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Targets and performance indicators for sustainable urban transport: a review of current practice in Sydney, Australia

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Abstract

A key element of success for any long-term process such as the development of a Sustainable Urban Transport system, is to monitor and evaluate progress over time, which may allow, if necessary, to introduce remedial measures and actions. An efficient monitoring process requires well-defined targets set at the design stage and performance indicators regularly measured during the lifetime of any project aimed at achieving the goals of sustainability. Based on a recent seminar held at the University of New South Wales, Sydney, this paper presents a review of the current international literature on setting and using targets for sustainable urban transport, and looks at the Australian practice on how these principles are applied in two recent urban development projects in Sydney. The review has revealed several weaknesses and missing links in the present practice, and the paper offers recommendations on how to make the targets "smarter" and what needs to be done to establish an efficient monitoring process.

1 Introduction

Sustainability, whether applied to transport or to other human activities, is seen as having three components. First, is economic sustainability, which involves creating incentives for efficient responses to human requirements. Second, is environmental sustainability, which involves protecting ecosystems and promoting more livable settlements and reducing adverse externalities. Third, is social sustainability, which focuses on equity issues. However, much of the more recent focus on sustainability in transport has been on environmental issues. The US Transportation Research Board conducted a study on climate and ecology, with the environment as its primary focus [13]. Although recognising the

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importance of economic, social, and other factors in sustainability of the transport system, they did not address these issues. The sustainable transportation conference in Vancouver, Canada, also focused on environmental issues [12].

The Ecologically Sustainable Development (ESD) Transport Working Group of the Commonwealth Government [4] noted the same three dimensions of sustainability. In formulating recommendations for action in urban transport, the working group focussed largely on the goals and objectives for sustainability and the intuitive solutions consistent with those goals: higher density development; future activities located near public transport; traffic calming; and the promotion of walking, cycling and public transport. However, the working group did not address data requirements and analytical methods that would allow any appraisal as to whether any particular city was becoming more, or less, sustainable.

This glaring deficiency in methodology was one reason behind the Institution of Engineers Australia, Sydney Division, Transport Panel, choosing as its theme the topic of "SMART targets for Sustainable Transport" for its annual seminar held at the University of New South Wales in September, 2001. The adjective "SMART" refers to the suggestion in the literature that targets must be SMART: specific, measurable, achievable, relevant and time-based. The aims of the seminar were to review the process of setting and using targets in planning and implementation of urban developments in Sydney, New South Wales, to compare current local and international practice and to draw conclusions on how to make the targets "smarter". Various speakers took up the challenge and presented aspects of theory and practice on sustainable transport targets.

The enthusiastic feedback received after the seminar has inspired the writing of our paper, to make this discussion available to a wider audience. The contribution of this paper is a synthesis of the presentations made at the seminar, a review of international practice to provide a broader context for the theme, and our own discussions and critical observations on the topic.

In the next section we cover the definition of performance indicators and targets, general criteria for setting targets, indicators used in different countries for Sustainable Transport, and a review of international practice based on the last two World Conferences on Transport Research. Subsequent sections provide a review of practical experience in NSW on setting and using targets in two recent urban development projects. Finally, in the conclusions, we summarise our comments and suggest some recommendations for the future.

2 Sustainable transport targets and performance indicators – the international literature

2.1 Performance indicators and targets

Performance indicators are generally applied to organisational performance with targets reserved for activities external to the organisation, for example, targets set by governments. The performance is a measure of how well an organisation meets its objectives. Good comparative information on performance can become a powerful tool for identifying gaps in performance and determining how to fill the gaps. Indicators are compared to establish reasons for different levels of

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performance and to identify best practice that could improve the performance. Complex statistics can create difficulties, whereas rough guides can be equally beneficial in order to make comparisons and raise awareness [6].

Note that the terms "performance indicators" and "targets" are used somewhat interchangeably in the literature and the usage in the references cited is preserved in this paper. However, in the conclusions we recommend that they should refer to two separate sets of attributes.

2.1.1 Criteria for targets

The OECD [11] has suggested three main criteria for indicator selection: policy relevance and utility for users; analytical soundness; and measurability.

The Commonwealth State of Environment report [4] listed a number of selection criteria for environmental indicators (Table 1). These can provide guidance on the selection of suitable indicators for sustainable urban transport.

Table 1 Selection Criteria for ESD Indicators (Source:[4])

1.	Robust	(be reliable)
2.	Sensitive	(early indication of change)
3.	Applicable	(across scale: national; regional; local)
4.	Measurable	(validity, data availability)
5.	Credible	(Scientifically, politically)
6.	Consistent	(with other approaches)
7.	Useable	(understandable, meaningful)
8.	Relevant	(satisfies information and management needs)
9.	Practical	(actionable, guidance for decision making)
10.	Cost-effective	(use of existing indicators where possible)

2.2 Indicators for sustainable transportation

According to decision theory [7], targets (indicators) must be derived from a common goal/visions and more specific objectives that are closely related in a hierarchical structure with the broadest goal/vision at the top (eg. sustainability) and the most precisely defined objective at the bottom (lower-level objectives). Measurable attributes (targets) are attached to each sub-objective and a specific policy instrument (action) is proposed to meet the target [3].

This hierarchical approach is best illustrated by a current research study (PROSPECTS) supported by the European Commission under its Environment and Sustainable Development Programme [9]. Sustainability – irrespective of how it is precisely defined – can be achieved through a number of sub-objectives. May (*et al.*, [9], pp.12-13) have developed a list of six sub-objectives for sustainability: (1) economic efficiency; (2) livable neighbourhoods and streets; (3) protection of the environment; (4) equity and social inclusion; (5) safety; and (6) contribution to economic growth. Energy efficiency could also be added to that list.

Indicators assess performance against the sub-objectives. They are indicators of the end results of the various strategies that contribute towards sustainability

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(the higher level goal). The PROSPECTS study proposes three types of indicators that are, directly related to the 6 sub-objectives ([9], pp.13-14):

- Level 1 indicators – comprehensive measures of all aspects of a sub-objective where the impacts are both quantified and monetarily valued (eg. cost benefit analysis for economic efficiency).
- Level 2 indicator – quantifiable measures of aspects relating to the achievement of a sub-objective.
- Level 3 indicator – qualitative assessments of the level of goal achievement.

Indicator systems are based on one of two approaches; (i) the measurement and monitoring of a particular indicator; (ii) the forecasting of indicator values based on modelling complex systems. Most of the research reviewed falls into the latter approach. The SPARTACUS indicator system is a good example of this forecasting approach: Table 2 shows the 3 primary components of sustainability (environment, social and economic), 5 "themes" and 22 indicators.

Table 2 The SPARTACUS Indicator System

Sustainability component	Theme	Indicator
Economic Index	Economic	Total net benefits
Environmental	Air pollution	Emission of greenhouse gases Emission of acidifying gases Emission of organic compounds
	Conservation natural resources	Consumption of mineral oil Land coverage Consumption of construction materials
Social	Health	Exposure to particulate matter Exposure to nitrogen oxide Exposure to carbon monoxide Exposure to noise Road traffic fatalities Road traffic injuries
	Equity	Justice of exposure to particulates Justice to exposure to nitrogen oxide Justice to exposure to carbon monoxide Justice to exposure to noise Segregation
	Opportunities	Total time spent in traffic Level of service – public transport and slow modes Vitality of city centre Accessibility to the centre Accessibility to services

(Source: based on [8], Table 1, p.36)

Typical applications of SPARTACUS involve the identification of land-use, transport and pricing policy elements, scenario testing and different

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combinations of policy packages. The analytical framework ([8], Figure 2, p.37) incorporates: a land-use/transport interaction model, MEPLAN, the Raster module which is a GIS-based method to calculate indicator values that are treated in a spatially disaggregate way; and a decision support tool that allows the user to define indicators, to give weights and value functions for the indicators in order to calculate "sustainability indexes".

3 Current practice in New South Wales, Australia

3.1 The Warren Centre Project

The Sustainable Transport in Sustainable Cities project series was launched in 1999 by the Warren Centre for Advanced Engineering (Sydney University) in response to growing community concern about the deteriorating trends in urban travel that is evidenced by increasing travel times and distances, and worsening environmental and social impacts on the community. While the project is focused on Sydney, the aim is to develop a methodology applicable to all major cities in Australia and overseas.

The project specification clearly follows a hierarchical structure starting with a vision, then specifying more detailed goals, objectives and strategic actions to achieve the stated vision. Strategies to achieve these goals are identified as follows: (i) increase community ownership through involvement; (ii) better manage the existing transport system; (iii) modify the form and structure of the city; (iv) modify the transport system to enhance sustainable accessibility; (v) lower barriers to change, and (vi) monitor and report on performance.

The project started with a comprehensive statement of Sydney's present transport situation (The State of Play). This was followed by the Community Values module that provides an insight into residents' and decision makers' attitudes, expectations and responses to change in transport supply, based on a broad community survey. The findings of the Community Values module will provide foundation for the subsequent components of the project: Community Awareness, Technology, Land Use, Decision-Making and Institutional Structure, and the final project which will present an integrated plan for sustainable transport: Putting it Together. The final module will address the question how to measure the outcomes. So far the following performance measures have been proposed: (1) Environmental performance measures: greenhouse gas emissions; use of non-renewable energy; cumulative adverse environmental impacts; (2) Social performance measures: accessibility to goods, services and persons; accessibility for the disadvantaged; and community health; (3) Economic performance measures: consumption of economic resources in transport. However, no specific targets have been defined for these measures so far.

3.2 Setting air quality targets

Air quality targets are essential because road transport is the principal contributor to urban air pollution in NSW. The improvements gained from stricter emission standards of modern vehicles are now outweighed by the increasing numbers of

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vehicles and trips. The issue is complex due to the variety of pollutants related to transport: carbon monoxide, photochemical oxidants (as ozone), nitrogen dioxide, sulfur dioxide, particles as PM10 and lead.

In 1998, the National Environmental Protection Council (NEPC) established national air quality standards and goals for the 6 common pollutants. In setting the standards, the NEPC commissioned a leading respiratory physician with expertise in the health impacts of air pollution, to review the relevant literature and to identify the range of concentrations necessary to protect health.

Historical airshed monitoring data were also examined to determine the pollutant status of each airshed. Following a review of technologies readily available for the control of polluting emissions, an assessment was made of the improvements that could be achieved over a 10-year period designated for meeting the standards. This included an analysis of the likely level of exposure to the various pollutants and a cost-benefit analysis of the various standard options being considered. Table 3 lists the National Environment Protection Measure for Ambient Air Quality (ANEPM) standards and goal for Ambient Air Quality for the six criteria pollutants of concern.

Table 3 NEPC Measure For Ambient Air Quality Standards And Goal

Pollutant	Averaging Period	Maximum Concentration	Goal Within 10 Years Max. Allowable Exceedences
Photochemical oxidants (as ozone (O_3))	1 hour	0.10 ppm	1 day a year
	4 hours	0.08 ppm	1 day a year
Nitrogen dioxide (NO_2)	1 hour	0.12 ppm	1 day a year
	1 year	0.03 ppm	None
Particles as PM_{10}	I day	50 $\mu g/m^3$	5 days a year
Sulfur Dioxide (SO_2)	1 Hour	0.20 ppm	1 day a year
	24 Hour	0.08 ppm	1 day a year
	Annual	0.02 ppm	None
Carbon Monoxide (CO)	8 hours	9.0 ppm	1 day a year
Lead (Pb)	1 year	0.50 $\mu g/m^3$	none

The process of setting ambient air quality standards or targets involves the careful evaluation of the available scientific, social and economic data. The final standard is a balance between these factors and the technical practicality of meeting the standard. Thus, the degree to which we clean up our atmosphere is a combination of technology, scientific understanding and community will. The key to this is an informed debate on the desirable ambient air quality standards and on the costs and impacts (positive and negative) associated with meeting those standards. Finally, once actions are taken, monitoring and reporting in accordance with national protocols is required to ensure that the targets are met.

3.3 Setting transport targets

Transport planning for the Greater Sydney Metropolitan Region provides examples from local practice where performance indicators and targets have

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been formulated. The integrated transport strategy released in 1993 divided the objects broadly into economic, social and environmental and then specified quantitative performance indicators for each [2]. This approach – representing best practice for the time – would have led to some interesting conclusions about change of indicators over time had the strategy been implemented. The incoming Labor Government produced *Action for Transport 2010* [10], in which the prime target was vehicle kilometres of travel (VKT) by private transport. A whole of government approach is committed to improving metropolitan air quality and the transport portfolio aims to achieve that by encouraging the use of public transport and setting VKT as a target. Specifically, these are halting the growth in per capita VKT by 2011, and halting the growth in total VKT by 2021 ([10], p.10). If these targets are to be met the proportion of commuters travelling to work by public transport must increase from 20 per cent to 30 per cent.

3.4 Using targets - Liverpool – Developing sustainable communities

The Liverpool Local Government Area is home to some of the most significant future developments in the Sydney Metropolitan Area, almost all of which are currently greenfield. In response to shortcomings of past developments in Liverpool, which have led to social problems, high infrastructure costs and overwhelming car dependence, Council commissioned Gutteridge Haskins & Davey Pty. Ltd. (GHD) in 1999 to undertake the Developing Sustainable Communities project. The project brief sought sustainable development incorporating the ecological, environmental, social and economic elements of future growth.

The GHD project incorporated the concept of sustainability into every level of the planning process. The project started from a vision that recognised sustainability as a quest rather than an end point in the process. The principal aim of the project, based on this vision, was a more sustainable interaction of transport and land use, and the planning instrument proposed to achieve this aim was the concept of transit-oriented development (TOD), with the following specific objectives: (1) reducing the need to travel, by locating a range of services and activities within reach of the community; (2) providing urban form and structure that promotes access by non-motorised modes such as walking and cycling; (3) higher residential densities around transit links.

The transport modelling process was founded on the agreed outcome that the project wanted to achieve. It involved a spreadsheet model called Environmental Baseline System, as a means of estimating different aspects of development on a per household basis. TOD recognises that travel behaviour is directly related to the availability and choice of transport alternatives. Therefore transit modal shares were based on proximity to transit stops. The following travel targets were set for the project as modal shifts from the existing mode shares:

- Zone 1 - High transit accessibility zones (areas within 800 m from a train station and/or 400 m of a transitway station): 15 % shift from car to alternative modes;

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- Zone 2 - Medium transit accessibility zones (areas outside Zone 1 and within 1000 m of a train and/or transitway station, or 400 m of a priority bus route): 10 % shift from car to alternative modes;
- Zone 3 – Low transit accessibility zones (areas outside zones 1 and 2): 5 % shift from car to alternative modes.

Road network improvements were modelled and planned on the basis of such significant modal shifts away from the car, and accepting a moderate level of traffic congestion (LOS C or even D) rather than planning for free-flow conditions. This meant that road improvements were required later or not required at all.

3.5 Using targets: ADI St Marys Development

The Australia Defence Industries (ADI) St Marys development site is situated in Western Sydney (Penrith Local Government Area). The Draft Parramatta Regional Environmental Plan (1998) has defined transport and air quality goals for the St Marys Development site. The ADI St Marys Environmental and Urban Development Masterplan and the associated Transport Management Plan (TMP) were developed in response to these main goals, while also building on the principles of the NSW "Integrated Transport Strategy" [10] such as: (1) more compact urban form, (2) maximise use of existing infrastructure, (3) good access to major transport corridors and employment centres, (4) greater choice in housing types, especially multi-household dwellings, and (5) reducing dependency on the private car.

The planning process included a comprehensive review of possible land use design and transport planning concepts and alternative strategies and selected a combination of design options aimed at influencing travel behaviour through the application of transit oriented development techniques. The objective of reducing car dependency is sought to be realised by using traditional neighbourhood layouts with greater accessibility and connectivity and by providing positive advantages to alternate transport such as walking, cycling and public transport.

The plan defines a 10 % modal shift to be achieved as a transport target: a 70/30 share of car versus other modes for all trips, as opposed to the 80/20 mode share which is typical within the surrounding local government areas.

Revised traffic modelling for the site has considered the effects of the measures to promote public transport and non-motorised travel and the recognition that during peak periods a lower level of service is acceptable on the road system. As a result of the various measures proposed to discourage use of the private car, the site is expected to generate only 73,000 two-way vehicle movements per day, 10,000 less than a similar size traditional development.

4 Conclusions

The following conclusions can be drawn from this review. Air quality targets in NSW are well defined and clearly justified by epidemiological research findings. The setting of transport targets – the role of which would be to determine more specifically the objectives for the transport task needed to achieve the given air

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quality targets – appears to be less well justified. Transport targets are typically stated in the form of maximum VKT for certain urban regions. However, there is no spatial dimension related to these transport targets, although it seems obvious that the same volume of travel in different parts of an urban region may have different impacts on air quality. There seems to be a missing link between the air quality targets and the specific transport targets to be set in a more detailed spatial dimension. The concept of "area-wide environmental capacity" [5] is one analytical tool that attempts to fill in this gap in the process.

The case studies of new urban developments in Sydney reviewed in this paper are based on a clear goal of achieving sustainable urban transport, and the proposed solutions are in good agreement with the current international practice. However, the only target used in these projects is a relative modal shift away from the current level of car use, one which is important but may not be enough to indicate the level of achievement of the final goal of sustainability. There is no time scale attached to the target. Also, the projects offer little justification, in terms of modelling the environmental consequences of various transport solutions, as to the setting of the actual target values.

The proposition that targets for sustainable transport should be "achievable" is a contentious one. That "targets" remain constant and inflexible over long periods of time is unlikely with such a dynamic system as land-use and transport, given changes in technology, scientific knowledge, community aspiration, and behaviour. Targets are in need of monitoring and revision where appropriate – thus, targets should be "adjustable" rather than "achievable". This is particularly important in the case of transport targets where the air quality impacts of technological development in vehicle and engine design and the use of alternative fuels are very difficult to predict for the long term.

While "targets" and "performance indicators" are used somewhat interchangeably in the literature, we suggest that these terms should refer to two separate sets of attributes. Targets must be set at the planning and design stage and mechanisms for institutional accountability must be articulated. Performance indicators must be measured after implementation during the lifetime of any new development and compared with the targets, to reveal the level of achievement and to allow any remedial measure or action to be taken when a discrepancy is detected. Only an efficient process of monitoring and intervention can ensure that the final goals will be achieved. The environmental legislation should be amended to define clearly the responsibilities and accountabilities of each party (local councils, government agencies, consulting and design organisations) in relation to monitoring sustainability indicators. Research organisations have a role in developing the required measurement and evaluation tools for various types of targets (air quality, transport, social and economic targets).

Finally, there is enough support in the literature for the proposition that "spatial" could be substituted for "specific" in the "SMART" acronym. Any target must be linked to its spatial reach. In particular, we note the literature on targets for sub-regions of metropolitan areas and for mobility management plans at the organisation level, both representing a more "bottom up" approach to meeting societal targets. In conclusion we suggest, therefore, that sustainable transport targets should, indeed, be SMART but: "spatial, measurable, adjustable, relevant and time-based".

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