Paper1 Week 3

VISUALISATION- MATCHING PLANNING TO COMMUNITY ASPIRATIONS & EXPECTATIONS

Literature shows that interest in sustainability has arisen as a result of increasing community concern for environmental and social aspects of development, especially since the 1970's. This awareness has been reflected in an underlying shift in values, and as a consequence, community aspirations and expectations for cities. This stimulated United Nations declarations and commissions seeking commitments from nations to achieve development that meets the three pillars of sustainability (environmental stewardship, social equity and economic efficiency). This has become an integral aspect of international policy and policy of governments since 1992.

Government, non government and academia have been actively responding to the goals of sustainable development. However there remains a need for methodology that enables city performance to be holistically assessed in terms of the three pillars of sustainability.

A challenge for researchers is to provide methodology that is not only objective but able to be simply and meaningfully understood and used by community and government. This may seem an obvious enough aspiration and a good idea to add as a secondary consideration; however the importance of this should be recognised. A strong voice of community was very much part of the stimulus that led to the focus on sustainability. Open community involvement (debate of needs, options and inclusion in decision making process) has been and continues to be recognised by professional and community groups as an essential process to getting appropriate asset investment outcomes (The Society for Social Responsibility in Engineering, 1984, 1986; Acorn, http://www.acorninc.org, Jan 2008). The importance of participation between government, non government organisations and local community is seen in the following extract from the United Nations 2007 report on the state of the world's population (http://www.unfpa.org/swp/2007/english /chapter_6/ preparing.html, Jan 2008):

> Cities must look urgently to the future. The projected expansion of the urban population in Asia and Africa, from 1.7 to 3.4 billion over a period of only 30 years, and the reduced level of available resources, stress the need for a more imaginative but pragmatic response. **In turn, this will demand a realistic vision for the future, better information at the local and regional level, as well as participatory approaches and negotiated agreements that build on the knowledge and experience of the poor.**
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> Decisions taken today in cities across the developing world will shape not only their own destinies but the social and environmental future of humankind. The approaching urban millennium could make poverty, inequality and environmental degradation more manageable, or it could make them exponentially worse. In this light, a sense of urgency has to permeate efforts to address the challenges and opportunities presented by the urban transition.
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> (chapter 6, p. 1)

Flipping this discussion in reverse, the need for methodology to holistically assess sustainability performance stems from the international requirements of the United Nations. However, the United Nations itself is responding to the collective aspirations and expectations of the world communities. From both angles, it can be concluded that the importance of providing methodology that is able to engage community as well as government is paramount.

In Australia, the values, aspirations and expectations for sustainability in cities has been heightened in the community in recent years as the urgent need for "Climate Change" action and the slow response by some governments were realised.

For example, key findings from the "perception of current transport problems survey" (Warren Centre for Advanced Engineering, 2002) with its sample of Sydney's residents, found broad agreement that there are significant transport problems and a loud call for better, long-term planning Sydney-wide. Sydney residents have a deep and passionate interest in major issues affecting their city. Lack of evidence of long-term planning is a major concern for residents. Traffic and transport are perceived as serious problems. Almost four in five (78%) of the residents believe Sydney has significant transport and traffic problems, with twenty percent believing the problems are major and that something drastic needs to be done about them. Road congestion was the number one issue, with housing affordability, greenhouse gas emissions and air quality following as very important issues. Sydney residents felt strongly about the need to develop public transport infrastructure and indicated a preparedness to pay for this at the expense of road funding. Almost three-quarters (73%) of respondents believed that not enough money and resources were being invested in Sydney's public transport. To a lesser extent (52%) indicated they also wanted increased road infrastructure, but not at the expense of public transport. Almost two-thirds of residents surveyed opted for demand management rather than building more freeways to manage the congestion problem.

In considering methodology challenges, it is important to recognise the baseline methodology in place at this time and to relate this methodology to this shift in community aspirations and expectations that has taken place since the 1960's. Literature shows that sustainability measurement methodologies often used individual indicators. Existing indicators and proposed methodologies although varied are typically numerically based. A number of indicators were measured directly e.g. passenger volumes, but others were derived e.g. average emissions and population density. Current methodologies (for example PROPOLIS and QOL) and methodologies currently under development for sustainability application (for example INSURE) use assessment indicators that are derived using methods such as land-use, transport modelling and econometric methods as their building blocks.

These building block methods can be viewed as methods that have evolved over many years through the analytical rigour of peer review and practical application. It is well understood in the scientific community that measures and methods of analysis should as far as possible be quantifiable and permit traceability to source data. The building block methods fit this requirement and as such are to be valued. This is an important foundation to ensure objectivity and traceability is a characteristic of any new method formed to fill the sustainability methodology gap. These building block methods have the added advantage of providing a basis for methodology that is predictive as well as descriptive. The next sub-sections provide a synopsis, from literature, of the key building block methods, their characteristics and discussion of their fit to the shift in community aspirations and expectations. The discussion then shifts its attention to identify visualisation methods that have been applied in relation to sustainability in cities.

3.1. Urban & Transport Planning Building Block Methods: Match or Mismatch to Community Aspirations & Expectations?

Historically two main types of quantifiable modelling have developed, mobility modelling, with Transport Planning Models (TPM) or four step process model and variations; and the Integrated Land-Use Transport Models (ILUTM) with the inclusion of land-use/transport interaction. The most prominent ILUTM type models are the spatial interaction models. These methods have formed the basis of most transport planning and urban planning analyses. As such they form basic methodologies suitable to underpin further methodologies for assessment of the three pillars of sustainability. These next sub-sections provide insight into the characteristics of the methods and by observing views expressed in the literature, come to a position on the fit to community aspirations and expectations. Both TPM and ILUTM models have a common transport supply characterisation in the transport impedance function which is either represented as travel time, distance or generalised cost (includes a cost equivalent of time and other non financial costs).

3.1.1. Mobility Models:

Transport Planning Models (TPM)

Known as the four step models, the classical TPM consists of trip generation, trip distribution, modal split and trip assignment to routes, usually in this sequential order (Black, 1981). Trip generation estimates the trips generated through land-use activity (see Ortúzar and Willumsen, 1994). Trip distribution is the spatial distribution of the generated trips. Most TPM consist of the gravity based form of this model with various levels of constraints. A re-emerging alternative to the gravity model approach is the intervening opportunities model, which distributes trips on the basis of relative accessibility to opportunities (Ortúzar and Willumsen, 1994; Cheung and Black, 2007). A variation in model form is the flexible gravity opportunity (GO) model which includes both methods of trip distribution and applies one method or the other depending on certain criteria (see Will,1986; cited and expounded in Ortúzar and Willumsen, 1994; also cited and expounded in Tamin and Suyuti, 2007).

Modal split is the allocation of trips to modes, based on choice parameters. Typical models are diversion curves, gravity model and behavioural models depending on the sequence in the four step TPM process (Black, 1981). The most usual sequence, of modelling modal split after trip distribution (often called Type IV sequence), utilises diversion curves and multiple linear regression equations. The explanatory variables are zonal land-use variables and transport characteristics such as relative out of pocket costs, relative travel times and service ratio. Service ratio is a ratio of the non travelling portion of trip e.g. parking, waiting trip times for a journey using different modes.

Trip assignment is the assigning of the trips determined in the TPM to the transport networks or routes. This is typically done as separate models for traffic and transit, sometimes called intramodal assignment. In all types of TPM sequence this is the last part of the process (Ortúzar and Willumsen, 1994). In trip assignment, the trip demand has to be balanced to the network capacity. Trip assignment models reflect both the network capacity and flow impact on network travel time and a choice rationale. Trip assignment is therefore an iterative process that balances the network loading with the available network capacity and the trip demand models for each route (for example, see Hu and Li, 2007).

Representation of transport supply in the four steps of classical TPM is typically as distance or travel time, but can also be expressed as generalised cost. Generalised cost is more typical of mode split modelling. Trip assignment also utilises the representation of transport supply embodied in the three steps of trip generation, distribution and mode split. However, it also uses a detailed representation of transport supply in order to model the flow effects on supply performance.

TPM models are also applied at different levels of scale from city level to national level. For example of national level (see Sillaparcharn, 2007)

Disaggregate Behaviour Models and Four Step Alternatives

Behavioural models, focusing on individual choice, represent the trip maker's importance of a greater variety of attributes which have typically included a greater complexity of transport system attributes. This modelling has come about through the understanding that aggregate travel behaviour comes about through disaggregate decision making by a large number of individuals. Three types of approach are the utility, attitudinal and activity rationales.

The hope was that this would give a behavioural theoretical foundation to the TPM. Disaggregate behavioural models developed around modal choice utility models came from consumer choice theory. The development of attitudinal models (Banister, 1994) shifted the focus from utility maximisation to behaviour satisfaction. This enabled other attributes to be included in the models, including measures of comfort, convenience, service reliability, perceived safety and security of transport modes. Activity based methods introduced frameworks within which people make decisions on trip making. Each of the three methods was partially representative of how people make choices. A strength of these models is that they provide insight on the choices individuals might make that are not averaged out and which may reflect response to policy changes, such as transport supply.

The logit model is a commonly used form for disaggregate modelling. The logit model when utilising disaggregate data makes use of the individual person's derived satisfaction of a transport alternative. Prior to analysis, the relevant alternatives and the relevant attributes are determined. For each alternative, and each individual, a revealed preference function is defined. The use of disaggregate behaviour models have been used to model simultaneous instead of sequenced decision making. For example multinomial logit models have been used for modelling trip distribution and mode split together. The logit model's disaggregate data enables different people to have different alternative sets. Commentary suggests that this is equivalent to the Type III TPM mode split with stratification by person type (Black, 1981). Comparison is also made with market segmentation in applications of logit models as aggregate prediction models. It is interesting to note that commentary suggests that stratification of the TPM Type III model into market segments or person type overcomes the averaging effect of aggregation. The multinominal logit model with disaggregate data does the same thing but with the need for less data.

The functions are all based on fixed values of time in a generalised cost algorithm, while the fixed costs vary generally according to the normal or extreme value distribution (called Quasi elastic). The logit model is able to be used for modelling with inelastic (i.e. fixed costs and value of time common to all individuals), quasi static or elastic demand (i.e. fixed costs and value of time vary for individuals). It was noted that models with variable values of time would require introduction of distributions for value of travel time, leading to complication in specification and estimation.

Since the 1980's, a commonly used form of the multinomial logit model is the nested logit model. Most applications of multinomial logit models have been on mode choice, particularly home based work trips (for example of logit model, see Fillone, *et al.*, 2007). Computer availability and capacity coupled with Geographic information systems based GIS/T software is opening up the potential application of behavioural models to other parts of the 4 step process such as trip distribution and assignment.

GIS provides opportunity to retain highly disaggregated information and procedures. Research in the last ten years has also seen a focus on improvement in estimation of parameters in the logit model (for example, see Benitez and Vazquez, 2007).

"Stated Preference" is also a common method of obtaining attitudinal data at a discrete level (Banister, 1994; Loo, 2002). Another method is that of "Contingent Valuation", where a price value is stated. Both are useful for preferences between alternatives, some of which do not exist.

3.1.2. Integrated Land-Use Transport Models (ILUTM)

Integrated land-use and transport models are characterised by an interaction between transport and land-use. There are degrees of interaction and as noted by recent researchers, there is a greater land-use to transport interaction than the reverse. The

Hansen (1959) spatial interaction model is based on the gravity model but elaborates on the location of residents as a function of accessibility to employment. Lowry models or Lowry based models are the most commonly used land-use transport interaction modelling. This type of model is based on accessibility concepts together with economic concepts linking land-use activities in an iterative system (Black, 1981).

Inputs to the land-use location portion of the model include transport costs, which are used in an iterative process until service and residential estimates have not changed from the previous iteration. In each iteration, the number of residents and service employment is added. The number gets smaller leading to convergence.

The model outputs residential and service location which together with basic employment is exogenously input into the transport models, typically classic four step TPM. In most applications, the feedback loop to the TPM is not included.

The ISGLUTI study (Webster and Dasgupta, 1990) reviewed the integrated land-use and transport models of the 1980's, and noted that these models often utilised the accessibility concept quite extensively. Good appreciation to the overall interactions involved in urban communities was observed to be the result. But the models were observed to be quite simplistic in their treatment of transport interactions, in comparison to the Classic four step mobility models. On the other hand the more extensively used Classic four step model, gave no appreciation to changes in land-use distribution or demand stemming from changes in mobility. The ILUTM models have developed varying degrees of feedback between the land-use location and transport demand modelling components. It has been observed that accessibility measures are an important explanatory variable in land-use location.

An alternative view of the interconnection between land-use and transport planning decision making paradigm is shown in Figure 3.1 as conceived by Wegener (cited in Rietveld and Bruinsma, 1998). In most of these integrated transport/land-use models, accessibility is a core concept in interfacing transport and the location pattern of activities (Rietveld and Bruinsma, 1998).

Vichiensan and Miyamoto (2001) provide a useful classification of ILUTI models. They position the models available today between an interactive structure, at the one end of a spectrum, where external interfaces exist between separate land-use and transport models, with a time lag in the process. These include TPM models as a component. At the other end of the spectrum is a fully integrated structure where land- use and transport is tightly modelled in a single framework. Intermediate are separate land-use and transport models that interact in the same software platform. Another variation in ILUTI models is the application of behavioural concepts using logit discrete choice modelling.

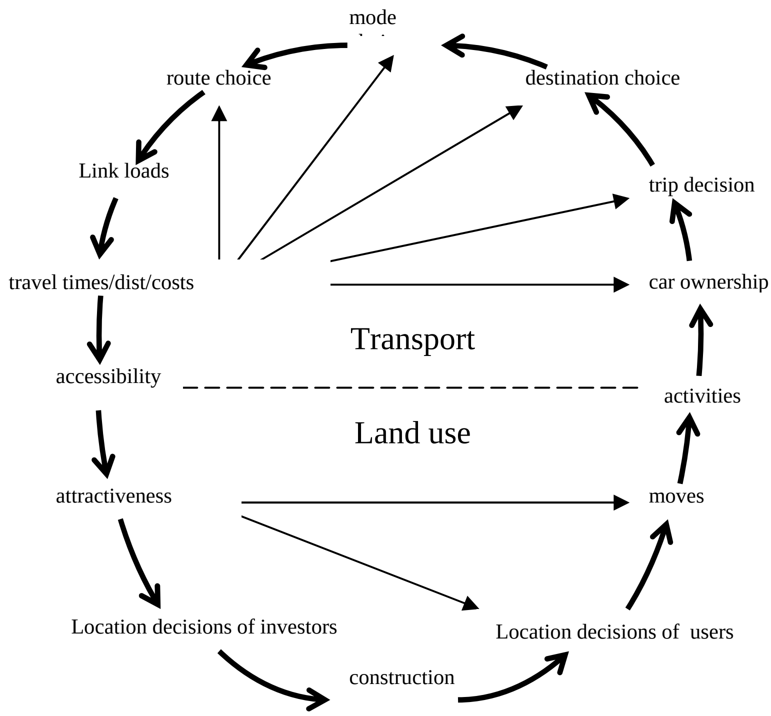

Figure 3.1 Wegener Accessibility Mobility Relationships

(source: Wegener, 1996, cited in Rietveld and Bruinsma, 1998, p. 94)

There are currently over thirty operational models worldwide (Vichiensan, *et al.*, 2007). MEPLAN, METROPILUS and TRANUS are three of the popular models. Variations to the aggregate form ILUTM models are the use of micro simulation.

3.1.3. Economic Models

Cost Benefit analysis (CBA) traditionally estimates consumer surplus (willingness to pay above market price) by using the “rule of half”, whereby the demand function is assumed as linear (Geurs and Ritsema van Eck, 2001; see also Lautso, *et al.*, 2004). The utility of direct impact items are included as a monetary value which is combined into a generalised cost function. Geurs and Ritsema van Eck (2001) observed that European CBA generally include environmental impacts in a monetarily valued manner. However, inclusion of indirect (welfare) impacts (e.g. production efficiency & distributional effects) are generally excluded from the analysis and considered in a qualitative manner.

The consumer surplus estimates used in traditional economic evaluation can be arrived at by the use of utility based accessibility measures. Geurs and Ritsema van Eck (2001, pp.100-104) cite the work by Williams (1976) and Martinez and Araya (2000) whereby non linear consumer surplus functions are developed. The benefits are seen to include an extension to include sensitivity to land-use change, spatial distribution (equity), a more correct definition of consumer surplus and inclusion of competition effects through relationship to doubly constrained interaction model.

An alternative approach to consumer surplus estimation is to use Compensating Variation (a measure of the amount of money that can be taken from a household to leave it as well of as it was before the accessibility change.). Geurs and Ritsema van Eck (2001, p. 102) observe that Small & Rosen (1981) showed how this could be estimated in discrete choice situations for the multinomial logit model and that Niemeier (1997) recently applied this approach for the first time to evaluate accessibility scenarios.

3.2. Match of Building Block Methods to shift in Community Aspirations & Expectations.

Batty (1989) commented that Mobility modelling had become institutionalised, retreated from the volatility of public policy making and had not responded to the challenge of social change. Richmond (Richmond, 1990; cited in Banister, 1994, p. 153) suggested that ‘traditional quantitative transport analysis be retained, but shifted off centre stage and replaced by a broader more critically oriented approach’ (p. 52). The underlying questions transport planners need to answer have shifted as the communities priorities have moved. Banister (1994) noted that this was due to the shift in emphasis in the 1980’s from planning growth and providing for the car, to management of decline in urban areas, managing the use of car and utilising transport as a lever in regenerating economic growth in areas where there has been a shift to a post-industrial urban society. Processes have become more complex with industry restructure, communications and increasing linkages between transport modes. Better understanding of urban dynamics is bound up in the issues the 1989 British National Road Traffic Forecasts raised (e.g. need for social analysis on interactions between transport and activities of people and industry, quality of life factors; cited in Banister, 1994, pp153 – 154). With hindsight each of these views reflects the shift in community aspirations and expectations and points toward current efforts to link the building block methods to sustainability assessment.

Figure 3.2 schematically illustrates the shift in community aspirations and expectations and the relationship to the building block models which have made up transport and land-use analysis over the period. Blue shaded areas indicate areas where practitioners (see Banister, 1994; Batty, 1989; and so on) have commented on the need for development of methodology.

Economic analysis has expanded to include “Production Function” analysis Geurs and Ritsema van Eck (2001, p. 117). This form of analysis focuses on the effect of urban system changes on the wider economy in terms of gross domestic product of specific economic sectors.

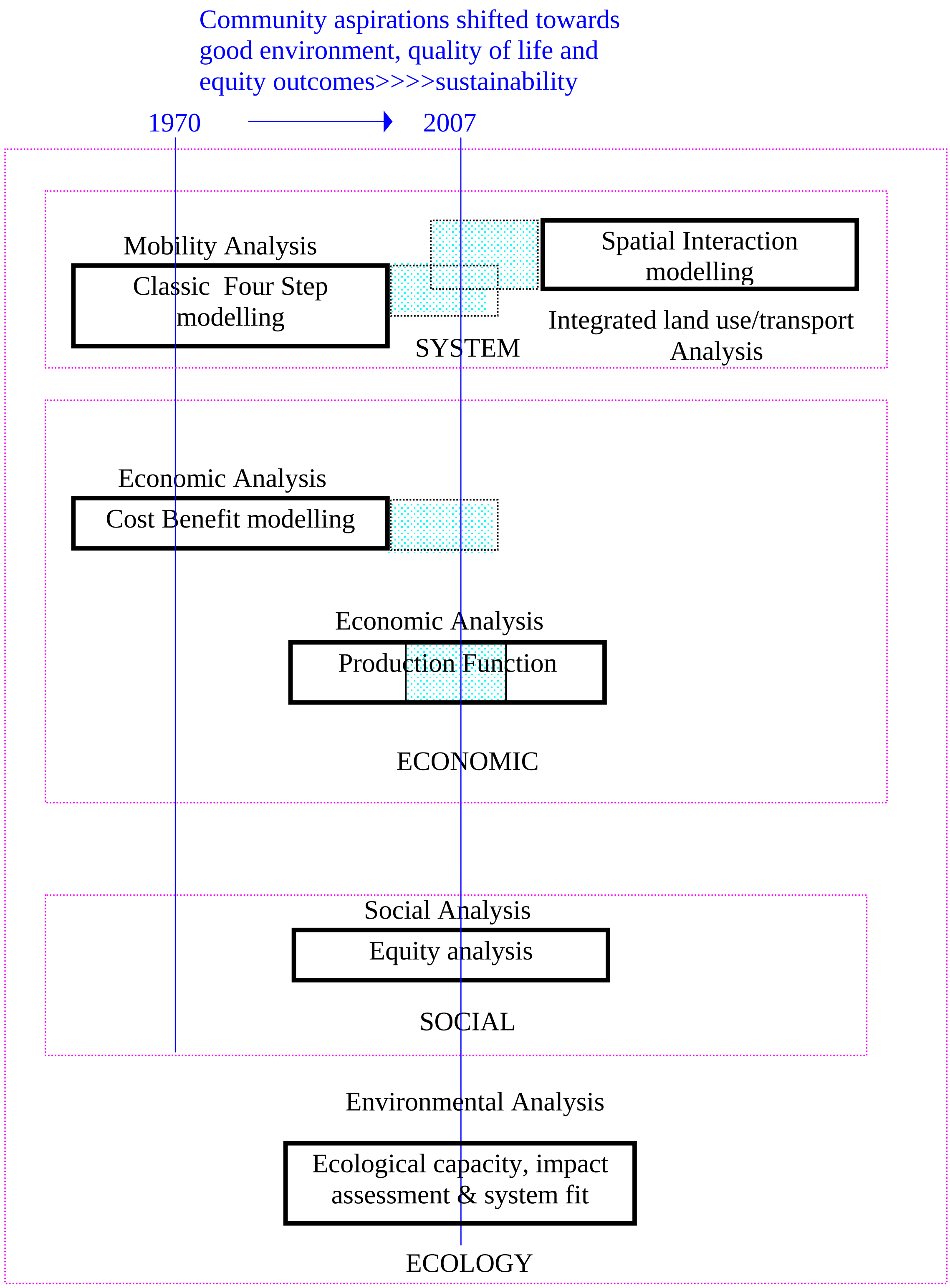

Figure 3.2 Match between building block methods and community aspirations and expectations after the shift from 1970's to the post 2000 period.

Social analysis (see Stopher and Meyburg, 1976, pp. 122 - 123 ; Geurs and Ritsema van Eck, 2001, pp. 121 – 122; Klug and Hayashi, 2007a) and environmental analysis (see Stopher and Meyburg, 1976, pp. 123 – 124) largely emerged during the late 1970’s, and has been gradually developing into set methodologies since that time. The emergence of these areas of analysis in combination with increasing attention to economic efficiency indicates the growing awareness amongst practitioners of the shift in community aspirations and expectations for sustainability in cities.

Figure 3.2 shows some of the systematic connection between these methodologies in relation to the urban system, urban dynamics and sustainability outcomes. Mobility analysis using TPM building block models relate largely to the urban system. The integrated land-use/transport analysis using spatial interaction models relate to both the urban system and the interaction between community and physical system (urban dynamics). The economic and social analysis is shown framed in the ecological capacity as determined by the environmental analysis.

Some of the characteristics of the building block methods for the purpose of sustainability assessment have been recognised. For example accessibility as a bridging method between transport and land-use location, economic and societal considerations is a feature in urban ILUTM in regional level applications (see Schurmann, *et al.,* 1997). However, historically accessibility has not developed a strong presence in TPM. Lautso, *et al.,* (2004, p. 37) observed that the present ILUTM models need to include environment in addition to land-use and transport interaction. Lack of spatial resolution and disaggregation of social and economic behaviour were seen as shortfalls with the current building block methods.

In summary, the application of these modelling tools and methodologies to support sustainability outcomes has been lagging the shift in community aspirations and expectations. However, the models and methodologies themselves form many of the building blocks to be able to respond to this shift.