

Environmental Implications of the Sydney Metro: A Case Study

Koorosh Gharehbaghi ¹⁺ and Amritpal Sagoo ¹

¹ RMIT University, Melbourne, Australia

Abstract. The Sydney Metro is Australia's largest public transport project, costing over eleven billion (Australian dollars) with a contract period of seven years. This mega infrastructure project is a new stand-alone railway network, and consists of more than sixty five km of metro rail from Rouse Hill to Bankstown, connecting the east and the west of the greater Sydney; via northwest and southwest sub-projects. Accordingly, both sub-projects are subject to an exhaustive Environmental Assessment under the *Environmental Planning and Assessment Act 1979* (EP&A Act). The finding of this paper is based on the Sydney Metro case study to investigate some of the primary factors considered within the Environmental Impact Assessment (EIA), and other related issues, which have influenced the decision making on the Sydney Metro mega project. Furthermore, this paper examines, how the Environmental Assessment Process (EAP) allowed the mega project to meet its environmental, economic and social goals; and therefore makes certain that the issues and concerns of the public, interested stakeholders and government agencies are vigilantly considered.

Keywords: Environmental Assessment Process (EAP), Environmental Impact Assessment (EIA), Environmental Systems approach

1. Introduction

Balancing environmental and economic objectives in developing country and cities requires a land-management strategy that facilitates the land market, protects land and cultural resources [1]. Urbanization and urban land use decisions are critical determinants of environmental quality. In developing countries, where cities are growing at unprecedented rates, distorted land markets and ineffective urban land management have resulted in the degradation of environmentally fragile land; occupation of hazard-prone areas; and the loss of cultural resources, and prime agricultural land [2]. Accordingly protecting and improving the urban environment is fast becoming a necessity rather than a indulgence. Rapid urbanization in the developing world is threatening health, the environment, and urban productivity [3]. Cities are the powerhouse of economic growth, with approximately 80 percent of GDP (Gross Domestic Product) growth in developing countries expected to come from cities in this decade. But the environmental implications of such growth need to be assessed and managed better [4]. Environmental Impact Assessment needs to be carefully carried out to ensure the ecosystem is vigilantly protected. This can be done by [5], [6].

- Understanding the variability in urban environmental problems including the sustainability issues and factors.
- Building on lessons learned to ensure all of the environmental dynamics have been thoroughly considered.
- Pursuing a strategic approach, thus considering a sustainable attitude.

Furthermore, Infrastructure is an integral part of countries economy and requires the precise implementation of Infrastructure Systems [7]. The demands on Infrastructure services for Sydney have increased exponentially, causing significant congestion within the main Infrastructure services. Moreover,

⁺ Corresponding author. Tel.: + 99255019.
E-mail address: Koorosh.gharehbaghi@rmit.edu.au.

rapid urbanization in Sydney is straining the public sector's ability to provide essential Infrastructure services hence the significance towards developing a sustainable society for Sydney community [6]. Although there is progress towards extending transportation infrastructure and related services, the delivery of these provisions lags far behind the needs, and the quality of some the services remains pitiable. To ensure that Sydney's Infrastructure needs are successfully met, specific infrastructure planning is required not only to provide sufficient services to communities, but it must also be efficient, effective and innovative to produce optimized engineering and economic systems.

An optimized Infrastructure System must incorporate engineering techniques such as Transportation design to ensure sustainability of systems during their predicted life span and maintain acceptable standards of service expected by the users. The fundamental challenges for optimization of Infrastructure within the Sydney area include, the ability to efficiently manage and sustain exact maintenance regimes of the Transport Infrastructure. In addition, supplementary challenges include, high level of service required by the community; and providing efficient, effective, economic solution that benefit all the key stakeholders [6]. The Sydney's Metro (mega) project not only will strengthen the standards of service delivery provision, but also indirectly contribute towards Sydney's future landscape.

Although, the Sydney Metro enhances the Transportation Infrastructure System of the city, such mega project is not in short of the challenges facing the designers and developers. Accordingly, careful planning and consultation with the community and the key stakeholders is paramount. This is to ensure efficient transitioning between the design and construction phases, catering for the ever changing landscape of the city and its communities.

The challenge to sustainable development requires, an adoption of holistic approach to ensure that the future needs of ever expanding cities are sustained. Consequently, the Sydney Metro project is deemed to be considered and approved under the *Environmental Planning and Assessment Act 1979* (NSW), before major construction works can commence [7]. According to the Sydney Metro Web Site (<http://sydneymetro.info/home/>), the Sydenham to Bankstown segment of the Project will be subject to a separate environmental assessment process. In addition, the New South Wales (NSW) Department of Planning and Environment is the authority responsible for the Environmental Impact assessment of the Sydney Metro.

The Environmental Impact Statement for Sydney Metro project incorporates environmental assessment of: noise and vibration; groundwater and geology; soils, water contamination and quality; and sustainability strategies. These environmental strategies which are required to avoid, mitigate and manage potential impacts, also need be identified and developed as a part of this Environmental Impact Statement.

2. Sydney Metro – Northwest (North West Rail link)

The Sydney Metro (mega) project consists of two stages. The Sydney Metro Northwest, formerly the North West Rail Link, is the first stage of Sydney Metro. Metro City and Southwest are the second stage. Sydney Metro Northwest will be the first fully-automated metro rail system in Australia and is scheduled for operation in the first half of 2019. Sydney Metro Northwest will deliver eight new railway stations and 4,000 commuter car parking spaces to Sydney's growing North West [7]. Trains will operate approximately every four minutes at the peak hours (at least fifteen trains an hour), and this will significantly reduce the waiting time [7].

Sydney Metro Northwest will deliver, for the first time, a reliable public transport service to a region which has the highest car ownership levels per household in Australia [7]. According to the department of Transport for NSW, over the coming decades, an extra 200,000 people will move into Sydney's North West, taking its population above 600,000. Fig. 1, represents the Sydney Metro Mega Project including the existing rail network.

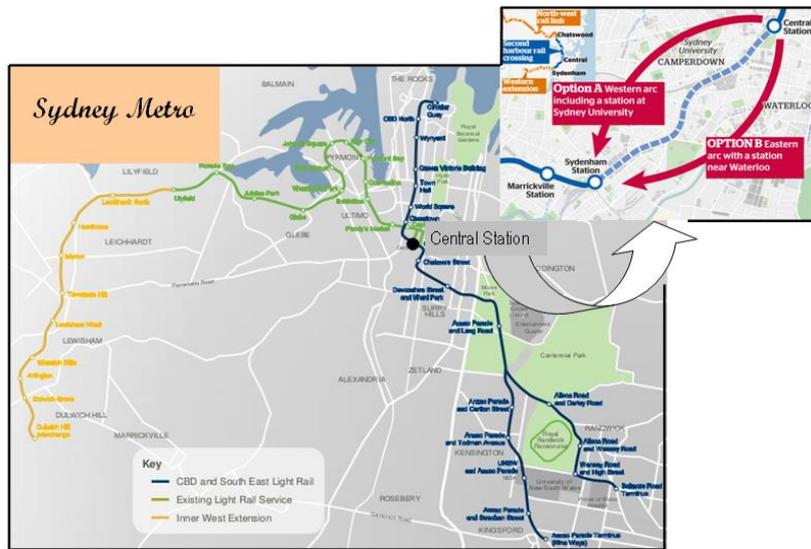


Fig.1: Sydney Metro: Overview [7].

As it can be noticed, the Sydney Metro is a part of the complete rail network system including the North West link. Sydney's new generation of fast, safe and reliable metro trains will be rolled out on Sydney Metro Northwest first. This mega project includes the construction of twin fifteen km tunnels from Bella Vista to Epping which are Australia's longest rail tunnels. This contract was awarded in late June 2013 and four tunnel boring machines are now in the ground [7]. An integral part of the Sydney Metro is the Environmental Assessment Process (EAP) which was initiated at the planning stage project.

2.1 Environmental assessment process (EAP) for Sydney metro

According to the Department of Transport for NSW, the Sydney Metro Northwest has a clear vision of the sustainable infrastructure delivery. This means Sydney Metro Northwest is delivering environmental, social and economic improvements throughout the project. Consequently, sustainable ecological measures for the project have been established to reduce environmental impacts such as; Waste management, Land use integration, and Biodiversity conservation. These impacts need to be carefully integrated holistically to represent both Environmental Dynamics and Sustainability issues [4], [8]. Fig. 2, demonstrates the Environmental Dynamics and Sustainability for the Sydney Metro.

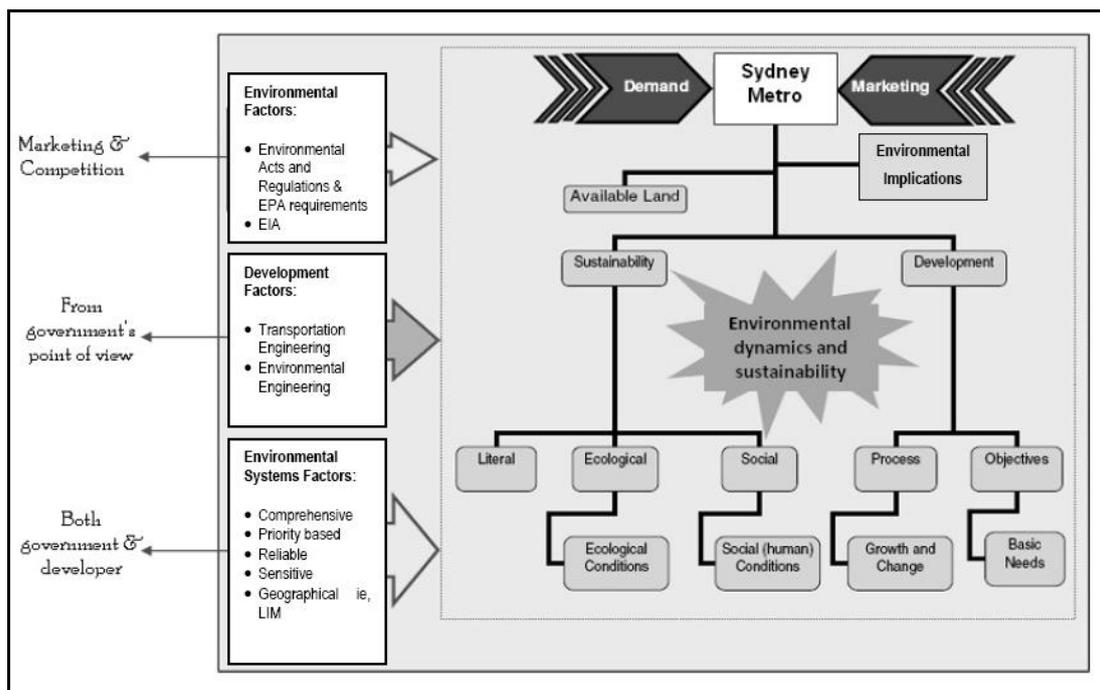


Fig. 2: Sydney Metro: Environmental Dynamics and Sustainability factors, adapted from [4].

From Fig. 2 it is evident that the Sydney Metro includes considerable Environmental Dynamics and Sustainability factors. These factors consider the outcomes for [6], [7].

- Ecological conditions such as condition assessment and any deterioration of the existing species.
- Social Conditions, including any growth restrictions, developments and future proposals.
- Growth Change, which investigate the rate of transformation within the demography and specific communities.
- Basic Needs, which examines the required Infrastructure and their related services.

These factors are influenced to varying degree and are sensitive to the changes in Government and private sector funding; and interaction with marketing and competition feature.

2.2 Environmental impact assessment (EIA) for Sydney metro

Environmental Impact Assessment (EIA) is a procedure which serves to provide information to local authority planners, key stakeholders and interested parties, including the general public about the proposed development and its effects on the environment and the immediate surroundings [8]. EIA is the complete process of collecting, analyzing information and the determination on the application for development or construction approval. The set regulations vary from state to state, however, they are very precise and cannot be disregarded. The environmental regulations indicate what should be included within an EIA including the following [9], [10].

- Description of the site and the development need to be precise and detailed, including any existing environmental conditions and settings.
- Outline of main alternative environmental studies, via the Feasibility Studies' Recommendations.
- Considering the significant of direct and indirect effects to all the existing inhabitants including the Wild life.
- Measurements and tools to prevent, reduce or offset significant adverse effects for the long and short term.
- Provide a non-technical summary, to represent the overall environmental finding and recommendations.

To further assist with the Environmental Impact Assessment (EIA) application specific Land Information Management is carefully utilized and applied.

2.3 Land Information Management (LIM) for Sydney metro

Land Information Management (LIM) is a dynamic system and often seen as a hub or a databank of inter-related knowledge and expertise, spatial data and information, policies, procedures and standards and information technology and communications [4]. Land Information Management (LIM) is designed and managed by the relevant authorities to administer the use of physical and spatial data (space, diameter). In addition, LIM contains information about the character of their region and the possible environmental impacts of development. Moreover, LIM retrains inventories of existing Infrastructure assets including, - transportation together with the socioeconomic character of the region.

LIM can also assist with measuring economic performance of local authorities and successive governments in terms of how well they respond to the dynamic changes within regions, states, and country. For example, high levels of migration or immigration (population changes) and service level provisions within region, state and country [5]. However, poor economic performance of local authorities will consequently create a decline in the population growth and lose confidence amongst the communities and businesses that they serve. Hence, the money invested by the local authorities within the region, state, and country will directly impact the growth and prosperity. LIM therefore presents the authorities and governments a better understanding of how to design and plan for future growth.

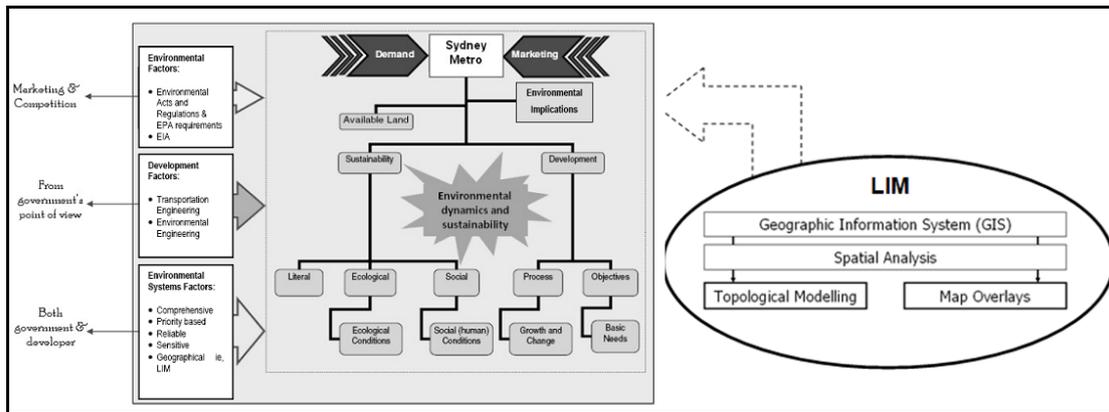


Fig. 3: Environmental Systems approach using LIM.

As it can be noticed from Fig. 3 a valuable environmental system approach need to comprise of the suitable LIM. In addition the LIM which is required to support the sustainable ecosystem, needs to collaborate the vulnerable environmental issues. To further improve the utilization of the LIM, Environmental vulnerabilities need to be carefully and thoroughly examined.

3. Vulnerability in environmental problems Sydney Metro

From the above discussions, it is evident that environmental vulnerability is a major challenge for any mega projects. Thus, the nature and severity of environmental problems together with the characteristics of potential intervention strategies incorporated in any one mega project will depend on the following factors[10]- [12].

- The unique natural features of urban areas-cities tend to take their form from the nature of their site, and their environmental problems are determined in large measure by regional ecosystem characteristics. This includes, the level of income and economic development as people climb out of poverty, the nature of their environmental problems changes.
- The diverse spatial dimensions of environmental problems in cities-spatial factors determine who is affected and how, the severity of impact, and the appropriate level of responsibility and decision-making needed to solve problems.
- The roles of local actors and authorities. The quality of the environment in a city are determined largely by the interaction of numerous public, private, and household actors who have an important effect on environmental problems and their solutions. This requires adequate Infrastructure and the relationship of the important parties such as stake holders need to be strong.

3.1 Policy lessons for urban environmental management (Building on lessons learned)

Experience in both developed and developing economies demonstrates that an effective approach for confronting urban environmental issues is to formulate an “*urban environmental management strategy and action plan*” [8], [13]. For large cities and metropolitan regions, this will entail a city-specific design focusing on agreed priority problems. For small towns and intermediate cities, a common approach or strategy may cover several cities, and sometimes will address a single issue [14]. The strategic approach to urban environmental planning and management suggested here is based on enabling participation, building commitment and choosing effective policy interventions [10], [15]. This requires strategic planning, comprehensive environmental impact assessment, and genuine consultation with key stakeholders including the business communities, the statutory undertakings and the general public. This process may result in elongation of the planning approval time and consequentially increases the overall development period. Although, the process may seem to be less efficient, if it reflects more effective stakeholders engagement, the outcome may have greater community support. Whereas fast planning approvals often delivers poor quality, unsustainable developments that are not in the best interest of the stakeholders, will deliver negative public attitude.

3.2 The key policies for Sydney metro environmental management

To assist with the Building on lessons learned, there are six key policies about the overall Sydney Metro Environmental Management schemes. These six policies are [9], [16].

- Mobilizing public support and participation by planning strategically. This involves Sequential and priority based contribution to ensure stakeholders commitment.
- Improving policy interventions through improved the overall quality control according to local, state and federal future's plans.
- Strengthening service delivery. This involves upgrading the management of local environmental Infrastructure and services for which cities are directly responsible.
- Building institutional capacity. As cities grow and develop, so must their capacity to manage the urban environment. Policy efforts should focus on upgrading local technical and management capabilities and on establishing "cooperative arrangements" for dealing with the environmental spill over's that cities generate.
- Closing the knowledge gap. Policies in this area should emphasize routine collection, assessment, use, and dissemination of critical (and currently scarce) data. Informed environmental analysis need to be based on adequate data and, making the correct decision based on the actual data.

3.3 Effective environment strategy for Sydney metro

To further promote the six key policies of Sydney Metro, valuable Environmental strategies need to be sympathetically implemented. These Environmental strategies for the Sydney Metro are [17]:-

- Institutional urban environmental management considerations. This includes collaborating global Sustainability with special focus on environmental conditions through cumulative local actions. As a part of this global sustainability attitude the Environmental Impact Assessment also needs to be regularly updated [18].
- Informational urban environmental management deliberation. This comprises of contemporary Software and Information Systems as a part of the flexible and functional approach [19].
- Technical urban environmental management contemplation. This consists of Solid Waste Management, Water, Sanitation and Air Quality Management, together with Traffic Management. All of these are based on the relevant acts a regulation including the AS/NZS 1547:2000 and the Commonwealth Radioactive Waste Management Act 2005.

As it can be noticed these environmental strategies require careful planning and development in align with the Environmental Dynamics and Sustainability factors of the Sydney Metro. Additionally, an integrated Infrastructure System must assimilate careful environmental strategies to satisfy the planning requirements [20]. Accordingly, the overall environmental planning strategies for the Sydney Metro were:-

- Detailed stakeholder's consultation. During this stage, comprehensive environmental assessment was discussed, and Government (at all levels) commitment was ensured.
- A comprehensive urban environmental management strategy was formulated and integrated into the Environmental Impact Assessment (EIA). This integration included the establishment of long-term goals and phased targets, including the identification of most cost-effective project options, together with valuable institutional strengthening.
- Conducting various Follow-ups and consolidation. During this phase policy re-forms and institutional arrangements were solidified, based upon the feedback received from the key stakeholders. In addition, no-going monitoring and evaluation procedures were carried out.
- As the part of the Environmental Impact Assessment (EIA), on-going checks were designated and are still systematically maintained.

4. Discussion and Conclusion

The Sydney Metro is Australia's largest public transport project, costing over eleven billion (Australian dollars) and taking up-to seven years to complete. This Mega Transportation project is subject to extensive Environmental assessment and implications on all the key stakeholders and the surrounding environment. A

valuable environmental system approach for Sydney Metro is an out most important consideration, including the application of appropriate LIM to clarifying the overall geographical implications. Accordingly, this paper has carefully considered all the main environmental implication of the Sydney Metro. In doing so, this paper discussed the specific Environmental Assessment Process (EAP) together with the Environmental Impact Assessment (EIA). Appropriate and detailed EAP and EIA ensure that this mega project meets its environmental, economic and social sustainability goals. Successfully meeting these concerns ensures that the overall apprehensions of the public, interested stakeholders and government agencies are carefully considered. A key factor in this success is the exploitation of vulnerability in environmental problems, have been carefully addressed in this paper together with the key policies of environmental management and the effective deployment on environment strategy for the Sydney Metro.

5. References

- [1] Vezzoli, C, and Manzini, E, "*Design for environmental sustainability*", Springer, 2010.
- [2] Bernstein, J, "*Land use considerations in urban environmental management*", Transportation, Water and Urban Development department, The World Bank, Urban No. UE-10, July 1993.
- [3] Bartone, C and Leitmann, J, "*Towards environmental strategies for cities*", Transportation, Water and Urban Development department, The World Bank, Urban No. UE-11, October 1994.
- [4] Faiza, A; Suleman, L; Shah, S; and Farhana, S, "*Incorporating permaculture and strategic management for sustainable ecological resource management*", Journal of Environmental Management, Vol.179, pp.31-37, 2016.
- [5] Andres, B; Manuele, M; Pierre-Olivier, R; Cecile, B; and Zwichy, M, "*A proposal to measure absolute environmental sustainability in life cycle assessment*", Ecological Indicators, 63 (13), 2016
- [6] Gharehbaghi, K. and Raso, V., "*Architecture Anthology I: Sustainable Design - Optimisation of Infrastructure Systems for Melbourne*", ATINER, pp. 73 - 84, 2015.
- [7] Department of Transport for NSW, Australia. <http://www.transport.nsw.gov.au>
- [8] AS/NZS ISO 14042:2001 - Environmental management - Life cycle assessment - Life cycle impact assessment_ (Environmental Impact Assessment)
- [9] UNE EN ISO 14040:2006 - Environmental Management - Life Cycle Assessment - Principles and Framework.
- [10] Young, R, "*The Oregon Way: Planning a Sustainable Economy in the American West*", Journal of Planning Education and Research, Spring 2016, Vol.36(1), p.76
- [11] Lawrence, D, "*Environmental Impact Assessment: Practical Solutions to Recurrent Problems*", Hoboken : Wiley-Interscience, 2003.
- [12] Byrne, J; Sipe, N; and Dodson, J, "*Australian environmental planning : challenges and future prospects*", Routledge, 2004.
- [13] Gharehbaghi, K, "*Infrastructure Asset Optimisation in Local Governments: Australia Study*", International Journal of Civil, Structural, Environmental and Infrastructure Engineering Research Development, 4(6), pp. 33 – 42, Dec 2014.
- [14] Casparian, A; and Sirokman, G, "*Chemistry for environmental engineering*", Momentum Press, 2016.
- [15] Chmielowski, Wojciech, "*Fuzzy Control in environmental engineering*", Springer eBooks, 2016.
- [16] Cao, Giacomo; and Orrù Roberto, "*Current environmental Issues and Challenges*", SpringerLink, 2014.
- [17] EPA (USA), "*Sustainability concepts in decision-making : tools and approaches for the US Environmental Protection Agency*", National Academies Press, 2014.
- [18] Tyler, G; and Spoolman, S, "*Sustaining the earth*", Cengage Learning", Eleventh edition. 2015.
- [19] Hardisty, P, "*Environmental and economic sustainability*", CRC Press/Taylor and Francis, 2010.
- [20] Gharehbaghi, K and Georgy, M, "*Utilization of Infrastructure Gateway System (IGS) as a Transportation Infrastructure Optimization Tool*", International Journal of Traffic and Transportation Engineering, 4(1), pp. 8-15, 2015.