

## **Introduction**

*"Electronic commerce [e-commerce], the buying and selling of goods and services on the net - or worldwide web - is growing at a phenomenal rate as companies and consumers discover the benefits of instant access to data and the ability to make on-screen transactions. But e-commerce is not the whole story. Through the rapid development of information technology, businesses can link up all their internal and external activities - from supply and purchasing to sales and marketing - into a single seamless operation. This is defined as e-business, although the two terms are often used interchangeably." (Fisher, 1999)*

When this definition is used, e-business is not such a new phenomenon, electronic data interchange has existed for around thirty years. At the same time business has been accustomed to bidding for shares or commodities via organised markets. This may help to explain the explosion of Business to Business [B2B] e-commerce, once the Internet provided enabling technology in 1996-97.

In the new century, e-commerce, both B2B and business to customer [B2C], plus the adoption of electronic technology within businesses, are expected to dramatically change the way business is conducted internationally, nationally, within states and at local area level. World-wide e-commerce revenues are estimated to reach \$US1300 billion by 2003 (IDC, 1999).

Suggestions about the impacts of such changes on the transport system abound. They range from e-business limiting the needs for deliveries and travel to e-business significantly increasing delivery of goods and services. This paper discusses some of the issues involved in assessing how transport, particularly road based transport, will be impacted by e-business, as well as the ways in which the development of e-business may be influenced by transport infrastructure over the period 2001-2010.

Discussion is primarily based on early findings from a study undertaken with the support of the National Transport Secretariat and the Queensland Government to identify and rank the major impacts of e-business on the Australian transport system. The study is assessing the implications of such changes both in terms of increased opportunities or increased costs at national and regional levels.

The paper is organised as follows: Challenges in assessing impacts of e-business on transport are discussed, then some possible changes to road based transport, for both freight and passengers are considered with reference to relevant literature. This is followed by discussion of the implications of such changes particularly in terms of road safety and health.

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## Assessment Issues

### Direct, Indirect and Reverse Impacts

The special nature of transport means that we need to consider three types of impacts from e-business, namely: *direct, indirect and reverse impacts*.

*Direct Impacts:* Like every other business, transport organisations from large multinationals to small local carriers are affected by the e-business revolution in two ways. *Generic applications* are available to business, such as those for automating offices and, at the same time, *industry specific applications* are developed, such as automated vehicle tracking. Similarly, businesses are impacted by these changes in two ways, either *internally* when they adopt them or *externally* when their suppliers or customers adopt them.

*Indirect Impacts:* Demand for transport is a derived demand arising from the need for travel or movement of goods. Thus, growth in any areas of the economy can lead to more transport demand. For example, increased goods or services production can increase calls for deliveries or general growth in the economy may lead to building booms with more truck movements to construction sites.

*Reverse Impacts:* Just as e-business growth may lead to general growth in demand for movement of goods and services, transport constraints could stifle e-business growth.

Figure 1 shows the main linkages between e-business and transport demand. B2B and B2C impacts on travel and location decisions are shown separately. The links between B2B, B2C and other trends, such as employment are included in the figure. Transport systems technology such as Intelligent Transport Systems [ITS] can be considered within our broad definition as an e-business effect.

E-business effects will be far ranging and of relevance to most of the main issues identified by Austroads (1999) and Taylor (2000) as likely to influence transport systems in the future which are:

- The appropriate use of new technology described as Intelligent Transport Systems [ITS];
- The further development of inter-modal transport systems;
- The need to provide cost-effective freight transport systems;
- The need to reduce and manage congestion;
- The need to alleviate problems of air quality and greenhouse gas emissions from transport sources; and
- The provision of more effective and safer transport systems in rural and remote areas.

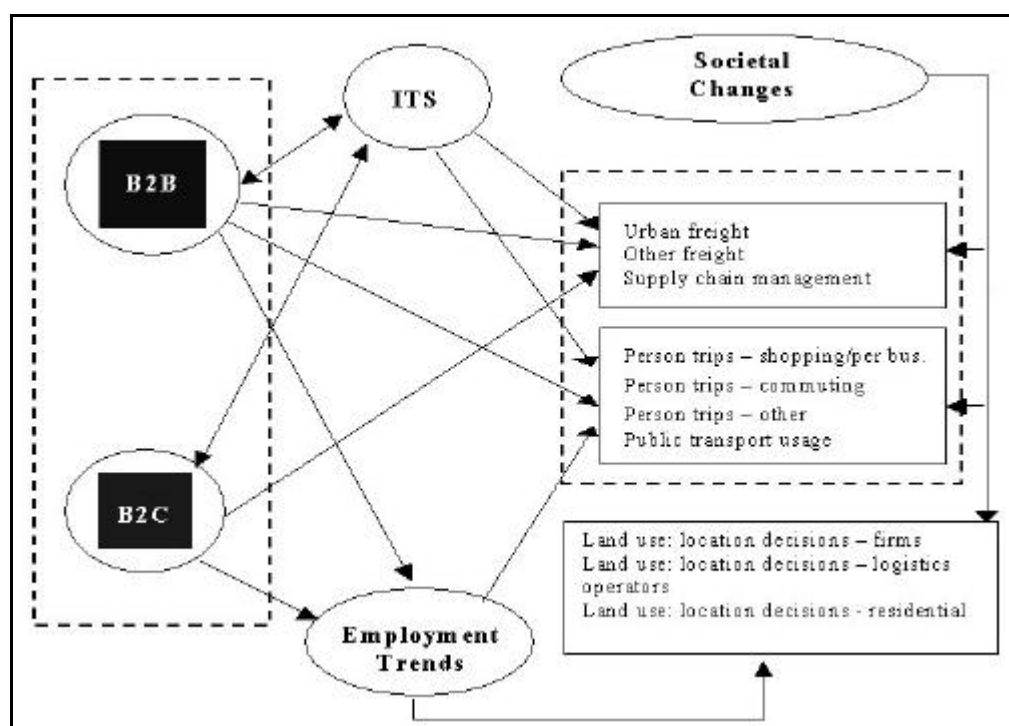
### Challenges in Assessing Impacts

Both the rapid speed of change and the changes in society due to the information revolution in general, pose special challenges for forecasting the future of e-business

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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. Problems arise in comparing information year-to-year, where scope and scale change, with the description of “the numbers of users and uses” at a given point in time becoming rapidly outdated. Projection of trends, which resemble exponential growth curves rather than a linear trend, is difficult. Change scenario assessments are based on impacts of a particular change of interest “if other things are unchanged”, yet the only certainty about the future at the moment is that many things will change.

These challenges apply to studies of e-business impacts on the economy in general but are greater in studies of impacts in specific industries, such as 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.



**Figure 1. Main linkages between road-based transport & E-business**

However an assessment process may begin by considering general types of transport changes which may occur and their possible effects on specific aspects of the transport system. Here we illustrate this initial process by addressing some of the possible changes to road based transport, first for people, then for freight, and, in view of the theme of this conference, relate these to possible impacts on road safety

## **Travel Demand - Person Trips**

### **B2C – Shopping Trips**

The concept of accessibility has been expanded from being measured in travel time or cost, to the notion of virtual accessibility to many activities (Golob, 2000). The way in which such rapid and far reaching increases in accessibility will affect the demand for transport, is very difficult to predict. Our ability to model travel demand in general, and freight demand in particular, has in the past been subject to a large degree of error and uncertainty. Major changes in emphasis are required for travel behaviour modelling to take into account the significant changes in business and personal information flows.

As yet B2C e-commerce has been dominated by online purchases of goods and services within a relatively narrow range. Grocery online shopping has been constrained by high delivery costs, restricted coverage area, high set-up costs and technical limitations from connections speeds to user friendliness. Broadband cabling should soon be able to create better virtual shopping experiences, plus some costs are being driven down by volume and technology. Then we are likely to see a marked increase in online shopping for household goods and groceries. This type of repetitive business could translate into reductions in some shopping trips, assuming that most of the shopping would have taken place at a store. In the US, there is some evidence to suggest that most online sales have shifted from ‘bricks to clicks’ [Jupiter Communications, 2000].

Golob (2000) has used the fact that one in five trips in the US are shopping trips, to argue that within two years the overall impact of online shopping could be substantial. However, other authors have noted that shopping trips are often parts of a chain of trips involving multiple purposes (Gould, 1998; Koppelman et al., 1991). Moreover travel survey data from both Sydney and South East Queensland show that the majority of shopping trips are short trips (Arup, 1998). It is less likely that 5 minute dashes for a loaf of bread or carton of milk will be replaced by online orders, except for customers willing to pay a premium. Any assessment of likely uptake will need to consider that only part of the community is ‘time poor and resources rich’. Others, for example the elderly, may actually be ‘time rich and resource poor’.

Some of the travel time saved by online shoppers of household goods and groceries is likely to be spent on making trips for other purposes (Gould and Golob, 1999; Gould, 1998). These could even include trips to the same shopping centres with this time used to shop for pleasure rather than to buy staples. There is a growing trend to blend entertainment with retailing, such as coffee shops and music in book departments or interactive sports departments to sell more discretionary purchases.

### **Tourism and Business Travel**

E-business changes are likely to increase the numbers of trips for business and tourism in Australia and may also change their spatial distribution.

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*Increased Business Travel:* B2B contacts will lead to increased trips to visit new clients and collaborators. Earlier significant changes in communications had exactly that effect. Introduction of the telephone increased rather than decreased trip making (Pool, 1977; Pool, 1983). While new technology offers increasingly improved opportunities for teleconferencing, it has proven to be a poor substitute for face-to-face communication in many applications (Button and Maggi, 1994). Teleconferencing may substitute for some meetings, for example seminar presentations but it is likely to prove less successful for delicate negotiations. While international and most interstate trips will be by air, expanded business in regional Australia could lead to extra road travel.

*Regional Tourism* could be boosted significantly by access to wider markets. For the first time, small individual suppliers or regional tourism associations are able to contact potential tourists directly. Commercial intermediaries provide products from the web equivalent to holiday guidebooks to complete search services. Extra international access beyond the resources of conventional advertising channels will certainly increase opportunities to attract travellers. Web based services also allow companies to better cater to niche markets and special interests, such as adventure tourism or eco-tourism.

Resulting increased markets could mean more demand for car tourism within the country, as tourists learn more about opportunities in regions. In the short term, the extra numbers will come from traditional sources of tourists, such as the USA, Europe and Japan. However, e-business and associated changes may result in growth of a prosperous middle class in South East Asia and India providing an entirely new and very large market (Foran et al., 1998).

## **Transport Demand – Freight**

### Logistics Impacts

Logistics encompasses warehousing, transshipments, information flows and the need to manage the entire transportation system. Increased market coordination changes the requirements for logistics. There is a need to offer integrated solutions from warehousing and delivery to payment services. Chain monitoring [tracking and tracing systems] and auction markets for capacity trading, are now common components of new logistics systems.

There is very little published material on quantifying the likely impact of B2B or B2C on freight movements, either in Australia or elsewhere, although in 1999 the NOIE '*Trucks Online – National Road Transport Scoping Study*' did look at technology uptake in the industry. Regan and Garrido (2000) presented a framework for such quantification in relation to the B2B components. The convergence of *just-in-time* practices with improved communications technologies are leading to changes in warehousing requirements and the need for freight consolidation centres. E-business is giving rise to more just-in-time supply chain management. This may not necessarily mean smaller consignments but will mean that business will move to larger freight forwarders able to consolidate loads. At same time customers will be able to better

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track their consignments. Increased reliability will lead to less need to hold inventory and hence perhaps more frequent consignments.

*B2B Impacts:* Application of B2B has a long tradition in the logistics sector (Stenger, 1986). Electronic Data Interface [EDI] systems, have been in existence for around 30 years. However low benefit/cost ratios in the short term (Sokol, 1995) have limited their influence. This situation will change as EDI systems are likely to be fully integrated within Web based B2B systems, given the software advances such as XML and other enhancements (Glushko et al., 1999).

E-business gives logistics operators the opportunity to form alliances without the need to merge. There is evidence from North America that strategic alliances and mergers are being formed to consolidate the logistics functions into multi-modal delivery of freight and warehousing services. There is a move from managing large physical assets to providing complete logistics solutions – managing information across networks of transport operators and logistics providers. The Internet will allow the coordination of the movement of goods and its tracking globally with clearing-houses for transportation information beginning to operate overseas.

Information is a critical component in the supply chain and it will drive changes in logistics. Intelligent electronic ‘agents’ are being used in logistics decision support systems to track freight and monitor transport costs, thereby measuring effectiveness and efficiency of the entire logistics function. These ‘agents’ allow managing and tracking of the multiple transport modes and systems, as well as identifying bottlenecks in performance. These developments will offer alternatives for contractors to mix and match loads and to consolidate freight consignments.

B2B will mean less predictable flows, smaller orders placed more frequently and some parts of the distribution chain disappearing altogether. In Holland, Transport en Logistiek Nederland (2000) estimates that road based trips will grow by 9% as a result of B2B.

*B2C Impacts:* Most home delivery online shopping systems are costly to operate due to the multitude of destinations and the low load factors involved. Handling and administration costs become significant for those systems. Punakivi and Holmstrom (2000) refer to developments in Finland aimed at increasing the financial viability of home deliveries through the use of mobile data aided ordering, payment and tracking systems. In addition, mobile data can be used to improve fleet productivity through fleet management systems. Value added services using mobile communication and data transfer technologies can increase the efficiency of urban logistics thereby lowering unit costs. Other services include the use of unmanned reception boxes at the household end of the chain, as well automatic replenishment services (Stank et al., 1999).

According to Lewis (2000), retailers in the UK expect that B2C will take between 2.5% and 10% of total UK grocery sales by 2005 and 15% by 2010. We note however that 15% of sales would not replace 15% of trips. Deliveries are being made under two types of logistics models, namely: store based order picking and e-fulfilment centres. Whatever the model used, additional travel by light commercial vehicles will result.

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Possible future developments include e-fulfilment centres at current stores or at existing regional distribution centres; or centralised e-fulfilment with picked orders being distributed to existing stores for onward home distribution. Order picking is the largest single cost per delivery (Lewis, 2000), whereas in the supermarket the customer performs the order picking function. Retailers like to use their own staff for deliveries for quality and marketing reasons. This could increase the number of trips greatly

The use of the Internet will stimulate demand for goods and freight movements with smaller vehicles being used in some instances. In the Netherlands, it has been estimated that consumers will buy 15% of non-food products and 10% of food items online (Transport en Logistiek Nederland, 2000). This leads to an increase in 8% in road based trips. B2B will mean less predictable flows, smaller orders placed more frequently and some parts of the distribution chain will disappear. Road trips will grow by 9 % as a result of B2B. Although some products, such as music and videos, will no longer need to be moved physically but will be downloaded directly over the Internet, resulting in a reduction in some freight demand.

*Online Freight Exchanges [OFE]:* Web based exchanges are common in North America. Over 200 such OFE are currently in existence although many are not profitable at present. Inter and intra-firm OFE have been set up with the main aim of increasing vehicle productivity and reducing administration costs. Throughout the 1990s, there has been a succession of failed exchanges (Alt and Klein, 1998). Some of the reasons relate to lack of freight on offer.

OFE increase information about the market place. This will be a major value-adding factor only if most of that information is not well known to the players already. Thus OFE may not be useful for local markets but as logistics supply chains are increasingly global in nature, it can be useful in discovering foreign markets. OFE, and B2B in general, have the potential to eliminate the role of intermediaries such as forwarding firms and to offer better consolidation practices. However, when forwarders also act as transport operators there is a tendency for them to shy away from a system that makes some of the functions redundant.

Dis-intermediation, as physical stages in a supply chain are eliminated, is accompanied by re-intermediation as human and electronic 'agents' add value to the communications links in the supply chain. However the overall effect should be more direct shipment.

*Rural Industries:* The widespread use of Internet-based services by rural and remote communities will mean that those communities will expect a high standard of service from logistics providers and suppliers. Improved delivery schedules of supplies will be increasingly demanded. The wider set of choices from consumers and producers will result in increased level of demand for freight movements. Coordination and cooperation is difficult in practice, for a number of reasons.

Pressure on an industry to adopt e-business practice can come from market forces. Customers are becoming more demanding regarding quality, convenience and standards from primary producers. For example, very soon the EU will require cattle to be individually identified, which means property of origin and whole-of-life identification

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for individual animals (Gregor and Menzies, 1999). Although such requirements do not have direct implications for transport, they may impact on the logistics functions by offering opportunities for value added services.

Bulk commodities such as sheep, cattle and wheat or minerals may not derive significant marketing advantages from the Internet. Their established markets are driven by different factors. However, there are numbers of niche products which might benefit from advertisement over the Internet. These range from stud services to organic produce. It is too early to assess the influence of the e-commerce in such areas. However, they should become increasingly important, not only for sale of products but also on advice on production, as more producers move to alternative crops to prevent land degradation.

### **Intelligent Transport Systems (ITS)**

Congestion, unreliability and costly inventories as a result of the lack of information about road network capacities and conditions can lead to added costs. It has been estimated that these problems cost 15% of total transportation costs in the EU (Alt & Klein, 1998). Some 50% of trucks in Europe are travelling empty. However care must be taken in translating such estimates. The situation is different in Australia where empty running occurs mainly out of Adelaide, Brisbane and Perth due lack of freight on offer. In Australia, urban freight deliveries have most of the empty running and in this area improved scheduling and routing will only partially reduce the cost. Most of it is due to fleets for specific commodities where firms do their own deliveries or contract operators using dedicated vehicle fleets.

ITS is a generic terminology commonly used to refer to the application of information technologies [computer software/hardware and communications] to enhance the efficiency of the existing road infrastructure in general, reduce operating costs, and improve safety. Freight Management Systems are those applications that benefit operators and regulators of the freight transport industry.

Many ITS applications fall into the category of e-business applications, using communication technology to improve efficiency within firms, and all have significant linkages with e-commerce, as shown in Figure 2. The two-way information flows between ITS components and B2B and B2C systems have 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. Some implementations of ITS providing benefits for e-commerce include Advanced Traffic Management Systems (ATMS), Advanced Traveller Information Systems (ATIS), and Commercial Vehicle Operations (CVO). Relevant direct applications include: automatic vehicle identification; weigh in motion; automatic vehicle location; two-way communications between fleet operators and vehicles; cargo tracking and electronic data interchange.

Systems for co-ordination of ITS and e-Business systems are already being implemented. Detailed information on vehicle movements is already possible with GPS and mobile data communications. Such technology allows more efficient vehicle

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utilisation through better load allocation and better visibility [tracking] of consignments. However to use such systems to full advantage, compatibility of systems and specifications regarding freight operations and vehicle regulations is required. In addition, a number of issues relating to inter-operability, intellectual property, data ownership and confidentiality will need to be overcome as implementation of ITS/e-business exchange of information/data needs is addressed.

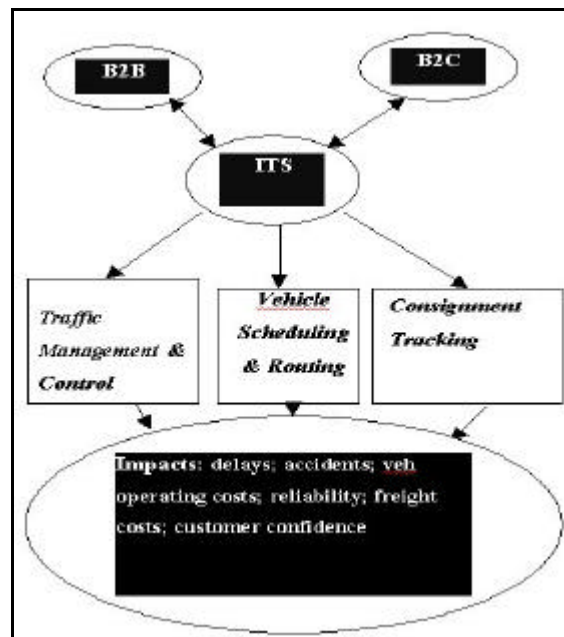


Figure 2. Linkages between ITS and E-commerce

### Safety Implications

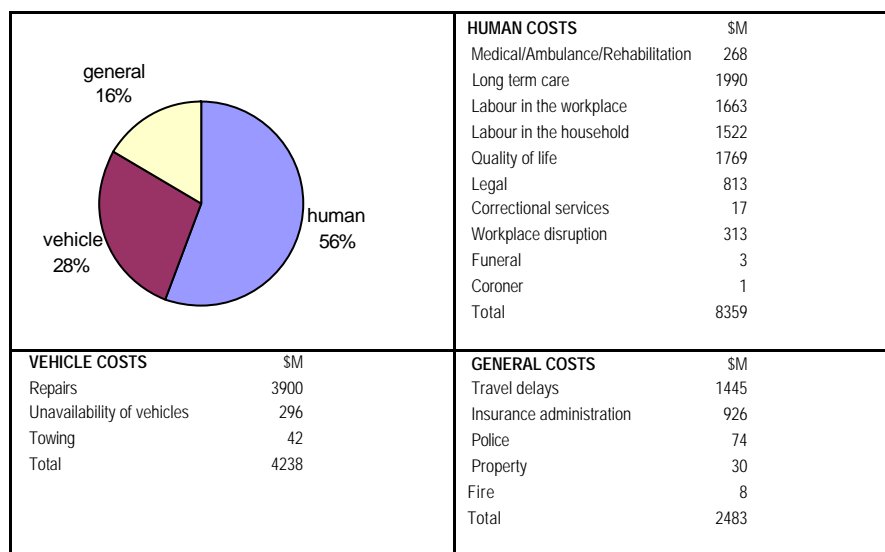
Currently in Australia, despite increase in traffic, the road toll is dropping. Whereas in 1970 there were 30.4 fatalities per 100,000 of population, this rate had decreased to 9.7 in 1997 (Federal Office of Road Safety, 2000). However, the current rate is not a cause for complacency. Road crashes are a major cause of death and injury in Australia, apart from the pain and suffering caused, both physical and psychological:

*“road trauma is an anti-industry destroying wealth instead of creating it”* [BTE, 2000].

Figure 3 shows the current cost to the nation.

The impacts of e-business on safety have been considered by a number of authors. This is mainly due to the ITS components of e-business since one of the main advantages of ITS is expected to be safer transport systems and less road trauma. Additionally ITS use for incident management, see for example Dia and Rose (1998), has the potential to significantly limit the travel delays to other traffic resulting for crashes thus saving some of the \$M1445 that the BTE estimates results from travel delays due to crashes.

There has been particular concentration on ITS for road safety in Scandinavian countries where policies aiming for zero fatalities from the road system are in place. In a Swedish study considering information technology impacts on transport (Snickers, 1999), around 70% of experts expected improvement in safety for freight and distribution trips while 50% of the experts expected improved safety for passenger trips, commuting, business, recreation and shopping.



**Figure 3. BTE Breakdown of Road Crash Costs by Category**

The above study did not investigate the reason for lower expectation of improved safety in passenger trips so we cannot tell whether it included any trade-off between extra vehicle kilometres travelled increasing risk and ITS making travel safer. In Australia we would expect increased risk with increased travel at the same time as better road systems cut risk. Current reductions in crashes have been attributed to safer roads, better vehicle safety, adjustment of speed limits to road conditions and community education initiatives by road authorities such as the NSW Roads and Traffic Authority “Stop, Revive, Survive” campaign.

Increased risks due to e-transport changes may stem from:

- Increased inter-urban freight trips due to just in time deliveries and sourcing from further afield;
- Urban freight trips as delivery vans infiltrate suburbs where vulnerable pedestrians such as the elderly and children are not accustomed to such traffic, and extra risk may apply if deliveries are made at early evening to “catch” households at home;
- Trips by Business Travellers and Tourists in regional areas travelling in conditions outside their experience.

While the number of extra trips in the third category will be much smaller than the number in the first two categories the risk of severe accidents may be particularly high. International visitors may be at risk because they lack knowledge of road conditions or

experience in driving long distances and often are accustomed to driving on the opposite side of the road. A 1999 study by the Federal Office of Road Safety showed that overseas nationals were twice as likely to be killed in car smashes as locals

### **Health Impacts**

There seem to be no predictions as yet on the impacts of e-business on pollution and associated health implications. Instead, we refer to estimates made before e-business impacts were considered and point to possible increased impacts on health from air pollution then noise pollution.

*Air Pollution:* Current estimates of the health costs of vehicle emissions range from 0.01% to 1% of GDP, some \$A5.3 billion a year (Brindle et al., 1999). There are particular concerns internationally about impacts of particle exhaust emissions from diesel. For example, the Californian Air Resources Board now categorises diesel as a toxic contaminant because of its detrimental effects on respiratory health and possible causal relationship with cancer (IEAust, 1999). The increases in freight deliveries stemming from e-commerce may be expected to increase the risk from diesel emissions unless there can be changes in the fuel use of such vehicles. Calculations from the latest BTE estimates available, for 1998, show diesel makes up 22% of the fuel used by light commercial vehicles (LCV) compared with 3% of fuel used by passenger cars (BTE, 1997).

While these negative impacts on air pollution can be expected in the short term, longer term impacts of e-business in general may lead to new city forms where populations are less subject to air pollution. An Inquiry into Urban Air Pollution in Australia (AATSE, 1997) investigated the impacts of different forms of future city development on emissions then pollution and finally population exposure to pollution. One of the scenarios was based on communication technology encouraging the growth of satellite cities. This and other future scenario cities encouraged by e-business may result in less people living and working under polluted air-sheds.

*Noise:* While noise is seldom life threatening, prolonged excessive noise can have impacts on health, especially if it disturbs sleep (Lansdell and Cameron, 1998). E-business changes may lead to increased noise even in areas of cities previously well protected from noise pollution. For example, increased demand for air travel may lead to aircraft overflight noise in previously quiet suburbs. Delivery vehicle trips will increasingly be through suburban streets and may also extend late into the evening so that householders are home to accept them. The comments of Glazier (1987), well before e-commerce, is particularly appropriate. He noted that *“urban populations will need to balance expectations to live in a quiet house, with expectations of high personal mobility, on a safe road network with high connectivity, of well stocked shops nearby and of employment opportunities, generally requiring freight and deliveries”*.

### **Summary and conclusions**

E-business is likely to have a significant impact on the demand and the supply of transport for freight and personal travel. The flexibility of road transport will mean it

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will attract a large proportion of the extra trips stemming from e-business changes. This will in turn have implications for the environmental impacts of road transport including those on safety and health. It is likely that we will see:

*Impacts on Trips*

- Higher levels of demand for goods and services due to wider choices and lowering of business transaction/administration. Increases in travel by light commercial vehicles (LCV) for local centre/home delivery;
- Increased personal business and tourism trips in regional Australia leading to increase in car travel outside cities;
- 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;
- Increased productivity through better scheduling & routing software. This will lead to cost reductions, the effect on trips will depend on whether lower transport prices lead to more shipments;
- Links between ITS systems and B2B alliances: more data/information on entire supply chain available to all, leading to reductions in delays.

*Subsequent Impacts on Safety & Health may include*

- Increased risk of crashes especially involving pedestrians from light commercial vehicles in suburbs, together with increased exposure to pollution from diesel fuels;
- Increased crash risk from many extra inter-city freight trips;
- These risks may be offset by ITS limiting accidents, vehicle operating costs and emissions;
- Increased serious accidents in regional areas due to international and or city drivers not used to driving conditions

Choosing the most effective responses to limit negative impacts of changes to transport demand due to e-business requires new approaches to estimating impacts. New methods able to deal a rapidly changing environment are needed at all levels from strategic level study of state wide impacts to cost benefit assessment of the value of local initiatives

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