E-Business Impacts for Urban Freight: Results from an Australian Study

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Abstract

E-Business is expected to dramatically change the way business is conducted internationally, nationally, within states and at the local area level. Moreover, these changes are very likely to happen well within the planning time frames required for provision of transport infrastructure and services. E-business is defined as including e-commerce, either between Businesses to Business (B2B) or Business to Customers (B2C), and the adoption of electronic technology within businesses.

This paper presents some results from a study commissioned by the Australian National Transport Secretariat (NTS) to assist Australian business and government pro-actively address the transport issues arising from e-business. The resulting working papers will be used to establish a research framework for identifying policy and planning levers to maximize benefits to Australia from national and global e-business activity. The study sought to investigate three principal questions on e-business impacts: how will the transport task change; what will be affected; and how can the transport system respond? Current literature suggests that growth in e-business stems from the combined existence of market demand, suitable enabling technology, and skills and familiarity in management/users/ industry/government. The results of the study suggest that e-business will have implications for urban freight including higher levels of demand for goods and services, increased requirements for logistics distribution, changes in location preferences and improved transport network performance.

INTRODUCTION

E-commerce continues to grow exponentially. Worldwide e-commerce revenues, worth less than $US20 billion in 1997 are estimated to reach $US5300 billion by 2005 [**1**]. Growth in business applications of electronic communications within companies which, together with e-commerce between companies (B2B) or between business and consumers (B2C), make up e-business, is even more significant. E-Business is dramatically changing the way business is conducted internationally, nationally, within states and at the local area level. This can impact transportation directly as transportation organizations adopt new practices and indirectly as businesses and consumers change their demand for freight and travel. The magnitude and speed of changes increase the urgency of planning infrastructure and services in line with changing needs.

The Australian National Transport Secretariat, representing state and federal governments, commissioned research into potential e-business impacts to answer three principle questions:

- how will the transport task change;
- what will be affected; and
- how can the transport system respond?

The scope of the study, carried out between October 2000 and May 2001, was quite wide as it sought to answer these questions for urban and rural regions across Australia. The study coverage included freight transport, passenger transport and associated issues ranging from direct impacts on land uses to associated impacts on environmental, social and economic fronts [**2**].

While some of the findings are location specific, the challenges encountered in forecasting the impacts of e-business on transportation in view of rapidly changing developments should be of general interest. This paper discusses some issues arising from ranking and rating the likely impacts of e-business on transportation. It uses the particularly significant urban freight results of the study as an example as they may be of relevance to numbers of cities across the world. While Australia has a land area of 7.7 million sq. km, approximately the size of continental USA, with a population of only 19 million as of December 2000, 65% of that population lives in 6 major cities and the three east coast cities, Brisbane, Sydney and Melbourne have growing populations from 3 to 4.5 million. The majority of the population of the cities live in low density suburbs, in common with North American cities. There is a gradual increase in apartment developments in inner city areas and land costs and rents are rising with proximity to city centers, in common with European cities.

Base line information for the NTS study was collected including a review of literature, appraisal of available data for on-going assessment; information about trends in e-business, and current and expected transport impacts. Interviews were conducted with stakeholders and experts in planning agencies, e-business companies and transport/logistics firms across Australia, as well as international experts. These fed into the ranking and rating process.

The paper first summarizes issues relevant for urban freight arising from literature. It then describes our approach to ranking and rating and describes the issues involved in ranking impacts and in the associated need to derive quantitative estimates of impacts for ranking. The approaches are then illustrated in a table rating impacts of e-business on urban road transport and some estimated impacts on urban freight and urban shopping deliveries. Finally, we propose a set of steps to provide ranking and rating results of sufficient accuracy and sufficient detail to inform decisions at local, state and national levels.

E-BUSINESS AND THE URBAN FREIGHT TASK

Changes in the transport task due to e-business can have particularly significant impacts in urban areas because many urban areas are already suffering traffic congestion and environmental stress from urban air pollution and noise. Of special interest are (1) the expected growth in traffic due to growth of business to business transactions and (2) the potential decrease in traffic due to on-line shopping replacing urban shopping trips, and virtual goods and services

replacing physical goods and services. Suggested factors which might influence such changes are briefly reviewed below to support the later discussion of likely significant effects.

Business to Business

As Figure 1 shows, by far the largest growth in e-commerce is in business to business transactions and this also applies in urban areas.

E-business technologies have allowed re-engineering of the entire logistics chain from a pull supply chain model where customers demand goods, which are built to order and quickly dispatched. This contrasts with the traditional push supply chain: forecast demand, produce the product for stock and warehouse close to the customer. Pull systems result in the movement of smaller quantities more frequently just-in-time (JIT) hence lower inventory holdings. However such systems are unforgiving and "on time intact" delivery is of higher importance

The Internet increases "reach" and "speed" of communications. While "speed" helps just-in time response, "reach" allows sourcing from further afield either across the country or across the city. Access to these distant markets may be either by direct web contacts, or via e-portals, really just electronic versions of a central market. These can be vertical, within an industry group. Examples in the transport industry include car industry and railroad portals. However possibly more important in the urban context are horizontal portals used by groups of companies to buy "high volume low value" goods such as office supplies. Such group tenders may result in delivery to firms outside the sellers usual market catchments.

Access to wider markets and a wider range of products together with increased capacity to design products to customer needs result in increased consumption. Thus there are more trucks because there are more packages, but also because of a change in delivery techniques. Same day and next day delivery can mean less than truckloads are carried. These increases will be additional to the general increase in freight with city population growth and general economic growth. A study in the Netherlands suggested a total increase in freight traffic of 38% by 2005 [**4**]

Freight industry productivity improvements can have some compensating effects. For example, the carrier, often aided by e-business tools, may be able to efficiently make multiple deliveries, either of one type of product to many addresses or many types of product to a single address. However, this will usually include the use of larger vehicles. Hassall [**5**] gives an example of an urban rigid truck operator reducing the fleet from 800 to 750 trucks between 1995 and 2005 despite a 21% task increase by moving from 9 tonne to 22.5 tonne vehicles. Over the same period a Light Commercial Vehicle operator reduced the fleet from 1550 to 1400 despite a 6% increase in task, due to a change from 1 tonne to 2 tonne vans.

Business to Consumers

There has been of particular research concentration on affects of electronic home shopping for supermarket goods because of the potential large effect of high levels of trip substitution. Approximately one in five household trips is for shopping and supermarket shopping is more repetitive than other types of shopping [**6**]. Complete replacement of car-based shopping trips by Internet ordering and fully loaded van-based delivery can reduce distance traveled by up to 70 to 80%. However, complete replacement is unlikely. A UK study has estimated that electronic home shopping will reduce car based shopping travel by 10% by 2010, offset by a 0.5% increase in delivery traffic by 2010 [**7**]. However, the Dutch study [**4**] concluded that home shopping in that country will increase vehicle mileage, because in the urban Netherlands, van deliveries will often substitute for cycle or foot trips. The two studies indicate the sensitivity of the outcomes to the assumptions made and the need for more empirical evidence.

Overall effect depends upon what is bought on-line and who buys it. This is likely to vary over time with gradual adoption of new shopping patterns for different socio-economic and cultural groups within a city. Effect also depends on the delivery pattern of the urban freight vehicles. It can be shown theoretically [**8**] that if delivery from a single depot on the city outskirts replaces shopping trips to local supermarkets, the total urban kilometers will increase.

While in the future impacts of groceries might be significant, at the moment most deliveries are of discretionary goods such as gifts and homewares. Delivery trucks from firms like Federal Express and the United

Parcel Service (UPS) carry e-commerce purchases directly to households in larger numbers than ever before. The high growth in Internet commerce is leading to an increase in demand for delivery vehicles. Growth of 15.3 percent and 25 percent for small/medium and larger vans respectively, have been reported. UPS, Federal Express, and the United States Postal Service (USPS) have all increased the size of their delivery fleets considerably over the past few years — the USPS's fleet alone now numbers nearly 200,000 ground vehicles; UPS's fleet, nearly 150,000 ground vehicles [**9**].

Many of these purchases are additional to rather than substitutes for in store shopping. E-tailers who went out of business in the "dot com" collapse are being replaced by traditional retailers who will, in most cases, want to continue trading from their store fronts. Such businesses aim to sell additional products on line rather than replace store visits. Such increased consumption affects demand for freight across the city from factory (or port for imports) through to final delivery to customer

Virtual Goods and Services

E-materialisation is the term used to describe the substitution of online products for physical products. E-materialisation is significantly impacting transfer of music, software, money and information. However transfer of information is likely to be most important for urban freight. Downloaded music is predominantly a complement to CD sales and software sales is not considered high volume. Electronic funds transfer provides convenience and saves on armoured van cash collection and deliveries. But the myriad of documents attached to B2B or B2C transactions from bills to legal documents and transported across cities generate significant numbers of courier and postal delivery trips.

In the USA there are trends towards decreasing physical mail per capita as information is moved electronically. Reducing the volume of paper bills mailed to consumers will also reduce the environmental impacts associated with paper production, printing, and transportation. Bills account for 60 percent of the first-class mail delivered by the US Postal Service. The average household receives 10 to 12 recurring bills each month, for an annual total number of more than 15 billion bills [**10**]. Financial transactions performed via the Web require far fewer material resources and none of the energy involved in moving information stored on paper to and from the home or office. It is estimated that electronic billing saves approximately 50 to 75 cents per bill in envelopes and postage, and another $1 in handling costs [**11**]. According to Forrester Research, about 47 percent of US households now use some form of automated payment for at least one bill, and an additional 17 percent say they would do so if the option were available [**10**]. Forecasters estimate that by 2001, 535 million bills will be presented electronically, up 275 percent from 1997.

RANKING AND RATING POTENTIAL IMPACTS

Both the rapid speed of change and the changes in society due to the information revolution in general, poses special challenges for forecasting the future of e-business and assessing its impacts. The traditional processes of collecting information over time, describing a base case and projecting of future trends, or assessing change scenarios, encounters problems in all stages.

These challenges apply to studies of impacts on the economy in general but are greater in studies of impacts in specific industries, such as freight and transport. More detailed information is required and more detailed outputs are expected. Almost always such studies are looking for sufficiently detailed insights on future conditions to allow plans to be put in place. This requires predictions to be linked closely to time frames and specifics of localities.

Assessing Degree of Importance

The initial task for the analyst is to define *importance*. This requires consideration of -

- *Quantity versus Quality*: Is the principal indicator the magnitude of the impact (quantity) or the significance of the impact (quality)?
- *Criteria*: Is the impact manifested in additional vehicle kilometres traveled, person trips, cost per kilometre, energy used, greenhouse gases generated, tonne kilometre, extra road infrastructure required, funding required or all of these? Will additional criteria be required?

- *Stakeholders*: Importance will vary with viewpoint. For instance, extra air travel will have limited impact on urban road authorities.
- *Where and When?* Even assessing what is happening here and now is difficult in a time of rapid change. Our work to date has noted both differences in impacts over time and variability of impact with place.
- *Thresholds*: E-business changes leading to strains on capacity will be subject to threshold effects. Demand may be satisfied up to some saturation level and then an entirely new facility may be needed. A related issue is the approach to thresholds of certain facilities, such as warehouses or road links. A one percent increase in road traffic outside peak periods may not cause any problem, but such an occurrence during peak travel may result in gridlock.
- *Urgency*: The order and speed in which resources are allocated correspond closely to the priority attached to a given area. Resources may need to be allocated first to a less environmentally deserving area because opportunities, frequently economic in nature, may be lost entirely otherwise.

Clearly, people will attach different degrees of importance to issues according to who they are, where they are and when they are considering the matter. From this viewpoint every stakeholder at every time in every place needs a personal impacts rating scheme. Certainly we believe that tailored schemes are needed and will suggest processes for putting them in place. However, we still aim for some general rating of issues of importance here to allow discussion.

Setting Criteria

To address the problem of comparing 'small apples with large oranges' we need some common terminology for comparison across all modes and for all authorities. We have adopted the change in vehicle trip numbers as a common measure of changing activity. Percentage change in trip numbers, rather than absolute trip numbers is the relevant metric as it needs to be compared to the current situation to estimate likely impact on stakeholders. We rate on a scale the impact of changes on different stakeholders.

We realise that many stakeholders are not interested in the number of vehicle trips per se. Rather they are concerned about persons carried or tonnage carried, transit or delivery times and a whole series of financial issues from cost per unit to bottom lines. However, it is difficult to encompass all such issues in a simple table. Instead, we base qualitative assessment of impacts on stakeholders as impacts on the issues of interest to such stakeholders due to increases (or decreases) in vehicle trips. For example, our rating of the impacts to greenhouse gas (GHG) targets from any increase in particular types of trips, are based on the expected change in the current GHG impacts of such trips.

The ratings are based on assessment over the course of the project and especially informed by discussions with stakeholders and review of information. We have chosen to tabulate them in terms of the *source* of the trips (for example, shopping deliveries) rather than *outcomes*, such as urban trips. While the outcome will be of more interest than the source for most transport purposes, noting the source makes the rating assessment more transparent. In numbers of cases, it will be the cumulative effect of trips from different sources that make the total impact on the transport system. These overall effects are addressed later in making impact estimates.

Where and When?

The base year for this study is 2000 and changes are expected within five years from 2001 to 2005 and those expected in 2006-2010 are compared with the situation in 2000. In particular, increases in 2006-2010 are interpreted as increases over 2000. Additionally, within the first category, we needed to include some changes that have taken place / are taking place in 2001. The cities considered in our study are multi-centered cities with a major CBD (central business district), and minor CBDs surrounded by low and medium density suburbs.

Good or Bad?

Impacts may be important because they offer advantages, such as extra service; or disadvantages, such as increased pollution, or in some cases, both. We have accommodated this by using signs in the rating system; plus (+) for advantage and minus (-) for disadvantage. Such signs require some assumptions of what stakeholders will see as

disadvantage. For example, we assume extra traffic will be viewed negatively by road authorities and local governments.

How Much and How Many?

A major challenge of this study has been 'putting some numbers on impacts'. An assessment of the transport impacts of e-business saying the impact will be 'big' would expect the immediate response 'how big?' Yet, as noted, 'how big' depends on 'when', 'where' and 'who' is asking. Both data collection and assessment processes are needed to evaluate impacts at detailed local level, regional level, state level and a national level. In the absence of such measures we have attempted to provide 'ball park' estimates of the extent of some important changes in transport demand and supply.

Overall impact depends both on the degree of change and the size of the base population subject to change. For instance, a one percent increase in the number of shopping trips per person in a large city can have a significant impact on total kilometres traveled, whereas 100 percent increase in the number of trips to market by organic produce suppliers would not.

Final estimates of additional activities included estimates of actual change now underway and estimates of potential change. They are estimates of *extra activity per year for stated years.* Cumulating the figures over a five or ten year period could be misleading in view of their indicative nature.

INDICATIVE RATINGS & ESTIMATES FOR AUSTRALIAN CITIES

The main areas where e-business is forecast to have a significant impact on the demand and the supply of urban freight are summarised as follows:

- Higher levels of demand for goods and services due to wider choices and lowering of business transaction/administration would bring about increases in travel by light commercial vehicles (LCV) for local centre/home deliveries, occurring mainly at off-peak periods. Hence there will be little impact on urban congestion. Consequently, relatively higher levels of GHG and decreased air quality are expected given that LCV have low standards for emissions. This presents a rationale for incentives to convert LCVs to alternative fuels such as electric power or natural gas.

- Increased pressure on logistics/distribution tasks from increased expectations or requirements from customers for greater flexibility and greater levels of reliability in the delivery of goods and services.

- Increases in transport demand through increases in freight task due to wider choices of supplier/provider. Additional demand, mainly on road based transport, given its greater flexibility, level of service and ability for value adding services. Rail will be unable to compete in what will be increasingly more demanding market segments.

- Location decisions by firms: Small centrally located freight terminals replacing large warehouses on city fringes. Consolidation trends into major centers; local distribution/collection centers using established 'bricks and mortar' (e.g. Seven-Elevens; petrol stations; newsagents; etc.). Possibly small warehouses for freight will emerge.

- Dispersion trends (e.g. self-employment; teleworking; loss of jobs in white-collar services industry), leading to longer trips. Less reliance on the CBD for commuting thus conventional public transport (fixed route/radial) will suffer continued erosion in market share. Flexible public transport will be valued. Location decisions by individuals; there will be a need for more personalized types of transport.

- Logistics operators increase productivity through better scheduling and routing software. This leads to cost reductions, less empty running and reduced emissions and GHG.

- Improved transport network performance through interfaces between *Intelligent Transport Systems* (ITS) components and data interfaces to B2B and B2C systems. This has the potential to reduce transit times and trip time variability through improved knowledge of transport demand, as well as improved real-time data on transport network performance. Safety will also be improved. Such co-ordination between ITS and e-business systems is likely to be implemented in practice in the medium term. Links between ITS systems and B2B alliances: more data/information on entire supply chain available to all, including ITS components, leading to reductions in delays, accidents, vehicle operating costs and emissions.

The above impacts are illustrated in detail in Table 1. The importance of the impact on the transport task or the associated service offered of listed e-business changes to particular groups of stakeholders, are rated on a scale of ' + ' for small but significant benefits to ' + + + + ' for very significant benefits. In the column next to the source of e-business change, the change/s in the transport task due to that type of e-business is listed.

We have taken the opportunity to include some stakeholders outside the transport area since governments want to take into consideration the interest of the business or the community in general in setting priorities.

Urban Shopping Trips Estimates

Urban Shopping Estimate	Small overall increase in total travel, an extra 1.1 million kilometres by 2005.

As reported in Smith et al. [**13**], only one of the transport experts interviewed during the study saw internet shopping opportunities as having an important impact on urban transport activity in the medium term. Moreover, more rather than less traffic is expected as use of e-shopping increases. Both these predictions will seem counter intuitive to the many people who think first of internet shopping when e-commerce is mentioned and expect reductions in trip making due to ordering online. Hence it is important to provide an estimate of e-shopping impacts on transport activity.

Shopping Trip Numbers

It is first necessary to estimate the total number of shopping trips available for conversion to e-shopping, together with an indication of the length of such trips. Melbourne's Transport Research Centre [**14**] and New South Wales Department of Transport's Transport Data Centre [**15**] both carry continuous area-wide surveys of household travel and identify shopping trips, as described in Smith et al. [**16**]. Estimating the amount of travel which might be foregone, if the shopping is done online, from either data set is complicated by two issues:

- *Multi-purpose travel* shopping is frequently one stop on a journey, such as work to shops to home. The TDC approach is to record trip in terms of their destination purpose. This makes it difficult to extract two-way shopping trip distances. We have approximated the two-way distance as 1.8 the average one-way distance drawn from the travel survey data.

- *Commodities purchased* are not recorded in travel surveys. Time spent shopping as a proxy has limitations. Instead, we approximated a proportion of shopping trips via a proportion of expenditure of goods from the Australian Bureau of Statistics Expenditure Survey [**17**]. Other sources of information such as the ACNielsen [**18**] shopping surveys could allow these estimates to be refined.

Access and Inclination to use online ordering will govern the take up of these options. Our assumptions are based on current pricing patterns where goods purchased over the internet cost more. Thus e-shopping appeals to the time-poor but resource-rich members of the community. Similarly only a proportion of the population uses the Internet, and ubiquitous use will be some time off, even allowing for technology improvements offering computer free internet access. ACNielsen [**18**] found that 41 percent of 25 and 39 year-olds expressed interest in ordering groceries over the Internet, as compared to 10 percent of all main grocery buyers.

Trip Substitution

Online ordering can replace a passenger trip with some proportion of freight trips. That proportion might range from one, for delivery of a 'one-off order', for example, medicine from a pharmacy; to 1/120, for a new special purpose vehicle now being commissioned for delivery of online grocery orders. In the former case, there is no travel saving, whilst in the latter it could be large; with the caveat that such large-scale deliveries would come from a central facility rather than the local vendor. We divided substituted trips which save travel into two categories:

- *Local Deliveries* for local shopping trips. For example, a home delivery of pizza from a local shopping centre. In this case, we assumed an average run of six deliveries saving the distance of six local return trips (*calculated: 6 by 1.8 average trip distances) for five percent of purchases.*
- *Citywide Deliveries* where goods from a central store substitute for local shopping trips. These are predominantly grocery or food deliveries. In this case, the delivery is more efficient, but the distance covered by the entire freight trip is considerably longer. While vehicles capable of 120 drops are on the drawing board, we have assumed an average 20 drops per trip to account for the use of general-purpose vans in the first instance. An average cross-city delivery loop distance is multiplied by a factor of 1.5 for detours into local streets. Ten percent of shopping trips by eligible households could be replaced by delivery.

Extra Trips are generated by e-shopping in two ways:

- *Induced Demand:* Online shopping provides new opportunities to buy goods which would not have been bought otherwise from retailers, such as Gowings, Amazon.com or even from other consumers at internet auction sites. Some of these purchases will be dispatched though the postal system and are outside the range of this initial estimate. However, an estimate of the impact of dispatch of special deliveries is included. It includes 30 percent of meal deliveries as replacement for preparing a meal out of food on hand.
- *Opportunities Identified:* Window shopping and comparison shopping on the Internet can lead to passenger trips outside the local area to purchase goods. Much of the evidence here is anecdotal. However, a survey of those who used the Internet for comparison shopping and some approximation of the increase in out-of-area customers due to internet advertising, have been used to provide an estimation.

Saved Trips and Replacement Trips

The old phone company slogan 'let your fingers do the walking' applies equally to Internet checking of prices and availability, and hence, saved shopping trips for discretionary goods. If banking is included in consideration of shopping trips, Internet banking is replacing bank offices.

We have not included any assumptions about trip making due to saving the time spent on collecting shopping. This could include visits to the shopping mall for pleasure as the distinction between retailing and entertainment blurs.

Urban B2B Freight Trips

Urban Freight Estimate	E-business changes to transport task when added to "old economy" freight growth has the potential to generate up to 16 thousand million extra kilometres for light commercial vehicles (LCVs) by 2005, a 50% increase over the 1999 urban total.

Extra trips are generated by e-business practices both increasing reliability of deliveries allowing customers to hold lower inventories and demand 'just in time' delivery. At the same time, e-procurement is likely to result in sourcing from further afield and more deliveries of small consignments, where contracts are judged on service as well as price.

A drop in urban freight trip numbers will occur with a higher proportion of larger vehicles in the fleet. However, as those vehicles would be introduced to deal with increased demand, this change would only slow the rate of increase rather than decrease trip numbers. Their impact would also be constrained by limited opportunities for consolidating loads and deliveries.

To be useful, assessment of urban freight trip impacts needs to be broken into categories according to the goods carried and types of vehicles used. At the moment such detail is not available for any urban area in Australia, although the New South Wales Department of Transport is in the process of collecting detailed commercial vehicle flow data for the Greater Sydney area [**15**].

Urban Freight Kilometres

The best available option for base figures was the Australian Bureau of Statistics (ABS) motor vehicle survey numbers on area of operation [**19**]. These are estimates of total kilometres traveled within capital cities, within other urban areas, within the vehicles' home state and interstate for different categories of vehicle. We concentrate here on

- light commercial vehicles because of their prevalence. LCVs traveled approximately 150,000 million kilometres in Australian urban areas in 1998-1999.

Segments Likely to Increase

We cannot estimate change by simply applying a percentage estimate to the base figures. As noted, some areas of the freight task will be little changed by e-commerce. A common example is the wholesale deliveries of food products, such as meat to butchers shops, where delivery frequency is governed by requirements of freshness.

Unfortunately, the ABS only categorises freight types in terms of either tonnes or tonne kilometres. For example, the number of tonnes carried by the number of kilometres traveled. This is useful for estimating freight task, but less useful for estimating freight activity. Moreover, these categories are not separated into urban and non-urban, when differences in the make up of freight between the two are expected. For example, much of the carriage of live animals would be non-urban among the 163 million tonnes of food and live animals carried by articulated trucks. However, as an approximation, we calculated the proportion of tonnage in the gross categories subject to e-business increase and applied that to the base vehicle kilometres. This gives a *base number of kilometres subject to increase*. Because the categories are broad, division is somewhat arbitrary. For example, we have included an increase in the carriage of tools of trade to account for increase in services, but an actual increase will depend on the proportion of the trade amenable to sale as new services.

Estimated Increase

Since increases due to e-commerce must be in addition to other increases, we have taken the rate of annual increase from the Bureau of Transport Economics before e-business could have affected the result. We have added a gradual exponential rise for those categories of trips subject to increase. An upper estimate is based on expected demand. However urban road infrastructure limitations and vehicle fleet supply constraints could limit that increase to around half the demand based estimate.

ACCOMMODATING CHANGE

Translating Transport Activity Increases to Stakeholder Impacts

As emphasized throughout this paper, impacts will differ by place, time and stakeholder. Estimates of increased transport activity are insufficient to judge importance. We have attempted to compensate for this to some extent by basing our qualitative rating on parcels of impacts relevant to particular stakeholders. For completeness, we describe the translation processes required to estimate particular types of impacts from increases in transport activity.

Congestion Effects

Increased transport activity and hence traffic volume, leads to congestion when it occurs at a time where there is insufficient capacity on a transport link. Thus the estimation of congestion effects needs estimates of the timing of extra traffic,on the parts of the transport network likely to be affected and the capacity of the links. Congestion estimation is relevant for diverse applications from urban congestion to the capacity of inter-modal interchanges for regional freight. Delay time estimates will be the most frequent output.

Service Level Effects

Requirements for totally new links and services will frequently stem from expected congestion and uses the same information on timing and capacity. However, assessment requires information on viability and capacity of existing alternatives for diversion of extra traffic before decisions on extra road rail or air services or infrastructure can be made.

Greenhouse Gases

To estimate GHG from transport activity, we need information on the fuel type, with fuel usage dependent on vehicle type, vehicle condition, loads where applicable, and operating conditions. For strategic level estimates, proxies such as fleet age for condition are applicable. The BTE estimation packages CARMOD and TRUKMOD are good examples of the calculation process required.

Air Pollution

The evaluation of impacts on air quality requires time and place estimates related to congestion and fuel efficiency, as well as vehicle type estimates for GHG calculation. This requires a package such as CSIRO's STEAM which accounts for the time, location and type of emissions that are expected. These emissions are then fed into an airshed model such a LADM or TAPM to estimate where photochemical reactions will occur. To apply this information to health impacts, a further step, the estimations of population exposure to pollution, is required.

Noise

To evaluate noise impacts, the whereabouts and timing of extra traffic is required, together with information about road geometry and conditions. For example, for the numbers of local areas which have had traffic calming devices installed, more noise may be expected from heavier commercial vehicles when negotiating these 'humps and bumps'. Of potential and greater importance is the issue of timing. Early deliveries may avoid congestion in inner city areas but could disturb the residents of the growing number of city apartments.

Safety

To evaluate road safety, information on the location of increased traffic and types of vehicles subject to increases are required. There may be no direct relationship between traffic volumes and accident rates but concerns have been raised. Increased traffic in local streets will endanger vulnerable pedestrians. In addition, the growth in vehicle kilometres traveled (VKT) by articulated trucks could increase the potential for serious accidents on regional roads.

Costs

Many stakeholders need to further translate the issues above into costs. This may require extra information such as:

- The identification of who or what is delayed is required for congestion costing. Freight operators may wish to apply estimates such as an average of one dollar per hour per pallet. Road authorities need estimates of traffic composition to quantify 'values of time'.

- Externality costs are frequently needed for project cost benefit assessment. Thus valuations for non-market goods such as clean air or safety are required.

Assessment and Planning Tools

Strategic planning does not require detailed estimates, but does require assessment of the right order and direction. To obtain even 'ball park' figures for e-business impacts on transport, several issues need to be considered. The use of 'back of the envelope' style estimates made by commentators based on very simple assumptions frequently miss

their mark by orders of magnitude. Our examination of urban shopping trips demonstrates the literal conversions such as 'one in five trips are shopping trips, hence a fifth of passenger trips will be replaced by e-business'.

There are two major challenges in developing an assessment capability:

- *Collation of data*: While extra data collection will be needed, the major task is linking appropriate data sets so that information from disparate sources can be brought together. In some cases, such as the ABS data, additional types of tabulation will be helpful.
- *On going assessments*: E-business changes are happening quickly and decisions need to be based on current developments rather than past ratings of need.

Fortunately the communications revolution and e-business technologies also help with solutions to these challenges.

- *Online data access:* It is no longer necessary to laboriously assemble the actual data from disparate sources and watch it become out of date while doing so. In principle, the most recent data available should be accessed directly online from agencies across the country or across the world (with access charges as required). In practice, a number of compatibility issues arise with systems and data sets, although processes for resolving such differences are improving.
- *Web enabled assessment tools*: E-business impact assessment software could very easily be 'web enabled'.Rather than use a static version of rating and ranking, dynamically updated software can be accessed across the web. The most up-to-date data is fed into the monitoring system from services across the globe. A controlled access process allows restriction to approved users and/or paying clients.
- *Intelligent Transport Systems:* There are excellent opportunities for productivity gains by linking ITS providing traffic information to commercial carrier routing systems. This offers just-in-time service to commercial vehicles by providing real-time routing advice or preferential traffic control. The European Union estimates that congestion, unreliability and costly inventories as a result of the lack of information about road network capacities and conditions make up 15 percent of total transportation costs [**20**].

The cost of providing such facilities, and of using them, will be offset many times over by the savings generated by planning. Rather than waiting to learn from experience, planning ahead actually offers greater flexibility and its value will grow in an era where there is virtually little time to correct wrong choices. Therefore it would be useful for measurement and analysis processes to be put in place for ongoing assessment of the transport impacts of e-business.

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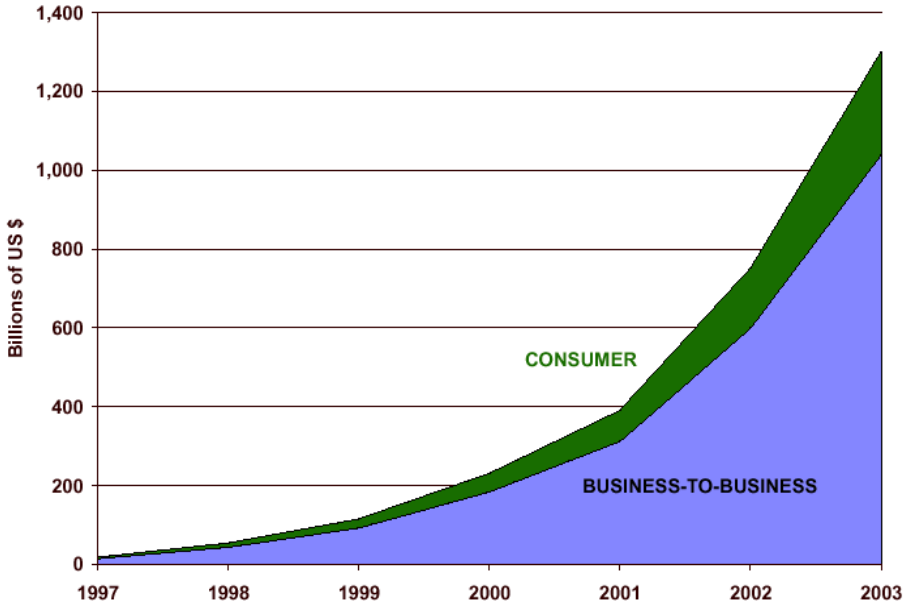

Figure 1. Growth in Worldwide E-Commerce Revenues [3].

Table 1. Estimated impacts on urban road transport.

E-Business Change	Task Change	Carriers		Road Authorities		EPAs & GHG		Business		Local Govt	
		2001 2005	2006 2010	2001 2005	2006 2010	2001 2005	2006 2010	2001 2005	2006 2010	2001 2005	2006 2010
JIT & low business inventories	Extra trips	+ + +	+ + +	- -	-	- -	- - -	+ +	+ + +	- -	- -
E-Procurement	Extra VKT	+ + +	+ + +	- -	- -	- -	- -	+ + + +	+ + +	- -	- -
Online shopping staple items	Increased delivery trips and VKT Less passenger trips	+	+ +				- -	+	+ +	-	- -
Online shopping discretionary items	Increased delivery trips & VKT	+ +	+ + + +	-	- - -	-	- -	+ +	+ + +	- -	- -
e-Business logistics	Better fleet size mix	+	+ +	+	+ +		+	+	+ +	-	-
ITS for vehicles*	Efficient scheduling	+ +	+ + + +					+ +	+ + +		
ITS for roads*	Traffic managemntt	+	+ + + +	+	+ + + +	+	+ + +	+ +	+ + +		+ +
Warehouse location	Shorter/ longer trips	+ +	+ +	-	-			+	+	- -	-
Business location dispersal	Extra suburban trips	+	+ +		-					-	- - -
*Integrated ITS systems for roads & vehicles 2006-2010											