POLICY INFLUENCE ON VOLATILITY IMPACTING URBAN TRANSPORTATION

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Introduction

This research focuses on light duty vehicles in urban environments. The research combines empirical research from 2007 and 2008 to create an understanding of typical urban light duty transportation challenges. This research-based information provides a baseline to quantitatively and/or qualitatively discuss the impact of volatility on transportation.[2]

For this discussion volatility is defined as the influence of external social, economic and environmental factors negatively impacting transportation systems. Changes in one or several of these externalities creates volatility affecting transportation systems

There are four primary global driving forces which influence the externalities that exacerbate volatility on current transportation systems. There is a fifth compelling driver for maintaining and improving social structures and capacity. These drivers are highly interconnected and all influence economic, social, and environmental challenges in transportation. These challenges, however, are diverse and require an equally diverse range of policy solutions. The five drivers are:

1. Climate Change

Transportation activities account for a significant portion of man-made, fossil-fuel CO2e emissions. Very recently, leading scientists

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[2] A Selected Bibliography for this paper is available from the authors.

have suggested that the anticipated impacts from climate change previously outlined in the literature and mass media, may be much worse than Intergovernmental Panel on Climate Change (IPCC) assessments suggest.[3]There are several implications of climate-related volatility on transportation. An example of these impacts is found in "The Changing Climate: Impact on the Department for Transport".[4] In Manitoba a strategic workshop on climate change and transportation recommended several key emission reduction and adaptation policies including work begin on designing damage tolerant infrastructure to address climate induced volatility on transportation systems.[5]

2. Emissions and waste products harming human and ecosystem health

Emissions from transportation, despite advances in energy intensity and efficiency, are growing rapidly.[6] These exacerbate respiratory and other health problems in humans and animals, and are harmful and disruptive to natural processes and cycles.

3. Energy supply pricing and security

Fuel security is an increasing reality. Energy prices rise and more production capacity is required from depleting sources. Because of this, fluctuations in price will grow more extreme even as new technologies are introduced in an attempt to increase production. Also increases in fuel demand from industrializing nations such as India or China impact energy security, supply and price.

4. Sprawling Land Use

Urban North America has developed over the past half-century in very low densities. This has resulted in numerous and widely

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[3] See: Weart, 2008; Norwegian Polar Institute, 2007; ep Overviews, 2009.
[4] Wooler, 2004.
[5] Karime et al., 2003.

[6] See: The CST, 2002; Gilbert, 2006.

discussed economic, environmental and social problems. Sprawling low-density development, most often on prime agricultural farmland, requires greater daily travel distances and high energy use.[7] Public and active transportation become less viable than in denser urban areas. Integrating transportation, land use and environmental planning is a necessary policy. Urban planning models are evolving to accomplish this.[8]

5. Maintaining and improving social systems, development, access, equity and quality of life factors

Broader intergenerational, interspecies and inter-social equity issues arise from fossil fuel use. Road-based transportation incurs social costs in terms of inefficient land use, paving over farmland, vehicle safety hazards and access to transportation for remote towns, the elderly, children and the disabled. For example, the winter road network in Manitoba spans a length of 2178 km and services 30 communities. This system is critical for the shipment of goods, employment of locals and travel between communities.[9] This network is seasonal and without theses roads the communities are isolated and access and departure is otherwise limited to air travel.

Examples of social inequity are revealed in evacuation plans from devastating hurricanes. As noted "...Katrina's evacuation plan functioned relatively well for motorists but failed to serve people who depend on public transit. Rita's evacuation plan failed because of excessive reliance on automobiles, resulting in traffic congestion and fuel shortages. Equitable and compassionate emergency response requires special efforts to address the needs of vulnerable residents...."[10]

Consider urban design scenarios where public investment and policy measures in public transportation infrastructure are minimal. Here investment is dominated by policy preferences on private vehicle

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[7] Zdan, 1980.
[8] Waddell, 2002
[9] Kuryk, 2003.
[10] Litman, 2006.

transportation infrastructure. Volatility on these urban transportation systems emerges in any and all situations from a spectrum of factors from climate to energy issues.

In periods of economic, social and environmental instability, transportation systems are at risk of increased pressure and volatility. The current economic turmoil is amplified by the financial policy support to auto manufacturers. New car sales are anticipated to reach a 27 year low in 2009 and vehicle owners are planning on keeping vehicles longer.[11] This reality challenges industry to invest in new technologies and designs for affordable, fuel efficient vehicles.

Many external factors create volatility on transportation systems. Research on characteristics of urban transportation and fuel use are a metric to assess the impact of volatility on the system. Research focused on transportation in Winnipeg illustrates how volatility may impact urban transportation fuel use and emissions.

CST researched transportation greenhouse gas emissions in urban transportation.[12] Emissions were estimated by calculating gasoline and diesel fuel use within the City of Winnipeg. Vehicle populations by class and distances were also estimated.

Key findings from this research found that:

- Winnipeg comprises 52% of all registered vehicles in Manitoba
- 52% of provincial VKTs occur in Winnipeg
- Vehicles in Winnipeg travel 5.7 billion kms.
- A significant portion; 27% of vehicle travel in Winnipeg is spent idling.
- 46% of all provincial on-road transportation fuel is used on Winnipeg streets and roads

[11] Business Wire, 2009.
[12] CST, 2007.

- 60% of provincial gasoline is used in Winnipeg
- 21% of provincial diesel fuel is used in Winnipeg
- The total amount of gasoline used in Winnipeg is 793,697,532 litres and the total amount of diesel fuel used is 146,195,911 litres
- Light duty passenger vehicles use 70% of the gasoline used in Winnipeg
- Heavy duty commercial vehicles use 61% of the diesel fuel used in Winnipeg
- 50% of Manitoba's on-road GHG, CO_2e emissions are generated within the city of Winnipeg

Since 70% of motor gasoline in Winnipeg is used by light duty passenger vehicles, this is the segment where efficiency gains and trip and congestion reduction strategies can produce the largest potential reductions in emissions.

The findings in this baseline research point to idling and slow speed in heavy traffic as the principle factors that greatly increase fuel use and GHG emissions. Understanding patterns of urban transportation activity help in identifying policies that would reduce the system's vulnerability to volatility.

Characteristics of Urban Light Duty Fleets

In 2008 CST and PERSENTECH undertook research to study driver feedback systems and driver behaviour in light-duty urban traffic environments.[13] Vehicle data was collected using PERSENTECH's Otto-Driving Companion® (Ottomate) and OttoView™ systems.[14] With this research, the project team provided awareness with participants and the general public. Disseminating the research results provides as a basis for discussing policy influence on volatility impacting urban transportation

[13] The project, "Using Otto to reduce transportation emissions by changing driver behaviour" was made possible through a financial contribution from Natural Resources Canada (NRCAN) ecoEnergy for Personal Vehicles Program.

[14] For information on PERSENTECH Inc., see http://www.persentech.com/.

Figure 1 shows the frequency of average trip speeds, while figure 2 shows the frequency of average trip distances. For average trip speed, a clear normal distribution can be seen, with a peak value around 30km/h. The large spike on the left hand side of the graph shows how trip fragments may influence the graph, while the spike on the right demonstrates the frequency of high-way (average speeds of 100km/h or greater) trips during the study period.

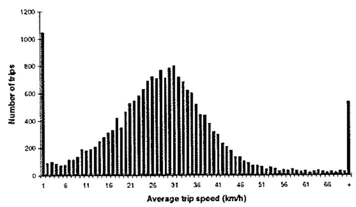

Figure 1: Phase I logged data – Frequencies of average trip speeds

The pattern for average trip distance is much different from average trip speed. It illustrates that many short distance trips were made, and that the frequency of longer distance trips drops off dramatically after 10km.

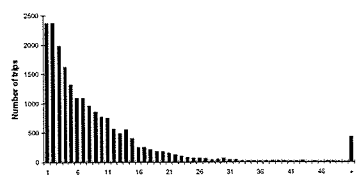

Figure 2: Phase I logged data – Frequencies of trip distances

Figure 3 demonstrates the frequency count of total trip durations. The same type of relationship to figure 3 can be observed; however the peak is skewed between the 5 to 10 minute ranges.

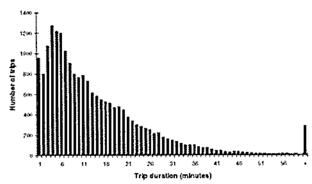

Figure 3: Phase I logged data – Frequencies of trip durations

Figure 4 illustrates the cumulative pattern of light duty vehicles during the study period. The pattern shows the expected peak trip to work and home periods and a quiet overnight from about 10 PM to 6 AM.

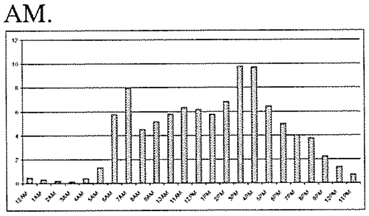

Figure 4 : Phase I logged data – Frequencies of trip time of day

Figure 5 is an overlay of all the data showing the bookends of urban transportation speed: excessive idling on one end and exceeding speed limits on the other. Because these data were collected in late spring and summer months idling in cold weather is ruled out. The slow speed and idling is clustered around the urban core. This reality has significant implication on air quality in urban cores. Idle clustering is also observed at regional shopping centres, along primary arterial roads with commercial zones, major intersections, and at grade-level rail crossings in Winnipeg. The estimated fuel cost of vehicle idling in Winnipeg is about $250 million a year.

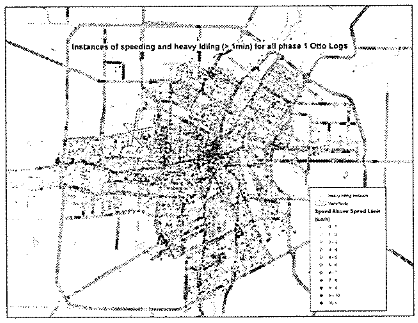

Figure 5 : Phase I logged data – heavy idling and exceeding speed limits

Given these data showing average speed, distance, travel time, time of day and idling, it is deduced that this traffic may generate its internal volatility in terms of congestion and idling. The CST measured actual idling time and surveyed users' opinions. Figure 6 documents that actual idling time ranged between 10 per cent and more than 30 per cent of the trip time. In comparison the majority of drivers believe idling is less than 10 per cent of the trip time. These empirical data align with CST's initial 2007 estimate of slow and idling urban vehicle traffic contributing to tailpipe and CO_2e emissions.

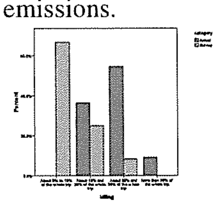

Figure 6: Phase II - Participants' perceptions of idling compared with actual idling

Figure 7 compares driver's perceptions with actual measurement of CO_2e emissions from their vehicles. The data show drivers have a very poor understanding of the relationship between fuel economy and greenhouse gas emissions. The fleet average for this study was well above 225 g CO_2e / km. In comparison the European Union has adopted targets for fleet averages of 130 g/km by 2015 and 95 g/km by 2020 and beyond.[15]

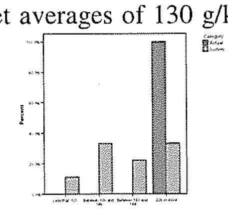

Figure 7: Phase II Participants actual vs estimated carbon dioxide emissions

These data create a baseline of understanding the dynamics of urban transportation systems. The data point to a clear description of urban driving behaviour – the majority of trips occur at peak to and from work hours and are the sum of several slow /medium speed, sort vehicle trips per day. In summation, the data points to an existing volatile urban transportation situation where the system is already stressed by its own behaviour. Any additional external forces impacting on these systems add additional pressures on the systems. Understanding these baseline conditions is important in designing a menu of policy responses to address this volatility.

Policy Measures Reducing Volatility Impacting Urban Transportation

Part III outlines a range of policies that can to reduce the impact of volatility on urban transportation systems. An overarching sustainable transportation policy objective is used to frame the discussion.

Policies that meet sustainable transportation objectives would be designed to meet the following description of a sustainable transportation system:

[15] European Commission, 2009.

- Allows the basic access needs of individuals and societies to be met safely and in a manner consistent with human and ecosystem health, and with equity within and between generations.
- Is affordable, operates efficiently, offers choice of transport mode, and supports a vibrant economy.
- Limits emissions and waste within the planet's ability to absorb them, minimizes consumption of non-renewable resources, limits consumption of renewable resources to the sustainable yield level, reuses and recycles its components, and minimizes the use of land and the production of noise. (CST Web Site).

Policies designed to achieve sustainability as defined above will also address issues presented by the drivers identified in Part 1 and the nuances of urban light duty vehicle operations detailed in Part II. Therefore, these policies will also address volatility impacting urban transportation systems.

Policies might be classified under the three categories of economic, technical and social. The good news is there is a wealth of policies available to resolve the situation. The tough news is they aren't always the easiest policies to adopt.

Economic policies refer to most anything that looks at monetary measures that can be possibly used to shift transportation practices. These policy options range from fuel taxation and road pricing to distance based insurance and vehicle emission –based registration fees. Economic instruments can be useful since most current transportation pricing is inefficient and does not reflect many of the externalities caused by transportation activity. [16]

Technical policies reference measures that can improve the environmental and/or energy efficiency performance of vehicles. Such policies can address such things as research and development, implementation, and marketing. Technology policies address not only mechanical refinements in vehicles but also policies that influence

[16] VTPI, 2009.

and improve infrastructures and the efficiency of transportation systems.

Social policies refer to measures directed at people, and generally deal with information and outreach. For example, Pollution Probe has identified "...a broad array of unique and integrated strategies that can be harnessed to help develop an underlying social value system regarding vehicles, fuel efficiency, greenhouse gas emissions and climate change. The campaign to reduce cigarette use and smoking in Canada (a credit to federal, provincial and municipal levels of government, as well as the efforts of nongovernmental organizations) demonstrates the potential of social marketing to effect positive social change..."[17]

Within each of the three spheres suggested above, the CST proposes a hierarchy of sub-policy sectors that may be designed to reduce the impact of volatility on urban transportation systems:

1. Design urban environments to encourage active transportation
2. Supplement active transportation with public transportation systems
3. Implement Transit Oriented Development (TOD) and Transportation Demand Management (TDM) policies in tandem.
4. Implement use of Plug-in Hybrid vehicles (PHEV) and Vehicle to Grid charging systems(V2G)

Although many policies and strategies can and do stand alone, it is important to consider the synergistic effect of companion and complementary policies that can be implemented concurrently. There are three conventional policy models often used to classify policy frameworks: comprehensive, mixed scanning and muddling through. An assessment of these policy models suggests the mixed scanning approach offers the best opportunity for integrating economic, technical and social policy options into a bundle of strategic action to

[17] Pollution Probe, 2005.

address the targeted issues.[18] An attribute of this approach is to select a combination of policy initiatives that address the issues and strategically implement them policies when and where the best opportunity presents itself to do so. Over time their synergistic effect is realized. Similarly with volatility in urban transportation the selection of appropriate policy options requires a mixed scanning approach. The success of policies' influence on volatility impacting urban transportation has been noted in recent times. A selection of examples below illustrates the policy approaches implemented and/or being considered in areas around the world.

A tool box of policy options exist – for example, an encyclopaedia for Transportation Demand Management measures can be found at the Victoria Transport Policy Institute website.[19] Another source of transportation and land use tools is the US Department of Transportation's website.[20] In the following examples our mixed scanning approach suggests that as opportunities were presented the respective authorities adopted a policy or decision to take specific action.

Bogotá, Columbia was awarded the Stockholm Challenge Award for its car-free day initiative that is part of something much larger.[21] Bogotá is a real world example of how urban transportation can prioritize active transportation and public transit. The city has used a wide range of policies over time to do this. Infrastructure changes have closed some roads to cars, creating pedestrian malls, and have also created over 100 kilometres of bicycle routes. As well, the city uses social marketing tools to encourage active transportation, such as its highly successful "Ciclovia" which closes over 100 kilometres of streets every Sunday, and allows them to be safely used for active transportation. Bogotá also has implemented an extensive bus rapid transit (BRT) system, TransMilenio, which is a model system, serving up to 780,000 people per day on dedicated lanes.[22]

[18] Zdan, 1980.
[19] See: http://www.vtpi.org/tdm/index.php
[20] See: http://www.fhwa.dot.gov/Planning/landuse/tools.cfm
[21] Stockholm Challenge, 2000.
[22] Runyan, C., 2003; Cain et al., 2006.

The State of California is a leading example of how state or provincial governments can create solutions through a range of measures to reduce the vulnerability of their urban transportation systems. A key part of the state's Global Warming Solutions Act of 2006[23] is "establishing targets for transportation-related greenhouse gas emissions for regions throughout California, and pursuing policies and incentives to achieve those targets". Policies for addressing light duty transportation greenhouse gas emissions include vehicle emissions standards and the introduction of a low-carbon fuel standard, requirements for increases in hybrid and electric vehicles, and investment in innovations in fuels and vehicle types. California also requires metropolitan planning organizations (MPOs) to prepare land use and development plans which foster reductions in vehicle use and enhance the viability of transit and active transportation. As stated in the Act's scoping document, "many of the measures in this plan complement and reinforce one another. For instance, the Low Carbon Fuel Standard, which reduces the carbon intensity of transportation fuels sold in California, will work in tandem with technology-forcing regulations designed to reduce greenhouse gas emissions from cars and trucks. Improvements in land use and the ways we grow and build our communities will further reduce emissions from the transportation sector."

Portland, Oregon has also implemented many policies which have improved its transportation system. These include land use policies, such as an urban growth boundary, as mandated by the state of Oregon. The city also has policies which encourage denser development, which increases the viability of transit use and active transportation. Portland has also implemented several policies to encourage active transportation, such as cycling infrastructure. The State of Oregon is also exploring economic policies that include piloting a distance-based pricing scheme which would charge people by how much they drive and would provide dedicated revenues for transportation projects. Such a system would reduce the vulnerability

[23] California Air Resources Board, 2008.

of relying on gas taxes to fund the transportation system, as well as discourage unnecessary driving.[24]

Several jurisdictions have begun to prepare for introduction of plug-in eclectic (EV) or hybrid-electric vehicles (PHEVs).[25] The federal government in Germany, along with Daimler and RWE (an electricity provider) has recently supported an initiative to provide one hundred electric cars, and five hundred charging points in Berlin. Similarly, San Francisco recently installed charging stations for PHEVs. The Rocky Mountain Institute has launched a project that will "collaborate with targeted communities that have started convening local players to develop and implement plug-in adoption plans, utilizing RMI's universally recognized convening power, as well as detailed technical analysis". The initial communities involved are Portland, Indianapolis and Raleigh.

Addressing natural environmental phenomena such as climate change and the volatility it creates in transportation systems requires a unique approach. Adaptation policies or strategies are measures which can be taken to reduce the risk of transportation system exposure to this class of volatility. Examples of adaptation research on Canadian transportation systems ranges from increasing understanding about permafrost to the design of climate change damage-proof transportation infrastructure.[26]

An example of an effective adaptation strategy to climate change addresses winter road systems. In Manitoba annual work is undertaken to relocated the winter road network off of water bodies and improve stream and river crossings to avoid risk to life and property from unpredictable and variable winter climates.[27]

Aligned with the definition, vision and mission for sustainable transportation the examples illustrate action to reduce the impact of volatility on transportation systems. These are only the tip of the

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[24] Whitty, 2007.
[25] See Fehrenbacher, 2009; RMI, 2009; Daimler, 2008.
[26] Natural Resources Canada, 2007.
[27] Province of Manitoba, 2009.

iceberg of initiatives. The point is that there are many policies which are useful and effective measures that can have a desirable influence reducing volatility impacting urban transportation.

Research documented in this paper point to light duty vehicle idling and slow speed in heavy traffic as the principle factors that greatly increase GHG emissions and creates volatility in urban transportation systems. An effective way to reduce this volatility would be to improved traffic flow, which has the added benefit of reducing congestion, emissions and associated financial and social costs. With reduced congestion vehicles will be operating at higher efficiency rate for a larger period of time thereby reducing their emissions.

There are numerous policy strategies to reduce volatility from adaptation strategies, to transportation demand management programs, to building new infrastructure, to coordinating lights and removing or redesigning traffic bottlenecks. Over the longer term it is critical to reduce the use of fossil fuel and the number of light duty vehicles cars using the roads. Policy options for alternatives to private vehicle use are required.

Such alternatives include safe routes and facilities for walking and cycling, well priced and timely transit that have a full range of quality service features such as real time transit information. Other alternatives include the introduction of plug-in hybrids, vehicle to grid and smart metering technologies to use electricity as a transportation fuel. These selected examples are not exhaustive. They do point the way to a promising sustainable transportation future achieved through a mix of economic, technology and social policies.