SHARING THE ROAD TO GREEN? SUPPLY CHAINS, CONSUMERS AND INDICATORS OF SUSTAINABILITY

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Introduction

Transportation plays a vital role in the modern city yet also has negative implications for the health of the city and its residents. In Canada's major cities, trends of high automobility, sprawling development, and globally sourced consumerism are contrasted against increasing investments in transit, smart growth initiatives and "buy local" programs. The industries that move goods in our cities similarly exhibit contrasting trends of increasing movement activity while adopting more fuel-efficient technologies. The ability of decision makers (planners, policy makers and private interests) to understand these trends is challenged by complexity and historic perspectives. A key question remains – are we making sustainable transportation choices? As cities pursue broader sustainability objectives, and compete along sustainability lines, indicators are increasingly playing a major role. As posed by Lawrence, the essential question addressed by sustainability indicators is – how might I objectively know whether things are getting better or getting worse? (Bell and Morse, 2008).

Traditionally, researchers and planners have examined personal mobility issues separate from those concerning goods movement and

the supply chain. Similarly, the indicators employed by decision makers to make more sustainable decisions are often fragmented along lines reflecting traditional areas of interest where the interaction effects are often overlooked. The goal of this paper is to explore the potential for a more comprehensive approach to the development of sustainability indicators in transportation. A brief examination of traditional indicators is offered in advanced of a closer look at an example of an indictor project conducted in Waterloo Region. The paper concludes with a discussion of the prospects for developing more comprehensive and integrated measures of transport sustainability.

Traditions in Transportation Indicators

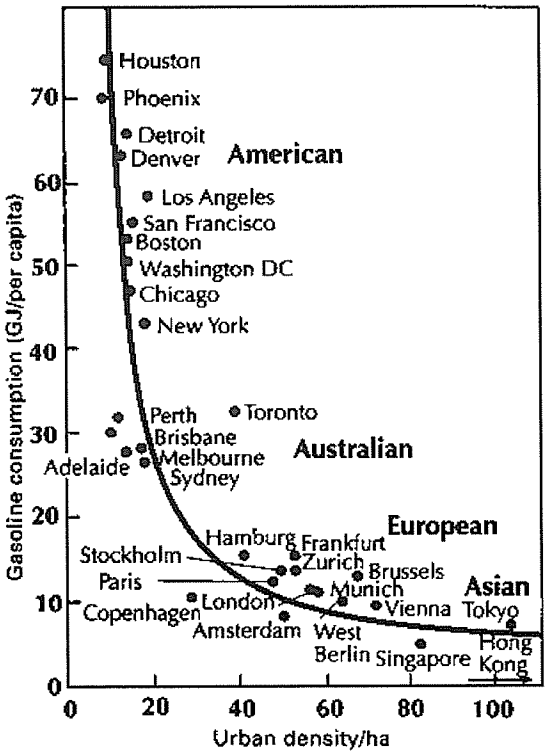
Transportation's engineering emphasis is a partial explanation for the prominent role of data analysis and collection in the realm of transportation. The planning realm relies on indicators - standardized information suitable for analysis – for guidance, informing decision making and measuring progress (TRB, 2008). Examples of some well known sets of indicators include, Texas Transport Institute's Urban Mobility Report, which offers such measures as "wasted fuel per traveler" and "annual delay per traveler". Focus there is on congestion and mobility – not sustainability per se, and there is sparse incorporation of freight activity into the reporting. The Transportation Association of Canada has provided a set of Urban Transport Indicators which also fall more to the activity side – a critical aspect in understanding sustainability.

In the freight realm, there are annual reports offered along modal lines in the Canadian context, with a mixture of activity, economics, accidents and fuel consumption among the collection of data highlights. They tend to be aggregate measures at the regional or national scale and certainly play a key role in efforts such as GHG estimations and forecasting. However, they often prove inadequate in the evaluation of policy or planning at the local scale. The challenges of freight data in the urban realm are well documented (see Woudsma, 2001 for example).

These limitations notwithstanding, it would be safe to argue that there is a strong tradition of measurement and data collection within the transportation realm, and not surprisingly, it has been an active area of progress with respect to the development of sustainability indicators.

Sustainability Indicators

Newman and Kenworthy (1999) , in their seminal book "Sustainability and Cities" presented an indicator that has had a pronounced affect on policy makers and researchers.



Like the infamous "hockey stick" graph within the global warming community, the scatterplot depicted above – showing the relationship between two key indicators – one of fuel consumption per capita and the other of people per hectare (density) – has been the focus of considerable attention – both positive and negative. It depicts strongly the link between density and energy use (transport) fanning the New Urbanism ideals and pushing intensification higher up the development and planning agenda. It also is criticized for the aggregate nature of the metrics, which mask key differences among the cities studied. This is but one small example – the field of sustainable transportation has been a hotbed of activity and much effort and debate is ongoing. The works by the Centre for Sustainable Transport are noteworthy for their efforts in enumerating possible sustainability indicators – including considerable discussion around freight dimensions.

There is a wealth of contention within the field of transport sustainability and indicators. Measurement approaches and considerations, present versus future accounting, assessing indicators that move positively in one dimension and negatively in another, are all points of debate. Further, there are distinctions in sustainability - among them "strong" and "weak" – with strong evoking an "environment first" perspective with no financial (protection at whatever financial cost) considerations and the weak incorporating the importance of economic sustainability, and attempts to monetize environmental impacts (Bell and Morse, 2008). The pursuit of "strong sustainability" is reflected in efforts to reduce the impacts of transportation, or reducing auto use, while the weak would allow transport activity increases in the name of economic growth (TRB, 2008). Finally, there are clear concerns about the selection and use of sustainability indicators at the urban level or local scale – as part of broader planning challenges involving monitoring and evaluation (Seasons, 2003; Wellar and Garrison, 2009).

Need for an Integrative Approach?

In recent years, the growth of E-commerce has been viewed positively from a mobility standpoint, associated with reduced personal mobility trips yet raising the likelihood of increased activity on the goods movement side (Lyons, 2009). But does increased activity always spell a decrease in sustainability? Certainly the last decade has seen a rise in the use of the term and spirit of "Green Logistics" which may offer the promise that the answer to this question may be "no". "Green Logistics can be thought of as an approach for planning freight logistics systems that incorporates sustainability goals with a primary focus on the reduction of environmental externalities" (Sathaye et al, 2006 pg 3). Yet the challenge of the "paradoxes of Green Logistics" remains – for example, reliability of delivery times improves, but with the use of the least efficient freight modes of trucking and air (Rodrigue et al, 2001).

This example serves to underscore the challenges in developing indicators that reflect the transportation system on the whole, and in particular that allow for the integration of people and goods. It can be argued on the basis of infrastructure or modal sharing (cars and trucks share roads), as well as from a supply chain standpoint, as part of the consumptive economic chain (driving home from the Big Box retailer, you are the "last mile" solution). If you're developing an indicator around a behavior or activity like food consumption, it may be more relevant to consider both the freight and the people aspects together.

Historically, people and goods movement planning and research have been conducted separately, with more recent exceptions around major integrated modeling efforts. Put simply, the transportation research community knows more about people movement than it does freight. There are examples of indicators developed for both people and freight but we're arguing in this context for the value of selectively integrating them.

The following example provides a backdrop for appreciating and exploring the concepts which underlie the development of sustainable indicators in transportation.

Developing Sustainability Indicators: An Example from Waterloo

In the fall of 2003, a project course focusing on this exact issue was mounted for senior undergraduate students enrolled in the Geography Program at the University of Waterloo by Professor Jean Andrey. The course enrolment was limited to eight students who worked, first as a class to develop principles of sustainable transportation that would be relevant to Canadian cities, and then in teams of two to explore municipal policy documents for the Cities of Cambridge, Kitchener and Waterloo as well as the Region of Waterloo. The review of policy documents culminated in an assessment of the extent and ways in which the adopted principles were evident in the policy documents. While these assessments provide interesting content on their own, the focus here is on the specific principles that were adopted and on their operationalization.

The development and fine-tuning of the principles occurred in three phases. First, the student gathered together literature on sustainable transportation and through discussion extracted key ideas about the meaning of sustainable transportation. Online documents published by Canada's Centre for Sustainable Transportation (CST, 2003) and the European Union were particularly influential. Second, the students presented their preliminary list of principles to the course professor and the then Research Director of the Centre for Sustainable Transportation (CST), Dr. Richard Gilbert. After considerable discussion and revision, a final list of principles was adopted. Third, through a dual process of brainstorming and empirically working through selected policy documents, each principle was translated into a set of measurable criteria. In turn, each criterion was judged to either be a move in the direction of a dimension of sustainability or in the opposing direction. It was fully acknowledged that a single criterion could be in the direction of one dimension of sustainability while moving away from sustainability in another way. For example, a policy that encouraged the expansion of transit services without the adoption of land use or other measures to ensure increased ridership would be interpreted as moving in a positive direction in terms of social sustainability (better access to disadvantaged groups), in a

negative direction in terms of economic sustainability (higher levels of subsidy needed) and neutral in terms of environmental sustainability (little change in vehicle kilometers). The principles and specific evaluation criteria are elaborated on below.

Principles of Sustainable Transportation

In its basic use, the term, "sustain", means "to keep in existence, withstand or endure". Thus, in the narrow sense, sustainable transportation refers to transportation systems that will endure into the future. In the broader sense, sustainable transportation is part of sustainable development, and sustainable development arguably has three components—environment, society and economy. However, that which distinguishes sustainable development/transportation from "smart" or "socially desirable" transportation is the emphasis on environmental sustainability as a foundation for building strong societies *today* and in the *future*. As a result, the class decided to put greater emphasis on environmental principles (40%) than either social (30%) or economic (20 %), and to allocate the remaining 10% of the scoring indications of long-term thinking generally.

Four environmental principles were adopted for the assessment. They address resource use, air quality and natural ecosystems:

1. Renewable, inexhaustible and recyclable resources should be favoured over other resources.
2. Transportation with lower energy intensity should be favoured over that with higher energy intensity.
3. Emissions from vehicles that compromise air quality should be reduced.
4. The integrity of ecosystems should be protected.

From a social perspective, there is general consensus that sustainable development is human-centred, and thus should embrace human needs, and the related issue of equity within and across regions, and also across generations. However, transportation is not normally considered a basic human need. Rather, transportation is derived

demand, i.e., the spatial separation of people, goods, services and information generates demand for mobility, and the fulfillment of these demands addresses human needs. Three social principles were adopted. These pertain to human well-being and local equity issues.

5. Human health and safety should be promoted and protected.
6. All people in the City/Region should have affordable access to jobs, schools and essential services, i.e. equity
7. Transportation systems/services should be reasonably convenient, comfortable and sensitive to culture, language and disabilities, i.e. they should be people-friendly.

The third set of principles adopted pertains to economic sustainability—something that considered in traditional transportation planning, and continues to be important even as other priorities emerge. The two related principles are

8. Transportation decisions should be compatible with society's ability to pay for the full costs of these decisions.
9. Transportation decisions should be supportive of a vibrant economy.

In order to operationalize these principles, a number of specific criteria were adopted. These criteria were chosen to reflect the current study's focus on municipal decisions in Canadian cities, and are worded in such ways that they can be applied at two levels: first, at the policy level, i.e. To what extent and in what ways do current policy documents reflect the principles of sustainable transportation; and second, in practice, i.e. To what extent and in what ways do current practices and decisions reflect the principles of sustainable transportation? The following Table represents the culmination of this effort with the shaded areas (moving from left to right) corresponding to the environment, society and economy respectively.

Evaluation Criteria[1] (below) as they reflect the Environmental, Social and Economic Principles of Sustainable Transportation (right)	1 Resource Use	2 Energy Intensity	3 Air Quality	4 Ecosystems	5 Health & Safety	6 Equity	7 People-Friendly	8 Ability to Pay	9 Vibrant Econ.
Reduce or limit the amount of land devoted to transportation infrastructure	+			+					
Promote the recycling of transport materials	+								
Invest in systems that can operate on renewable energy	+								
Adopt transit-friendly land-use planning		+					+		
Discourage single-occupancy vehicle use		+	+					+/-	
Promote telework, e-commerce and other programs that discourage vehicle travel		+	+					+/-	
Discourage automobile ownership		+	+						
Reduce freight transport, especially by truck, e.g. by buying locally produced or low-carbon footprint goods		+	+					+/-	-
Support inter-regional public transport		+	+				+/-		
Support anti-idling initiatives			+		+				
Protect natural areas				+					
Minimize the use of road salts, roadside pesticides and other toxic chemicals				+	+				
Promote mixed land use and the development of activity nodes		+			+				
Support active transportation modes	+	+	+		+				
Upgrade or remedy accident-prone locations					+				
Design transportation systems to minimize conflicts between motorist and other modes					+		+		
Improve the frequency, reliability, speed and spatial coverage of transit services						+	+		
Provide safe and comfortable alternatives to automobile travel		+/-			+		+	-	
Ensure transportation systems/services are appropriate to those with special needs						+	+	-	
Encourage more extensive and more effective public participation in municipal decisions							+		
Minimize citizens' exposure to noise and aesthetic pollution from transportation							+	-	
Promote higher densities, infilling and other practices that reduce service costs		+				+		+	
Optimize traffic flow using signalization, traffic circles and other design features			+					+	
Lobby senior governments to promote alternatives to road transport								+	
Maintain existing infrastructure in cost-effective way						+		+	
Expand highway and airport infrastructure to increase or guide economic development		-						+/-	+
Reduce congestive delay/bottlenecks through selective capacity expansion			+					+/-	+
Improve the livability of the Region								+/-	+

[1] A positive (+) symbol indicates that working to achieve this criterion is in the direction of sustainability, whereas a negative sign (-) indicates that working to achieve this criterion is contrary to sustainability principles. When both symbols are shown together, the effect could be mixed.

Issues, Challenges and the Way Forward

The student project example above is demonstrative of the challenges stakeholders and policy makers' face when developing indicators for transportation. While the Centre For Sustainable Transport (CST,2003) and other groups (Litman, 2006) have developed extensive reports on the range of possible indicators, the challenge remains in selecting them along criteria lines and using them in practice for the given planning agency/jurisdiction.

These include developing indicators that are meaningful and measurable, representing the diversity of impacts that are associated with transportation in its various forms. There are also challenges of reflecting differing priorities and discussion around the use of single key measures (think GDP) or composite measures (think Consumer Price Index) (CST, 2003). The need for flexibility in spatial and temporal boundaries for developed sustainability indicators is also critical, alongside the need to be able to capture differing priorities and perspectives among constituents (Amekudzi et al. 2009). In the preceding example, one key aspect is the weighting among the three areas of economics, environment and society. The chosen weightings would potentially differ depending on the group involved in the indicator process.

Three are persistent calls for standardized data, (TRB, 2008) and recognition of challenges of obtaining good data on urban freight (CST, 2003). Considerable national effort in North America is directed at freight standards at a higher level, and in general, with trade considerations at the forefront, there are good data on inter regional freight flows. However, the urban realm is the exception, with inconsistent and imprecise estimates of freight activity, in part because of the prominence of private carriage that dominates cities.

The fact that for many modes, passengers and freight share the infrastructure presents challenges for those attempting to develop indicators. This maybe an opportunity for the logistics industry to apply its quantitative and analytical expertise in helping to better

understand and work towards being "green", with incentives coming from consumers who may have the power to influence the outcomes.

All of these challenges are in the face of a transportation system that is undergoing persistent transformation, with energy, communications (Lyons, 2009) and global supply chains altering the transportation landscape we seek to measure and understand. Perhaps these pressures are most acute on the freight side, where ongoing efforts to establish reliable and consist indicators of activity in the urban realm face an uphill struggle for political and planning relevance (Ambrosini and Routheir, 2004).

There is certainly not a shortage of create efforts to build more integrated and comprehensive sustainability indicators, with examples like Facana and Horvath's (2006) Life Cycle Assessment of freight in the U.S. a promising development, along with other examples using "decision support systems", the "footprint" approach (Moos et al. 2006), and concepts like "food miles" which take a more holistic view on the path products take from production, to consumption and disposal. These represent the types of initiatives that we would argue have the potential to be leveraged to bridge people and goods sustainability indicators in a meaningful way.

We would also offer this final note of caution to those active in the area: "That is, relatively little analytical thought and vigorous effort has gone into rigorously critiquing the concept of sustainability, and ensuring that we are not looking through rose-coloured glasses when it comes to the matter of achieving sustainable transport practices. (Wellar and Garrison, 2009 pg. 9)". The case study presented in this paper did well in this aspect, with concerted effort devoted to thinking about sustainability, its measurement, and ultimate utility of the indicators developed. It provides a sound example for developing an integrative approach where we can share the road to a more sustainable transportation future.

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