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Reality Check – The Identification of Sustainability Perception and Deliverables for Australian Road Infrastructure Projects

ABSTRACT

The recent resource boom and economic development is putting extreme pressure on Australia's infrastructure, particularly on roads and railways. Developing these infrastructure typically demand a high level of resources and long term financial commitments. Governments and other stakeholders will also need to pay particular attention to sustainability outcomes, given the current public awareness and global challenges on sustainability. This will require the adoption of sustainability principles during project conception, design and planning. But equally important are the evaluation of results of doing so and the consideration of accountability in project delivery. However, literature study and consultation with the infrastructure industry found that in the absence of common understanding and priorities among stakeholders on what constitutes sustainability, tangible outcomes is often neglected, with little efforts on evaluation and feedback for future work. As a result, policies and strategies on sustainability remain largely ideological and cannot be sufficiently reflected in the actual project delivery.

This paper discusses results of the initial findings of a two-round interview with a group of senior practitioners in Australian infrastructure industry, which was aimed at identifying existing perceptions on sustainability and the agreeable priority issues between stakeholders. Base on these findings, a generic integrated perception-reality framework on sustainability in roads infrastructure has been established. It paves the way for further identification of critical issues that impact upon sustainability deliverables through another component of the on-going research. These research efforts will help promote more integrated thinking and consistent approach to enhance deliverables of the sustainability agenda in road and highway infrastructure projects in Australia.

Keywords: Sustainable development, road infrastructure, project delivery, performance enhancement.

1.0 Introduction

Sustainability calls for “*development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs*”. These notions are becoming more pressing given the current shortage of grains, fuel and other resources, social unrests in many parts of the world, stronger evidence of climate change, and signs of a major economic slowdown.

Infrastructure development plays an important role in determining environmental sustainability since it locks in consumption patterns for decades to come (UN-ESCAP, 2006c). It is intimately and essentially intermeshed with economic growth, people’s lives and environmental sustainability (UN-ESCAP, 2007). Road infrastructure projects in particular are often large in project scope and financial scale. They require high energy input, huge resource consumption and considerable land use, all elements which may cause serious impacts to the environment and social dislocation. This is further implicated by the projects’ long construction time and service life that require constant maintenance and upgrade. Thus road infrastructure development today will have an impact on future sustainability and people’s welfare for many years to come. While their impacts to environmental and social issues are of great concerns, infrastructure development also underpins a nation’s economy and prosperity therefore is equally important and necessary. It is important to balance the constraints and develop sustainable road infrastructure.

Stakeholders, both private and public sectors, are under pressure to look for economically feasible, socially viable and environmentally accountable project outcomes. This will require not only the adoption of sustainability principles during project conception, design and planning, and innovative technologies and products during construction, but also the evaluation of results of doing so and the consideration of accountability during project delivery. However, current efforts are often impeded by different interpretations on sustainability by stakeholders involved in these types of projects. As a result, achieving sustainability outcomes for all stakeholders remains as a formidable task.

The above phenomenon calls for the need to establish new approaches that are able to integrate and synthesize all the dimensions and different points of views for the holistic consideration by multiple stakeholders in developing sustainable road infrastructure.

2.0 A Snap-shot on Australian Road Infrastructure

Australia is currently in the grip of buoyant national economy. A few catalysts have contributed to this growth, surge in resource export, political stability that attracts substantial foreign investments and increased population, to name a few. These development patterns have coupled with improved living standards and growing societal expectations, which in turn caused an unprecedented demand for infrastructure development.

The Business Council of Australia has estimated the cost to the national economy due to infrastructure shortage to be about \$100 billion, while the Committee for the Economic Development of Australia reported last year that the nation’s economic worth could increase by 0.8% if unmet infrastructure needs were realized (Atkins, 2008). The fast pace of

economic growth is placing immense pressure on government to repair, upgrade and build new infrastructures in order to set free development bottlenecks to allow further growth.

For Australian road infrastructure, it has been under constant scrutiny for not being able to sufficiently cater for its rising demand. The land freight task is projected to double by 2020 and critical linkages such as the Pacific Highway between Sydney and Brisbane is under-developed, and the Hume Highway linking Sydney and Melbourne, in many sections, a two lane road (Infrastructure Partnerships Australia, 2007). Besides, Australia has a strong motorcar culture that further strains the nerve of road infrastructure. The geographical widespread and decentralized nature of development means more roads are needed to commute from one place to another. Additionally, many urban roads are old and in need of repair.

In response to the massive road infrastructure needs, the government is spending billions of dollars, and conduct regulatory reforms to speed up the planning, development and delivery of major road works. For example, in Queensland, it is reported that the state government will invest over AUD\$ 82 billion in the next 20 years under an ambitious infrastructure program; road, rail and public transport infrastructure tops the list which accounts for over 60% of the total investment (Queensland Government, 2007). During the 2008/09 budget, the Australian federal government has also a \$20 billion expenditure on developing new and improving existing infrastructure nationwide.

While governments' initiatives set important directions, the challenge lies in the ability for infrastructure stakeholders to actively take into account environmental and social sustainability, while meeting the financial accountability and challenges. Naturally one of these elements may require additional attention from time to time to ensure that balance is achieved; persistent favoring of one element over the others is not sustainable development (Engineers Australia, 2008).

3.0 Sustainability and Road Infrastructure Development

It is widely acknowledged that sustainability is a vague, uncertain and polymorphous concept (Philis, 2001). To different people, sustainability could mean differently (Chaharbaghi, 1999). On whether social, economic and environmental concerns have to be treated equally and simultaneously or giving priority on one over the other is still controversially discussed (Luetzekendorf, 2007). Yet, others suggest sustainability could mean anything that is being encapsulated in the equation of '*n Bottom Line*'.

Summarily, the beauty and wisdom in this clashing of concepts is that all parties agree there is a need to change for better. However, as to '*how to change*' and '*what need to change*' remain open for interpretation. Above all, the emphasis should be on implementing a process which seeks to achieve consensus among interested parties on which principles are more, and which are less, important to be applied in an infrastructure project.

It is time to think differently. The notion that infrastructure being physical assets serving only economic gains tend to achieve its objective at the expense of social and environmental sustainability. This will result paying off social and environmental consequences in the long run. Worst still, the consequences are not sudden, and may be far more costly by the time it

was identified. Therefore the short-lived economic goal, in this instance, is to be challenged by sustainability principles in order to tread the path of a holistic and healthy development.

Sustainable infrastructure can be defined as “*infrastructure in harmony with the continuation of economic and environmental sustainability*” (UN-ESCAP, 2007). Hence, to put it simply: a road infrastructure is sustainable when its development is in harmony with the continuation of economic and environmental sustainability. In relation, sustainable construction can be construed as a construction process which incorporates the basic themes of sustainable development (Chaharbaghi, 1999; Parkin, 2000). Clearly, for realization of road infrastructure sustainability, two key areas are to be understood and integrated in principal – “sustainability principles” and “road infrastructure development processes”.

Infrastructure development generally consists of several key stages: (1) planning; (2) design; (3) construction; (4) operation; and (5) recycling and disposal (Howes and Robinson, 2005). Proper design, operation, and management of infrastructure must deal with every facet of its service life, ranging from conception, feasibility studies, design, construction, operation, maintenance, repair and rehabilitation, and finally decommissioning and disposal of the system after it has outlived its useful life (Mirza, 2006). In other words, if a road infrastructure were to be sustainable, every phase of its development must be guided by the principles of sustainable development. By close monitoring of these processes and checking them against sustainable principles and its indicators, we can thereby ensure and enhance sustainability deliverables in the overall road infrastructure development.

4.0 Multiple Stakeholders in Road Development and Sustainability Agenda

Great is the benefit of sustainable road infrastructure to our society; greater indeed is the complexity of its planning and execution to which it is involved. The complex interaction between many factors of transport, land use and multiple stakeholders causes difficulty in implementing sustainability initiatives in these projects.

Different stakeholders have different levels and types of investment and interest in construction project (Newcombe, 2003). It is important for the project’s objectives to mesh with its stakeholders’, and that they continue to fit with stakeholders’ strategic interests as the project evolves, conditions vary and the interdependencies of key systems, stakeholders and their objectives change (Morris, 1994). Failing to realize this would potentially jeopardize the project objectives and its smooth implementation. Successful completion of construction projects is therefore dependent on meeting the expectation of stakeholders.

As each stakeholder is motivated by their own interests, their perceptions on what constitutes sustainable road infrastructure development vary accordingly. Often, they perceive from their own point of benefits and priorities. This is exacerbated by the adversarial culture that beset the industry. Often the disciplines are unwilling or unable to consider the views represented by others because there is no common language (Lombardi & Brandon, 1997). In the absence of common understanding among these stakeholders, achieving sustainability outcomes in road infrastructure development remains as a formidable task. A number of international organizations have realized the problem and are making efforts in bringing stakeholder issues on board of sustainable development strategies. For the International Federation of Consulting Engineers (FIDIC) for example, one of the main activities is to develop and promote Project Sustainability Management (PSM), an all encompassing sustainability strategy for the

consulting engineering industry. PSM products are developed as an extension of FIDIC's work on Environmental Management Systems (FIDIC 2008).

Therefore to achieve road infrastructure sustainability, understanding the stakeholders' varying perceptions and needs becomes crucial. This requires systematic identification of the perceptions, needs and priorities before integrating them into the design and delivery of road projects. In doing so, it will help meet the sustainability objectives, and at the same time, satisfying the needs of those stakeholders. As such, the outcome is win-win for all parties.

5.0 An Initiative Towards Road Infrastructure Sustainability

Thus far, much of the focus on sustainability has concentrated on buildings. Little has been done on infrastructure systems, such as sanitation, transportation, and utilities, which may extend over large geographic spaces, have much wider and more varied potential impacts, and may be harder to understand from a sustainability perspective by multiple stakeholders (Dasgupta and Tam, 2005). Similar to buildings research, current focus on infrastructure sustainability has been by large on macro-level policy planning, with little research focusing on the micro level (Ugwu and Haupt, 2005).

On the other hand, the multifaceted nature of the sustainability objectives requires all stakeholders involved in road infrastructure projects to adopt an integrated approach. There is a need for multidisciplinary action and to ensure the appropriate stakeholders are involved in the decision-making process (Loucks et al., 2000). This explains that decision-making for sustainable development in the built environment requires new approaches that are able to integrate and synthesise all dimensions and different points of views, in a holistic manner (Deakin et al., 2001; Mitchell, 1999). To do this, it requires the application of a suitable operational framework and an evaluation method or approach that is able to guide stakeholders through the decision-making processes. However at the moment, such a structure for organising the information required in decision-making is not yet available or at least not agreed upon by the different disciplines and fields of activities. This lack of an agreed structure that can help decision-making processes achieve greater sustainability is a major problem (Brandon and Lombardi, 2005).

As an exploration on ways of rectifying some of the problems discussed above, a research project is being undertaken at the Queensland University of Technology (QUT), Australia. It is aimed at identifying and integrating the different perceptions and priority needs of the stakeholders, along with identifying issues that impact on the gap between sustainability foci and its actual realization at project end level. Filling the niche found in previous studies, this research focuses on the practicality and real-world implementation of sustainability agenda in road infrastructure projects delivery. This can be achieved based on the common understanding by various stakeholders, with individual view points shared, understood and mutual benefits supported.

6.0 A Generic Integrated Perception-reality Framework on Sustainable Road Infrastructure Development

As an integral part of an on-going research at QUT, this paper discusses initial findings of a two-round interview with a group of senior practitioners in Australian infrastructure industry.

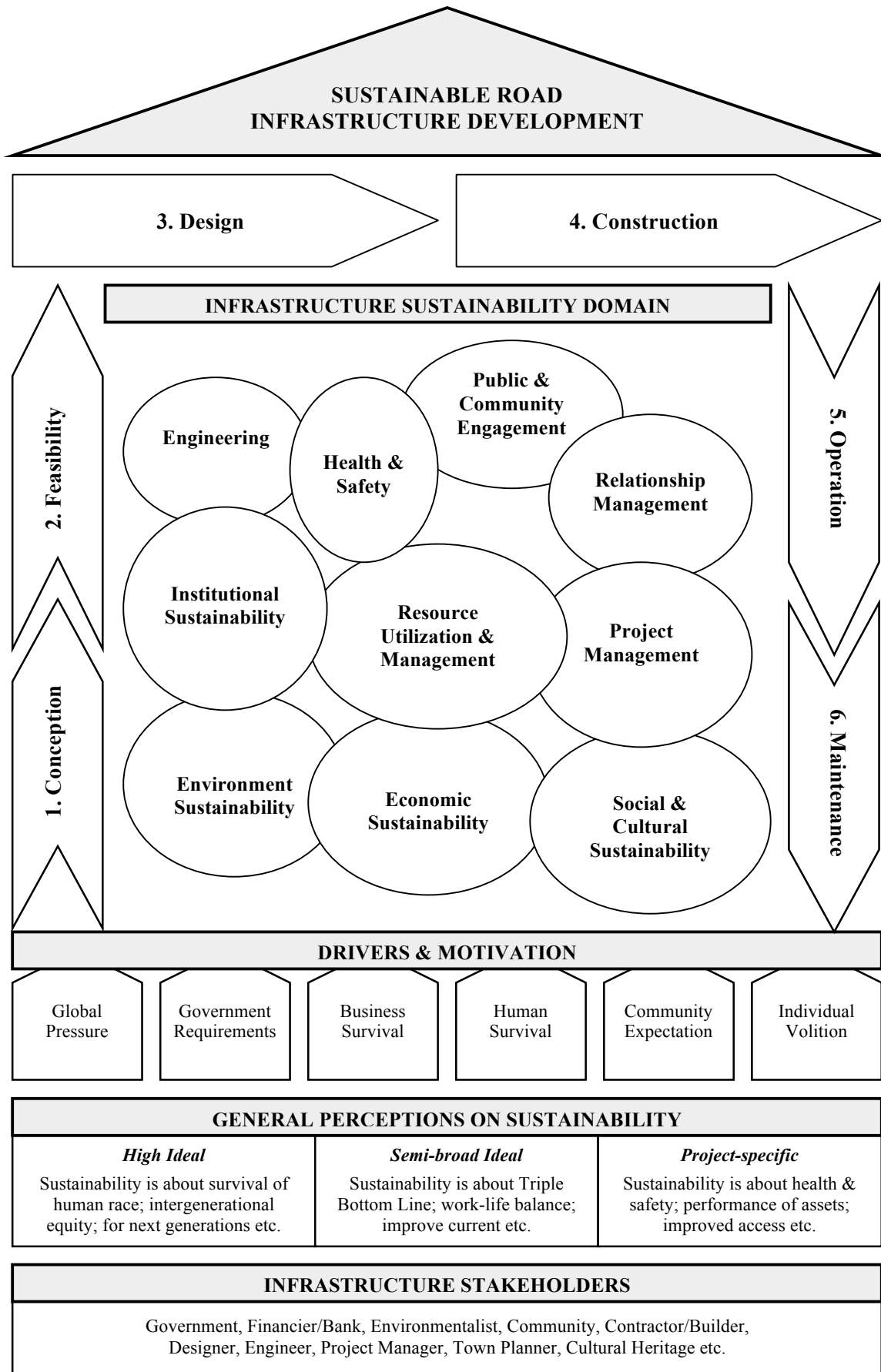


Figure 2: Generic Integrated Perception-reality Framework on

Sustainable Road Infrastructure Development

A generic integrated perception-reality framework on sustainability in road infrastructure development has been established based on the findings (Figure 2).

6.1 General Perceptions on Sustainability

The word ‘sustainability’ was described by the respondents as broad word, buzz word, catchword, watchword, ambiguous, incorrect, out of context, panacea, elixir, over-used catch phrase, misused word, new badge and some commented that it simply sounds good. Though sustainability awareness among the respondents is generally high, they were not certain on what constitutes sustainability. Most of them were pessimistic on the achievability of absolute sustainability. However, in principal, they agreed that sustainability is an important agenda.

The respondents were requested to provide their comments on their initial understanding on sustainability. Below comments were recorded. While some comments were broad in nature and therefore ambiguous, others provided more road project-specific remarks. The comments could be categorized as follows:

A. High Ideal (Ambiguous)	<i>Sustainability is about survival of human race; about inter-generational equity; about children and next generations; ‘We don’t own the future, we inherit from our children.’; about individual and community well-being; and about improving the quality of life.</i>
B. Semi-broad Ideal (Semi-ambiguous)	<i>Sustainability is about carrying out project that satisfies as many people as possible; about balance among the Triple Bottom Line and all other aspects; about political and governance issues; about work-life balance; about any move that improves current state/condition; and about fit for purpose, suitable and meet the need.</i>
C. Project-level (Specific)	<i>Sustainability is about high quality of infrastructure; about health and road safety; about improved access and equity of access; about environmentally clean and appealing project outcomes; about minimization of asset maintenance and LCC cost; about performance of asset; about efficient and effective use of resources; and about off-setting impacts.</i>

Table 1: Categories of General Perceptions on Sustainability.

Given the increasing external pressures as well potential commercial benefits to company, most respondents recognized that ‘business as usual’ mentality has to give way to sustainability considerations in infrastructure projects development which involves multiple aspects of community and environment. Sustainability is good for business as well as for all.

6.2 Sustainability Drivers and Motivation

Six motivation factors that drive the sustainability agenda in road infrastructure projects have been identified. They could be broadly categorized as:

- 1) External Pressures (Global Pressure, Government Requirements and Business Survival)

2) Internal Volition (Human Survival, Community Expectation and Internal Volition).

While External Pressures connote involuntary yet not within control, the latter is the result of increased civic consciousness. Education has been singled out as the key determining factor in deciding between the two.

Global pressures resulting from growing concerns on climate change as well as depletion of resources had prompted Australia to start heed the call of sustainability. This is supported by government's initiatives such as the Kyoto international treaty. As legislations on green infrastructure were gradually translated into road project contracts and specifications, the stakeholders are expected to comply with the new government requirements.

Forward-thinking companies have started to set up new departments to look into sustainable development during their project implementation and delivery. They hope to be seen as good corporate citizens in the market. Projects with sustainability focus win merits honored by the government and are often well received by the community. Sustainability branding is certainly a market differentiator which boosts company profile and in return, yields financial benefits.

Given the fact that Australians are generally used to high quality infrastructure services, the expectation on new infrastructure delivery is higher. This pressures engaging stakeholders to look for economically feasible, socially viable and environmentally responsible project outcomes. In this respect, community engagement and participation in infrastructure projects development becomes crucial and necessary, and is being prioritized by the stakeholders.

Sustainability is addressed as a powerful market differentiator in winning bids and convincing the public. It is often discussed in the light of business. In other words, business drive precedes voluntarism. To expedite the process, however, both drives are necessary to supplement each other.

6.3 Infrastructure Sustainability Domain

The interview had helped the identification of 10 categories and around 200 sub-indicators, appropriate and applicable under local conditions. The triangulation of interview results provided an overall picture of sustainability in relation to road infrastructure development in Australia. Besides the conventional Triple Bottom Lines (Environment, Social and Economic) and Institutional Sustainability, 6 other sustainability benchmarks specific for these types of projects have been identified (Table 2).

Sustainability Priorities	Indicators
1. Resource Utilization & Management	Site Access, Material Availability. Type of Material, Constructability, Reusability and Quality Assurance.
2. Health and Safety	Occupational and Public.
3. Project Management	Contract, Procurement Method, Training and Education.
4. Relationship Management	Responsible Stakeholders, Impacted Stakeholders and Interested Stakeholders.
5. Community Engagement	Public Governance and Community Involvement.
6. Engineering	Functional performance of physical assets.

Table 2: Road Infrastructure Project-specific Priorities and Indicators.

Based on the initial list of sustainability indicators as presented above, a Delphi study is being conducted to further identify key sustainability indicators in terms of strengths, along with

identifying the critical issues that impede on infrastructure sustainability initiatives and the possible relationships among them. The list of key sustainability indicators and critical issues identified through the Delphi study will reflect the consensual opinions of a group of highly experienced and regarded industry professionals and academic experts on both the theory and practice aspects of infrastructure sustainability in road projects. While not meant to be exhaustive, the list will serve as a basis for finding solutions for the critical issues identified in a defined context.

By integrating the different perceptions and priority needs of the stakeholders, identifying and applying key sustainability indicators and solutions for critical issues, a set of integrated decision-making guidelines for enhancing sustainable deliverables can be expected for the promotion and implementation of sustainability strategies in projects delivery processes.

7.0 Conclusion

Road infrastructure development in Australia is currently going through an unprecedented boom due to strong economic growth and demands from resource export. Developing these projects sustainably is the only way forward but this will require close orientation towards the interests and needs of all stakeholders. Understanding sustainability drivers and integrating different perceptions and priority issues of infrastructure stakeholders will help improve sustainability outcomes. Based on interviews and literature study, an on-going research project at QUT has developed integrated decision-making guidelines on the practical implementation of sustainability strategies during infrastructure project delivery. These research efforts will help promote more integrated and consistent approaches to decision-making for enhancing deliverables of the sustainability agenda in road and highway infrastructure projects in Australia.

8.0 References

- Atkins, L. (2008). "Needs of Resource States to be a Priority." *The Courier-Mail*, Tuesday, Jan 22, pg. 4.
- Chaharbaghi, K. and Willis, R. (1999). "Study and Practice of Sustainability Development." *Engineering Management Journal*, Vol. 9, No. 1, p.p 41-48.
- Dasgupta, S. and Tam, E.K.L. (2005). "Indicators and Framework for Assessing Sustainable Infrastructure." *Canadian Journal of Civil Engineering*, 32: p.p 30-44.
- Deakin, M., Curwell, S. and Lombardi, P. (2001). "BEQUEST: Sustainability Assessment, the Framework and Directory Methods". *International Journal of Life Cycle Assessment*, 6(6), p.p 373-390.
- Engineers Australia. (2005). "2005 Australian Infrastructure Report Card." www.infrastructurereportcard.org.au, August.
- FIDIC (2008) FIDIC news, Initiatives to promote the uptake of Project Sustainability Management, <http://www1.fidic.org/news/content.asp?articlecode=45De&Rubrique=Development> (accessed September 2008).

Howes , R. and Robinson, H. (2005) “Infrastructure for the Built Environment.” *Butterworth-Heinemann*, the United Kingdom.

Infrastructure Partnerships Australia. (2007). “Australia’s Infrastructure Priorities – Securing our Prosperity.” www.infrastructure.org.au , access on 15 March 2008.

Lombardi, P. and Brandon, P.S. (1997). “Towards a Multimodal Framework for Evaluating the Built Environment Quality in Sustainability Planning”. In: *Evaluation of the Built Environment for Sustainability* (Brandon, P.S., Lombardi, P. and Bentivegna, V.). Chapman & Hall, London.

Loucks, D.P., Stalhiv, E.Z. and Martin, L.R. (2000). “Sustainable Water Resources Management.” *Journal of Water Resources Planning & Management*, 126 (2), p.p 43-47.

Luetzkendorf, T. (2007). “Enhancing Sustainability Deliverables for Infrastructure Project Delivery.” *SB07HK – Sustainable Building Conference Hong Kong*, 4-5 December.

Mitchell, G. (1999). “A Geographical Perspective on the Development of Sustainable Urban Regions”. In: *Geographical Perspectives on Sustainable Development*. Earthscan, London.

Mirza, S. (2006). “Durability and Sustainability of Infrastructure – A State-of-the-art Report.” *Canadian Journal of Civil Engineering*, 32: pg 639-649.

Morris, P.G.W. (1996). “The Management Projects.” *Thomas Telford*, London.

Newcombe, R. (2003). “From Client to Project Stakeholders: A Stakeholder Mapping Approach.” *Construction Management and Economic*, December, 21, p.p 841-848.

Philis, Y.A. and Andriantiatsaholiniaina, L.A. (2001). “Sustainability: An Ill-defined Concept and its Assessment Using Fuzzy Logic.” *Ecological Economics*, 37: 435-456.

Parkin, S. (2000). “Context and Drivers for Operationalizing Sustainable Development.” In: *Proceedings of ICE*, Vol. 138, Nov. 2000, p.p 9-15.

Queensland Government. (2007). *Northern Economic Triangle Infrastructure Plan 2007 - 2012*.

United Nations Economic and Social Commission for Asia and the Pacific (ESCAP) (2006c). “Green Growth at a Glance: The Way Forward for Asia and Pacific.”

United Nations Economic and Social Commission for Asia and the Pacific (ESCAP) (2007). “Sustainable Infrastructure in Asia: Overview and Proceedings.”

Ugwu, O.O. and Haupt, T.C. (2005). “Key Performance Indicators and Assessment Methods for Infrastructure Sustainability – a South African Construction Industry Perspective”. *Building and Environment*, Volume 42, Issue 2, p.p. 665-680.