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CHAPTER 19
Brisbane urban growth model: an integrated infrastructure management framework for Brisbane, Australia

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Abstract: *In recent years, local government infrastructure management practices have evolved from conventional land use planning to more wide ranging and integrated urban growth and infrastructure management approaches. The roles and responsibilities of local government are no longer simply to manage daily operational functions of a city and provide basic infrastructure. Local governments are now required to undertake economic planning, manage urban growth; be involved in major infrastructure planning; and even engage in achieving sustainable development objectives. The Brisbane Urban Growth model has proven initially successful to ensure timely and coordinated delivery of urban infrastructure. This model may be the first step for many local governments to move toward an integrated, sustainable and effective infrastructure management.*

Keywords: Infrastructure management, sustainable urban development, urban simulation model, Brisbane Urban Growth model

Introduction

Sustainable urban development and the liveability of a city are increasingly important issues in the context of land use planning and infrastructure management. In recent years, the responsibilities of local governments with regards to infrastructure management practices have increased under the pressure of rapid urban growth. Aside from managing the daily operational functions of a city, such as assessment of property development applications and maintenance of urban streetscapes, local governments are now also required to undertake economic planning; manage urban growth; be involved in major national and state infrastructure planning and even engage in achieving sustainable urban development objectives.

The increase in the responsibilities and roles of local governments have meant that local elected officials and urban planners have less time to make decisions, and so rely more on planning support systems that inform the decision making process and improve urban management practices. Urban modelling tools have been widely used in developed countries for this purpose. However, many of these models are generally 'one-off' applications with a single purpose, rather than multi-dimensional applications. As a result, many of them become obsolete in a relatively short period of time.

The aim of this chapter is to examine the complex relationship between infrastructure management, land use planning and economic developments, and to illustrate why there is an urgent need for local governments to develop a robust planning support system to facilitate better infrastructure management. The development of the Brisbane Urban Growth (BUG) Model has proven initially successful for Brisbane City Council as the first step toward establishing a sustainable urban and infrastructure management framework. Compared to the conventional land use planning approach, it is a better approach to facilitating sustainable urban development and infrastructure management.

Infrastructure management for sustainable urban development

Contemporary land use and urban planning originated from the industrial revolution that began in the 1850s. Planning by public authorities was first used as a tool for improving the health of the working population which was compromised by epidemics, water contamination and urban slums. The main reason for this action was to improve the health conditions of labour workers so that they could work harder, and at the same time reduce the cost of supporting an unhealthy labour force and their families (Friedmann, 1987; Sies & Silver, 1996; Taylor, 1998; Hall, 2002). Gradually, local authorities took responsibility for providing urban infrastructure such as clean water, and for the removal of domestic waste such as sewerage and garbage.

In modern times, greater emphasis on the decentralisation of urban governance structures has meant that the traditional roles of local governments in managing basic land use, infrastructure and services are no longer sufficient to meet the local community needs. Local governments are now increasingly involved in regional and national strategic planning initiatives and programs such as regional economic development, major road and public transport infrastructure projects, and management of urban growth (Stren, 1993; Worthington & Dollery, 2000; Haywood, 2005; Atterton, 2007).

As a consequence of more demand on local government in managing legislative requirements and meeting community needs, the roles of land use and urban planning have also evolved rapidly in the past several decades (Cetinic-Dorol, 2000; Byrnes & Dollery, 2002). Urban planners are now required to provide strategic advice on many urban growth and infrastructure management issues, ranging from rezoning of land for community use to strategic distribution of public transport routes and infrastructure. Due to the demand for greater linkages and accountability among different projects, planners can no longer deal with such issues in isolation.

Contemporary land use planning approaches used by local authorities to tackle emerging urban growth and infrastructure management issues are often based on trends and strategic assumptions, rather than on groundtruthed data and information about the local area. It has been suggested that there is a constant mismatch between what is a planner's view of a desirable spatial outcome and the realities of the evolving urban structures. Such mismatch is a result of our limited understanding of localised urban patterns (Gleeson & Randolph, 2001; Forster, 2006). Therefore, this brings

forward the concept of urban management in the context of land use and infrastructure planning.

In order to examine the concept of infrastructure management, it is important to firstly understand the responsibilities and functions of governments. Table 1 illustrates the typical responsibilities of local governments. Local governments assume these primary responsibilities because they directly provide services and usually have authority to levy charges for what they can provide (Brown, 2002; Cuthill & Fien, 2005; Carnegie & Baxter, 2006; Worthington, 2007). The provision of infrastructure, services and their maintenance are, therefore, viewed as rights that the community expects – partly as a result of the taxes they pay, and partly because of the political legitimacy that they give to both federal and local authorities.

Table 1 Typical functions of a local government (derived from Wekwete, 1997, p. 4)

Key Functions	**Typical Components**
Public Utilities	• Water supply • Sewerage and drainage • Electricity
Social Services	• Community education • Health and medical services • Social welfare • Social housing
Transportation	• Highways • Suburban and local roads • Street lighting • Public transport and pathways
General Urban Services	• Refuse collection • Parks and recreation • Markets • Cemeteries • Fire protection • Local law enforcement
Planning & Engineering Services	• Development assessments • Infrastructure construction • Business permits and licensing • Administration of land use plans

Local governments are intimately linked to communities because they can address local economic, social and environmental issues through regulatory regimes, and can provide infrastructure and services more effectively (Zifcak, 2001; Warburton & Baker, 2005; Westendorff, 2007). Nonetheless, the range and scale of influence of local government functions and responsibilities relies heavily on the availability of financial assistance, loans, and grants. It also relies on the availability of professional resources (Dore, 1998; Carnegie & Baxter, 2006; Hohn & Neuer, 2006; Dollery & Johnson, 2007).

Effective operational management of a local government requires, in modern times, cross sectional analysis of various issues (Wilmoth, 1987; Wekwete, 1997). Many local governments have been facing the issues of rapid urban sprawl and increasing pressures by global and local communities demanding sustainable population and

economic growth (Taylor, 1998; Lewis, 2001; Hall, 2002). There has been a great deal of literature written about the lack of integration among different local government policies in tackling urban sprawl, and their failure to achieve sustainable development (Amberger, 1992; Nelson *et al.*, 2004; Haywood, 2005; Boyle & Mohamed, 2007). There is also a significant amount of research which discusses different approaches to tackling these urban management issues (Roberts, 1999; Nelson *et al.*, 2004). Nonetheless, there are only a handful of cities (such as Vancouver and Copenhagen) that have been successful in achieving sustainable urban management (Shibusawa *et al.*, 2003; Nelson *et al.*, 2004; K'Akumu, 2007; Brunet-Jailly, 2008). The concept of infrastructure management is not only confined to the typical operational responsibilities of a local government. Rather, it entails two very important aspects: 1) achieving and maintaining sustainable urban development, and; 2) effective urban growth and infrastructure management.

Achieving sustainable urban development is among the key goals of most local governments internationally (Nass, 1989; Blumenthal & Martin, 2007; K'Akumu, 2007). The confirmation that current resource consumption patterns and living habits of both developed and developing countries is resulting in problems such as global warming, inter-generational inequity, and rapid destruction of eco-systems, has made national and local governments revise their strategic directions and management of their cities and urban areas (Nass, 1989; Worthington & Dollery, 2001; Tregoning *et al.*, 2002; Nijkamp *et al.*, 2007).

The concept of sustainable urban development is generally implemented through the conventional planning approach which utilises macro level information to support local government policy setting for local areas (Meadowcroft, 1997). The current macro (global and national) level land use and infrastructure planning and urban growth management approaches have shown their limitations in achieving sustainability at a micro (local and parcel) level (Cho, 2002).

The promotion of sustainable urban development in Australia and overseas is facing various physical, socio-economic and environmental challenges. These challenges arise due to a lack of capability of local governments in accommodating the needs of their residents – that is land supply, employment distribution, open space, infrastructure, and amenities – as well as urban growth. Historically, local authorities generally sought to tackle these challenges by conventional land use planning and urban management approaches, with limited knowledge of the local areas and the nature of the proposed developments.

Local governments have an insurmountable role in ensuring a sustainable urban development that is achieved at the local level. As a majority of developments are required to be assessed and approved by local governments, the implementation of an effective and operational assessment framework at this level of government is critical. Even though the concept of sustainable urban development has been discussed for over three decades now, effective implementation of this concept is still elusive to many local governments (Alexander & Tomalty, 2002; K'Akumu, 2007). Again, there have been many attempts to achieve sustainable urban development. However, many of these

approaches either narrowly focused on one or two aspects of development (especially in respect to environmental or economic sustainability) or were too imprecise, with no clear outcomes to be achieved.

If moving towards sustainable urban development that is sensitive to local issues and context is the ultimate goal for society, it is necessary to establish new and adaptive tools, competencies and governance models to support such development (Scanlan & Gillen, 2004). However, this new framework must incorporate the needs of all stakeholders. The large majority of key urban planning initiatives and provision of infrastructure in Brisbane up until now have been based on a piecemeal approach as a direct result of pressures from development industries and from the local community. Policies, projects, infrastructure provision and management of land use planning and economic development are often dealt with in isolation as a result of development pressures, rather than being dealt with in an integrative way.

Moving toward effective urban growth and infrastructure management

Cities around the world take different spatial shape and forms. Urban decentralisation, urban sprawl and low residential density at the outer fringe of a city have been suggested as the underlying factors that are responsible for many of the undesirable and non-sustainable outcomes for cities such as increased automobile travel and congestion, poor public transport accessibility, lack of functional open space, concentrated poverty, loss of agricultural land, and increased cost of delivering infrastructure (Brueckner, 2000; Wassmer, 2008). Australian cities are highly suburbanised and have lower densities by world standards, with high levels of suburban home ownership and automobile dependence (Forster, 2006). In North American cities, this phenomenon is often described as 'urban sprawl' or 'urban decentralisation' (Wassmer, 2008). For decades, urban planners have been planning and allowing developments at the urban fringe; these are often dictated by the property market and development industry.

Urban growth is part of a city's natural evolution. Most of the major cities around the world have experienced, or are still experiencing, urban growth and increasing population. As a city grows, it uses more resources and undergoes fundamental changes in character and structure (Forster, 2006). Sustainable urban development is no longer a concept for debate; however, what may need to be debated is how cities can ultimately achieve sustainable urban development within their current governance and economic framework (Altmann, 2007).

For many years, urban planners have generally accepted the conventional position that increasing urban density at the urban fringe will reduce the quality of suburban living but achieve negligible land savings (Buxton & Scheurer, 2005). It has been argued that the amount of land required for infrastructure, services and other facilities must remain constant, regardless of the location of the population (McLoughin, 1991). In the mid 1990s, the term 'Smart Growth' emerged as an effort to address the policy debate of urban decentralisation, urban sprawl and low residential density development at the outer fringe of cities (Mayer *et al.*, 2002; Nelson *et al.*, 2004a; K'Akumu, 2007). Among

the characteristics of smart growth are economically efficient land uses; the promotion of higher densities, mixed uses and public transit; the revitalisation of existing neighbourhoods; and the provision of affordable housing (Alexander & Tomalty, 2002; Degrove, 2005; Filion & McSpurren, 2007).

There have been many planning initiatives world wide to tackle issues associated with urban growth. A very common approach is the use of urban growth boundaries (Nass, 1989; Mayer *et al.*, 2002; Nelson *et al.*, 2004a; Nelson *et al.*, 2004b). The approach was first introduced to forcefully constrain development into rural or environmentally significant areas, and to seek to intensify infill redevelopment. However, due to disjointed planning frameworks preventing the integration of various planning initiatives, development within the urban growth boundaries has become much more lengthy and costly, and is often ineffective in meeting real community needs (Nelson *et al.*, 2004a; Rodriguez *et al.*, 2006; Weitz, 2008).

Another common planning practice to tackle urban growth is to promote higher densities. Most of the major cities have established, or are establishing, strategic growth management plans which generally seek to increase urban density and consolidate urban development to achieve a sustainable urban form (Cho, 2002; Buxton & Scheurer, 2005; Norman, 2005). The idea that simply increasing urban density will resolve most of the growth problems has been challenged (Pund, 2001; Searle, 2004). The United Nations conference on Environment and Development (held in June 1992 in Rio de Janeiro) has been an important catalyst for sustainable urban development. The Local Agenda 21, a major result of the conference, provided a framework for local authorities to work toward sustainable urban development by developing efficient and environmentally friendly public transport systems, encouraging non-motorised trip making, and supporting the concept of compact cities (Roo & Miller, 2000).

Planning policies promoting urban consolidation and compactness have been widely used for managing growth in Australian cities and overseas. These have offered a series of solutions to a range of pressing urban growth issues, but increasing consolidation is slowly reaching the threshold of cities' limits (Searle, 2004). It has been suggested that there is a need to recognise potential limits to further city consolidation. These potential limits are: infrastructure capacity, land capacity, loss of economic activity and market demand (Searle, 2004). These limitations have already imposed great challenges to urban consolidation. Insufficient spare capacity can seriously constrain the density of consolidation. Residential density beyond capacity is not impossible; however, significant costs are required for upgrading the infrastructure network. There are also limited open spaces and recreation areas to sustain the growing population in the inner city area. The current land capacity of inner cities may have already reached its full potential and the cost of new open space areas is not economically viable (Searle, 2004).

Other growth management approaches such as the polycentric city model and the activity centre model have also been used for managing population growth. The polycentric city model and activity centre model have extended the monocentric city concept to account for the fact that there are multiple centres of employment in a city

(Anderson & Bogart, 2001). The success of these growth management strategies requires massive investment in infrastructure.

There are many reasons for failing to achieve the intents of containing urban growth and providing sufficient infrastructure. Among these are the lack of a consistent and reliable planning support database, and the failure of integrated evaluation frameworks to enable strong and well-grounded decisions to be made (Tregoning *et al.*, 2002; Cheng & Masser, 2003; Haywood, 2005; Joshi *et al.*, 2006). The rippling effects of these two causes directly exacerbate typical implementation issues and problems normally associated with public sector projects (such as construction costs blow out) and, therefore, instigate further local community dissatisfaction.

The use of modelling tools to facilitate better infrastructure management

Urban systems are becoming increasingly complex and large in scale as local urban economies, social and political structures, transportation systems, and infrastructure requirements evolve. The sustainable and efficient usage of scarce resources, together with competing economic and social priorities, are now a part of the everyday decisions required to be made by local governments (Baccini, 1997; Berliant & Wang, 2004; Andersson *et al.*, 2006). Many mathematical, engineering and theoretical models have been used to attempt to develop an understanding of some aspects of urban structure, transportation and socio-economic relationships (Cheng & Masser, 2003a; Fragkias & Seto, 2007; Jat *et al.*, 2008).

The use of geospatial models to assist policy making, urban planning and management is not new. Modern urban simulation models have been widely used in developed countries to evaluate major public and private urban development projects and to forecast development patterns (Ward *et al.*, 2001; Cheng & Masser, 2003b; Wilson *et al.*, 2003). The steady expansion of local governments' responsibilities (as mentioned earlier) has also resulted in the development of multi-modal approaches to urban and transportation modelling, including mode choice, travel demand management, land use policies change, working hours, and congestion pricing (Waddell & Ulfarsson, 2004; Marinoni, 2005).

Figure 1 shows the typical conceptual framework of an urban model, with a clear emphasis on physical planning and infrastructure provision. The agents, choices and interactions provide an overview of linkages that connect a broad range of policy inputs to outcomes. Government actions such as regulations and infrastructure investment would cause systematic changes in the final outputs of urban development and vice versa.

Figure 1 Agents, choices and interactions in a sophisticated urban model (derived from Waddell & Ulfarsson, 2004, p.14).

There have been many attempts by planning scholars to put forward urban models as tools to inform better public decisions making. However, the ultimate goal of using urban models as public decision making tools has proven unsuccessful due to the poor

and inconsistent evaluation frameworks adopted by local governments. (Hoffhine Wilson *et al.*, 2003; Waddell & Ulfarsson, 2004; Filion & McSpurren, 2007)

The rise of a planning support system for infrastructure management

Current best practices in search of attaining integrated urban management predominantly focus on the development of robust and integrated planning support systems to inform and enable greater public and private sector engagement in the decision making process. The states of Oregon and Florida, for example, have implemented containment strategies (with the use of robust land use and planning support systems) to inform urban planners and decision makers on the effectiveness of existing land use policies (Nelson *et al.*, 2004a; Nelson *et al.*, 2004b; Boyle & Mohamed, 2007).

As a result, decision makers were able to regularly evaluate the impacts of their urban management policies, particularly in relation to the efficiency of public transport systems and other development infrastructure to meet the demand of urban growth. Nonetheless, current research on integrated infrastructure management to date has not fully explored the potential of a robust planning support system that can be further developed and integrated into local government authorities to facilitate sustainable urban growth and infrastructure management outcomes (Mattingley, 1994; Reddel, 2002; Carnegie & Baxter, 2006; Hohn & Neuer, 2006; Worthington, 2007). An integrated urban management system would have the potential to provide outcomes to evaluate land use policies, but also could be integrated into local government systems to inform corporate decisions making regarding estimates and benchmarks, to plan for future cost recovery of infrastructure charges, and to determine the human resources needed.

The recent introduction of the Brisbane Urban Growth (BUG) model by Brisbane City Council has successfully revolutionised the approach to forecasting developments and the planning of urban infrastructure. Brisbane is anticipated to grow rapidly in the next 15 years as one of the fastest growing cities in the South East Queensland region of Australia. Various scales of brownfield redevelopment are already in progress. It is expected that the rate and scale of brownfield redevelopment will intensify further as the last remaining greenfield land in Brisbane is fully developed as Brisbane continues to grow strongly as a major economic capital.

At present, various planning documents set out planning priorities for Brisbane including urban renewal, neighbourhood plans, Transport Orientated Developments (TODs), major transport projects and other major developments. All these projects are closely related and illustrate the urgent need to establish an integrated framework to ensure that land use planning, local economic development and infrastructure provision will be delivered to meet the needs and demands of the anticipated economic and population growth.

The unprecedented urban growth has prompted Brisbane City to develop a robust urban simulation model, the BUG model, to provide strategic directions to planners and political decision makers on the anticipated sequence and scale of future greenfield and

brownfield development clusters. The BUG model is a promising tool for Brisbane's local government to ensure timely and coordinated delivery of urban infrastructure to ensure that sustainable urban development can be achieved throughout Brisbane.

The conceptual framework of the BUG model was first developed and implemented at the Gold Coast as a one off exercise for the preparation of the Priority Infrastructure Plan (PIP) for Gold Coast City Council (Lau & Lister 2006). The BUG model is an advance oracle database linked to a GIS analytical and visualisation interface for analysing and identifying future developments and sequences. Its prime data is extracted from the local government rate database. Local environmental constraints such as slope gradient, flooding and waterway corridors are included in the BUG model. The BUG model uses the information in the spatial database – as well as basic development factors such as property value, land value and conversion rate – to forecast development potential at property level for the city.

Figure 2 illustrates the conceptual framework of the BUG model. The operational framework of the BUG model consists of a variety of urban and property development factors, as well as transport accessibility factors, to ensure the maximisation of future urban development along public transport nodes and corridors. The BUG model focuses on supply side information, uses a detailed bottom-up growth forecasting approach, and provides a triple bottom line sustainability planning and policy approach for its municipal government (BRISBANE CITY COUNCIL, 2008).

Figure 2 Conceptual framework of the BUG model

This model is anticipated to be the fundamental tool to assist planners to understand the limitations of the local environment and the planning implications for a city. The results of the model outputs enable planners and decision makers to provide better planning, policy and infrastructure that adequately address the local needs and achieve sustainable outcomes and spatial form.

Over the last two decades, cities in Australia and overseas have taken a range of innovative sustainability initiatives to ensure that each step of the urban development process contributes to a reduction of the ecological footprint and to an improvement in the quality of life (Stimson, 2002; Jones, 2005). Rational comprehensive planning is still one of the most influential urban planning methodologies in Australia and overseas (Rosenhead, 1980; Gleenson & Low, 2000). Many of the existing growth management approaches and policies are developed using this methodology. In this approach, urban planners and decision makers are making their rational decisions based on abstract values. These values are generally presented as agreed consensus, and higher level agencies can expect the compliance of lower level agencies with their decisions (Rosenhead, 1980). This top-down approach emphasises management, measurement and control. However, it often disregards local limitations and other externalities because its decisions are based on a set of abstract values (Sabatier, 1986).

Figure 3 illustrates the conventional local government process used by Brisbane City for the planning and delivering of urban infrastructure under a top-down approach. In this

approach, the planning of infrastructure is often seen as a discrete exercise among different infrastructure providers. Planning studies are often carried out to justify a pre-made decision or objective, rather than to provide a factual recommendation.

Figure 3 Conventional top-down approach for delivering infrastructure in local government

In contrast to the conventional top-down approach which focuses on delivering its objectives, the bottom-up approach focuses on exploring the local limitations and establishing sensible realistic solutions to revolving issues (Sabatier, 1986). However, this type of approach may not be the most time efficient method for solving urban growth issues at a citywide level. The alternative to this approach is the collaborative or joined-up approach which utilises the strengths of the top-down and bottom-up approaches.

Figure 4 illustrates the new infrastructure planning and management process used by Brisbane City under the BUG model framework; these provide greater linkages within internal infrastructure providers. Planning studies and assumptions are carried out in a coordinated manner among different infrastructure providers. Statutory documents such as the SEQ Regional Plan and the City Plan provide a strategic direction rather than absolute outcomes. Throughout the BUG model framework and processes, this information is being groundtruthed through detailed planning studies, and the outputs are then used to inform and refine the objectives of these statutory documents.

Figure 4 Integrated and sustainable urban infrastructure planning and management

Planning for a city requires consideration of the complex interactions among economic, environmental and social factors. While the BUG model framework has proven to be initially successful for the delivering of urban infrastructure and its management, there is a need to include a more comprehensive economic dimension into the model. The current BUG model does not fully consider the local economic factors such as commercial and industrial land availability and its implication for the planning and management of infrastructure. Nonetheless, the BUG model is the first step for Brisbane City Council to move toward an integrated infrastructure management approach, while at the same time providing accountable infrastructure management to the public.

There are two main types of accountability in the context of infrastructure management: political accountability and public accountability (Sinclair, 1995; Byrnes & Dollery, 2002; Cho & Choi, 2005). Political accountability relates to the public servant's responsibility to an elected official, and the elected official to the public. Public accountability is a more informal type of accountability, but exists where public servants are directly accountable to the public via the media or surveys which ask for public comment on the performance of a public sector entity (such as a local council).

In the last two decades, the public sectors of many Western countries have embraced New Public Management (NPM) which, according to Kluvers (2003), consists of seven elements:

- A shift towards greater disaggregation into corporate units
- A shift towards greater competition between public sector organisations and public sector and private sector
- Greater use of private corporate management practices by the public sector
- Greater stress on discipline and parsimony in resource use
- More hands-on management
- More explicit and measurable standards of performance; and
- Attempts to control public organizations in a more 'homeostatic' style according to preset output measure.

The rise of corporate management and planning, program budgeting and performance measures in public sector management mean that local elected officials are confronted by a greater volume of documentation, but with no increase in time to evaluate key projects and programs being delivered (Felmingham & Page, 1996; Dore, 1998). As a part of the task of achieving effective management of rapid urban growth while seeking to attain sustainable development, a new approach or decision making framework must be developed to enable improved and well thought out decisions. The traditional approaches to management taken by local government – which treat management of urban development and organisational management issues in isolation – are no longer adequate. Many studies have proved that, in the public sector, these two components are closely interrelated and should not be treated in isolation (Cetinic-Dorol, 2000; Kluvers, 2003; Reddel & Woolcock, 2004; Kloot & Martin, 2007).

Effective infrastructure management is the key responsibility of local governments, and efficient corporate management of local government organisations enables and ensures that objectives of infrastructure management are attainable. There is research to show that poor corporate management of local government organisations leads to poor (or sometimes adverse) outcomes in major urban development projects; this is the result of a lack of availability of comprehensive planning information, and disjointed project, policy and decision evaluation frameworks (Worthington & Dollery, 2000; Byrnes & Dollery, 2002; Tuckey, 2002; Cannadi & Dollery, 2005; Kloot & Martin, 2007). However, there is almost no, or very limited, literature on how effective urban management practices (such as having comprehensive planning support systems) have led to significant improvement in local government corporate management practices and vice versa (Hasan & Hasan, 1997; Reddel, 2002; Kluvers, 2003).

Conclusion

The roles and responsibilities of local governments are expanding beyond simply the daily operational maintenance of a city and the assessment of property development applications. Local governments are now also required to undertake economic planning; manage urban sprawl; be involved in major national and state infrastructure planning and even engage in achieving sustainable development objectives. Delivering sustainable urban development and maintaining liveability of a city become increasingly important for local governments around the world. The use of conventional

top-down land use planning approaches cannot promote sustainability without impairing particular aspects of the complex urban environment.

Planning scholars have been researching alternative approaches to urban infrastructure management. The BUG model is a good example where a planning tool, which was originally developed to provide a transparent forecasting process for future development, acts as the catalyst for change in corporate infrastructure management. The evolution of computer and internet technologies in the past decades has made public information more accessible; as a result, the performance of elected local officials and governments are constantly under the media spotlights. Local communities from both developed and developing countries have demanded greater transparency in public sector reporting, and there have been numerous examples of public inquiries regarding the poor performance and ill-informed decisions of local elected officials.

Understanding sustainable urban development requires a sound understanding of the complex relationship between effective urban management and comprehensive infrastructure management. This chapter has examined and identified limitations of the contemporary planning approach to facilitating sustainable urban development and effective urban management. The BUG model, on the other hand, has proven initially successful in improving the effectiveness and efficiency of infrastructure management. It has also improved the accountability and transparency of the planning and delivering of infrastructure by providing an integrated development forecasting framework to facilitate sustainable urban development.

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