Chapter 53
Accounting for Noise Pollution in Planning of Smart Cities

A.W.A. Hammad
University of New South Wales, Australia

A. Akbarnezhad
University of New South Wales, Australia

D. Rey
University of New South Wales, Australia

ABSTRACT

The incorporation of sustainable design measures in urban planning and development has been steadily increasing in the recent years. Achieving a sustainable urban environment requires accounting for the economic, environmental and social impacts of the development involved. An important factor affecting the social and environmental sustainability of urbanised areas which is commonly overlooked in urban planning is the noise pollution level. Despite the proven impacts of noise pollution on the general wellbeing of individuals within an urban setting, there remains a lack of systematic methods to integrate the impact of noise within the design of urban areas. This chapter seeks to raise awareness of the issue of noise pollution in urban settings while proposing novel approaches for its incorporation as a design parameter in planning the layout of smart cities.

INTRODUCTION

The rapid growth in population of cities due to the increasing rate of urbanisation is among the major issues faced by many city planners around the world (Jenkins, Smith, & Wang, 2007). With the increase in population comes a massive surge in the demand for infrastructure and thus the need to undertake substantial construction work, the results of which are construction sites associated with a number of adverse social and environmental impacts. This is yet on top of the environmental and social impacts associated with the operation of the new infrastructure needed to cater for the needs of the increasing population. Therefore, this necessitates the need for adopting appropriate environmental protection

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strategies to be taken into account during the design and planning phases of urban cities (Ding, 2008; Neirotti, De Marco, Cagliano, Mangano, & Scorrano, 2014). Enhancing environmental and social sustainability by taking advantage of advances in technology and engineering has been emphasised as a core objective in planning of smart cities ((Anthopoulos & Tsoukalas, 2006))). This requires accounting for the adverse environmental and social impacts of various factors in urban planning (Tiwari, Cervero, & Schipper, 2011).

One of the critical environmental and economic impacts associated with construction and operation of new infrastructure is the noise pollution (Goines & Hagler, 2007). Due to its significant and immediate health and safety implications, accounting for noise pollution in planning of sustainable cities is crucial (Adams et al., 2006; Næss, 2001). The level of noise pollution in the cities can be affected significantly by a number of design and planning decisions including the location of different facilities in the city. Accounting for the noise pollution in planning the location of facilities, however, requires the availability of reliable methods for estimating the level of noise pollution generated at the source and the level of noise pollution at different noise-sensitive receivers as well as the availability of optimisation models that incorporate such estimation methods to select the optimal location of the facilities.

This chapter is centred around the issue of smart planning to tackle the environmental and social aspects of urban design, by placing emphasis on reducing urban noise pollution, through facility layout planning. The aim of this chapter is to therefore highlight the importance of accounting for noise pollution during the planning stages of smart cities, which has received little attention in the literature. In addition, this chapter aims to present a methodology for minimising the noise pollution at noise-sensitive facilities across a smart city by incorporating appropriate mathematical optimisation models in urban layout planning.

The chapter starts by reviewing some of the major negative impacts of noise pollution, where reference is made to the relevant literature. The chapter then continues by discussing various methods for quantification and minimisation of noise pollution in smart cities. Developments within a city that are known to produce high levels of noise are analysed, and guidelines for their noise assessments are reviewed. A mathematical modelling method for incorporating noise minimisation as an objective in planning of smart cities is presented. The application of the method is demonstrated by developing optimisation models for certain scenarios applicable to smart city planning and applying them to hypothetical case studies. Finally, a framework for planning the layout of facilities in a smart city setting under the consideration of noise is proposed.

DEFINING NOISE

There is a difference between what can constitute being labelled as noise and what is in general known as sound. Sound is physically defined as a longitudinal mechanical wave, characterised by the variation in pressure that it causes in the elastic medium through which it traverses (Berg & Stork, 2005). Noise is any sound that is considered to be a disruption. Throughout this chapter noise levels from different activities will be reported in the A-weighted decibel scale. This is a filter which considers the non-linear frequency response of the ear to noise at different frequencies (Fricke, 1985).

Distinguishing between different noise sources within a city is critical when assessing the overall impacts of noise pollution. Some of the characteristics present in the sound emitted from disturbing noise sources include intermittent sound levels that are irregular in nature, sound with conspicuous tonal