Australia, ecologically sustainable development with the inter-governmental agreement is the current external driver to urban transport planning and policy. The Ecologically Sustainable Development (ESD) Transport Working Group of the Commonwealth Government issued a report in 1991 full of recommendations for change in the transport sector. When these recommendations are classified into the steps of the systems approach – goals/objectives, data and analysis, plan making and forecasting, evaluation criteria - most of them are either aimed at altering the value system by specifying new goals and objectives for a more sustainable transport sector, or they were aimed at solutions to the perceived problem, such as encouraging higher density cities (for a full summary, see, Black, 1996).

Noticeably absent from the set of recommendations by the Working Group were suggestions on analytical tools and evaluation methods (see, Minken, *et al.,* 2002), including appropriate "sustainability" indicators, and on targets to achieve them. Thus, in Australia, this political, economic and social context has realigned appropriate urban transport technologies in favour of public transport (and associated techniques) that then lead on to a series of research questions. Globally, sustainable cities are one of the major challenges (see, World Conference on Transport Research Society and Institute of Transport Policy Studies, 2004). The river is, perhaps, in a process of rejuvenation.

Having sketched, very briefly, a few of the key relationships between urban transport technologies (and techniques) and policies, and the changing societal context, it is appropriate to consider the role of policy-relevant research on sustainability. Approaches to urban policy research can be classified in various ways, but much of transport research is directed to estimating the costs and benefits, and distributional consequences of alternative technological projects, programs and policy instruments. Whilst the ultimate aim of this paper is to raise some research topics for debate and discussion, it is now timely to indicate some of the current streams of research engagement on sustainable transport and cities – that is, matters of form and technique.

Urban Transport Sustainability – Various Definitions

Reaching a consensus on an acceptable definition of "Sustainable Urban Transport" is a bit akin to 19th Century explorers tracing the exact source of the River Nile. A research study (PROSPECTS) supported by the European Commission under its Framework 5 Environment and Sustainable Development Programme (May, *et al*., 2001), has provided a working definition of sustainability of the urban land-use and transport system, and furthermore, has sought decision makers' acceptance of such a definition:

> "A sustainable urban transport and land use system:
> - provides access to goods and services in an efficient way for all inhabitants of the urban area
> - protects the environment, cultural heritage and ecosystems for the present generation, and
> - does not endanger the opportunities of future generations to reach at least the same welfare level as

> those living now, including the welfare they derive from their natural environment and cultural heritage".
>
> (May, *et al*., 2001, p.12)

Decision makers in 54 European cities were asked to consider how appropriate the above definition of sustainability was to their circumstances (the definition had been previously agreed amongst the six "core cities" working in close collaboration with the research team – Edinburgh, Helsinki, Madrid, Oslo, Stockholm and Vienna). Only a quarter of the responses considered the above definition to be "very appropriate"; the majority (61 percent) thought the definition to be "quite appropriate" (May, *et al*., 2001, p.12).

The research team concluded that there could be scope for identifying a definition of sustainability that is more appropriate to the circumstances of European cities. This conclusion has relevance too for Australia: a useful exercise would be to review the various metropolitan strategies for Australian cities (for example, State of Victoria, 2002) and tease out the nuances of different definitions. It would be especially interestingly to compare definitions in the Sydney metro-strategy released in late 2005 with those in "Sustainable Transport in Sustainable Cities" – a Warren Centre for Advanced Engineering, Sydney University project that was the winner of the 2003 Bradfield Award - Engineers Australia's premier award in engineering excellence.

Sustainability – irrespective of how it is precisely defined – can be achieved through a number of sub-objectives. At the simplest level, sustainable development ("comprehensive sustainability") is usually seen as consisting of three inter-connected components: environmental sustainability, economic efficiency and social sustainability (Lautso and Toivanen, 1999, Figure 1, p.36). Some would add "financial sustainability'. In consultation with the Core Cities, May (*et al*., 2001, pp.12-13) have developed a list of six sub-objectives for sustainability:

- economic efficiency;
- liveable streets and neighbourhoods;
- protection of the environment;
- equity and social inclusion;
- safety; and
- contribution to economic growth.

Over 90 percent of decision makers in 54 European cities considered these sub-objectives of some importance (economic growth received the highest scores; equity and social inclusion the lowest).

There is an important, and broade,r conceptualisation of the problem of sub-objectives that packages them under a higher goal of "quality of life". Hayashi and Sugiyama (2003) illustrate this diagrammatically with the additional link to a set of performance indicators (Figure 1). Confirming the relevance of these sub-objectives and performance indicators for Australian cities, together with qualitative surveys of stakeholders and their values and trade-offs (see, for example, Hayashi, *et al.,* 2006; Kuranami and Black, 2006), are potential research topics that could not be undertaken without an understanding of the role of performance indicators. Planning practice and

policy in New South Wales appears to be slow in responding to setting targets and specifying performance indicators (Black and Hidas, 2001; Hidas and Black, 2002).

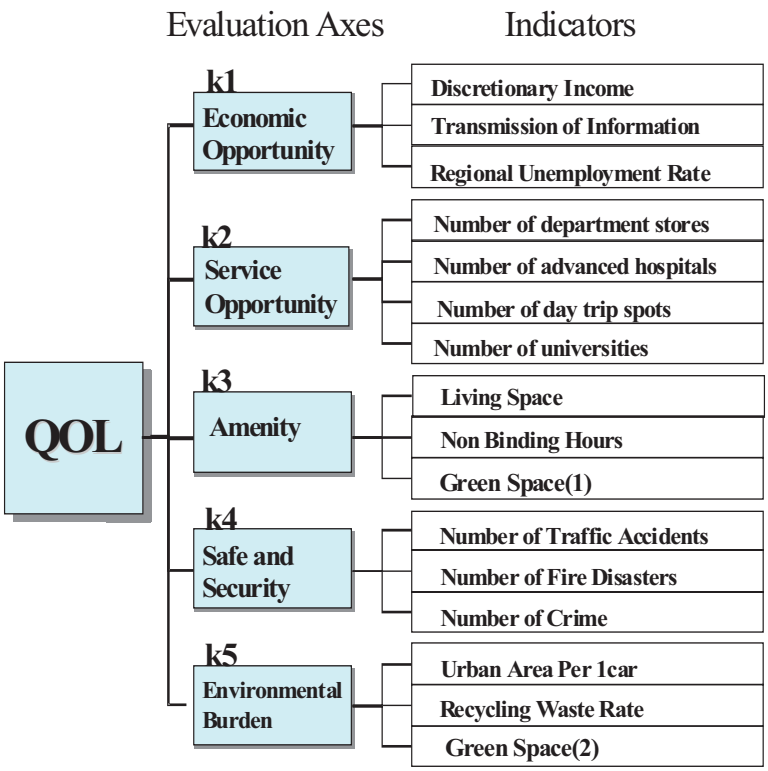

Figure 1. Overall Quality of Life (QOL) - Its Component Objectives and their Goal Indicators
(Source: Hayashi and Sugiyama , 2003; Kachi, *et al*., 2005)

Performance Indicators

As foreshadowed in Figure 1, quantitative and qualitative indicators are needed to assess performance against objectives. Indicators are the end results of the various policies, strategies and transport technologies that contribute towards sustainability (the higher level goal of QOL). Indicators directly relate to the sub-objectives of the basic objective of urban land-use and transport strategies – that is, sustainability. The basic objective –"sustainability"- requires a working definition before the sub-objectives and indicators can be determined. An agreed set of indicators will emerge only if there is a consensus of support of this working definition. For example, the PROSPECTS study proposed indicators that are, as far as possible, directly related to the six sub-objectives specified in the previous section. Each sub-objective is given its own indicator, or set of indicators.

> "Indicators are of three types with this structured approach being welcomed by our core cities", and reflecting practice in the 54 cities surveyed[1] (May, *et al*., pp.13-14):
>
> Level 1 indicators – comprehensive measures of all aspects of a sub-objective where the impacts are both quantified and monetarily valued (for example, cost benefit analysis produces a comprehensive measure of 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.

Nevertheless, May (*et al*., 2001, p.21) conclude there is considerable doubt amongst cities on the value of these indicators.

Indicator systems are based on one of two approaches: the measurement and monitoring of a particular indicator; or the forecasting of indicator values based on modelling complex systems. Most of the research in urban transport falls into the latter approach. Modelling the city in an integrated fashion is precisely the purpose of the land use-transport interaction models, and the need for performance indicators is one of the reasons why urban modelling has seen a renaissance in recent years. For example, the general goal of the SPARTACUS project was to develop and pilot the use of (in Helsinki, Naples and Bilbao) a comprehensive analytical framework for building and evaluating long-term strategies for sustainable urban development. The analytical framework (Lautso and Toivanen, 1999, Figure 2, p.37) incorporates: a land-use/transport interaction model, MEPLAN (developed by Marcial Echenique and Partners); 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".

Indicators and Spatial Scales

Different quantitative approaches are required for different spatial scales, and a literature review to identify practical urban approaches (techniques) is an important research task. For example, Black *(et al.,* 2001), drew on a data base of papers submitted at the 2001 World Conference on Transport Research Society triennial Conference in Seoul, South Korea, and considered all geographical scales, noting the dominance in the literature of indicators at the global and trans-national scales. They proposed a framework (Table 1) for classifying the literature on targets and performance indicators at the metropolitan scale, the suburban scale and for individual

[1] Twenty percent of the cities in Europe had no indicators; 80 percent use indicators of some type – quantified in monetary terms, quantified in non-monetary terms, or qualitative. One quarter of the cities use all three types of indicators. Only 35 percent use indicators, which are quantified in monetary values (May, *et al*., 2001, pp.13-14).

trip generators (the bibliographic references in Table 1 and in the text can be found in Black, *et al.,* 2002).

Table 1. Classification of Sustainable Urban Transport Techniques by Scale

Geographical Scale	Examples from the Literature
Cities	Kim (2001) – comparison of Canadian and Korean Cities; Lee (1999) – sustainable spatial development for Kwangju, Korea; Lautso and Toivanen (1999) – policy scenarios for Helsinki tested by MEPLAN/GIS model; Lu and Zhang (2001) – sustainability and environmental capacity; May, *et al.,* (2001) – survey of decision makers in 109 European cities; Zuidgeest, *et al.* (2001)
Suburban/Local Government Areas	Páez, *et al.*, (2001) – spatial statistics to identify differing journey to work travel behaviour in 44 LGAs of Sydney; Suthanaya and Black (2001) reviews US literature on urban form and travel behaviour
Organisations/ Developers	Black, *et al.,* (1999) – UNSW Transport Program; James and Greensmith (2001) TAPESTRY framework for mobility management plans ("green transport plans") in Europe; NSW Department of Transport and NSW RTA (2000) – Transport Management and Accessibility Plans

(Source: Black, *et.al*., 2002)

The majority of the practice reviewed applies indicators to help assess the economic, social and environmental implications of alternative scenarios or policy packages (for example, Lautso and Toivanen, 1999). Some of the practice is directed at specific elements of sustainability – for example, sustainable accessibility and mobility (Zuidgeest, *et al*., 2001) or environmental capacity (Lu and Zhang, 2001). There is a large stream of literature at the suburban (zonal) scale – much of it of North American origin – as reviewed by Suthanaya and Black (2001). The general characteristics of this work are: investigating whether planned urban developments have different travel characteristics than that of neo-traditional neighbourhoods (where density is higher and land uses mixed); or determining whether zones close to railways or light rail systems generate less car travel than zones more distant from public transport. None of the North American literature reviewed was aimed at targets or performance indicators, and others have also raised the same criticism. Páez, (*et al*., 2001) have argued that differential targets and policies need to be set for different regions of a complex metropolitan region. Targets require a spatial dimension in addition to a temporal one.

Table 1 identifies a scale where the responsibilities for action are explicit – an individual organisation (in Australia, the best known example is that of the corporate transport plan of the University of New South Wales and its travel demand management framework, as described by Black *et al*., 1999). Mobility management is an innovative approach to tackling local transport problems, in which key new

players[2], such as employers and owners of site developments, work together, often with local government, to develop appropriate transport solutions. The emphasis is on information, communication, organization and co-ordination. Part of the European Union's 4th Framework Programme for Research, Technological Development and Demonstration Activities have supported MOMENTUM (Mobility Management for the Urban Environment) and MOSAIC (Mobility Strategy Applications in the Community). A European Platform on Mobility, Management, established with the support of European Commission DG VII, aims to promote and further develop mobility management plans. James and Greensmith (2001) describe initiatives with mobility management plans. Classification of papers presented at the last World Conference on Transport Research, in Istanbul, 2004, and from other sources, would enrich Table 1, as would bench marking of international practice on sustainable urban public transport technology and policies.

Sustainable Transport Policy and Technology in Japanese Cities

Any scientific study of fluvial geomorphology requires an understanding of different river systems and processes. Similarly, with urban transport and sustainability being a global issue it is inevitable that international comparisons of best practice techniques and outcomes are made, such as those provided by Newman and Kenworthy (1999) and World Conference on Transport Research Society and Institute of Transport Policy Studies (2004). For westerners, Japan has been a neglected source of information but it is important because of the nation's innovation in urban public technology. With financial support from the Japan Society for the Promotion of Science (JSPS) interviews were arranged and conducted by the author in 2003 and 2004 with government officials responsible for transport and urban development in major Japanese cities outside of the two major conurbations of Tokyo and Osaka. The focus was on policy initiatives, programs (techniques) and technologies for a more sustainable city. A rich database has been established.

For the purposes of this paper only examples of innovative practice in Japan is mentioned (see, Hayashi, *et al*., 2004). First, there is evidence of strategic thinking in the formulation of a city vision that is so important in the continuous path towards sustainability. For example, according to Sapporo Mayor Nobuo Katsura, the fourth long-term comprehensive plan entails a partnership in which Sapporo citizens, businesses and local authorities are asked to trust and co-operate with each other (Sapporo Municipal Government, 2000, p. 1). Based on earlier work there are three themes.

1. Formation of an urban environment in harmony with the rich natural environment.
2. Reinforcement of urban functions making the most of the unique characteristics of this northern Japanese city on Hokkaido.
3. Encouragement of creative urban activities that connects Sapporo to the world.

[2] Potential players include: local/regional authorities; site owners or managers, public transport companies; event organisers; commercial interest groups; trade unions, employers organizations; environmental organisations; pedestrian, cyclist or other specific road user groups; and community groups.