7. INFORMING – MITIGATING THE IMPACTS OF UNRELIABILITY

This section focuses on the role for information in mitigating the negative impacts of unreliability. Travel time reliability depends on the user's expectation of travel time. This expectation can vary according to the information available. Developments in technology may make it increasingly cost-effective to supply up-to-the-minute information to network users. Traffic information can be used by network users to adapt their behaviour at short notice.

Infrastructure managers can facilitate network usage and reduce the impact of unreliability by informing users of prevailing conditions. The information does not stop an incident happening but rather reduces the costs that arise from the incident. Hence, information can mitigate the unreliability and reduce the "ripple effect" or "snowballing" consequences of unreliability.

7.1 The role of information

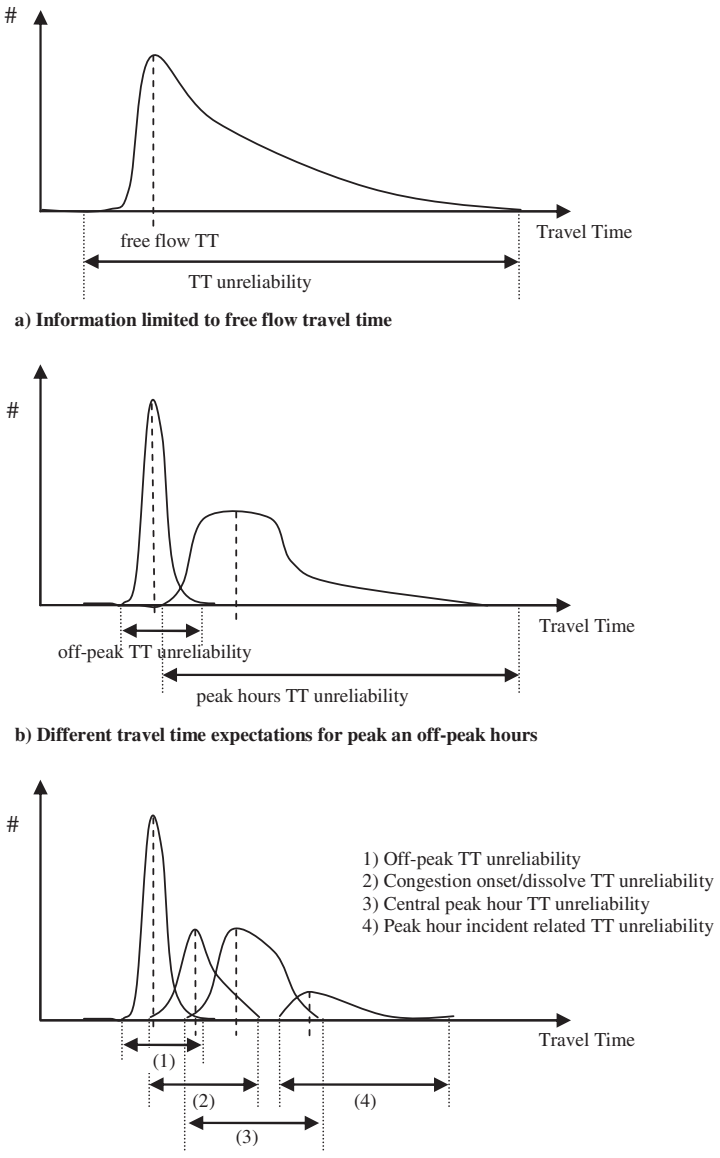
Information plays an important role in managing reliability. A crucial issue in travel time is whether the network user faces recurrent, or non-recurrent, delays. If delays are recurrent and predictable, then network users can alleviate the worst effects of those delays by adjusting their travel plans to accommodate the delays. An irregular network user would not be familiar with these recurrent delays *unless* informed of them.

The provision of information enables network user to manage their travel behaviour (such as when to travel and which routes to travel on) and to mitigate against the consequences of late arrival at the destination. For instance, a delay on a route may be unavoidable if there are no alternatives to the route or if it is too late to alter routeing around the delay. In this instance, the role of information may at the least ease the user's mind about the extent of the delay; the information also enables the user to advise parties at the destination that a late arrival should be expected. Such information can therefore facilitate rescheduling at the destination.

Figure 7.1 illustrates the role of information. The more information provided to the user (in this case a car driver), the closer is the *expected* travel time to the real travel time and, as a result, the higher the reliability of the trip travel time. If infrastructure managers can communicate the travel-time variability at different times of the day, unreliability can be reduced.

Where the infrastructure manager has not given the driver any travel time information, it is probable that the user's knowledge is limited to the free flow travel time, which would be inferred from the *expected average speed* for the type of road and the distance. In this situation travel time reliability is very low, if travelling in an area subject to congestion. The poor reliability results from a very wide travel time frequency distribution with a high range of possible travel times. If the driver is informed about travel times in peak and non-peak hours, and the associated expectations of delay (*i.e.* knowledge of recurrent delays), then the travel time unreliability is reduced. Finally, drivers with good knowledge of the traffic conditions likely to be encountered on a trip (a daily commuter or a user of very accurate travel time information for a freeway), can predict travel time fairly reliably.

Figure 7.1. **Variation of travel time unreliability in relation to the drivers' informationin a multilane freeway**



Source: Soriguera and Robusté (2008).

In this context the relationship between travel time variability and reliability is not direct, as a road with heavy peak hour traffic with large travel time variations according to time of day, could also be reliable if accurate information is provided to the driver and there is an efficient incident management system. In contrast, a road subject to less travel time variability could be very unreliable for a driver provided with no information.

Box 7.1. **Value of information**

There is abundant evidence that travellers place a high value on travel time information. Airline pilots generally provide information to passengers on predicted arrival time and any expected delay. In a study of motorists' preferences, Harder *et al.* (2005) found that travellers are willing to pay up to $1.00 per trip for convenient and accurate travel-time predictions, such as when traffic is delayed and alternative routes would be faster. The value of this information is higher for commuting, special event trips, and when there is heavy congestion.

Studies of the welfare impacts of providing different types of information to road users have found that (under certain assumptions) provision of both perfect and imperfect information leads to a strict Pareto improvement (see for example Emmerink *et al*, 1998). The results of these studies suggest that it will always be beneficial (from the welfare economic consideration) to provide any information, even if incomplete, rather than no information at all.

Thus, travel time information is a key element in managing reliability. The fundamental variable to provide network users with is traffic time information. Several surveys have confirmed that travel time is the single most valuable piece of information from the user point of view, allowing the user to decide in advance the best time to start a trip and the best routing option, or to modify this initial planning once on route.

7.2 Travel time information dissemination

7.2.1 Dissemination techniques

Dissemination techniques can be divided into two main types: pre-trip information and on-trip information. Both forms of information can reduce the ripple/snowballing cost consequences of likely delays. However, pre-trip information allows trip planning (to possibly avoid the unreliability entirely) while on-trip information enables network users to (possibly) modify the initial planning according to current traffic conditions. Users will be able to optimise their routing behaviour and their travel time management on the spot or just-in-time while information on rerouting will enable users to keep to their travel schedule more easily.

To be effective, traffic information must be short, concise, quantified and specifically addressed to the network user. Travel time information itself fulfils the three first conditions, and the dissemination technology must fulfil the last one. That is, the travel time information to be conveyed must be that of specific interest to the driver.

There are several different techniques for travel time information dissemination, each one related to a particular technology. Their detailed characteristics are shown in Table 7.1.

Funding information infrastructure is a challenge, whether state-funded or recovered from network users. One difficulty for managers is how to integrate new communication technologies as they emerge while retaining sufficient homogeneity to allow them to be maintained (Janin 2003). Traffic information is often organised by the state for national roads, by motorway concessionaires on toll motorways, and counties and towns for their local road networks. Information equipment is generally funded by the various authorities responsible for their own networks. The question of funding becomes more complex for systems seeking to provide integrated transport information for both road and rail services which concern the overall infrastructure in a geographical area. There is then no "natural" funder and specific organisations have to be put in place for these new services.

Table 7.1. **Travel time dissemination techniques**

Techniques	Characteristics
Press	• Only pre-trip information • No user discrimination • Discrete information times
Internet	• Pre-trip information (on-trip using mobile phones) • It is a service on demand. User must log-in and ask for a specific itinerary
TV Broadcasts	• Only pre-trip information • No user discrimination • Discrete information times
Information Points	• Capable of disseminating all types of information and discriminate between users. However its accessibility is very low because the driver must stop at the service area to obtain the information.
Radio Broadcasts	• Traffic information bulletins • Capable of disseminating pre-trip and on-trip information • No user discrimination. Each driver must carefully listen to the whole bulletin and select his own information of interest. • Discrete information times, subject to the scheduled bulletins. • In case of short range dedicated radio signal, these last two limitations can be overcome.
Traffic Call Center	• Capable of disseminating pre-trip and on-trip information, with the limitation of on-trip telephone calls • It is a service on demand. Driver must ask for it and usually pay a price for it. This implies a limitation of access to the information.
Variable Message Signs	• Capable of disseminating pre-trip and on-trip information • Specifically addressed to the driver, as only inform the drivers who travel below them. • Continuous and very accessible information
Car Navigator (RDS-TMC radio signal)	• Capable of disseminating pre-trip and on-trip information • Specifically addressed to the driver (GPS/GSM/UMTS) • Continuous and very accessible information
Cellular Phone (text service)	• Equivalent to a call centre with the improvement that you can subscribe to a particular corridor and receive information without asking every time for it.

Source: Soriguera and Robusté (2008). Note, that the GPS (global positioning system) is used to provide information on positioning and routing, RDS (radio data services) is used to transmit real-time traffic information, while cell phone networks is used to transmit real-time traffic information and to calculate traffic condition while providing real time traffic data.

Network users, for their part, have grown accustomed to considering that information should be provided free of direct charge. The need for traffic information is considerable, but users often do not see why they should have to pay for access to information. Nonetheless, for those who place a high value on reliability (that is, are prepared to pay for greater reliability), there are often premium services available on subscription. For instance, in finding their way across a network, users can use a simple paper road map or can pay to use GPS-based tracking systems to direct them. That is, there can be a price for reliability mitigation.

The range of policy options quoted above require tools to monitor reliability and to inform operators and users in real time with the precise location of events. With funding and space for large-scale infrastructure construction becoming increasingly scarce, governments, infrastructure operators and public authorities *may* find that new technology such as Intelligent Transport Systems and Services (ITS) offer cost-effective systems. Such technologies include ramp metering systems, traffic and incident detection and variable message sign systems. Such investments should, of course, be subject to cost-benefit analysis.

It is important to note that ITS technologies may be applied to a range of objectives: easing congestion, providing data to support management and pricing systems, improving safety and reliability. Some technologies are more dedicated to congestion (*e.g.* ramp metering), others to reliability (*e.g.* incident detection), others are clearly multi-objective (*e.g.* variable message sign systems, or video-surveillance). Benefits may also be numerous. Road users may benefit from higher transport safety, optimised traffic flow and shorter and more reliable travel times. The national economy may benefit from less accident and congestion related costs. Surface network administrations may benefit from improved maintenance planning, more efficient network use and consecutively from postponed costs related to construction and reconstruction.

7.2.2 Information before departure

Pre-trip travel-time information allows the user to decide the time of travel, the mode of travel, or even cancel the trip all together. Pre-trip information can reduce the risk of delivering goods late or arriving late at a destination.

There are many options available to disseminate pre-trip information. Traditionally, newspaper or radio has been a source of traffic information, especially in case of an already-scheduled event such as a sporting event or a festival. These types of information basically warn network users of the possible delays and provide information on the extent of the disturbance on the network. Even though these types of traditional measures might be considered as too static, they can provide valuable information to the users of the network and mitigate possible unreliability impacts, if correctly targeted (see, for example, Box 7.2).

Traffic management and information services are an important strategy in many countries. There are many examples available of this type of service, especially related to pre-trip information. Most of them are currently internet-based services while some also provide up-to-date information to mobile phones. Some service companies offer the calculation of journey times or provide travel information with added value. The first websites grew up in the mid 1990s. Most of them originally provided traffic information for a certain region but have since been extended to cover whole networks. These websites initially targeted the general public but have subsequently offered tailored systems for targeted network users with specific reliability needs.

Box 7.2. **Travel warning for the Grand National race**

Racegoers are being urged to use public transport to get to Aintree racecourse as the 161st Grand National festival gets under way in Liverpool.

About 150 000 people are expected to attend the three-day event and police are warning the area will become heavily congested.

People are being urged to use trains, taxis or local park-and-ride services to avoid traffic delays.

The Grand National steeplechase takes place on Saturday, on the final day.

Chief Superintendant Mark Matthews said: "Merseyside Police would encourage race goers to travel to the event by public transport where possible to avoid congestion and parking problems.

"I would like to thank the public in anticipation of their cooperation for what promises to be a memorable and enjoyable event."

Source: BBC News.

Bison Futé, for example, is a French website directly managed by the ministry of transport. Bison Futé was founded in the 1970s during a period of severe traffic jams on trunk holiday route. Originally it operated through more traditional media (television, radio and newspapers) but now has a very well used website.

Box 7.3. **Bison Futé (France)**

Bison Futé is operated by the ministry of transport in France. It is an interactive website that gives information about current traffic conditions in France, provides safety advice, information about road works and weather. Information about traffic conditions for the week-end are given each Thursday and Friday evening after the news on the TV at 8h40 PM, when the audience is very large.

Source: *www.bison-fute.equipement.gouv.fr.*

Access to lineside and roadside cameras can provide would-be network users with information on network performance, including reliability. Many road administrations use cameras to facilitate traffic management. Network operators are often able to swivel these cameras, to monitor and identify incidents or congestion. In recent years there has been a growing demand to view images from traffic cameras by different parties, such as travel information businesses and more importantly general public. The cameras may also provide information regarding weather conditions. Being able to consult weather conditions on a certain part of network may be very useful in order to assure on-time arrival at the destination. Box 7.4 provides an example from Finland, where weather can have a strong influence on estimated travel times (especially during the winter).

Box 7.4. **Weather camera provided by the Finnish Transport Agency**

The following web image illustrates how the output from a roadside camera is used by the Finnish Transport Agency to inform road users on the impact of current weather on road driving conditions. The website also provides information on the air and road temperature and other important information regarding road conditions.

Photo. **Webcam capture**

Source: *www.liikennevirasto.fi.*

In the British example in Box 7.5, the Highway Agency website uses an interactive map to display planned events and real-time traffic conditions. Icons pinpoint incidents and road works. Information posted on the variable message signs can be also viewed from the website (see more on next chapter on on-trip mitigation). By ticking the "Future Conditions" box, the web site shows all known *planned* events. Constantly updated, real-time traffic conditions are shown through color-codes, with green or blue showing when traffic is flowing freely on roads and motorways, yellow for delays of between 15 and 30 minutes and purple for delays of 30 minutes or more.

Box 7.5. **Traffic England**

Traffic England is a new service from the Highways Agency that provides real-time traffic information from the National Traffic Control Centre. This real-time traffic service is also available as a downloadable desktop application and as traffic radio news service delivered live to compatible mobile phone or PDA.

Source: *www.highways.gov.uk/traffic/traffic.aspx.*

In 1999, the U.S. Department of Transportation (USDOT) petitioned the Federal Communications Commission (FCC) to designate a nationwide three-digit telephone number for traveller information. This petition was formally supported by 17 State DOTs, 32 transit operators, and 23 Metropolitan Planning Organisations and local agencies. In 2000, the Federal Communications Commission designated "511" as the single traffic information telephone number to be made available to states and local jurisdictions across the country. An interesting point here is that the number is national but information is local.

Box 7.6. **US Call 511 traffic information**

The US Call 511 phone-based traffic information system uses one easy-to-remember number, regardless of the traveller's location. The system gives travellers' choices – choice of time, choice of mode of transportation, choice of route.

There are no Federal requirements and no mandated way to pay for 511; however, USDOT and FCC expect to see nationwide deployment. In 2005, the FCC reviewed progress in implementing 511.

While the flexibility provided in the FCC ruling is highly desirable, it also presents a challenge. If not thoughtfully planned, 511 services could devolve into an inconsistent set of services widely varying in type, quality and cost. There is a great deal of interest in using 511 throughout the U.S. It is expected that there will be multiple requests for 511, at least in some parts of the U.S., from State DOTs, transit agencies, regional and local transportation agencies, as well as private service providers who will offer to implement 511 services for some sort of compensation

Source: www.fhwa.dot.gov/trafficinfo/511.htm.

Information tools are also available for train passengers. Live train arrival and departure updates by station are helpful in planning a journey. The VR Passenger Services in Finland provides a website where passengers can view departures and arrivals at or from selected stations. User can also view train punctuality data by train, comparing train's arrival and departure time at the stations to that of timetable. The site also includes info on the time which the train left or arrived at the station and an estimated arrival time on next station. Additional information is provided in case of a cancellation or delay of the train. The same data is also accessible by mobile phone. A similar example is provided in Melbourne, where the passenger train operator sends automatic text messages to a patron when services on a specified line are delayed (or are subject to disruption) by more than 15 minutes[1].

Box 7.7. **Live train updates by the Finnish Rail**

The Finnish rail company VR offers up-to-date information for each train regarding their scheduled departure and arrival times, actual observed times as well as causes for possible delays. For passengers, this information may be useful when planning the trip or for those going to pick up a passenger from the railway station, reducing extra buffer time.

Source: *www.vr.fi*.

A specific internet tool to tackle unreliability is provided by the Washington Department of Transportation. It uses travel time data to provide a reasonable approximation of the "worst case" travel time scenario. That is, the tool provides users with the likely buffer time required if the user wants a high degree of confidence that they will arrive at the destination "on time". The web calculator shows how

long it will take to make the trip and when the user needs to leave the origin to arrive at destination on time in 19 cases out of 20 (that is, with 95 per cent probability). The calculator does not use real-time data; it uses travel time data from year 2006 and cannot be considered as fully accurate in terms of reliability measures. However, it is an interesting example of information provided for the public.

Box. 7.8. **Washington Department of Transportation webpage calculator**

The Washington Department of Transportation has a webpage that calculates the 95th percentile travel time for selected routes mainly in urban areas, and determines what time a person must leave on a trip from some origin to some destination in order to arrive on time 19 out of 20 times, or with 95% reliability. The user needs to enter information on journey origin, destination, and preferred arrival time.

The calculator presents the journey time and the time of departure needed to arrive at the destination with a reasonable approximation of the worst case travel time scenario.

Source: *www.wsdot.wa.gov/Traffic/Seattle/TravelTimes/reliability/.*

To sum, pre-trip information enables network users to improve their reliability; it also enables them to mitigate against the adverse effects of late arrival at the destination. Information on real-time performance of the network, incidents, weather and possible delays help in planning the trip. It should be acknowledged that quite often the same pre-trip information is now available on-trip through, for example, mobile phones. Thus, the distinction between pre-trip and on-trip information has blurred in recent years.

7.2.3 Information en route

Using on-trip information may mitigate undesired impacts of network incidents. Depending on the information, users may decide to change their route, if an alternative is available. Users may also reduce the impact of arriving late by rescheduling their deliveries or planned destination activities and hence reduce the ripple or snowball effect on that activity and subsequent activities. Even where the user cannot take alternative en-route or destination actions, just passing on the information of being late can reduce the stress related to not knowing how long the possible delay may last.

Roadside information signs are increasingly used to provide real-time information to road network users. Electronic information signs are now a familiar sight across the world on motorways and trunk road networks. These signs provide advance warning to drivers of emergencies, incidents and road works. Variable Message Signs (VMS) is a term often used to describe these signs.

The main purpose of VMS is to communicate information and advice to drivers about emergencies, incidents and network management, aimed at improving safety and minimising the impact of congestion. Messages displayed on VMS are often limited to those that help drivers complete their journey safely and efficiently. There are a number of types of VMS in use around the world and they provide the capability to display a wide range of warnings, messages and other traffic information.

Box 7.9. **The UK variable messages signs**

The UK Highway Agency provides travel and delay times on roadside Variable Message Signs. The service is available on the majority of motorways and some major A-roads across England. The messages advise drivers about the road conditions ahead, therefore allowing them to make informed decisions during their journeys.

Customer research on the trial of VMS ahead of general introduction found that 89% of respondents thought travel and delay time messages on motorways across England were a good idea. Over half of respondents said they would consider taking action, such as changing route, if they saw a delay time message. The service compares historic data for a route with current traffic conditions to set estimated travel time messages. These travel times are recalculated every five minutes and the messages updated. If a traffic event, such as a collision, causes delays on the network above an agreed threshold the message will automatically switch from the travel time message to an estimated delay message. The service is operated by the National Traffic Control Centre.

Source: *www.highways.gov.uk/knowledge/knowledge.aspx.*

Some applications currently are provided on a commercial basis. Many in-car navigator models, for example, already provide real-time information on incidents, weather, and traffic to car navigators. They calculate estimated travel times and take into account incidents in order to improve the estimated travel time. However, they are often limited in their capability to take into account changes in the traffic conditions due to new information in real-time. Cell phone networks can be used to collect data about current traffic conditions. A GPS receiver is the basis for all personal navigation systems. Each unit equipped with GPS-receiver and GSM/UMTS can be used as a sensor providing real time traffic data. Systems exploiting this opportunity are being introduced by various navigation service providers.

Box 7.10. **"Dash" – a car navigation system incorporating real time information**

"Dash" is an in-car navigation system that presents up to three different routes to a destination, and uses traffic information to calculate Estimated Time of Arrival (ETA) for each route. The traffic-based arrival times are expected to be more accurate, helping users decide which route is best. Even after a route is selected, Dash automatically alerts users when traffic conditions change significantly. Each Dash in-vehicle monitor anonymously and automatically sends its position and speed back to servers at the Dash Network Operations Center. The Dash servers then update all other Dash devices in the area with current road speeds. The system utilises real-time route information sent automatically back to Dash's central servers by each Dash user's equipment. Then the central system sends specific route and traffic information back to individual users so that they can benefit from the experience of fellow Dash users ahead of them. Similar systems are being introduced by other providers such as TomTom and Navigon.

Of course, in this case, the benefit offered by the aggregation of traffic data is only as good as the total amount of information being sent back to Dash. Thus, it will clearly depend on a critical mass of users in order to work as advertised.

Source: *www.dash.net*.

Many public transport systems now offer real time information. See, for example, Box 7.11, which describes two of the systems in use in London. This information provides many benefits (Turnbull and Pratt, 2003). It reduces waiting stress and allows passengers to better use their time and coordinate

activities. For example, if a passenger knows when the next bus will arrive they can decide whether there is sufficient time to stop at a nearby store to make a quick purchase, when they are likely to arrive at their destination, and whether they should use an alternative mode, such as calling a taxi. In situations with multi-route options, passengers use the information for enroute travel decisions. Customer response to this innovation has been positive.

Box 7.11. **Information reduces stress – train and bus travel in London**

In 1984, signs providing real-time information on the status of London Underground service were tested at several platforms on the Northern Line (Turnbull and Pratt, 2003). Passenger surveys indicated a small, but significant, stress reduction in response to the information system. Passengers both with and without access to the information tended to overestimate actual wait times for trains. However, when passengers are given the information, the over-estimation was reduced by 0.68 minutes on average. The platform signs gave order of arrival information for the next three trains, route and terminal destination as needed, and the number of minutes before expected arrival. Passenger response to the system was very favourable: 95% of respondents indicated it was useful and 65% reported it helped reduce uncertainty in waiting for a train.

In more recent years, Transport for London has extended the information service to buses – traditionally one of the most difficult areas for public transport arrival time uncertainty and delays. The "Countdown" system is a real-time bus arrival estimation system, using GPS technology to detect each bus's location relative to each bus stop. The electronic display at the bus stop indicates the likely number of minutes away a bus is from the stop. The Countdown signs list the order in which buses will reach the stop, their destinations, and the number of minutes to arrival. Information on traffic and safety conditions can also be displayed. Visual observations indicate that 90% of passengers at the equipped stops looked at the sign at least once during their wait time. Average perceived wait time declined from 11.9 minutes before the trial to 8.6 minutes with the Countdown system, although there was no actual change in bus frequencies. 83% of respondents agreed that "if you know the bus is coming, time seems to pass more quickly" and 89% agreed that the signs made the wait time more acceptable. Respondents expressed a slight willingness to pay higher fares for the system.

Source: Turnbull and Bratt (2003);
www.tfl.gov.uk/corporate/projectsandschemes/technologyandequipment/7204.aspx.

7.3 Conclusions

This section presented a few case studies on information technology used in mitigating the negative impact of unreliability. It is argued that providing pre-trip and on-trip information can be a cost-effective way of improving reliability and reducing unreliability-related costs. In particular, information helps in rescheduling tasks and reduces the snowballing disruptions of schedules that otherwise might result from unreliability.

However, funding information infrastructure is a challenge and needs to be subject to cost-benefit analysis. In the meantime, numerous privately-available systems are being developed and those road users who find high value in information and reducing unreliability can purchase information.

Even though network users may be able to mitigate negative impacts of unreliability, the role of network operators is an important one. Travel time information is not only useful to the driver, but also to the road system operator as it is basic operational management and planning of the network. Travel time forecasting allows the operator to plan for responding to incidents and operational problems while real time information provides effective monitoring of the evolution of incidents.

Network operators need to consider the cost-effectiveness of providing pre-trip and on-trip information on travel time variation. The diffusion of expected travel times (from travel time patterns) is the first step, but in addition to mean value, variance in travel time should also be provided. This allows drivers to accommodate safety margin times and reduces anxiety levels. Even though some information is not possible to be provided in advance (*e.g.* accidents), information regarding the incident once it happens still reduces the cost of unreliability.

NOTE

1. See *www.metlinkmelbourne.com.au/using-public-transport/sms-services#1*.

KEY MESSAGES

- Informing users of travel times and variability is a core policy option for managing reliability. The information may enable users to set appropriate buffer times for travel and can facilitate mitigation of the adverse consequences of delays.
- The more the information provided to network users, the closer is the expected travel time to the real travel time and the higher the reliability of service provided.
- The network user can use pre-trip information to assist in deciding the time of travel, the mode of travel, or even to cancel the trip all together. Pre-trip information reduces the risk of delivering goods late or arriving late at the destination in general.
- On-trip information mitigates undesired impacts. Depending on the information provided, network users may decide to change their route, or reduce the impact of arriving late by rescheduling their deliveries or planned activities. Even where no mitigating action can be taken, information can reduce the stress of d to not knowing how long the delay may last and can be used to reduce the downstream impact of delay.