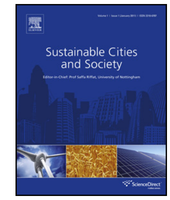
Sustainable Cities and Society 22 (2016) 11–18

Contents lists available at ScienceDirect

Sustainable Cities and Society

journal homepage: www.elsevier.com/locate/scs



A review on co-benefits of mass public transportation in climate change mitigation

Soo Chen Kwan [a,b,*], Jamal Hisham Hashim [a,b]

[a] United Nations University-International Institute for Global Health (UNU-IIGH), UKM Medical Centre, 56000 Kuala Lumpur, Malaysia
[b] Department of Community Health, National University of Malaysia, UKM Medical Centre, 56000 Kuala Lumpur, Malaysia

ARTICLE INFO

Article history:
Received 20 October 2015
Accepted 4 January 2016
Available online 7 January 2016

Keywords:
Co-benefits
Modal shift
Public transport
Health
Emissions

ABSTRACT

The magnitude of co-benefits from policy targeting climate change mitigations has been widely promoted due to the desirable win-win results of such policies towards both local and global targets. This review looks at studies on quantitative environmental and health co-benefits from various modal shifts to public transport scenarios. A systematic review was conducted to evaluate publications from 2004 to August 2015. A total of 153 articles were identified and 9 articles fulfilled all the criteria in this review. Many studies that have been done merely focused on the environmental benefits, especially on reduced air pollution from public transport in cities.

Contents

1. Introduction

Co-benefits, also called ancillary benefits are used to describe multiple, equally important rationales that could be achieved by a single policy or measure (Allwood, Bosetti, Dubash, Gómez-Echeverri, & von Stechow, 2014). Recently, the importance of co-benefits has been highly promoted along with mitigation strategies for greenhouse gases (GHG) reduction. Particularly for cities in developing countries which are facing the triple challenges of development, environmental pollution and climate change adaptation (Puppim De Oliveira, 2013), co-benefits creates a win-win situation of both local and global advantages. Co-benefits were crowned as an important bridging tool to environmental and development issues (Castillo, Sanqui, Ajero, & Huizenga, 2011). If effectively used, co-benefits can be an important integrated part of the strategy to achieve Sustainable Development Goals of the post-2015 development agenda.

The transportation industry is the fastest growing energy end-use industry that contributes to greenhouse gases emissions (Sims et al., 2014). Globally, the transport sector accounts for 15% of the

* Corresponding author.
E-mail address: sc.kwan@yahoo.com (S.C. Kwan).

http://dx.doi.org/10.1016/j.scs.2016.01.004
2210-6707/

total GHG emissions and 23% of CO_2 emissions, of which 30% of CO_2 is from the combustion of fossil fuel (OECD, 2010). Unsurprisingly, land transports specifically passenger cars dominate 80% of transport energy use (Ribeiro et al., 2007). Many developing countries in Asia are undergoing rapid urbanization and the emerging economies require increased mobility. Due to urban sprawl, poor public transportation systems, and socio-economic issues, people have gradually switched from the traditional forms of transportation (walking, cycling) to motorized vehicles (Hosking, Mudu, & Dora, 2011). This has not only increased environmental pollution, it also creates social and health issues such as overflow of road infrastructure capacity causing traffic jams, and physical inactivity among car users.

With increasing incomes and economic capacity, people are able to have individual private automobile for increased comfort and ease in travelling. This can be observed from the escalating number of motorcycles in many Asian countries as it is affordable and easy to manoeuver during traffic congestions due to their smaller size. It is projected that globally the number of motor-vehicles are likely to triple between 2000 and 2050 (Ribeiro et al., 2007). This could place a significant impact on urban emissions and environmental stress. An increase of 45% in CO_2 emissions from global transport has been observed from year 1990 to 2007 and it is expected to grow 40% more in 2030 (OECD, 2010). Therefore it is pertinent that local governments place emphasis on sustainable transport systems to alleviate greenhouse gas emissions.

Climate change mitigation in the transport sector has been generally addressed through technology and behavioural change. Public transportation moves people collectively and reduces the use of motorized transport. Compared to private vehicles, public transportation produces 95% less CO, 45% less CO_2 and 48% less NO_2 than private vehicles (Shapiro, Hassett, & Arnold, 2002). Public transports and active transports (walking and cycling) are closely related, especially for multi-modal transit purposes. In the European region, active transportation such as the implementation of a bicycle sharing program has been widely promoted to reduce the number of passenger vehicles on road, and received encouraging results (Rojas-Rueda, de Nazelle, Teixidó, & Nieuwenhuijsen, 2012; Woodcock, Tainio, Cheshire, O'Brien, & Goodman, 2014). Co-benefits evaluation from these programs has shown promising improvements from both the environmental and health perspectives.

In developing nations, the development of infrastructure and built environment for efficient transportation has been prioritized as part of the design in the early planning stage, particularly in cities. This is important to avoid any future negative lock in that is detrimental to both the environment and human health. These developmental plans, especially of those mega structures in public transportations such as the mass rapid transit system, entail substantial commitments, supports, capital allocations and co-operations at both the national and local governmental levels. Thus, co-benefits approach is important to inform policy-makers on the value of the policy implementation, and to mainstream climate strategy considerations into the development agenda (Puppim De Oliveira, 2013). Co-benefits maximize the use and positive effects from development at the global and local scales. This paper aims to review the magnitude of environmental and health co-benefits from the implementation of a public transport system that leads to modal shifts, while being part of climate change mitigating strategies.

2. Method

A literature search was conducted using the databases of Google Scholar, Science Direct, and PubMed from October to November 2014 and updated in September 2015. The articles included are peer reviewed English articles published from the year 2004 to August 2015. The search terms employed include public transport, transport, rail, bus, co-benefits, health, and environment.

Articles search focused on quantitative modelling of the environmental and health co-benefits from the use of public transportation. Papers that included modal shift to public transport as one of the multiple scenarios studied were included. Papers that did not include quantification of carbon savings or co-benefits or use of public transport were excluded. Mass public transits in consideration included rail and buses. Papers that were not being specific to transportation and not addressing potential modal shift to public transport were excluded. Cost-benefit articles and reports that do not give direct quantification of co-benefits were excluded from the review.

Initial search identified 153 articles. About half of the articles and reports were general discussions, reviews and commentaries of climate change and co-benefits in transport without quantitative analysis. Out of the 78 selected, half of them (35) analysed transport sector as part of the entire energy system, leaving 43 articles. Excluding those without fulfilling the inclusive criteria of addressing public transportation (27), CO_2 and co-benefits (8), a balance of 9 articles were selected for this review(Fig. 1). The articles were analysed for their policy/scenarios, parameters included, quantification methods, and comparisons of co-benefits between scenarios within each study.

3. Results

There were not many assessments that integrated all three interdisciplinary elements of this review criteria i.e. public transportation, carbon quantification, and co-benefits. From the nine selected articles addressing public transportation, six articles addressed the co-benefits from air quality only. From the six articles, four articles evaluated co-benefits from reduction in air pollutant emissions; one extended emission reduction benefits to air pollutants exposure; and one further modelled health endpoints of air pollution. Three articles modelled health impacts from noise, traffic injuries and physical activities from public transport use. Most of the article analyses were based on urban settings in cities, whereby five were from developing countries (Mexico, Indonesia, India and Malaysia) and four were from developed countries (U.S.A., Spain and Australia).

3.1. Scenarios

Generally, three common transport mitigation scenarios were analysed among the papers included. They were the use of technology, infrastructure expansion, and behavioural change by modal shift. Two other mitigation scenarios were limitation of car traffic and aggressive land use policies. The types of public transport scenarios considered were not significantly different between locations. Scenarios mainly included public transport vehicle fuel technology such as hybrid buses, infrastructure network development through metro expansion, bus rapid system, and behavioural change with modal shift and increased use of public transport. The percentage of modal shift to public transport in scenarios ranged from 10% to 40%. Scenarios combining both public transport vehicle quality improvement and modal shift were also assessed.

3.2. Parameters

For climate mitigation, CO_2 was the common indicator. Other greenhouse gases were accounted for in CO_2 equivalent which included carbon monoxide (CO), methane (CH_4), nitrous oxide (N_2O), nitrogen oxides (NO_x) and non-methane volatile organic compounds (NMVOC). Air pollutant emissions were quantified for