Towards More Comprehensive Multi-modal Transport Evaluation

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Abstract

This article critically evaluates current transport planning evaluation practices, and describes ways to make them more comprehensive and multi-modal. Conventional planning tends to evaluate transport system performance based primarily on automobile travel conditions. A new planning paradigm recognises that the ultimate goal of most transport activity is accessibility, which refers to people's overall ability to reach desired services and activities. The new paradigm expands the range of objectives, impacts and options considered in the planning process. More comprehensive and multi-modal planning can help identify truly optimal transport improvement options, considering all impacts. This is especially important in large growing cities where increased motor vehicle traffic imposes particularly large costs.

Introduction

Transportation policy and planning decisions affect our lives in many ways. It is important to consider all significant impacts when evaluating potential transport system changes. It is therefore timely for transport planning to undergo a paradigm shift, a fundamental change in the way problems are defined and solutions evaluated (ADB 2009; GIZ 2011; Litman and Burwell 2006). With a more comprehensive and multi-modal evaluation, better decisions can be achieved.

The old paradigm assumed that transportation simply means mobility (physical travel), and so evaluated transport system performance based mainly on travel speeds. The new planning paradigm recognises that the ultimate goal of transport is accessibility (people's ability to reach desired services and activities) *(Figure 1)*, and considers an expanded range of impacts, objectives and options (LaPlante 2010; Litman 2013). *Table 1* compares the old and new paradigms.

Figure 1. Ultimate goal: Ready access to transport mode

Reductionist Vs Win-Win

The old planning paradigm was reductionist, meaning that problems were evaluated individually with little consideration to other objectives. For example, transport agencies were concerned with traffic congestion, social service agencies with helping disadvantaged people,

Table 1. Shifting Transport Planning Paradigm (ADB 2009; Litman and Burwell 2006)

	Old Paradigm	New Paradigm
Definition of Transportation	Mobility (physical travel)	Accessibility (people's ability to reach services and activities)
Modes considered	Mainly automobile	Multi-modal: Walking, cycling, public transport, automobile, telecommunications and delivery services
Objectives	Congestion reduction, roadway cost savings, vehicle cost savings, reduced crash and emission rates per vehicle-kilometre	Congestion reduction, road and parking cost savings, consumer savings and affordability, improved access for disadvantaged people, safety and security, energy consumption and emission reduction, public fitness and health, support for strategic land use
Impacts considered	Travel speed and congestion delays, vehicle operating costs and fares, crash and emission rates	Various economic, social and environmental impacts
Favoured transport improvement options	Roadway capacity expansion	Improve transport options (walking, cycling, public transit etc.), transport management, more accessible land development
Performance indicators	Vehicle traffic speeds, roadway level-of-service (LOS), distance-based crash and emission rates	Accessibility for various groups, multi-modal LOS, various economic, social and environmental impacts

environmental agencies with pollution reduction, and public health agencies with public fitness and health. This can result in government agencies rationally implementing solutions that address one problem but exacerbate others, and tends to undervalue solutions that provide multiple benefits. The new paradigm applies more integrated analysis, and so can identify win-win solutions that help achieve multiple objectives.

For example, roadway expansion tends to reduce traffic congestion but by degrading walking conditions and inducing additional vehicle travel tends to exacerbate other problems such as poor transport options for non-drivers, physical inactivity, and pollution emissions.

The old planning paradigm favoured automobile-oriented transportation improvements. The new planning paradigm expands the range of objectives, impacts and options considered.

Similarly, shifting to more efficient or alternative fuel vehicles tends to reduce fuel consumption and pollution emissions, but the reduced cost of driving can induce additional vehicle travel, which contradicts other planning objectives. On the other hand, improving transport options (walking, cycling, public transit etc.), transport pricing reforms, and more compact "smart growth" development tend to achieve multiple planning objectives by reducing total vehicle travel *(Figure 2)*. These can therefore be considered win-win solutions.

Figure 2. Accessing public transport systems

Table 2. Comparing Transport Improvement Strategies

Planning Objective	Roadway Expansion	Efficient & Alt Fuel Vehicles	Transport Options	Price Reform	Smart Growth
Motor Vehicle Travel	**Increased**	**Increased**	**Reduced**	**Reduced**	**Reduced**
User convenience and comfort	-	-	√	-	√
Congestion reduction	√ / x [1]	x	√	√	√
Roadway cost savings	x	x	√	√	√
Parking cost savings	x	x	√	√	√
Consumer savings	√	x / √ [2]	√	x / √ [3]	√
Reduced traffic accidents	x	x	√	√	√
Improved mobility options	x	-	√	x / √ [4]	√
Energy conservation	x	x	√	√	√
Pollution reduction	x	√	√	√	√
Physical fitness and health	x	-	√	√	√
Land use objectives	x	x	√	√	√

(√ = Achieve objectives. x = Contradicts objective.)

Critique of Conventional Transport Evaluation

Conventional urban transport planning typically applies this process (Markow 2012):

1. Use travel surveys and traffic counts to measure current travel activity and extrapolate trends to predict future travel demands (how and how much people will want to travel).

2. Evaluate transport system performance using indicators such as traffic speeds and roadway level-of-service to identify where inadequate capacity will cause excessive congestion.

3. Calculate the travel time savings that would result from transport system improvements such as roadway expansions or increased public transit service.

4. Assign monetised values to reductions in travel time, vehicle operation costs, crashes and pollution emissions, and use that to calculate the cost effectiveness of proposed transport system improvements.

Roadway expansion and more fuel efficient vehicles provide few benefits, and by increasing total vehicle travel they can exacerbate other problems such as congestion, accidents and sprawl. Win-Win solutions improve travel options, encourage the use of alternative modes and create more accessible communities, which reduces total vehicle travel and increases economic efficiency. This helps achieve many planning objectives.

Table 3. Scope of Impacts Considered

Usually Considered	Often Overlooked
• Financial costs to governments • Travel speed (reduced congestion delays) • Vehicle operating costs (fuel, tolls, tyre wear) • Per-kilometre crash risk • Project construction environmental impacts	• Downstream congestion impacts • Traffic impacts on non-motorised travel • Parking costs • Vehicle ownership costs • Indirect environmental impacts • Strategic land use impacts • Improved mobility for non-drivers • Social equity objectives • Impacts on physical activity and public health

While this process may seem rational and objective, it is constrained by a limited set of impacts, objectives and transport improvement options *(Table 2)*. For example, it considers roadway and vehicle operating costs but not parking or vehicle ownership costs *(Table 3)*.

As a result, it underestimates both the total costs of planning decisions that increase vehicle ownership and use, as well as the benefits of alternative solutions that reduce vehicle travel and the number of vehicles that households may own.

Overlooking Accessibility

For example, when comparing a highway expansion with a public transit improvement to reduce urban traffic congestion, conventional evaluation often ignores the increased surface street traffic congestion, parking costs, accidents and pollution emissions caused by increased vehicle travel, and the savings enjoyed if transit improvements allow some households to reduce their vehicle ownership. Similarly, conventional evaluation does not consider objectives to improve transport options for non-drivers, improve public fitness and health, or to create more compact development.

By evaluating transport system performance based primarily on vehicle traffic speeds, conventional evaluation also tends to ignore other accessibility factors such as the quality of alternative modes (walking, cycling and public transport), roadway connectivity, and proximity. These overlooked factors can significantly affect overall accessibility. For example, research by Ewing and Cervero (2010) and Handy, Tal and Boarnet (2010) indicate that roadway connectivity (the density of connections within a road network) significantly affects the distances that people must travel to reach destinations, as illustrated in *Figure 3*. Similarly, studies by Levine, et al (2012) and Levinson (2013) indicate that development density has a much greater effect than automobile travel speed on the number of jobs and services available within a given travel time.

Trade-Offs in Planning

It is important to consider all of these accessibility factors *(Table 4)* since planning decisions often involve trade-offs between them. For example:

- Road space must often be allocated between sidewalks, bike lanes, bus lanes, general traffic lanes and parking lanes, and therefore between accessibility by different modes.
- Wider roads with higher traffic speeds can increase automobile access but degrade pedestrian and bicycle access (called the barrier effect), and

Conventional transportation planning tends to focus on a limited set of impacts.

therefore transit access since most transit trips include walking and cycling links.

- One-way streets, longer block lengths, and reduced cross-streets tend to increase traffic speeds, but increase travel distances as well.
- Urban fringe highway locations tend to offer convenient automobile access but poor access by walking, cycling and public transit. Conversely, urban centre locations tend to be more difficult to access by car but easier to access by walking, cycling and transit.

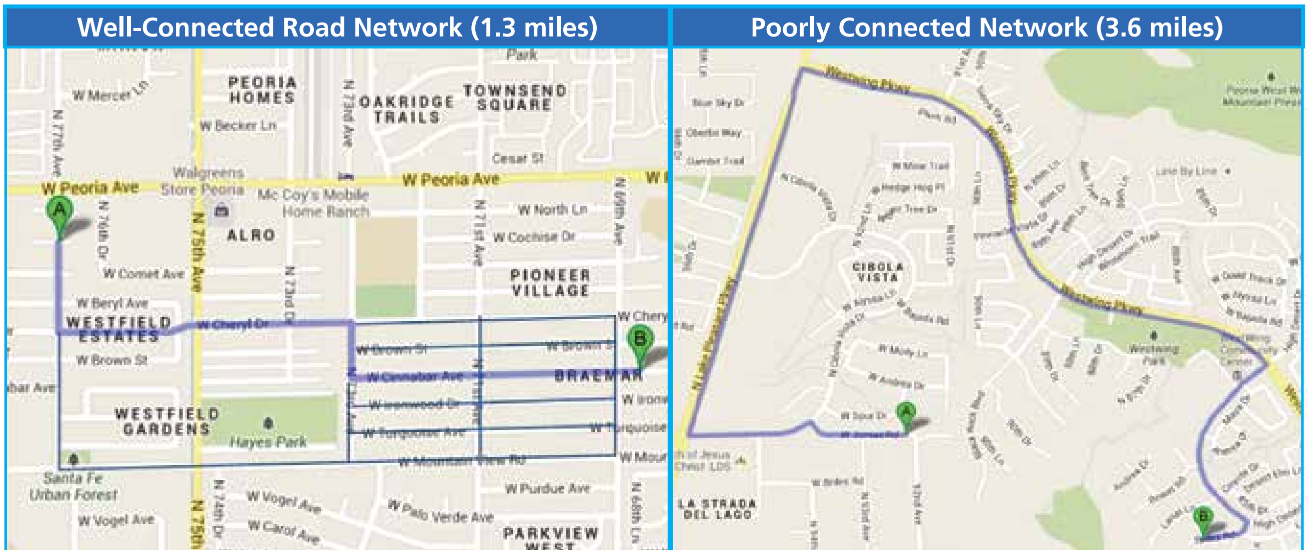
Conventional planning evaluates transport system performance based primarily on regional travel speed. Additional factors must be considered for comprehensive accessibility evaluation.

Limited Scope, Limited Options

Table 5 summarises the impacts and accessibility factors considered in conventional transport evaluation. It focuses on government costs, and vehicle travel speed, safety and operating costs. Other impacts and accessibility factors are sometimes discussed, but are generally not quantified or monetised, and so are not considered in formal economic evaluation. This favours highway investments over other transport improvements.

Conventional planning evaluates transport system performance based primarily on regional travel speed. Additional factors must be considered for comprehensive accessibility evaluation.

Figure 3. Roadway Connectivity Impacts On Travel



*Although points **A** and **B** are approximately a mile apart in both maps, the well-connected road network offers more route options and has shorter travel distances, which increases the feasibility of walking and cycling. The poorly-connected hierarchical network forces most trips onto major arterials, which increases total vehicle travel, traffic congestion and accident risk.*

Table 4. Accessibility Factors In Transport Planning

Factor	Consideration in Conventional Evaluation	Required for Comprehensive Evaluation
Mobility (physical travel) - vehicle traffic speed, congestion delays, vehicle operating costs, crash rates	Usually considered using indicators such as roadway level-of-service, average traffic speeds and congestion costs, and crash rates	Impacts should be considered per capita (per capita vehicle costs and crash casualties) to take into account the amount that people travel
Quality of other modes - convenience, comfort, safety and affordability of walking, cycling, commuting on public transport	Considers public transit speed but not comfort Non-motorised access is often ignored	Multi-modal performance indicators that account for convenience, comfort, safety, affordability and integration (Dowling et al. 2008)
Transport network connectivity - density of connections between paths, roads and modes, and therefore the directness of travel between destinations	Traffic network models consider regional road and transit networks but often ignore local streets, non-motorised networks, and intermodal connections	Fine-grained analysis of path and road network connectivity, and connections between modes, such as the ease of walking and biking to transit stations
Land use accessibility - development density and mix, and therefore travel distances	Often ignored. Some integrated models consider some land use factors	Fine-grained analysis of how land use factors affect accessibility by various modes

Table 5. Scope of Impacts and Accessibility Factors Considered

Impacts	Accessibility Factors				
	Automobile	Transit	Non-motorized	Road Connectivity	Land Use Accessibility
Costs to governments	Yes	Yes	Yes	Yes	Yes
Travel speeds, delays	Yes	Yes	No	Sometimes	Sometimes
Safety and security	Yes	Yes	Sometimes	No	No
User costs & affordability	Yes	Yes	No	No	No
Mobility for non-drivers	No	Yes	No	No	No
User comfort	No	No	No	Not Applicable	Not Applicable
Parking costs	No	No	No	No	No
Energy consumption	Yes	Yes	Sometimes	No	No
Pollution emissions	Yes	Yes	Sometimes	No	No
Land use objectives	No	No	No	No	No
Public fitness and health	No	No	Sometimes	No No	No

Reforms for More Comprehensive and Multi-Modal Evaluation

Table 6 summarises problems with existing transport evaluation, and how they can be rectified.

Conclusion

The process commonly used to evaluate transport problems and potential improvements is incomplete and biased. Non-motorised travel is more common than reported by most travel surveys, congestion costs are often smaller than reported, and highway expansion benefits are often exaggerated because induced travel impacts are ignored.

Such omissions and biases, often subtle and technical, tend to skew planning decisions in favour of automobile-oriented improvements. This is to the detriment of other modes and accessibility factors. They tend to contradict sustainable development objectives such as resource conservation, affordability, benefits to disadvantaged people, pollution reductions, habitat preservation, and improved public health.

It is through a more comprehensive and multi-modal evaluation that truly optimal transport improvement options can surface. This is especially important in rapidly growing cities where accommodating increased automobile travel is particularly costly, and where situations must be sought for greater social equity, energy conservation and environmental protection.

Table 6. Pathways to Improved Evaluation

Shortcomings of Existing Evaluation	Recommendations for Improved Evaluation
Inadequate data on alternative modes (walking, cycling and public transport)	Collect better data on alternative mode activity and demands
Models provide inadequate guidance on how alternative mode improvements, demand management strategies, and "smart growth" policies affect travel activity	Improve modelling to better reflect how policy and planning changes will affect travel activity
Transport system performance is evaluated based primarily on mobility, ignoring other accessibility factors	Use accessibility-based analysis, which considers various modes, transport network connectivity and land use accessibility
Transport system performance is evaluated using roadway level-of-service, which only reflects motor vehicle travel	Use multi-modal level-of-service indicators that evaluate the speed, convenience and comfort of various modes
Ignores generated and induced travel impacts	Account for generated and induced travel impacts
Ignores equity objectives, such as providing basic mobility for disadvantaged people, and affordability	Use comprehensive evaluation of equity impacts, including horizontal and vertical equity
Considers a limited set of transport improvement options, consisting primarily of roadway expansions and major public transit projects	Consider a diverse range of transport options including improvements to alternative modes, demand management strategies, and more accessible land use
Inadequate understanding by decision-makers of evaluation omissions and biases	Provide better information on potential evaluation omissions and biases, perform sensitivity analysis, and report results as ranges rather than point values to indicate uncertainty
Inadequate stakeholders involvement	Inform and involve people who may be affected by planning decisions
Funding allocation favor roadways, parking facilities and large transit projects, even if alternatives are more cost-effective overall	Apply least cost planning, which allocates resources to the most cost effective solutions, including alternative modes and demand management strategies

Notes

[1] Congestion is reduced on the expanded facility but often increases downstream, such as on surface streets, due to induced vehicle travel over the long run.

[2] More fuel efficient vehicles tend to have lower operating costs but higher purchase costs.

[3] User fees increase driving costs but reduce general taxes otherwise used to finance roads and parking.

[4] Higher fuel, road and parking prices reduce the affordability of driving, but distance-based pricing and lower public transit fares make travel more affordable.

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