Survey methods for driver mobile phone use October 2014

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NZ Transport Agency research report 556
Contracted research organisation – Opus Research

ISBN 978-0-478-41981-8 (electronic)
ISSN 1173-3764 (electronic)

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Burton, J, J Thomas and A Paterson (2014) Survey methods for driver mobile phone use. *NZ Transport Agency research report 556.* 34pp.

Opus Research was contracted by the NZ Transport Agency in 2013 to carry out this research.

Keywords: best practice, detection, driver survey, international review, mobile phone, national review, New Zealand

An important note for the reader

Acknowledgements

The authors would like to acknowledge the inputs of the Steering Group chair and research owner Jennifer McSaveney (MoT), the Steering Group members Paul Graham (NZ Transport Agency), Saskia Rightarts (NZ Police) and Adrian Stephenson (NZ Transport Agency), as well as the external Peer Reviewers Brian Fildes (Monash University) and Mäkinen Tapani (VTT Technical Research Centre of Finland) for their valuable contributions to this work.

Abbreviations and acronyms

4G	fourth generation
BVS	Berkeley Varitronics Systems
CDR	call detail record
CDC	Centers for Disease Control and Prevention
DAS	data acquisition system
GPS	global position system
MoT	Ministry of Transport
NHTSA	National Highway Traffic Safety Administration
NOPUS	National Occupant Protection Use Surveys
Opus	Opus International Consultants Limited
RSSI	received signal strength intensity
Transport Agency	NZ Transport Agency
WHO	World Health Organisation

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Executive summary

A key aim of the Safer Journeys programme in New Zealand is to reduce driver distraction, which includes driver mobile phone use. This is particularly important to monitor, as the rate of mobile phone ownership and usage in New Zealand is likely to keep increasing over time. Similarly, phone technology continues to advance, with the introduction of bigger screens, more features, and networks that are becoming increasingly faster (eg with 4G). These factors all suggest that phone habits and type of use, including use while driving, will alter.

Currently driver mobile phone use in New Zealand is monitored via direct visual observation. However, there are indications that roadside observation of driver mobile phone use may be under-reporting actual use. For example, some self-report surveys indicate up to 69% of drivers use a mobile phone while driving, yet direct roadside observation generally records less than 10% of drivers using mobile phones. A review of the research indicates five key methods to detect mobile phone use that could be further investigated:

1. Self-report
2. Roadside observation
3. Roadside observation with mobile phone detectors
4. Naturalistic driving surveys
5. Call detail records.

The best method to detect mobile phone use is by a naturalistic driving survey, where a sample of instrumented vehicles observe driver behaviour. However, the expense and complexity of running such a study over time with a large enough sample of drivers is prohibitive. A naturalistic driving study is a gap within New Zealand research, but to make the implemented system cost-effective would require a wider driver monitoring programme that is beyond the scope of collecting a single measure such as mobile phone usage. Similarly, call detail records from mobile phone companies contain a rich data set, but have issues in terms of identifying whether the mobile phone use was made on the road and identifying that the driver (and not a passenger) was the user. Access to the data and issues around privacy is an additional barrier.

More traditional methods adopted consistently overseas are self-report and roadside observation. However, these survey methods have shown that there are discrepancies between how often people say they use their mobile phone while driving (up to 69% in some cases) and what is directly observed from the roadside (generally below 10%). These differences in usage levels come down to what is observed and when.

Based on the constraints outlined, roadside observation surveys are the best option for monitoring mobile phone usage at a point in time. This is what is required when evaluating the success of different interventions, such as changes to policy or enforcement. There are several drawbacks to using pure roadside observation methods, such as the difficulty of detecting hands-free usage, detecting usage in free-flowing traffic, or monitoring data use. Therefore, the preferred method to monitor mobile phone usage over a longer period is supplementing existing visual roadside observations with a mobile phone detector that could corroborate mobile phone use.

A preferred mobile phone detector was evaluated for use in a New Zealand trial. The evaluation required the detector to meet three key criteria, specifically that: 1) it could cover all frequency bands in New Zealand; 2) had an area of detection that was directional and; 3) the detection threshold/sensitivity of the detector could be adjusted. An earlier trial in the United Kingdom revealed that a key limitation to a device was that it lacked directionality and sensitivity. Based on these criteria the BVS Wolfhound Pro was selected for the trial.

The pilot trial of the device examined use at three sites that were selected based on different speed zones and at areas with varying levels of background mobile phone use (or noise) from devices being used in the vicinity of the road (but not necessarily by drivers). This allowed for a good evaluation of the accuracy of the detector under different real-world conditions.

The key indicator that the detector was accurate enough to robustly identify mobile phone use was its ability to confirm use when a driver held a mobile phone to their ear (as opposed to other conditions, such as when drivers appeared to be texting, but the device was not necessarily in use). In the survey, the device corroborated this type of use 41.7% of the time. This may have been due to issues with one particular frequency band, or that the drivers observed holding their phone to their ear were for some reason not making a call. Therefore there are still issues with the technology that need to be overcome before it can be concluded that it robustly complements roadside observations. However, there is also evidence that technology can overcome some of the under-reporting of mobile phone use.

The technology findings indicated there was a high amount of mobile phone use at each of the three sites, with the level of usage detected by equipment being comparable to overseas findings, at 9.6%. However, roadside visual observers only detected 5.5% phone usage, which means that up to 43% of mobile phone use is not detected by existing visual observation methods. Some of this discrepancy could be mobile phones passively sending or receiving data without driver manipulation. Similarly, it could be false detections by the device (of nearby mobile phone use), although the sensitivity thresholds set at each site were altered to minimise this noise, so at least part of this activity was likely to relate to mobile phone use missed by visual observation. Therefore, the mobile phone detector could be out-performing the visual observation method by a substantial amount.

A controlled study should be run, where confederates drive past the technology so that actual mobile phone usage is known. This would reveal the differences between technology and visual observation. This controlled study could be further enhanced by multiple mobile phone detectors using triangulation to improve the accuracy of the device in regards to issues around directionality, sensitivity and the ability to filter out extraneous ‘noise’ from mobile phones outside of the target vehicle. If the issues identified in this technology study could be overcome, there is evidence that observational methods of mobile phone detection could be greatly enhanced through technological solutions. Enhancing accurate detection is critical to monitoring and implementing policy and enforcement interventions to reduce driver distraction and improve safety.

Abstract

Reducing driver distraction, including distraction resulting from mobile phone use, is an aim of New Zealand's Safer Journeys programme. Currently mobile phone usage by New Zealand drivers is captured by self-report or observational surveys. However, studies have indicated that these methodologies might be under-representing actual usage rates. The aims of this study were threefold: first, to establish how drivers' mobile phone usage has been monitored worldwide through a review of relevant literature; second, to assess whether there was an improved method for monitoring mobile phone usage through a review of available equipment; and, finally to conduct a trial of the identified method to evaluate whether it could improve mobile phone monitoring in New Zealand. Trial results show that a mobile phone detector did not identify all observed mobile activity. However, roadside observers detected a lower level of mobile phone usage in passing vehicles (5.5%), compared with the mobile phone detector (9.6%), meaning that up to 43% of mobile phone use is not detected by the existing visual observation methods. Further testing is required to resolve the gaps between roadside observations and equipment detection, but there is evidence that observational methods of mobile phone detection could be enhanced through technological solutions.

1 Introduction

One of the aims of the New Zealand's Safer Journeys programme is to reduce driver distraction, of which mobile phone usage is a known cause. To know if drivers are managing their mobile phone usage correctly the New Zealand Transport Agency (hereafter referred to as the Transport Agency) needs to accurately measure how many New Zealanders are using their mobile phones while driving. However, the Transport Agency has identified that the current method of direct observation used in New Zealand may be under-representing the number of drivers using mobile phones. This is a valid concern as will be demonstrated in the literature review section of this report.

The aim of this research study was three-fold. The first part involved a review of both international and New Zealand research literature to assess how drivers' mobile phone usage was currently monitored. Second, a review of potential equipment was carried out to assess whether there was an improved method for monitoring mobile phone usage outside of the vehicle. The third and final aim was to design and conduct a pilot trial of the selected improved method. This report is structured around these three aims, providing recommendations for the future measurement of mobile phone use by drivers in New Zealand.

2 Literature review

How and where people use their mobile phones is in a constant state of flux. Since the introduction of large touch screen devices (such as the iPhone in 2007) there has been a fundamental change in how people use their phones (Ling and Sundsøy 2009). The general population has gone from phones predominantly used for text and calls with limited data to multimedia devices that perform tasks such as browsing the web, playing videos and satellite navigation. With increasing levels of mobile phone ownership along with this advancement in technology, it can be argued that mobile phone surveys have a limited period of relevance (McCartt et al 2006). Due to the constant state of change in the mobile phone sector, this review will focus predominantly on studies published after 2006. For an extensive review prior to 2006, please see McCartt et al (2006).

The following literature review is divided into four main sections:

1 Self-report surveys

2 Roadside observation surveys

3 Vehicle-based naturalistic driving surveys

4 A possible method based around call detail records.

2.1 Self-report

International research has indicated a disparity between observed mobile phone usage by means of roadside observational techniques and self-reported usage. A Centers for Disease Control and Prevention (CDC) (2013) report on mobile phone behaviour of drivers in the United States and Europe indicated that 21% of respondents in the United Kingdom and up to 69% in the United States made a call while driving in the 30 days preceding the survey. The figures for reading/sending text messages or emails were lower, ranging from 15% of respondents in Spain to 31% in Portugal and the United States.

Other reviews have reported that observational studies show approximately 1% to 6% of drivers use mobile phones while driving, whereas between 36% and 81% drivers self-report having used their mobile phones while driving (Breen 2009). The World Health Organisation (WHO 2011) has also found high rates of self-reported usage; providing evidence that 60% to 70% of drivers in the United States, New Zealand, Australia and some European countries report using their mobile phones while driving.

In New Zealand, Sullman and Baas (2004) found that over half (57.3%) of surveyed drivers 'occasionally' used a mobile phone while driving. These rates are supported by another New Zealand-based survey conducted by Hallett et al (2012) in which 60% of the respondents stated they talked on their mobile phone while driving. The authors additionally found that over half the respondents reported reading (66.2%) or sending (52.3%) a text message while driving (Hallett et al 2011).

While the above studies demonstrate that self-reporting is an effective way to survey mobile phone use, this method does not come without weaknesses. One issue with self-reporting is social desirability bias, ie the possibility that responses may vary based on what respondents feel is the socially appropriate answer or what they think is wanted by the surveyor.

This potential bias highlights a critical issue with the self-reporting method, which does not actually observe the behaviour in question but provides a second-hand report of it, meaning that true usage can only ever be inferred. This issue can be addressed by observing the behaviour directly, such as through roadside observation.

2.2 Roadside observation

An observational study by Wilson et al (2012) of 17,855 New Zealand drivers found that since the law change in 2009 (banning all mobile phone use bar hands-free) usage was around 1.6%, compared with 3.9% in 2006. However the observers were unable to capture either hands-free calls or the manipulation of the phone when performing such tasks as reading/sending a text message. This limitation was due to the difficulty in differentiating between someone holding a conversation via a mobile phone versus talking to a passenger, talking to themselves or singing along to music. The observers also could not monitor any covert manipulation of mobile phones (eg when the phone was in the driver's lap).

These New Zealand usage rates found in the survey above are congruent with rates found by the Ministry of Transport's (MoT) (2013) survey of approximately 37,000 vehicles from 52 sites located around New Zealand. Most of the sites selected in this survey were where vehicles were travelling slowly or stopped. Observations were made of drivers who were holding a phone to their head as well as drivers who were 'probably texting', ie operating a device in manner that indicated texting. The results indicated 1.3% of drivers appeared to be making calls while 2% may have been texting.

This type of survey is also used overseas, such as in the United States where it is part of the National Occupant Protection Use Survey (NOPUS). This is a nationwide probability-based survey of driver behaviour such as safety belt compliance and mobile phone use[1] conducted by the National Highway Traffic Safety Administration (NHTSA). Mobile phone usage rates are derived from data collected from vehicles observed at controlled intersections. Usage is classified into three types: 1) holding the phone to ear, 2) speaking with a headset and 3) visibly manipulating the phone (with visible manipulation also covering the use of any hand-held device). The 2011 NOPUS of 38,215 vehicles reported that the number of observed drivers holding a phone to their ear was 5%, while a total of 9% were using a hand-held or hands-free phone (NHTSA 2013).

A slight variation of the roadside observation method was conducted by Johnson et al (2004) who used photos of 40,000 vehicles on the New Jersey Turnpike (a 200km toll road in the United States). Their analysis of the photos indicated that 1.5% of the observed drivers were using mobile phones. This method has some advantages over standard roadside observation, such as having a visual record for later referral if required and observations are not made in real time so the results are more accurate. Drawbacks include factors such as the cost of equipment if it is not already in place.

As with other methods, capturing of mobile phone usage via direct observation has some weaknesses. Perhaps the most important of these is the possibility of usage estimates being lower than actual usage rates. This may occur if drivers use their phones out of view of observers or via a hands-free unit, meaning such usage is not captured. Technological solutions to detect mobile phones being used (even out of the observers' line of site) are one possible solution to address this identified weakness. This possibility is already being explored overseas, with the NHTSA stating that the NOPUS survey may include the use of electronic devices to monitor mobile phone use in the future in an effort to have clearer picture of actual usage rates (NHTSA 2013).

[1] This is the only nationwide survey of its kind in the United States.

2.2.1 Roadside observation with mobile phone detectors

Based on this review there appears to have been only one published survey world-wide that has used an external device to capture drivers' mobile phone usage (Walter 2010). This survey was of safety belt and mobile phone use in England and Scotland. The mobile phone component of the survey covered a total of 30 sites of varying road types around England and 30 sites of urban roads around Bristol. This survey observed a total of 50,141 vehicles. All sampled sites had free-flowing traffic (as opposed to other surveys that monitored traffic either slowing or stopping for lights) (NHTSA 2013; Wilson et al 2013 MoT 2013). The surveyors monitored drivers' mobile phone usage via both observation and technology.

The observational component followed the same general guidelines as other observational surveys (ie observers viewed driver behaviour through the vehicle windows and manually recorded both hand-held and hands-free mobile phone usage). Supporting the observations was the use of a portable mobile phone detector manufactured by Starport (http://starporteurope.com/). This device would sound an auditory alarm whenever a mobile phone was detected near the device. However, this detector had a limited range of approximately 30m and was omni-directional, meaning it detected phones not only from vehicles on the road, but also any phone in a 30m radius from the detector. Therefore, observers did not fully rely on the detector, and used their judgement to count phone use only 'if they were fairly sure that the driver was using a phone' based on visual observation (Walter 2010). Overall, the results indicated that 1.4% of drivers were using hand-held mobile phones, with another 1.4% observed using hands-free phones.

The technology used in the Walter (2010) study was very basic, with limited range and the inability to limit the detector to a specific area due to its omni-directional design. While technology can be used to detect mobile phone usage from outside the vehicle, the limitations of the equipment must be clearly understood before the technology is implemented in a real world setting. This study does show that it is possible to use technology to supplement standard observational methods with some level of success. The issues surrounding Walter's (2010) work could be addressed by using a more advanced mobile phone detector with better range and directionality.

Using external detectors is not the only technological method for monitoring drivers' mobile phone usage, the vehicle itself can also be modified to monitor driver behaviour including phone use. This has the advantage over roadside studies of monitoring behaviour for the whole journey rather than just at a specific observation site. This method is a naturalistic driving survey and is discussed in the following section.

2.3 Naturalistic driving surveys

Naturalistic driving surveys involve fitting a vehicle with a data acquisition system (DAS) which generally uses cameras, GPS, accelerometers and/or radar to record the behaviour of the driver, the vehicle and other road users near the vehicle. This equipment is in the vehicle for the duration of the survey and is always recording when the vehicle is running. According to Regan et al (2012) there have been approximately 40 published naturalistic driving surveys. These studies have been conducted in several countries, including Canada, the United States and several European countries and have ranged in length from a week to over a year.

A study by Funkhouser and Sayer (2012) in Michigan, USA, followed 108 participants for a period of six weeks with their mobile phone usage being monitored during the first week though naturalistic observation (via recorded video). Of the 108 participants, 87% engaged in calls for 6.7% of their drive time. They manipulated their phone 2.3% of the time. The results also indicated there was a difference between mobile phone use while the vehicle was stationary versus in motion. The largest percentage of phone interactions, approximately 23%, took place when the vehicle was stationary and a further 5% to 9% of interactions took place under 8km/h. These results suggest two things: 1) drivers are much more likely to use their phones at lower speeds and 2) 70% of mobile phone usage is missed when observation sites are only in places where traffic is travelling at less than 8km/h. Results of such roadside observation surveys may therefore not be suitable for extrapolating to free-flow traffic.

When Funkhouser et al (2012) compared their stationary data to that of NOPUS they found NOPUS reported a lower rate of drivers using mobile phones while stopped. This is most likely due to the video capture method missing fewer incidents than observations from outside the vehicle (eg the video capture method may have captured more covert use of the mobile phones than the observation method and sampled usage across the entire trip, rather than at a certain point along a trip).

Another study following 204 drivers for a period of 31 days reported that 92% of participants made/received calls for 10.6% of their time driving and sent/received a text message on average once every hour (Fitch et al 2013). In fact, 28% of all calls and 10% of all text messages the participants made over the 31-day period happened in their vehicle while it was running. It should be noted that this study actively recruited participants who reported using their mobile phone at least once each day while driving. However, given the large proportion of drivers who self-report using mobile phones while driving (CDC 2013), it is possible that this sample could be representative of the general population.

Because of the short periods being measured (Funkhouser et al 2012; Fitch et al 2013), there was the potential for drivers to adjust their behaviour for the duration of the study. Indeed nearly a quarter of Stutts et al’s (2005) participants (approximately 22%) reported adjusting their behaviour due to the presence of recording equipment in their vehicle. This can be mitigated by extending the period of time that participants are monitored for, though this has to be balanced against cost.

The Virginia Tech Transportation Institute (Neale et al 2005) conducted a study involving 100 vehicles for a period of 13 months from 2001 to 2002. Over the course of the study the vehicles were involved in 9,125 incidents, crashes and near crashes. Approximately 8% of these recorded crashes, near crashes and incidents were while the driver was performing a task with a wireless device (predominantly a mobile phone). The most frequent task performed with the wireless device leading to a crash/near crash/incident was talking or listening, with the second most frequent task being dialling on a hand-held phone.

These studies highlight two vital points: 1) observation surveys may be misrepresenting actual mobile phone usage rates and 2) it may not be appropriate to estimate mobile phone usage in free-flow traffic from data captured from stopped or slow-moving vehicles due to drivers using their phones more when slowed or stopped.

Naturalistic driving probably offers the best method for observing drivers’ mobile phone usage as it allows the capture and monitoring of all driving situations, such as varying speeds and times of day. However, there are limiting factors to using this method. First, this method requires the active recruitment of participants, as opposed to simply observing all users at a defined site, which can result in a reduction in the number of drivers observed. Second, the method can be time exhaustive, as each vehicle taking part in the survey requires equipment to be installed, monitored and then removed at the end of the survey, in addition to any data downloading and processing requirements. Finally, while naturalistic observation does provide the best measure of mobile phone usage, it is by far the most expensive method for surveying usage.

2.4 Call detail records

The final method identified for monitoring mobile phone usage is to utilise call detail records (CDR) from mobile phone companies. A CDR is used for billing mobile phone customers and can be used for passive anonymous mobile positioning (ie the phone's location can be deduced from billing information alone with identifying information protected). Each CDR contains at minimum an anonymised user ID, activity type (call, SMS, data), date/time of activity and the base station the phone was connected to at the time. This information can then be used to determine how many people were using their phones in a defined area at a specific point in time. This method has previously been used in the United States and Europe (Wang et al 2010; Becker et al 2011; Järv et al 2012; Tiru et al 2012) to determine transportation mode and city dynamics such as daily population movement, to analyse traffic flow and generate tourism statistics.

As with all the other methods outlined in this review, there are some limitations to the use of CDRs to measure mobile phone usage while driving. First and foremost are issues around privacy, so it is essential that data is anonymised by the mobile phone company before it is passed to any research body. Another issue centres on the degree to which the mobile phone can be tied to a specific location. Base stations vary from Femotcells (which have a connection range of 10m) to Macrocells (which can have a connection range of up to 35km. This means that the larger the range of a base station, the greater an area a phone can be located in. There are various methods for dealing with this (eg, using multiple base stations, anchoring IDs) but it needs to be acknowledged that CDRs from a base station beside a road will not just reveal usage on that road. Another issue with using only CDRs (once the location issues have been addressed) relates to the fact that no observations are made at the site of interest. This means that while there might be high confidence that a mobile phone was being used on the road, there is no way to tell whether it was the driver or a passenger who was using a phone. If the locational issues are addressed then CDRs might be utilised best in conjunction with a roadside observation method to mitigate this risk of error inherent in the method.

2.5 Summary

Classical survey methods have shown there are discrepancies between how often people say they use their mobile phone while driving (up to 69% in some cases) and what is directly observed from the roadside (generally below 10%). There is also a discrepancy between the level of phone use observed through roadside observations and naturalistic driving surveys. These differences in usage levels come down to what is observed and when. Roadside studies are limited to monitoring usage only at the sites where observers are based, whereas naturalistic driving studies have the advantage of monitoring the driver for the entirety of their journey.

This review also examined the use of technology in improving roadside observation surveys, though to date it appears only a single survey in the United Kingdom has sought to improve surveys in this manner. Overall, there are many methods for observing drivers' mobile phone usage, each with their own set of limitations and benefits. Many countries use different or multiple methods. Table 2.1 provides a list of the methods employed to date in various countries in the studies identified by the authors.

Table 2.1 Short list of countries and surveys they conduct on driver mobile phone usage

Country	Self-report	Road side observation	Road side observation with detectors	Naturalistic driving surveys	Call detail records
Australia	✓	✓	x	✓	x
Canada	✓	✓	x	✓	x
New Zealand	✓	✓	x	x	x
United Kingdom	✓	✓	✓	✓	x
United States	✓	✓	x	✓	x

The aim of this literature review was to identify methods available to measure driver mobile phone usage rates and recommend a preferred method that improves upon the pure roadside observation surveys currently used in New Zealand. The preferred method is outlined in chapter 3.

3 Preferred method

Mobile phone surveys have a potentially limited period of time for which they are relevant (McCartt et al 2006). The number of mobile phone registrations in New Zealand is likely to keep increasing, phone technology will keep advancing (bigger screens, more features etc) and networks will become faster (eg with 4G), which will lead to constantly changing phone habits. There is also further potential for change to usage brought about by policy changes and enforcement methods relating to policy changes that may take place within New Zealand in the future. Therefore any survey of drivers' mobile phone usage should be conducted on an annual basis as a minimum, and would benefit from additional surveys to understand the effect of any specific changes or new interventions.

Given the need for longitudinal data, the use of the naturalistic driving survey method is excluded on the basis that it is complex, costly to run and is unlikely to provide a representative sample (which is mostly based on cost). A naturalistic driving study is a gap within New Zealand research, but to make this cost-effective over time would require a wider driver monitoring programme that is beyond the scope of collecting a single measure such as mobile phone usage. Self-reports do appear to have the advantage of revealing greater usage than is typically seen in roadside observational surveys; however, there is a draw-back that self-reporting samples are generally self-selecting, not random and may suffer from social desirability bias. In addition, it is more difficult to reliably recall the specific driving context when mobile phone use did take place.

Call detail records from mobile phone companies contain a rich data set, but still have issues identifying whether the mobile phone use was made on the road and identifying that the driver and not a passenger was the user. Access to the data is another barrier. In the future it would be of use to investigate the possibility of using CDRs from any mobile phone companies that have a base station covering the survey area. However, as CDRs have not been used for this purpose before, gaining access for research purposes would take time. Preliminary contact has been made with Vodafone New Zealand which is currently reviewing whether it would be able to release its CDRs for the purpose of calculating drivers' mobile phone usage.

Overall, it appears that roadside observation surveys are still the best option for monitoring mobile phone usage. There are several drawbacks to using pure roadside observation methods, such as the difficulty of detecting hands-free usage, detecting usage in free-flowing traffic, or monitoring data use. Therefore, the preferred method to monitor mobile phone usage would be to supplement existing visual roadside observations with a mobile phone detector. The previous United Kingdom trial using this method had a piece of equipment with limited range and ability to detect a specific location. With improved technology there is an opportunity to overcome these limitations and provide an improved understanding of driver mobile phone use. The next section reviews technology options.

4 Equipment review

Potential equipment was identified by performing an internet search using variations of the terms mobile, cell, monitor, detect (eg 'mobile phone detection' or 'cell phone monitoring'). This search resulted in a list of equipment ranging from simple devices that did nothing more than flashing a light or sounding an alert when a phone was detected, to very complex equipment that required vehicle mounting and external personal computer control.

The initial list was reduced by removing devices that were deemed inadequate due to being too simplistic or due to their very high cost (for example, being costed at approximately $NZ180,000). Some devices were also removed due to questionable legality and considerable privacy issues. The remaining equipment was predominantly from companies that design devices for use in security and corrections settings, such as counter-corporate espionage and for the detection of contraband mobile phones in prisons.

There were three main criteria that the final piece of equipment had to meet to ensure it could adequately perform for the current purpose. These included that the chosen piece of equipment:

- could cover all frequency bands in New Zealand
- had an area of detection that was directional
- had a detection threshold/sensitivity which could be adjusted.

Covering multiple frequencies is an important issue in New Zealand, as the two largest mobile phone networks, Telecom New Zealand[2] and Vodafone New Zealand, operate equipment on partially disparate sets of frequencies. This means that if a device was only monitoring the frequencies used by Vodafone, for example, it would always not detect mobile phones being used by Telecom New Zealand customers and vice versa.

Directionality is integral because an omni-directional device would increase the difficulty of the observation task. This is because the area of detection could not be restricted to the area of interest (eg the road in front of the observer), resulting in a lack of confidence in the exact location of the mobile phone being used (eg in the vehicle in question as opposed to a nearby house).

Finally, in conjunction with the directional ability of the device, it would also need to have adjustable detection sensitivity/threshold levels. Some of the devices identified in the early stages were able to detect mobile phones at a range of over 1,000m. At this range it would not be possible for an observer to make a visual confirmation that a phone was being used by a driver. Therefore the device range needs to be adjustable (through reducing the sensitivity/raising the detection threshold level of the device) in order to make it effective and useful.

Taking the above into account and after a thorough review of the specifications of each piece of identified equipment in the public domain, it was concluded that the Wolfhound Pro, a received signal strength intensity (RSSI) meter, from BVS would be a suitable piece of equipment for field testing in this project. Table 4.1 gives an overview of each piece of shortlisted equipment outlining their general features.

[2] On 8 August 2014, Telecom New Zealand changed its name to Spark New Zealand.

Table 4.1 Feature list of identified and shortlisted mobile phone detectors

							
Features	**BVS Wolfhound Pro**	**BVS Watchhound**	**PDA CPD-3000**	**PDA CPD-197**	**PDA GMS-196**	**Harris Corp Stingray II**	**Starport Detector Plus 610**
Battery operated	✓			✓	✓		✓
Auditory alerts	✓	✓		✓	✓	unknown	✓
Visual alerts	✓	✓	✓	✓	✓	unknown	✓
Tactile alerts	✓						
Direction finding	✓			✓	✓	✓	
Logging	✓	✓	✓	✓		✓	✓
PC support	✓	✓				✓	✓
Multi-function display	✓	✓	✓	✓			
Threshold/sensitive settings	✓	✓	✓	✓		unknown	✓
Covers all New Zealand bands	✓	✓				unknown	
2/3/4G detection	✓	✓	✓	✓		unknown	
Networkable		✓	✓			unknown	
Approximate cost (NZ$)	3,500	3,000	POA	In development	1,500	180,000	800

5 Pilot study

After reviewing the five methods previously employed to monitor drivers' mobile phone usage (outlined in the literature review) it was decided that the pilot study would implement a roadside observation method supplemented by the use of a mobile phone detector. Following the equipment review the Wolfhound Pro from BVS was chosen to fulfil the technological component of the method. The following sections outline the process undertaken and the findings of the pilot trial, including recommendations for future measurement of mobile phone usage by drivers in New Zealand.

5.1 Sites

The three sites for the pilot survey were chosen in consultation with the study steering group and represent typical New Zealand roads with varying speeds. The secondary goal of the site selection was to test different levels of background noise to investigate what effect this would have on the detector's ability to produce a usable output. Table 5.1 outlines the details of the three selected pilot sites, and figures 5.1 to 5.3 provide images of the sites.

Table 5.1 Pilot sites

Site	Speed limit	Description	Background noise	Longitude and latitude
1	100km/h	Junction of Flightys road and State Highway 58, facing east. Porirua	Medium	41˚6'59.30"S 174˚55'57.49"E
2	50km/h	Outside 422 Broadway, Miramar, facing east. Wellington	High	41˚19'30.94"S 174˚48'57.27"E
3	80km/h	State Highway 2 between Buller Rd and State Highway 57, facing north. Levin	Low	40˚38'58.1"S 175˚15'32.0"E

Figure 5.1 Site one

Figure 5.2 Site two

Figure 5.3 Site three

5.2 Method

Data collection was conducted by two observers twice at each site; once in the morning between 9am and 11am and once in the afternoon between 2pm and 4pm. All observations took place from a parked vehicle and were of oncoming vehicles in the opposite lane. Only class 1 licence vehicles (eg car, van or ute) were chosen. Before carrying out the full data collection, a pre-pilot study was undertaken whereby two separate methods were trialled to determine which would be the most suitable. These are outlined below and were conducted at the first site.

5.2.1 Method one: Observer one visual observation, observer two recording and detector monitoring

The observers' vehicle was positioned as inconspicuously as possible while ensuring an adequate viewpoint for visual inspection of the vehicles. Observations were taken from the left side of the road of traffic approaching the observers in the right-hand lane. A landmark was selected diagonally across the road from the observers' vehicle as a reference point and observations were intended to be taken on or near the line from the observers to the landmark. See figure 5.4 for an example of reference point.

Figure 5.4 White arrow pointing to reference point across lane (power pole)

The detector was mounted to the inside of the windscreen using a suction cup bracket and aligned with this line. Observations were made as close as possible to this reference point. This reference line helped when viewing the RSSI trace (as depicted in figure 5.5) from the detector and associating any peaks in RSSI to a specific vehicle.

The threshold level at which the detector would trigger an alert to the possible use of a mobile phone was site specific, taking into account factors which affected the level of noise at each site. These were such things as awareness of local base station or cell tower locations, as those that were highly active would render the detector ineffective. The presence of residential or highly populated areas in the far field of the antenna also had to be taken into account.

Observations commenced once the vehicle was positioned, a reference marker was agreed on and the detector's threshold was set. The following visual observations were made for all oncoming vehicles:

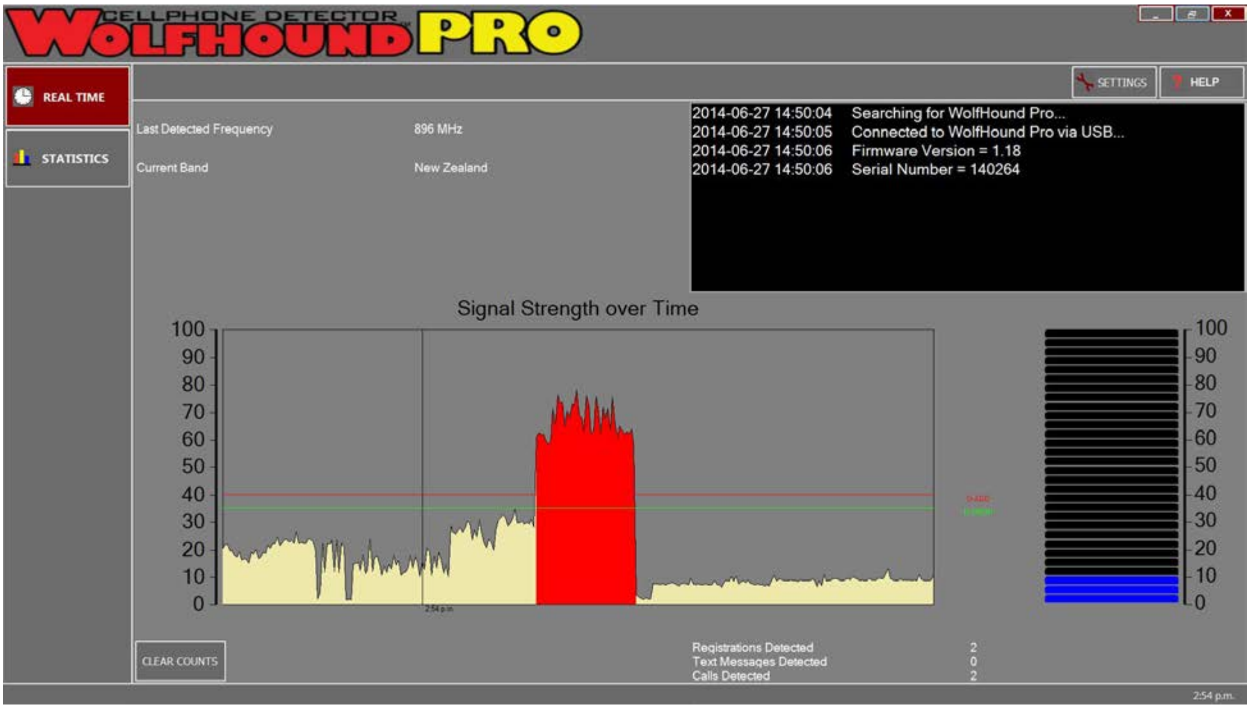
- driver possibly making a call while holding phone
- possibly making a call using a hand-free device, eg a headset
- driver possibly texting

- presence of a passenger
- driver gender.

Observer one verbally recorded these measures for each vehicle and this was logged by observer two on a tally sheet (See appendix A: Example tally sheets). While observer one was visually inspecting the oncoming vehicles, observer two was monitoring the mobile phone detector (as well as recording what observer one could see from their visual inspection of the vehicle).

For each vehicle observed it was also noted if mobile phone activity was above or below the site defined threshold (with activity above the threshold indicating potential mobile phone use).This was accomplished by connecting the mobile phone detector to a tablet PC which ran visualisation and logging software. This made it easier for the observer monitoring the detector to determine if a mobile phone was being used. An example of the information produced by the software can be seen in figure 5.5. The red block indicates a sustained period of mobile phone activity (call or data) above the detector's threshold level (red line above green line).

Figure 5.5 Screenshot of tablet PC running logging/visualisation software



In cases where the activity threshold was broken for a significant period of time and the signal was deemed unlikely to be contributed to drivers, data collection was put on hold and the noise floor reassessed. Large increases in the noise level were often temporary and were waited out.

There were two issues with this first method that needed to be considered before proceeding with the full data collection phase:

1 Care needed to be taken that the vehicle being visually inspected was the same vehicle that was being monitored with the detector, and

2 When vehicle density was high, there was the potential for the person physically recording the observations to have difficulty keeping up with the person verbally making the observations in addition to monitoring the detector.

5.2.2 Method two: Observer one visual observation and recording, observer two visual observation, recording and detector monitoring

The second pilot method involved *both* observers visually inspecting the vehicles with observer two also monitoring activity on the detector (eg whether activity was above or below threshold on the mobile phone detector) at the same time.

Observer two stated which vehicle was going to be visually inspected during data collection as it was not possible to monitor each vehicle that came through the site when vehicle density started to increase. Also it was not possible for observer two to visually inspect all the vehicles travelling through the site while also looking at the detector.

The results of this method indicated there was 'substantial agreement' (Kappa > 0.61) between observers one and two for all observation types. This excluded 'possible call while holding phone' which could not be calculated due to one observer having no variation in their response (observer one saw 0 phones in 118 observations, while observer two saw three phones in the same number of observations, indicating there was a 97.5% agreement rate between the two observers).

As with the first method piloted there were several issues with this second method that required consideration:

1 There was a reduced number of observations due to observer two, who was monitoring the detector, nominating which vehicle to visually inspect (approximately three vehicles per minute were observed using this method compared with five per minute using the first method). This has implications for the generalisability of the eventual findings.

2 There was a greater chance of observer bias as not all vehicles were being observed (eg therefore the eventual sample of selected observed vehicles could be biased).

3 Care was required to make sure both observers were visually inspecting the same vehicle.

5.2.3 Chosen method: Method one

Method one was chosen as the most appropriate method for the full data collection phase for the pilot study. This was because it allowed for every vehicle to be observed, and for the second observer to focus on the detector while recording observations, rather than having to monitor vehicles at the same time. The lack of visual inter-rater reliability using this method was addressed by the fact that method two indicated there was indeed a high level of reliability between the two observers when they both performed the visual observation task. Therefore it can be concluded with confidence that observations are accurate when conducted by an observer, meaning that just one observer is adequate for the work. The issue of making sure both people were referencing the same vehicle was controlled for by using the reference marker system described above. In addition, vehicle density became less of an issue as the observers became more experienced and could conduct the observations more efficiently.

In addition to the hand-held and headset observations, a third option of talking was added following the piloting phase. This was designed to cover people making calls where they were neither actively holding the phone nor visibly wearing a headset. In the rare case of observing a visor-mounted Bluetooth unit, a comment was made but not marked down on any of the three call observation measures. The talking observation metric would indicate instances where a call was being made using such a system.

5.3 Results

In total, 4,837 vehicles were observed across all three sites (site one N=1,359, site two N=1,557 and site three N=1,921). Of these 4,837 vehicles, 5.5% (N=265) of the drivers were visually observed to have been using a mobile phone while driving (including via hand-held, headset seen, texting and talking when no passenger was present). Table 5.2 shows the total number of observations of each type across the three sites, as well as the individual breakdown for each site.

Table 5.2 Total observations for all three sites and observations per site

Observation type	Site			
	Overall	Site one	Site two	Site three
	N (%)	N (%)	N (%)	N (%)
Phone held in hand (in a manner of making a call)	96 (2.0%)	8 (0.6%)	24 (1.5%)	64 (3.3%)
Headset seen	16 (0.3%)	6 (0.4%)	4 (0.3%)	6 (0.3%)
Appeared to be texting	116 (2.4%)	15 (1.1%)	45 (2.9%)	56 (2.9%)
Driver talking when no passenger present	37 (0.8%)	15 (1.1%)	17 (1.1%)	5 (0.3%)
Total observed mobile phone use	265 (5.5%)	44 (3.2%)	90 (5.8%)	131 (6.8%)
Overall mobile phone detections (technology)	462 (9.6%)	92 (6.8%)	145 (9.3%)	225 (11.7%)
Total (number of vehicles passing)	4,837	1,359	1,557	1,921

In contrast to the 5.5% rate of observation (N = 265), the detector was above threshold for 9.6% (N=462) of vehicles passing the observation reference point. This shows that only 57% of the mobile phone use identified by the mobile phone detector was being identified by visual observation. Therefore, the mobile phone detector could be out-performing the visual observation method by a substantial amount. However, when looking at all the visual observations combined across all three sites, the detector was only recording activity above the threshold 35.8% of the time when drivers were observed to be using a mobile phone. When selecting only those observations where the driver was holding their phone as if they were making a call, the mobile phone detector recorded activity above the threshold 41.7% (N=40) of the time. Therefore, over half the time (58.3%, N=56) the device did not detect mobile phone use when a phone call was observed.

The higher number of detections above the threshold compared with visual observations could be due to the phone not being active when the visual observation was made. Alternatively, there may have been a technical issue with the detector itself. The mobile phone network in New Zealand is mixture of different frequencies, eg 850 Mhz vs 900 MHz, depending on the network operator and the generation of equipment being used, eg 2G vs 3G. While the detector stipulates it covers all bands in New Zealand, there is the possibility that the unit may have been defective on a particular band, or the mobile phones observed in use but not detected were using a different frequency altogether. With the information available it is currently not possible to detangle these possible explanations; however, further research could further explore this issue.

6 Discussion

The aim of this study was to investigate survey methods for monitoring drivers' mobile phone use. Based on a review of various methods it was decided to trial a roadside observation method of free-flowing traffic supplemented by the use of a mobile phone detector. Other methods of monitoring usage, particularly roadside observation where traffic has slowed or stopped, may be under-reporting actual usage rates because other methods (such as naturalistic driving surveys) have shown varying patterns of usage at different speeds, with potentially higher usage in free-flowing traffic (Funkhouser et al 2012). Therefore this study focused on mobile phone use in free-flowing traffic using visual observations supplemented by the use of an external mobile phone detector.

Overall, the results indicated there was potential for using mobile phone detector technology to monitor drivers' mobile phone usage from outside the vehicle, but further robust testing would be required before it could be used to enhance roadside observation.

Despite technology limitations the detector registered much greater levels of mobile phone activity than were visually observed, indicating that observational methods of mobile phone detection could be greatly enhanced when complemented by technological solutions. Roadside visual observers only detected 5.5% phone usage in passing vehicles, compared with 9.6% detected by the mobile phone detector, meaning that up to 43% of mobile phone use was not detected by existing visual observation methods.

Other reasons for the visual observations being lower than rates found via the mobile phone detector could be factors such as covert texting (which is hard to observe directly in fast-moving traffic) or drivers not speaking on a call at the time of observation (eg using hands-free while the phone is out of sight or listening rather than talking). It should also be noted that other environmental factors could have reduced the number of visual observations, such as difficulty seeing through the windscreen due to different levels of tinting or varying weather conditions.

Another more general limitation of the types of detector used in this study which could explain high detection levels was the possibility the driver's phone had been passively sending or receiving data, such as recalculating a route in a mapping program, downloading emails or receiving calls or texts in the background, with no interaction from the driver. Therefore, while the detector would detect activity, the actual activity may not have had any influence on road safety (as the driver would not be using, or be distracted by, the device).

This use of passive data will become more of an issue in the future when using external mobile phone detectors. This is because technology is moving further away from using different bands for each activity to a unified system such as 4G (where there is no difference between calls, texts and data). At this point it may become impossible for an external detector relying on RSSI to inform the observer of anything other than a phone being active. This is not to say that an external technological method will not be appropriate, but it will be an important consideration when assessing the potential effectiveness of new technologies as they emerge.

The activity that should have been picked up most often by the detector, ie 'phone held to head' was detected less than half the time (41.7%). Possible explanations for this incongruence include that the detector's threshold level was set too conservatively, or the high level of noise at the site was masking the activity. This is a very real issue as the greater the noise at a site, the higher the detector's threshold has to be set in an effort to detect phone usage from a specific vehicle. These low signal-to-noise ratios may be caused by mobile phone masts, pedestrians with phones near the site or residential sites with high mobile phone usage within homes (eg anywhere with a large non-vehicle-based mobile phone user group). As this threshold is increased, there is a growing chance of dismissing drivers' mobile phone usage as noise rather than actual usage (eg there is an increased probability of registering false negatives). This is where techniques such as triangulation can be used, for example, with multiple mobile detection devices to corroborate the signal comes from the target vehicle.

There is also a potential issue with the detector itself in relation to the mobile phone network in New Zealand. As stated before, New Zealand mobile phone companies operate across numerous frequencies, utilising up to four generations of different equipment. While the detector should cover all frequencies used in New Zealand, there may be a fault with one or more frequencies which could lead to mobile phones using the frequency not detected as being in use.

While the results indicate further testing is needed before a recommendation can be made to use this technology to monitor drivers' mobile phone usage, the results from the direct observations indicate a greater level of mobile phone usage than has been found previously in New Zealand (MoT 2013). MoT's Wellington sample indicated that the number of drivers who appeared to be texting was 1.2%, while the current study found a probable texting rate of 2% at Wellington-based sites (rising to 2.9% at suburban Wellington sites). There was also a difference between the MoT's rural site (Manawatu) and this study's rural site, with MoT rates showing 'phone held to head' at 0.5% and 'probably texting' at 0.0%, while this study observed 3.3% 'phone held to head' and 2.9% 'probably texting'.

The following chapter outlines recommendations that may help address the limitations found in the pilot trial. It also makes suggestions for future research based on this study's findings utilising technological methods to monitor drivers' mobile phone usage.

7 Recommendations

The key recommendation to unlock the potential of existing technology is to run a controlled trial with the current equipment, as follows:

- Trialling the detector in controlled driving and usage conditions to see how the device performs in optimal testing conditions. This can be accomplished by confederates driving on a road with the passenger in the target vehicle performing a predefined set of activities with a mobile phone (no use, text, call, data use).
- The control over mobile phone use takes into account any environmental noise, so it will be known when the detection is correct, as opposed to being a false detection caused by something external to the target vehicle.
- The controlled environment will also provide the ability to test whether the detector does indeed cover all frequencies currently being used in New Zealand on the various mobile phone networks.
- This trial could be run in conjunction with an investigation into the possibility of using multiple mobile phone detectors to improve accuracy through triangulation (by actively reducing false detections and misses).

The following recommendations are also made regarding 1) refinements to the method, 2) research focused on alternative technologies, and 3) research focused on alternative methods.

- Methodological recommendations:
  - It is important to note that future use of this type of equipment needs to take into account site selection, with heavily populated sites making detection more difficult.
  - It is also important to note that use of a two-person team increases accuracy and efficiency when using a technological solution, as it allows for one person to concentrate on visual observations while the other can focus on monitoring the device and recording the observations.
  - If the accuracy of technological solutions does improve, rates of passive mobile phone use (eg where texts, calls, data are received, but the driver does not use the device) will need to be investigated.
- Research employing alternative technology:
  - Test the ability of other equipment to mitigate background noise.
  - It will be important to regularly review the technological options for monitoring driver mobile phone usage from outside the vehicle, with a particular focus on directionality and sensitivity as new devices are introduced into the market which may be more effective than the current device employed.
- Research exploring alternative methods:
  - A review of the existing MoT visual observation methods should be undertaken to see if they can be improved, for example, by observing free-flow traffic. As this study indicates there are higher levels of mobile phone use than previously observed. Similarly, a night-time study could be

conducted to assess if there is a change in usage compared with during daylight hours. Visual observation can be achieved through the use of night-vision equipment.

- A review of the benefits of conducting a naturalistic driving study (such as the 100 car study by Neale et al in 2005) within New Zealand should be undertaken.
- Call detail records could also be employed when mobile networks have been suitably upgraded by New Zealand mobile phone companies, and agreements are in place between the Transport Agency and these companies.

8 References

Becker, RA, R Cáceres, K Hanson, JM Loh, S Urbanek, A Varshavsky and C Volinsky (2011) A tale of one city: using cellular network data for urban planning. *Pervasive Computing IEEE 10,* no.4: 18–26.

Breen, J (2009) *Car telephone use and road safety: final report, an overview prepared for the European Commission*. Accessed 15 July 2013 http://ec.europa.eu/transport/road_safety/pdf/car_telephone_use_and_road_safety.pdf

Centers for Disease Control and Prevention (CDC) (2013) Mobile device use while driving-United States and seven European countries, 2011. *MMWR. Morbidity and mortality weekly report 62,* no.10: 177.

Fitch GA, SA Soccolich, F Guo, J McClafferty, Y Fang, RL Olson, MA Perez, RJ Hanowski, JM Hankey and TA Dingus (2013) *The impact of hand-held and hands-free mobile phone use on driving performance and safety-critical event risk*. Accessed 10 July 2013. www.distraction.gov/download/811757.pdf

Funkhouser, D and J Sayer (2012) Naturalistic census of mobile phone use. *Transportation Research Record: Journal of the Transportation Research Board 2321,* no.1: 1–6.

Hallett, C, A Lambert and MA Regan (2011) Cell phone conversing while driving in New Zealand: Prevalence, risk perception and legislation. *Accident Analysis and Prevention 43*, no.3: 862–869.

Hallett, C, A Lambert and MA Regan (2012) Text messaging amongst New Zealand drivers: prevalence and risk perception. *Transportation research part F: traffic psychology and behaviour 15,* no.3: 261–271.

Huth, V, V Lanmobilee, C Gabel, A Bonnard and C Brusque (2012) *Exploring mobile phone usage and its context with naturalistic driving observations*. Accessed 26 November 2013. http://hfes-europe.org/books/proceedings2012/Huth.pdf

Järv, O, R Ahas, E Saluveer, B Derudder and F Witlox (2012) Mobile phones in a traffic flow: a geographical perspective to evening rush hour traffic analysis using call detail records. *PloS One 7*, no.11: e49171.

Johnson, MB, RB Voas, JH Lacey, AS McKnight and JE Lange (2004) Living dangerously: driver distraction at high speed. *Traffic Injury Prevention 5,* no.1: 1–7.

Ling, R and PR SundsØy (2009) *The iPhone and mobile access to the internet*. Accessed 2 December 2013. www.lirneasia.net/wp-content/uploads/2009/05/final-paper_ling_et_al.pdf

McCartt, AT, LA Hellinga and KA Bratiman (2006) Cell phones and driving: review of research. *Traffic Injury Prevention 7*, no.2: 89–106.

Ministry of Transport Te Manatū Waka (MoT 2013) *Cell phone use by drivers*. Accessed 6 December 2013. www.transport.govt.nz/research/roadsafetysurveys/cell-phone-use-by-drivers/

Naumann, RB and AM Dellinger (2013) *Mobile device use while driving-United States and seven European countries*. Accessed 20 November 2013. www.cdc.gov/mmwr/preview/mmwrhtml/mm6210a1.htm

Neale, VL, TA Dingus, SG Klauer, J Sudweeks and M Goodman (2005) *An overview of the 100-car naturalistic study and findings*. Accessed 20 November 2013. www.nhtsa.gov/DOT/NHTSA/NRD/Multimedia/PDFs/Crash%20Avoidance/2005/100Car_ESV05summary.pdf

Regan, MA, A Williamson, R Grzebieta and L Tao (2012) *Naturalistic driving studies: literature review and planning for the Australian naturalistic driving study*. Accessed 27 November 2013. http://acrs.org.au/wp-content/uploads/57_Regan-PR.pdf

Stutts, J, J Feaganes, D Reinfurt, E Rodgman, C Hamlett, K Gish and L Staplin (2005) Driver's exposure to distractions in their natural driving environment. *Accident Analysis & Prevention 37*, no.6: 1093–1101.

Sullman, MJ and PH Baas (2004) Mobile phone use amongst New Zealand drivers. *Transportation Research Part F: Traffic Psychology and Behaviour 7*, no.2: 95–105.

Tiru, M, R Ahas and LBS Positium (2012) *Passive anonymous mobile positioning data for tourism statistics*. Accessed 3 December 2013. www.congress.is/11thtourismstatisticsforum/presentations/Rein_Ahas.pdf

US Department of Transportation, National Highway Traffic Safety Administration (NHTSA) (2013) *Traffic safety facts, research note: driver electronic device use in 2011*. Accessed 14 November 2013. www-nrd.nhtsa.dot.gov/Pubs/811719.pdf

Walter, L (2010) *Seatbelt and mobile phone usage surveys: England and Scotland 2009*. Accessed 1 December 2013. www.gov.uk/government/uploads/system/uploads/attachment_data/file/8899/seat-belt-phone-usage.pdf

Wang, H, F Calabrese, G Di Lorenzo and C Ratti (2010) Transportation mode inference from anonymized and aggregated mobile phone call detail records. In *Proceedings of 13th International IEEE Conference on Intelligent Transportation Systems (ITSC)*: 318–323

Wilson, N, G Thomson, N Starkey and S Charlton (2013) Persisting mobile phone use while driving and possible solutions for New Zealand. *New Zealand Medical Journal 126*, no.1384: 138–140.

World Health Organisation (WHO) (2011) *Mobile phone use: A growing problem of driver distraction.* Accessed 8 July 2013 www.who.int/entity/violence_injury_prevention/publications/road_traffic/distracted_driving_en.pdf

Appendix A: Example tally sheets

A1 Method one/two

Obs	Call hand-held	Call hands-free	Threshold reached	Texting	Passenger	Gender	Comments
1	HH ☐	HF ☐	>TH ☐	TXT ☐	Pass ☐	M ☐	
2	HH ☐	HF ☐	>TH ☐	TXT ☐	Pass ☐	M ☐	

A2 Full pilot

Obs	Hand-held	Headset	Talking	Threshold reached	Texting	Passenger	Gender	Comments
1	HH ☐	HS ☐	TK ☐	>TH ☐	TXT ☐	Pass ☐	M ☐ F ☐	
2	HH ☐	HS ☐	TK ☐	>TH ☐	TXT ☐	Pass ☐	M ☐ F ☐	