Coordination Forum will be tailored to the particular circumstances of the parties involved. In our opinion, a PSS is the perfect vehicle to support the decision makers in the Planning Coordination Forums.

2.3 Planning Support Systems (PSS)

Geertman and Stillwell (2003) define Planning Support Systems (PSS) as any geographical information and spatial modelling system that has been developed to support public or private planning processes (or parts thereof) at any defined spatial scale and within any specific planning context. Geertman (2002) proposes that PSS is the missing link between planners and technical geographic information systems (GIS). Key to PSS are the use of metrics and terminology that planners and decision makers can readily understand.

A large variety of PSS have emerged in recent years and numerous taxonomies of them have been presented in the literature (Geertman and Stillwell, 2004, Klosterman and Pettit, 2005, Snyder, 2003). Klosterman and Pettit (2005) present a good insight into the off-the-shelf PSS that are ready to support planners and researchers alike. It would appear that the usage of PSS is becoming more widespread and that planners are more accepting of the outputs they generate.

2.4 Benefits of PSS for Australian Airport and Regional Planning

Australia's privately owned airports are an interesting contrast to the publicly owned airports of Europe and the USA. This distinction coupled with its associated governance frameworks makes facilitating collaborative planning more problematic in Australia. A PSS with its ability to compare and communicate different spatial planning policies is seen as a prefect tool to bridge the gap between federal, state and local planning requirements. With the increasing number of stakeholders in the airport panning domain, a system that has the ability to express a common planning language would be invaluable to bring together the disparate groups.

In addition, the PSS will employ an analytical method of evaluation via an agreed set of indicators. This will allow the different stakeholder positions to be communicated to the broader planning group with less emotion and in factual terms. A PSS could support the Planning Coordination Forums through integration of the local and state spatial plans with the airport spatial plan.

3 METHODS AND MATERIALS

This section will discuss the rationale of selecting the study area and PSS, and the process utilised to develop scenarios, policies, indicators and to evaluate the PSS.

3.1 Brisbane Airport case study

Brisbane Airport (BNE) is Australia's third busiest airport behind Sydney Airport (SYD) and Melbourne Airport (MEL). Passenger numbers at Brisbane Airport in 2008 were 19,011,760 making it a relatively small airport when compared to Atlanta International Airport (ATL) which had 90,039,280 passengers in the same year (Centre for Asia Pacific Aviation, 2009). However, the property size of approximately 2,700 hectares, of which 1,000 hectares is suitable for land use development, makes it one of the largest in area of any of its national and international contemporaries. Brisbane Airport is privately owned by Brisbane Airport Corporation (BAC) which has clearly articulated its intention to develop this land and transform BNE into an airport city (Brisbane Airport Corporation, 2009). Planning of Brisbane Airport falls under federal control through the Airports Act 1996.

Brisbane Airport is part of the larger 8,000 hectare Australia TradeCoast (ATC) precinct which is developing as an economic and employment centre of major regional and national significance. The site is currently home to 7,500 businesses (including Brisbane Airport and the Port of Brisbane) and it is anticipated that by 2026 the area could provide up to 103,939 jobs and qualify as the largest employment centre outside of Brisbane Central Business District (CBD) (Queensland Government, 2008a). While not all of the ATC will develop into aviation related industries, its size and proximity to the airport will allow the Brisbane airport city to development outside the airport's property boundary. Such development would be necessary if Brisbane Airport is to develop into a true airport city as described by Conway (1993) and Kasarda (2006).

Key airport and regional planners in the Brisbane case study have formed a Planning Coordination Forum of sorts. It currently comprises representatives from Brisbane Airport Corporation, Brisbane City Council (the only municipality adjacent to Brisbane Airport) and the Queensland State Government. It was established before the NAPWP was published and its aim and structure closely align to the Planning Coordination Forums of the NAPWP.

3.2 Available data

Due to the nature of the stakeholders involved in the Brisbane case study, a rich set of diverse GIS datasets were available. The following is a list of the main datasets utilised in the PSS:

- property parcel information,
- both airport and local government land use information,
- major planned infrastructure projects,
- employment area information,
- population forecasts,
- airline growth forecasts,
- demographic information (i.e., Census data from 1996 to 2006),
- transportation zones and network,
- transport travel study information,
- aircraft noise contours and flight path densities,
- noise complaint information,
- economic activity areas and statistics, and
- aerial photography.

3.3 Implementing the PSS

Numerous PSS tools exist in the market place today. Since both airports and urban planners utilise geographic information systems (GIS) for their particular planning problems it makes sense to use this same tool to bring the parties together. Snyder (2003) presents a nice summary of the functionality of current PSS applications. From his review of 28 PSS applications, it can be seen that only CommunityViz and UGrow have the complete set of functionality. More recently, Klosterman and Pettit (2005) suggested that the most notable off-the-shelf planning support systems are CommunityViz, SLEUTH, INDEX®, UrbanSim and What if?™. From this set of PSS only CommunityViz and INDEX provide comprehensive impact assessment tools.

It is also import to consider the type of planning problem when choosing the appropriate PSS to support it. In this case, all stakeholders will come together at the Planning Coordination Forums so a desktop and not web-based tool will suffice. Finally a GIS-based system that supported customisation through a programming SDK was seen as an important criteria to select an appropriate PSS for this case study. After careful consideration, CommunityViz was evaluated as the most suitable for this research project. This decision was supported by a number of other projects that have utilised CommunityViz in a similar fashion (Zolnik et al., 2010, Kwartler and Bernard, 2001, Brown, 2010).

4 RESULTS AND DISCUSSION

This section presents the results of the Brisbane case study implementation of the PSS. The resulting PSS is shown in Figure 1. It uses a standard GIS interface that allows different data sources to be layered together in a 2-dimensional mapping interface. In addition, a third dimension of "time" can also be displayed on the basic mapping interface or as a chart indicator. The interface runs within ArcMap and requires the CommunityViz extension. While most of the functionality is controlled by CommunityViz toolbars some additional customised toolbars have been implemented.

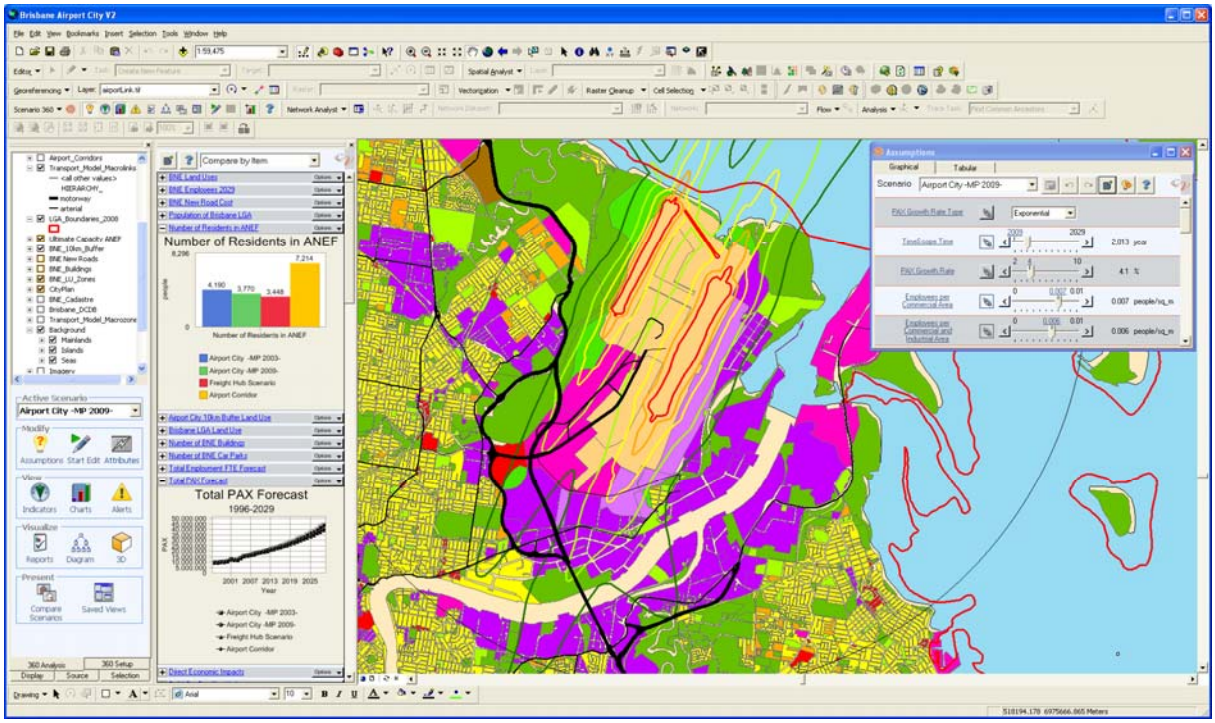

Figure 1 - Prototype PSS

The prototype PSS has the following functionality:

- Scenario planning that allows the user to create and analyse alternative land-use plans for Brisbane Airport and compare them side-by-side;
- Land use, transport and economic modelling that will a allow dynamic analysis of plans (i.e., on-the-fly changes to a plan will automatically cause recalculations of impacts); and
- A standard set of sustainability indicators that are clearly understandable to stakeholders, decision makers and public.

4.1 Modelling

Table 1 shows the main models that have been implemented in the prototype PSS. Various methods were used to develop the models. These included utilising TransCad's software development kit to create TransCad models within the ArcGIS interface. In addition, ArcGIS's model builder and CommunityViz's dynamic attributes were used to create models. Existing CommunityViz tools like the Build-Out Wizard were also utilised. The models were enhanced through considering the spatial relationships between datasets. These models need further calibration and testing but serve as a good starting point for the prototype PSS.

Some of the models rely on a set of initial assumptions. These assumptions have been calculated from historical values and validated with expert knowledge. The assumptions are dynamic and can be changed interactively within the PSS as shown in top right section of Figure 1.

Model	Description	Tools
Road transportation model	The transportation model is a simplified version of the Brisbane Strategic Transport Model (BSTM) (Queensland Government, 2008b). Brisbane City Council originally developed the BSTM. This simplified model comprises 5,376 links and 46 zones and utilises a combined model to compute network utilisation.	TransCad software development kit (GISDK)
Development suitability model	A weighted multi-criteria analysis framework was implemented to produce a polygon feature class that indicates where certain types of development should occur given stakeholder input.	Combined ArcGIS model builder and CommunityViz dynamic attribute functions
Direct economic impact model	An input-output model derived from an airport commissioned Access Economics Pty Ltd (2008) Report. The models predicts the direct economic impact of in AU$ as the airport develops over the 20 year planning period.	Combined ArcGIS model builder and CommunityViz dynamic attribute functions
Building build-out model	The existing CommunityViz Build-Out tool was used to visualise the amount and location of bulding develop given the different stakeholder policies. The floor space ratios used were obtained from a survey of existing airport developments.	Built-in CommunityViz function

Table 1 - Implemented Models

4.2 Sustainability Indicators

The majority of the indicators were selected from the SEQ regional plan (Queensland Government, 2009) with a few extras added during the stakeholder workshops. The indicators are listed in Table 2.

Economic Impact Airport's financial performance Regional economic growth Employment levels Tourist visitor numbers PAX	**Environmental Impact** Air quality Greenhouse gas emissions Extinct, endangered and vulnerable species and ecological communities
Social Impact Total number of dwellings Number of dwellings (within ANEF) Education access and affordability Education attainment Housing access and affordability	**Integrated Transportation** Road congestion Access to PT Mode share Freight movements Number of cars

Table 2 - Sustainability Indicators

4.3 Scenario Development

Scenarios are descriptions of alternative futures which are likely to occur for the study area. Scenarios are made up of a series of external factors which are out of the control of the stakeholders. The scenarios themselves provide important inputs and assumptions to the models within the PSS and are a critical part of the policy analysis framework as described by Wijnen et al., (2008) and Walker (2000).

The scenarios were developed utilising a similar process to that described by Van der Heijden et al. (2002). This process involved obtaining a list of external factors from the stakeholders through a series of small workshops. The stakeholders were required to rate the external factors in terms of uncertainty and impact on the system model. After this evaluation, the external factors that have both high uncertainty and high impact were clustered together to produce the scenarios for the case study. The following scenarios were developed:

Scenario 1: Placid Brisbane

In this scenario, population growth for Brisbane is non-existent and global environmental concerns have not eventuated. The war on terror has past and international communities are more focused on their own economies an interfering with problems of other countries. Due to lack of growth in the region, labour and accessibility costs have remained low and demand for developable land is very low. Brisbane demography is has remained constant and is very supportive of airport development, as the population believe this could improve the economic prospects for Brisbane. Infrastructure charges like road pricing have not eventuated. The cost of green energy remains high with very little motivation to pursue this type of technology.

Scenario 2: Booming Brisbane

In this scenario, population growth for Brisbane is extreme, but global environmental concerns have not eventuated. The war on terror has past and international communities are more focused on their own economies an interfering with problems of other countries. Due to extreme growth in the region, labour and accessibility costs are extremely high and demand for developable land is high. Brisbane demography is extremely diverse but is unsupportive of airport development, as the population believe Brisbane is developing too fast. Infrastructure charges like road pricing have been introduced as a way to reduce road congestion. The cost of green energy remains high with very little motivation to pursue this type of technology. The aviation demand in the region is high and a second Brisbane airport is planned.

Scenario 3: Overwhelming nature

In this scenario, population growth for Brisbane is non-existent and to make matters worse global environmental changes have placed additional pressure on the region. The sea level rises gradually but the region's economic situation prevents any real solutions to the problem being implemented. Storm activity has increased and is affecting the operation of the airlines. The Australian Government has enforced strict environmental regulations. These restrictions decreased the attractiveness of the city, which also has affected business, industry and leisure activities. The war on terror shows no sign of ending and terrorist mitigation places additional operational costs on the region. Due to a lack of growth in the region, labour and accessibility costs have remained low and demand for developable land is very low. Brisbane demography has remained constant and is very supportive of airport development, as the population believe this could improve the economic prospects for Brisbane. Infrastructure charges like road pricing have not eventuated. The cost of green energy has become cheap through the government's pursuit of this type of technology. However, fossil fuel energy has become extremely expensive but some industries are still struggling to migrate to green energy.

Scenario 4: Brisbane versus nature

In this scenario, population growth for Brisbane is extreme and global environmental changes have placed additional pressure and opportunities on the region. Due to extreme growth in the region, labour and accessibility costs are extremely high and demand for developable land is high. Brisbane demography is extremely diverse but is unsupportive of airport development, as the population believe Brisbane is developing too fast. Infrastructure charges like road pricing have been introduced as a way to reduce road congestion. The aviation demand in the region is high and a second Brisbane airport is planned. The sea level rises gradually but the region's economic situation

has allowed novel solutions to be implemented. Storm activity has increased and is affecting the operation of the airlines. The Australian Government enforced strict environmental regulations before other countries so Australia's economy has benefited greatly for exporting this technology. The cost of green energy has become cheap through the government's pursuit of this type of technology. However, fossil fuel energy has become extremely expensive but the prosperous economic climate has allowed industry to make a gradual transition to green energy. The war on terror shows no sign of ending and terrorist mitigation places additional operational burden on the region.

4.4 Airport and Regional Planning Policies

The main policies that were initially built into the PSS were related to land use zoning, transportation infrastructure and mode share options. One of the main airport stakeholders mentioned the need to test policies on the fly in real time was a priority for him. In general terms the policies inputted into the PSS mainly illustrated various investment options that the main stakeholder, Brisbane Airport Corporation, could make as it developed its airport into an airport city. In addition, the land use zones policies from both the 2003 and 2009 airport master plans were compared against each other.

4.5 Application and use of PSS for Brisbane case study

The prototype PSS has been demonstrated to most of the Brisbane case study stakeholders. These demonstrations have taken place at research advisory committee meetings and in small focus groups. The initial feedback on the system is good but more functionality is still required. The main advantages of the PSS are:

- The PSS provides support for Airport Coordination Forums;
- The main stakeholders currently maintain GIS datasets for planning support and spatial analysis tasks, therefore, the adoption of a GIS based PSS required little extra data requirements;
- Likely impacts of airport developments of the surrounding environment and communities can be visualised and quantified in the PSS;
- The PSS has an improved understanding in the relationship between transportation network and land use plan;
- The PSS will facilitate more effective engagement with communities through real-time evaluation of planning policies; and
- The PSS provides a transparent decision making process.

4.6 Limitations of current system

At the time of writing this paper, the full integration of the transportation model has not been completed. While a completed model has been implemented in TransCAD software the procedures to programmatically control it via CommunityViz are still under construction.

5 CONCLUSION

The prototype PSS provides a holistic approach to airport and regional planning through integrating multiple models into one decision framework. It provides a system that can inform all stakeholders of the impacts and consequences of alternative planning policies thus facilitating greater stakeholder participation in the planning process.

The CommunityViz software package was easily extensible and provided a good foundation to develop a planning support system. As most of the planning stakeholders were utilising GIS for a planning tool, the supporting planning data was readily availability and required minimal manipulation for use in the prototype PSS. The ultimate goal of any PSS is to make it easier for all stakeholders to reach consensus on planning decisions. From the results of the Brisbane case study,

it would appear that this prototype PSS has achieve that goal. The prototype PSS will undoubtedly assist the new Planning Coordination Forums in Australia.

In conclusion, as airport-regional interactions become more complex, a broader understanding of trends, problems, challenges and sustainable policy solutions becomes increasingly important for public and private policy makers. Modelling these interactions and integrating them into one system has provided invaluable support for stakeholders grappling with the challenges of new airport city type developments. Finally, although the prototype PSS is still under development, the current system provides a good foundation for further work in this area.

6 FUTURE WORK

With the basic PSS completed, the next stage of development will focus on improving the models within it. In addition, further consultation with stakeholders will be conducted to establish a full suite of indicators and policies to be tested on the Brisbane case study.

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