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Construction logistics and cyclist safety

Summary report

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Executive summary

Background

One of the Mayor's objectives is to bring about a significant increase in cycling in London, with a target that it accounts for at least 5% of modal share by 2026 (Greater London Authority, 2011). Cycling is seen as a mode of transport to be encouraged within London because of the health and traffic congestion benefits it brings, and the number of cyclists in London is increasing. The improvement of cyclist safety is seen as a key priority for TfL, as concerns about safety are a barrier to increasing cycling levels further.

Detailed analysis of cyclist fatalities has shown that of the 16 in 2011 in London, nine involved a heavy goods vehicle (HGV), and seven of these were construction vehicles. Given that the construction industry is responsible for only a small proportion of freight traffic in GB and London this suggests that construction vehicles may be overrepresented in cyclist fatalities in London.

TfL has therefore commissioned TRL to undertake research aimed at understanding the following general themes around this issue:

1. Is it possible to understand the relative risk represented by construction vehicles to cyclists, when compared with general haulage vehicles? If so, what is it? What are the limitations in the data available?
2. Are there features of contractual arrangements, working practices, driver behaviour, or vehicle design (or combinations of these) that contribute to the apparent over-involvement of construction vehicles in fatal collisions with cyclists in London?

The research also aimed to identify measures that could be implemented to help reduce the number of such collisions.

The current report is a summary of the research carried out and the resulting recommendations. A technical report (Delmonte et al., 2012) gives more detail on the methods used, the data gathered, and the supporting evidence that give rise to these findings and recommendations.

Methods

The project employed multiple research methods. Initially Stats19[1] and enhanced Stats19 data were analysed, and a literature review conducted. These informed the later stages of the project, which involved a detailed investigation into the use of construction logistics plans (CLPs) in London, 3D scanning and modelling of two construction vehicles (and a general haulage vehicle for comparison), observed drives with the same three types of vehicle on real drives in London, and interviews with stakeholders (clients, principal contractors, subcontractors, drivers) within construction networks[2] in London and also with stakeholders who had experience of general haulage.

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[1] Stats19 statistics are based on data recorded by the police at the scene of a road traffic accident in which someone has been injured (or subsequently in a police station).

[2] A 'network' is defined here as the collection of contractors (principal and subcontractors) and the client involved in a particular construction project.

Findings and recommendations

Eleven findings and twelve associated recommendations emerged from the research. Importantly, the evidence collected in the data analysis suggested that construction vehicles are over-represented (relative to their exposure) in fatal collisions with cyclists in London (although see data limitations and recommendation 11).

The findings and their associated recommendations are grouped here under four key areas: 'Raising the profile of work-related road safety', 'Improving work-related road safety management in the construction industry', 'Making construction vehicles and journeys safer', and 'Data improvements'. In addition, a final recommendation is given relating to the ownership of recommendations one to 11.

Raising the profile of work-related road safety

The first general finding was that in the construction industry (as in other business sectors) road risk is viewed as less important than general health and safety risk. There are two recommendations designed to address this issue.

Recommendation 1: HSE should extend the Reporting of Injuries, Diseases and Dangerous Occurrences Regulations (RIDDOR) to include on-road collisions

This will send a clear message to businesses (including the construction sector) that road risk and general health and safety are to be treated equally. To improve the likelihood of this happening, HSE should extend RIDDOR to include on-road collisions as a matter of urgency. It is likely that changes to RIDDOR of this magnitude will take a considerable amount of time to implement. In the shorter term, HSE could develop an Approved Code of Practice (ACoP) for work-related road safety (including the requirement to record on-road collisions), for use by all industry sectors, including the construction industry.

Recommendation 2: Adherence to a nationally recognised standard on work-related road safety (such as the ISO39001 standard on road traffic safety management) should be promoted

A new International Standard has recently been issued (ISO39001:2012). Organisations of five or more employees driving to or from construction sites within London should be required to achieve this standard, or a similar standard as determined by the industry. Consideration should be given as to how this standard would apply to companies of different sizes. TfL should extend and mandate Construction Logistics Plan (CLP) guidelines to support these activities.

Improving work-related road safety management in the construction industry

A number of specific findings relate to the management of road risk in the construction industry. Firstly there is a lack of ownership of road risk by clients and primary contractors in the construction industry. Secondly, presumably as a consequence of this lack of ownership, data on accidents and near misses on the road are not generally collected on construction projects. A third finding (that may partly explain the first) is that the evidence suggests a lack of awareness about road risk in the construction industry. Three recommendations are offered here to address these specific issues.

Recommendation 3: HSE should include off-site safety in the Construction Phase Plan (mandatory under the CDM regulations)

The regulations governing the construction industry, construction design and management regulations (CDM), owned by HSE, do not require driving for work to be included in the construction phase plan (currently it only covers on-site health and safety). HSE should mandate inclusion of off-site safety (i.e. driving for work) in the construction phase plan. Under the CDM regulations the principal contractor takes ownership of the construction phase plan and therefore, if it were included, ownership of road risk.

Recommendation 4: Existing channels should be utilised more effectively to raise awareness of road risk within the construction industry

There are many associations within the transport sector who should use their networks improve communication of the importance of managing construction vehicle safety (including the risk they present to cyclists and other vulnerable road users) once vehicles have left sites. These include the FORS network, Construction Equipment Association, the Construction Industry Council and the Mineral Products Association.

Recommendation 5: CLP guidance should be updated by TfL and its use promoted throughout London. CLP compliance should be monitored by TfL. This should be embedded into the planning application process for London-based construction projects

There needs to be a standard to which all organisations operating in the construction industry within London adhere. Updated CLP guidance which is used by all London boroughs for public and private construction work should be used for this. The CLP guidance should be updated to make it more robust as a means of ensuring each construction site has a mechanism for managing road risk.

Making construction vehicles and journeys safer

Six specific findings relate to the safety of vehicles, journeys and drivers in the construction industry. The first two of these specific findings relate to the visibility around vehicles, and driver mental workload. First, although total blind spots seem likely to be rare based on the small number of vehicles scanned in the current project, visibility of cyclists in some areas around construction vehicles still has the potential to be poor. Second, from the task analyses carried out it is clear that there is great potential for driver error and high mental workload in construction industry driving, and multiple changes will be needed to reduce this. Two recommendations are offered to address these issues.

Recommendation 6: Vehicle manufacturers should work to improve vehicle and mirror design

Of the vehicles examined, some had a much larger non-visible area (at ground level) than others; various aspects of vehicle design can be addressed to improve drivers' view of cyclists, and vehicle manufacturers should seek to identify and implement design improvements that might be made specifically for vehicles driving on London's streets. This could include changes to windscreen or dashboard design, as well as new technologies and improved mirror design. It is important that the introduction or modification of mirrors (or mirror configurations and combinations) does not result in an increase in driver workload; the best combination of mirrors needs to be identified which enables optimal visibility and workload. Further research will be needed to define this, in line with the following recommendation.

Recommendation 7: A wider review of the blind spots in different construction vehicle types should be conducted

The current research considered three vehicles of differing ages and produced by different manufacturers, and therefore was not representative of the range of tippers, mixers and curtain side vehicles available. A comprehensive review of vehicles used in the construction industry would greatly improve understanding of the challenges faced by drivers in relation to observing cyclists on the road. The outcome of such a review would be a business case for demonstrating the need for regulatory change in the UK or EU.

Recommendation 8: Principal contractors and clients should use more realistic delivery time slots

The use of more realistic time slots (for example by allowing vehicles arriving either side of their allocated slot to enter the site where reasonable, or use of holding bays to facilitate early arrival) would help to reduce driver pressure, and thus would help reduce driver errors. This should be included as an additional aspect to the CLPs.

The fourth specific finding relating to vehicles and journeys is that mechanisms that might be used to manage road risk in the construction industry in London are not used as widely or as seriously as might be hoped. Two of these were investigated within the project. One is the Fleet Operator Recognition Scheme (FORS), which is a voluntary certification scheme ensuring and assisting fleets (not just construction fleets) in managing their legal responsibilities and helping them strive for best practice. The project also investigated Construction Logistics Plans (CLPs), documents prepared by developers which detail the planned logistics activity associated with a given construction project.

Route planning to avoid interactions with cyclists is especially difficult on construction projects due to the transitory nature of sites. Recommendation 4 should help in this respect through involvement of FORS as an enabling mechanism. In addition, the following recommendation is made regarding CLPs, to assist with route planning.

Recommendation 9: CLPs must include the definition of safer routes to construction sites

As part of the mandatory CLPs, principal contractors should define safer routes to their site (within a set local radius, for example five miles), where possible avoiding risky areas such as schools, cyclist 'hotspots', narrow roads and difficult junctions. In all cases consideration should be given to minimising exposure to vulnerable road users.

The final finding specific to vehicles and journeys relates to pay per load contractual arrangements. It was not possible to reach a definitive answer on this with the data collected. The evidence does suggest that pay per load contracts do exist in the construction industry, but it is not clear whether such contracts are a major contributory factor in cyclist accidents. The following recommendation is offered to address this gap in knowledge.

Recommendation 10: Further research should be conducted to understand the effects of pay per load contracts

Pay per load contracts are sometimes used in the construction industry, principally where owner-drivers are involved. No definitive evidence emerged in the current research to support the perception that paying a driver per load may discourage safe driving. However further research with a much larger sample is required to fully understand the current use of pay per load contracts and any effects they may have on driver behaviour.

Data improvements

Although road casualty statistics make it difficult to identify industry sectors associated with collisions, the evidence did suggest that construction traffic is over-represented in collisions with cyclists in London. A single recommendation is offered here to help address the data problem within national casualty statistics.

Recommendation 11: The vehicle type 'construction vehicle' should be included in Stats19

This would improve knowledge of the incidence of collisions between cyclists (and other vulnerable road users) and vehicles used for construction. If possible, this should be done quickly with the involvement of the Metropolitan Police Service, or otherwise should be prioritised in the next consultation on Stats19.

Ownership of recommendations

Recommendation 12: Recommendations 1 to 11 need to be addressed by stakeholders from across the industry, working with relevant regulatory bodies when necessary

Where possible, the ownership of the previous recommendations should lie with the relevant industry stakeholders, including regulators, the construction industry, and vehicle manufacturers. Without clear ownership there is a risk that the recommendations will not be addressed; the identification and engagement of relevant key stakeholders is crucial to ensure that the recommendations are taken forward and acted on appropriately.

Limitations and general considerations for future research

The research should be seen as having identified some general and specific issues that deserve action, and in some cases that demand further investigation using more quantitative techniques on larger samples (where quantification of issues is desired). Many of these are represented in the recommendations. It is noteworthy that no previous research could be found in the literature that has addressed the specific issues associated with the construction industry and cyclist safety; this suggests that further research in the area would be timely.

1 Introduction

One of the Mayor's objectives is to bring about a significant increase in cycling in London; accounting for at least 5% of modal share by 2026 (Greater London Authority, 2011). Cycling is seen as a mode of transport to be encouraged within London because of the health and traffic congestion benefits it brings. In line with this aim, the number of people cycling in London is increasing; between 2000/01 and 2011/12, the cyclist flow on the Transport for London Road Network (TLRN) increased by 173% (TfL, 2012a).

The improvement of cyclist safety is seen as a key priority for TfL and data suggest that the risk of being killed or injured on a bicycle reduced steadily between 2000 and 2008 (e.g. TfL, 2010 states that there was a 107% increase in cycling flow between 2000 and 2008[3] on the TLRN, compared with a 9.8% increase in cyclist casualties on the same network). However, including borough roads, since 2008 the number of KSI cyclists and all cyclist casualties has increased substantially: in Greater London there were 3,506 cyclist injuries (422 killed or seriously injured) in 2000, and 4,497 (571 killed or seriously injured) in 2011 (TfL, 2012a).

TfL has also identified that the movement of goods has a crucial role to play in supporting the future growth of London's economy, and TfL's London Freight Plan (published in October 2007) identified steps to be taken to address the challenge of delivering freight sustainably in the capital. It stated that "…it is essential that freight activity is considered…to avoid generating conflict with other road users, particularly pedestrians and cyclists" (TfL, 2007, p.27).

Recent research (Keigan, Cuerden & Wheeler, 2009) used Stats19 data on 92 fatal cyclist collisions between 2001 and 2006 to show that 38% involved an HGV of 7.5 tonnes or over in weight. A substantial proportion of those (25%) involved a large vehicle turning left or changing lanes to the left and striking a pedal cyclist. More detailed analysis of collisions resulting in fatal injury to a pedal cyclist has shown that of the 16 in 2011 in London, nine involved a goods vehicles, and seven of these were construction vehicles (TfL bid specification, 2011c). Given that the construction industry is responsible for only a small proportion of freight traffic in GB and London this suggests that construction vehicles may be overrepresented in cyclist fatalities in London.

Against this context, TfL has commissioned TRL to undertake research aimed at understanding the reasons for this potential overrepresentation. The general research themes addressed by the project were as follows:

1. Is it possible to understand the relative risk represented by construction vehicles to cyclists, when compared with general haulage vehicles? If so, what is it? What are the limitations in the data available?
2. Are there features of contractual arrangements, working practices, driver behaviour, or vehicle design (or combinations of these) that contribute to the apparent over-involvement of construction vehicles in fatal collisions with cyclists in London?

The research aims to identify potential measures that could be implemented to help reduce the number of such collisions in the future. This report summarises the methods used (Section 2), the main findings (Section 3), and the key recommendations (Section 4) arising from the research.

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[3] The 2000 to 2008 data are used here to compare increases in cycling flow and cycling casualties because the casualty data were not available up to 2011/2012.

2 Method

A multi-method approach was taken to addressing the following specific research questions:

- Is it possible to define what counts as a construction vehicle in the collision data that are available? What are the data limitations? What do the most recent data suggest in terms of the scale of the problem?
- Are there aspects of the design and specification of the vehicles used by the construction industry that contribute to their apparent over-involvement in fatal collisions with cyclists?
- Are there aspects of driver behaviour in the construction industry that contribute to the apparent over-involvement of construction vehicles in fatal collisions with cyclists?
- Are there aspects of contractual or operational practices in the construction industry that contribute to the apparent over-involvement of construction vehicles in fatal collisions with cyclists?

Detailed information on the specific methods used is available in Delmonte et al. (2012). A summary of the methods is given here.

2.1 Analysis of collision and exposure data

Road casualty statistics (Stats19, including enhanced data held by TfL) were analysed along with what is known about exposure data on construction traffic (in so far as this can be determined) to understand the levels of risk for cyclists that are associated with construction vehicles. This analysis informed the choices of vehicles for the visibility assessment (see Section 2.3) and observed drives (see Section 2.4).

2.2 Literature review

A search of the published literature and various industry materials was conducted to establish any existing knowledge related specifically to construction traffic and cyclist risk, or related to the wider issue of interactions between any large vehicles and cyclists.

2.3 Direct and indirect visibility assessment of construction vehicles

Three vehicles (a construction tipper, a concrete mixer, and a general haulage curtain side lorry) were assessed for the visibility they afforded drivers of areas in which cyclists are known to be at risk from collision with such vehicles (to the left, and in front of the vehicle). The vehicle types were chosen on the basis of the analysis of collision and exposure data, with the individual vehicles scanned being those available during the timeframe in which the study was being run. This work was conducted using a laser assessment tool and scanner that permits three-dimensional modelling of the vehicles including direct and indirect lines of sight available to the driver. This process makes it possible to establish any blind spots, and also an assessment of the extent to which cyclists are visible in different areas around the vehicle.

2.4 Observed drives and task analysis

Three observed drives were conducted using the same type of vehicles as had been scanned in the visibility assessments (again these were the individual vehicles available during the project timeframe). A TRL researcher accompanied drivers of these vehicles on journeys through London and observed the drivers' action sequences in controlling their vehicle and interacting with other road users. Short interviews were also held with drivers after the observed drives. All the data gathered were used to inform an analysis of driver tasks while turning left at a junction or exiting a roundabout, and an assessment of possible driver errors that could result in these situations was made, along with an assessment of the factors that might increase or decrease the likelihood of these errors.

2.5 Semi-structured interviews with stakeholders

Semi-structured interviews were carried out with 26 stakeholders in three construction networks (clients, principal contractors, subcontractors, drivers), with six individual construction industry stakeholders, and with an additional stakeholder with in-depth knowledge of general haulage for comparison. Responses to these interviews were analysed using qualitative techniques designed to build a picture of the dominant themes raised by respondents around the topics discussed. The topics covered were the selection of contractors, contractual and operational practices, route planning and scheduling, risk assessment and management of road risk (specifically cyclists), reporting of incidents, and general communications.

2.6 Consideration of Construction Logistics Plans

A specific task examined the availability, content and use of Construction Logistics Plans (CLPs) in the London Area. CLPs are documents, prepared by developers, which set out the planned logistic activity associated with a particular construction project, and which are designed to act as the catalyst for reducing the negative effects of construction work on local residents, and on the local environment in terms of congestion, pollution, and safety. A lead has been taken in the development of CLPs in London by Croydon Council over the last two years. This is as result of extensive redevelopment both taking place and anticipated to take place in the town centre (an Opportunity Area Planning Framework). Croydon Council has developed, in conjunction with TfL, a series of publications giving guidance and a code of practice to developers to utilise in the production of CLPs. These documents were produced in liaison with selected developers working in the wider London area. Other CLPs were sought in the public domain but were found to be extremely limited in availability. A total of nine CLPs from a variety of developers were examined for their content.

3 Findings

The current project used multiple research methods to address the following general research themes:

1. Is it possible to understand the relative risk represented by construction vehicles to cyclists, when compared with general haulage vehicles? If so, what is it? What are the limitations in the data available?
2. Are there features of contractual arrangements, working practices, driver behaviour, or vehicle design (or combinations of these) that contribute to the apparent over-involvement of construction vehicles in fatal collisions with cyclists in London?

In this section, we discuss the key findings related to these themes, taking into account all of the data gathered in the project. For a much more detailed discussion of the findings from the individual research tasks, the reader is referred to the technical report (Delmonte et al., 2012).

An important finding from the literature review carried out as part of this project was that while there is a significant body of research into the problem of cycle collisions and large vehicles, no research was found that specifically considered construction vehicles or the construction industry. As far as the authors are aware, the current project therefore represents the first published work addressing this issue directly.

It should be noted that due to the fact that this project took a broad (and largely qualitative) approach to the area, a definitive statement as to the *quantitative* differences between construction and general haulage is not always possible; nonetheless the findings all represent opportunities to increase the safety of cyclists in relation to the risks they face from construction traffic.

3.1 General findings

General finding 1: Road risk is viewed as less important than general health and safety risk (see recommendations 1, 2 and 3)

The construction industry does not appear to be immune to the wider neglect of work-related road risk seen even in those organisations that represent good practice (see Helman, Buttress & Hutchins, 2012); at the operational level the construction industry does not ascribe road risk the same level of importance as general health and safety risks when selecting who to work with, and when managing safety performance.

The following quotes from various members of construction networks spoken to within this project illustrate this well:

> **Respondent:** *(discussing safety requirements of who they contract) "They have to demonstrate to us, you know, it's not just on-site safety, it's across the board, Health & Safety policy statements, public liability assurance, other assurances, you know, how do they monitor safety, have they got any other safety issues externally, all of those sort of criterion."*
> **Interviewer:** *"And is there anything relating to road safety?"*
> **Respondent:** *"Good question. Probably not."* (Principal Contractor – Construction Network 1)

> **Interviewer:** *"When they [your subcontractors] leave the site, do you see any responsibility then for their driving safety?"*

Respondent: *"No."* (Primary Subcontractor – Construction Network 1)

This finding, although not specific to the construction industry, sets the context in which all the other findings from this project should be viewed; in the construction industry as in other sectors, the management of work-related road risk clearly lags behind the management of more general health and safety. Therefore even if *only* considering the exposure to risk in London (see general finding 2) that arises from construction traffic, changes to general work-related road safety practice have the potential to have a large impact on cyclist safety.

See section 7 of the technical report for a full description.

General finding 2: Although road casualty statistics make it difficult to identify industry sectors associated with collisions, construction traffic appears likely to be over-represented in collisions with cyclists (see recommendation 11)

By making several assumptions about which vehicle body types are associated with construction and other industries, and by examining the types of goods moved in London and in the country as a whole by freight vehicles (and again making assumptions about the industries with which these goods may be associated), the analysis of exposure data suggests that in London the construction industry is responsible for a greater proportion of the exposure to risk to cyclists than it accounts for nationally.

When fatal collisions with cyclists involving HGVs in London are considered, it can be seen that rigid vehicles (which are more likely to be associated with construction than are articulated vehicles) make up 89% of the fatalities from 75% of the distance travelled; articulated vehicles are responsible for 11% of the fatalities from 25% of the distance driven. When the freight task is also considered this analysis becomes much more stark, with rigid vehicles involved in 89% of the fatalities but only 54% of the freight lifted (tonnes) or 27% of the freight moved (tonne km); articulated vehicles are involved in 11% of the fatalities despite lifting approximately 46% of the freight (tonnes) or 73% of the freight moved (tonne km), on journeys to, from and within London.

It is likely that the differences in risk between rigid and articulated vehicles are associated with features of the routes they drive, the vehicles themselves, and the types of journey in which they are engaged; the current project provides some initial findings on these issues, although more detailed research (including modelling of flow rates of cyclists and other vulnerable road users on routes used) would be required to answer this question conclusively.

See section 2 of the technical report for a full description.

3.2 Contractual and operational practices

Specific finding 1: There is a lack of ownership of road risk by clients and principal contractors in the construction industry (see recommendations 3, 4, 5, 8 and 9)

There is limited ownership of road risk within the construction industry by clients and principal contractors. This stands in contrast to the ownership of health and safety risk on site. Based on the interview data, it is clear that the principal contractor tends to take responsibility for the health and safety of all workers on the site, but once a driver leaves the site, principal contractors commonly report that the driver's safety is no longer their responsibility. The client is generally not concerned (contractually) with the safety of drivers delivering to the construction site, and of other road users.

Several quotes from members of construction networks interviewed as part of the research illustrate this point. An example is given below, and the quotes listed in general finding 1 also apply.

> *"As far as when they leave the gates, once the driver has actually exited and is out, effectively out of our site they are then no longer our responsibility."* (Primary Subcontractor – Construction Network 1)

This suggests that the ownership of construction vehicle driver safety typically rests with their employer (who may be a subcontractor or the driver himself in the case of owner-drivers). In contrast, the interviews conducted with individuals who worked, or have previously worked in general haulage suggest that a haulage driver working for a large delivery company will generally be working directly for the client, who will have a vested interested in the driver's safety, and that of cyclists. The following quote illustrates the issue well:

> **Interviewee:** *"And do you think construction contracts differ in any other way from general haulage contracts?"*
> **Respondent**: *"I think…an in-house haulier…has a lot more control in terms of they can manage both ends of the supply, if you want, the supply chain. So they can manage the customer, which is effectively the source, so that helps."*

Construction Network 3 provides a counter-example to this finding and to general finding 1; in this case the client and principal contractor appear, generally, to take ownership of driver health and safety including off-site driving, in both their health and safety policies, their consideration of who to contract, and their reporting. The following quotes illustrate this:

> *"The health and safety element is a priority…we've got a whole range of initiatives that address both the behaviour of the driver and the culture of the company, and by addressing both and aligning drivers and companies with Target Zero golden rules, that's how we address work-related road safety…we've treated health and safety as being ubiquitous across the whole project, and the journey to and from the work site."* (Client – Construction Network 3)

> *"We…investigate what their history is of the accident rate prior to awarding a contract…that is driving accidents for the haulier but they will also be asked an audited on their system."* (Principal Contractor – Construction Network 3)

> **Respondent:** *(Discussing the reporting of road collisions) "It's treated as an accident onsite and it's reportable…it's got to be reported by the principal contractor responsible for that subcontractor through the health and safety report system."*
> **Interviewee:** *"So that all gets fed up to you as a client…"*
> **Respondent:** *"It does, yes…we would get involved and look at the company involved and if we conclude that the company should be reminded that there are lessons to be learnt, then we would advise the principal contractor."* (Client – Construction Network 3)

It should be noted however that Construction Network 3 is not without fault in its treatment of road risk as equal to more general health and safety risk (see specific finding 2).

See section 7 of the technical report for a full description.

Specific finding 2: Data on collisions and near misses on the road are not generally collected on construction projects (see recommendations 1, 3, 4 and 5)

Statistics relating to on-road collisions are usually excluded from an organisation's overall safety statistics. These are often inspected during contractor procurement, but the key concern is on-site collisions. Driver safety, particularly off-site, does not generally appear to be considered. The following quotes illustrate this finding:

> **Interviewer:** *"If there's any near misses off site, do you report them?"*
> **Respondent:** *"Not really."* (Secondary Subcontractor – Construction Network 1)

> **Interviewer:** *"Would you report [a collision on road] to your customer on-site or would you solely report that within [your organisation]?"*
> **Respondent:** *"No, it's reported immediately to the management at [organisation]…if it occurs on a construction site, then obviously everybody is informed."* (Tertiary Subcontractor – Construction Network 2)

Again, Construction Network 3 provides the counter example by demonstrating good practice. It is worthy of note however that even in this network, some confusion existed about reporting of road incidents; again there seems to be an underlying attitude that managing road risk is not a legitimate use of time. For example the principal subcontractor on one site within the Network, when questioned whether road collisions would be reported through the site health and safety reporting, gave the following answer:

> *"No, because it's in the roads, it's nothing to do with the site. So if it happens on site then it's generally, it's a totally different story, but if it happens in the street then it's down to whoever it is…these people have got enough to do."*

In addition, at another site within this network, the principal contractor gave the following information regarding the reporting of road collisions off site:

> **Respondent:** *"Unlikely [to receive a report] as…we don't deal as being onsite until he arrives either in the lorry holding area or through the gates…ultimately we would, potentially, but I can't see the mechanism…it's not happened on this site…"*
> **Interviewer:** *"There's nothing in their contract that you remember that requires action?"*
> **Respondent:** *"No, nothing that I can remember."* (Principal Contractor – Construction Network 3)

Clearly even within the exemplar 'good practice' network, although the culture is that on-road incidents are reported, practice is not perfectly aligned with this expectation; this is more evidence that road risk is being treated differently to on-site risk.

See section 2.1 of the technical report for a full description.

Specific finding 3: Evidence suggests that there is a lack of awareness about road risk in the construction industry (see recommendations 1, 2, 3, 4, 5 and 9)

Another key finding is that despite the wide publicity that the issue of cyclist collisions with large vehicles has received, the levels of awareness of the issue in the construction industry in London appear to be low. The following quote illustrates this well:

> *"The industry doesn't know that these accidents are occurring…the industry is not going to do much about it until they're told…how do you get everybody else to [improve their safety] unless you're telling them that these things are going on, and*

> *unless people start getting prosecuted?"* (Principal Contractor – Construction Network 1)

See section 7 of the technical report for a full description.

Specific finding 4: The Fleet Operator Recognition Scheme (FORS), and Construction Logistics Plans (CLPs), are existing mechanisms that might be used to manage road risk in the construction industry; however they are not used as widely or as seriously as might be hoped (see recommendations 5 and 9)

There are two existing mechanisms by which road risk might be managed in the construction industry; these are FORS and CLPs. Some evidence was found in the research that although these are used, there are shortcomings in *how* they are used and monitored, and (in the case of CLPS) how widely they are used. For example with FORS, some evidence was found of organisations gaining accreditation to secure contracts, but subsequently not taking an active interest in FORS and its requirements and guidance:

> **Respondent:** *"There was a requirement on this job for, was it FORS, the Freight Operator Recognition Scheme? All of our suppliers had to sign up to that…if it's a requirement of the main contractor, we will piggyback on the back of that…and they then have to register."*
> **Interviewer:** *"Are you a member of FORS?"*
> **Respondent:** *"We've registered but, again, we don't do anything as such other than manage the processes to deliver the project…"* (Primary Subcontractor – Construction Network 1)

In addition, there was a suggestion from one client that monitoring of the scheme is something for which there is insufficient time:

> *"Main contractors will be expected to demonstrate that their suppliers are committed to safer and more efficient operating by requiring them to register for membership with TfL's FORS…and attain bronze membership as a minimum…we haven't got the time to sort of monitor that as such, we would expect the site manager there to…but I mean I suppose we could ask [the site manager] to provide us with proof."* (Client – Construction Network 1)

In terms of CLPs, it was found that there are few examples of them being used within the London area, outside of Croydon and TfL-led contracts. There is generic guidance in place and freely available (TfL's document 'Building a better future for freight: construction logistics plans'). However, this guidance takes a higher level approach, explaining the needs, benefits and features of CLPs without providing a definitive template for planners and developers to utilise. The Croydon series of publications provide both an explanation of CLPs and a working template, with instructions for developers. These documents were being finalised at the time of the research. Croydon is in the process of making the production of CLPs a requirement of planning.

The guidance documents that were examined, and some CLPs that were scrutinised, make reference to road safety and the importance of routing and site access with respect to traffic flows and vulnerable road users. However, with the exception of TfL-specified conditions of contract (including Crossrail) no reference is made of the need to ensure that cyclist safety is specifically addressed in terms of contractual obligation, driver training or vehicle specification. This is an area where action is recommended through the development of a pan London CLP template – for planners and developers – that includes cyclist safety as a key road safety feature.

See section 4 of the technical report for a full description.

Specific finding 5: Delivery time slots used in the construction industry may contribute to driver pressure (see recommendations 5 and 8)

Many construction sites utilise a delivery booking system to manage arrivals to the site, whereby vehicles are assigned a time slot in which to arrive. Although one respondent reported that there was no expectation of meeting time slots, there was widespread evidence of an awareness that this can place pressure on drivers, particularly when the time slot is tight (e.g. if they have a 15 minute window in which to arrive) or when the construction site has a policy of refusing any early or late deliveries. The following quote is illustrative of the fact that there is awareness that this can contribute directly to incidents:

> **Interviewer:** *"Is there much pressure to get to site?"*
> **Respondent:** *"Yes, there's a lot of pressure. That's the one thing about this job, it's very stressful…so I can see why accidents happen sometimes."* (Secondary Subcontractor – Construction Network 1)

See section 7 of the technical report for a full description.

Specific finding 6: Route planning to avoid interactions with cyclists is especially difficult on construction projects due to the transitory nature of sites (see recommendations 5 and 9)

The transitory nature of construction sites makes route planning to avoid interactions with cyclists (the best way of avoiding collisions) challenging. The following quote from one of the subcontractors in Network 3 illustrates this comparison with general haulage:

> *"[With general haulage] you're driving down the motorway, you come off the motorway for about a mile… all the main depots like B&Q and Asda and all that kind of stuff, they're literally just like a mile off the motorway for that reason, to make it easier for the driver. Whereas obviously construction they pop up everywhere and anywhere, which seems to be a problem for us to get to because if, sometimes it is a bit of a nightmare to get to them… Coming into London or Liverpool or Glasgow or wherever or any of the main cities, central London, little streets like this, they're totally different. It's a lot harder."* (Primary Subcontractor – Construction Network 3)

Clearly this finding makes it even more important that CLPs are used properly and that drivers are appropriately trained and prepared for the task.

See section 7 of the technical report for a full description.

Specific finding 7: Evidence suggests that pay per load does happen in the construction industry, however no evidence was found to suggest that it is a crucial factor in collisions with cyclists (see recommendation 10)

It is clear that pay per load contract arrangements do exist within the construction industry; however many of the organisations in all of the supply chains used employed drivers who were paid an hourly or annual wage. Some companies (usually further down the supply chain than the principal contractor) either use owner drivers or small businesses to supplement their employed staff when necessary, and these individuals or organisations would be paid by the load. Other companies only used self-employed drivers in their work. The driver would own and maintain the vehicle, which would often display the umbrella company's livery. These drivers may also be paid per load delivered (based on delivery time, distance, load carried or a combination of the three). No specific evidence was found however that paying drivers in this manner changes the amount of work drivers attempt to do, or the time in which they attempt to complete the work, as illustrated by this quote:

> **Interviewer**: *"Do you think there are some drivers that kind of use the pay per load to potentially do more work?"*
> **Respondent**: *"It'd be difficult to argue against it, I suppose, but at the same time, you know, we know what they'll work on and they'll call it a day at that point because they've earned whatever. As I say, the reality is that because they can contact us, you know, we will try and push them to work a full day but sometimes they like to finish early. So it wouldn't suggest that they're chasing money all the time, which is essentially what you're saying, I suppose*."

In the three interviews conducted relating to general haulage, no evidence was found of pay per load contracts in that industry.

See section 7 of the technical report for a full description.

3.3 Drivers and vehicles

Specific finding 8: Although total blind spots are likely to be rare, visibility of cyclists in some areas around construction vehicles is still poor (see recommendations 6 and 7)

The main finding from the vehicle scanning task was that the view afforded of cyclists in some positions to the left and in front of the vehicle, even with mirrors fitted to meet legal requirements and positioned by a fully qualified driver, can be poor. Several analyses illustrate this general point.

Firstly we can consider what happens when the areas of the ground visible either directly or indirectly for the three vehicles scanned were compared, considering the 4m to the nearside of each vehicle (to reflect the lorry being in lane two with a 3.5 wide lane to its left) and approximately 9m in front. Figure 3-1 illustrates this comparison.

Comparing the 'grey' areas in Figure 3-1, it can be seen that the area not directly or indirectly visible (at ground level) to the DAF Mixer (21m^2) is 50% greater than the area not directly or indirectly visible to the MAN curtain side (14m^2). The visible area in direct view through the windscreen in this assessment was found to be greatest in the MAN curtain side lorry. The design of the vehicle dashboard and size of the windscreen contributes to the view available through the windscreen. The MAN curtain side lorry is the newest of the three vehicles assessed and thus it is possible that it has benefitted from design improvements to increase the visible area. The DAF Tipper is the vehicle which provides the least visible ground zone for the assessed area through the windscreen. One potential explanation for this is the height of the driver with respect to the ground. The driver's eye point for the DAF Tipper is higher than that of the DAF Mixer and MAN Curtain side, consequently for the same height driver and similar shaped dashboard the first point at which the driver will be able to see the ground in front of the vehicle in the DAF Tipper will be further away.

On the DAF Mixer vehicle tested, the forward projection mirror (designed to give an indirect view in front of the vehicle) was retrofitted inside the cab. This resulted in there being a true blind spot large enough for a 1.22m tall cylinder 0.3m in diameter to be hidden completely from view in the forward projection mirror from the driver's normal eye position if placed directly in front of the lorry. This is illustrated in Figure 3-2.

Dark blue: View through rear window

Green: Plain rear view mirror

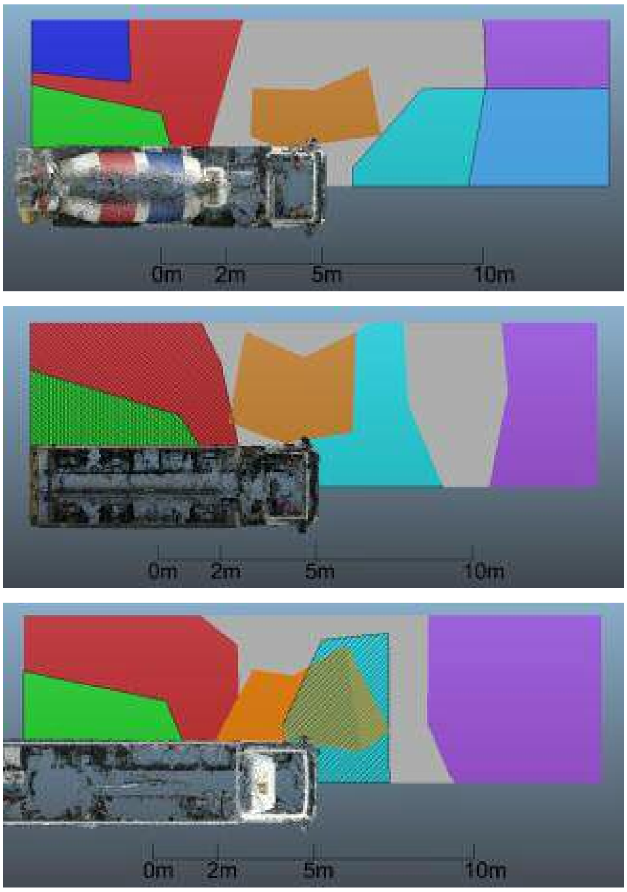
Red: Wide angle rear view mirror

Orange: Side close proximity mirror

Light blue: Front projection mirror

Purple: Windscreen direct view

Grey: Not directly or indirectly visible at ground level



DAF Mixer ($21m^2$ grey area)

DAF Tipper ($19m^2$ grey area)

MAN Curtain side ($14m^2$ grey area)

Figure 3-1: The ground level visibility coverage area assessed over an area of 4m to the nearside of the vehicle, representing a road lane width to the nearside.

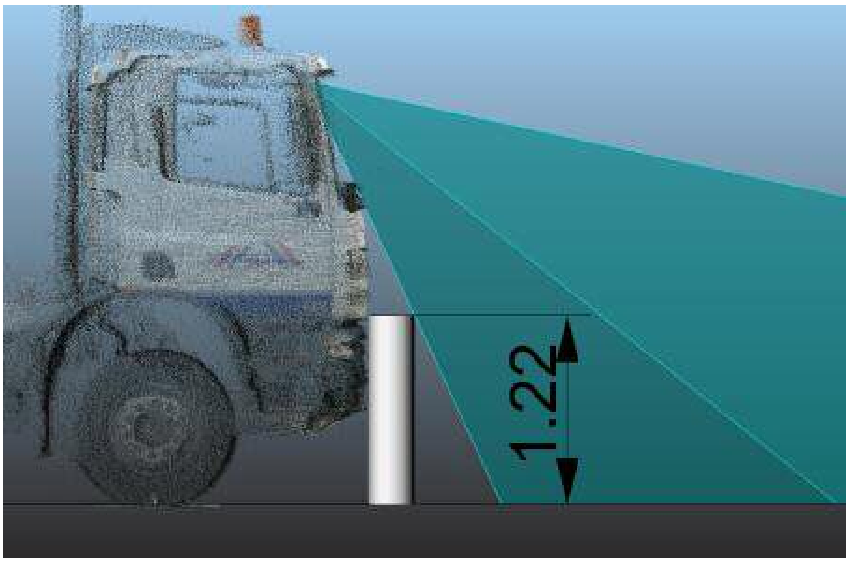


Figure 3-2: Image showing a 0.3m diameter cylinder positioned directly in front of the lorry and the height with which it could be to remain hidden from view in the front projection mirror.

A third analysis was the examination of the 3D models of the visibility of cyclists (modelled as 1.5m tall) in different positions to the left of and in front of the vehicle. Figure 3-3 shows the positions assessed. The analysis showed that in all vehicles there were positions in which cyclists could barely be seen from a static viewing position at the driver's eye level. For example in the DAF Tipper, only a tiny proportion of the cyclist in position 9 could be seen through the windscreen (a small proportion would also be visible in the forward projection and side close proximity mirrors) – see Figure 3-4.

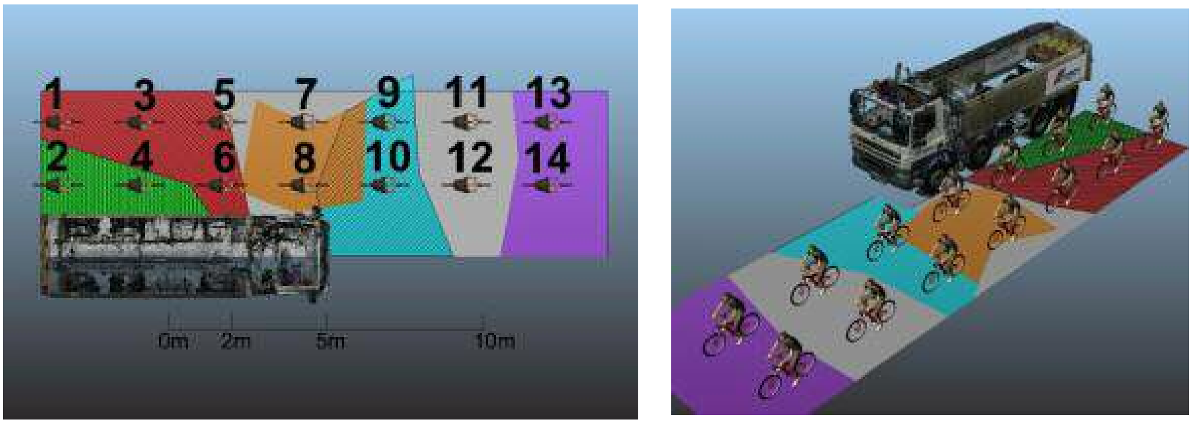


Figure 3-3: The positions of the cyclist considered during the assessment, the two rows of cyclists are 1m and 3m away from the nearside of the vehicle respectively.

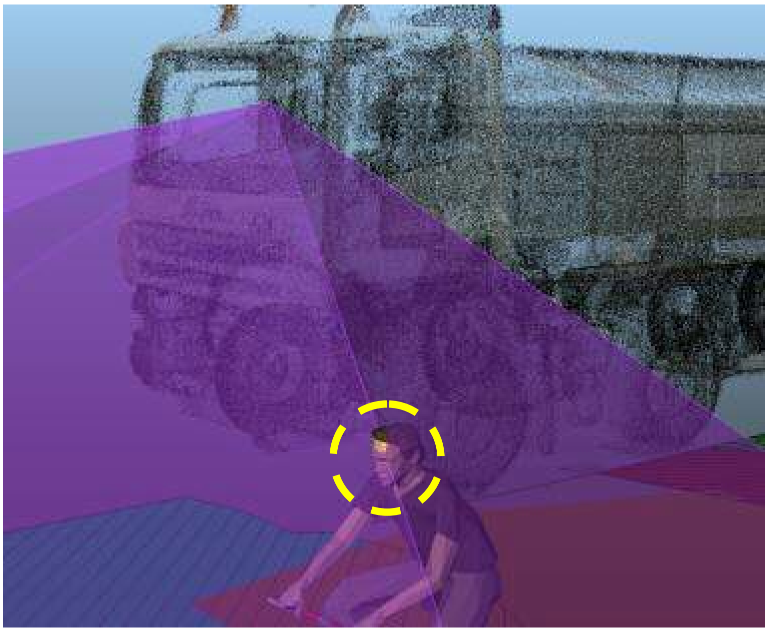


Figure 3-4: The 1.5m tall cyclist in position 9 showing the small area of forehead that is potentially visible in the lower nearside corner of the windscreen of the DAF Tipper

In fact for all the vehicles scanned, between positions 5 and 12 inclusive, none of the vehicles would provide the driver with a complete view of the 1.5m tall cyclist. This is not unexpected following the assessments of ground level views, due to the fact that these positions lie within the regions where the ground is not always visible to the driver. Table 1 shows whether a 1.5m cyclist would be wholly or partially visible for each viewing component of the three lorries assessed.

Table 1. The collated results of the assessment of the cyclists that would be visible (wholly or a proportion thereof) for each viewing component of the three assessed lorries. The cyclist was 1.5m tall in this assessment

Component	Vehicle	Cyclist position (as per Figure 3-3) • denotes wholly visible, (•) denotes partially visible													
		1	2	3	4	5	6	7	8	9	10	11	12	13	14
Plain rear view mirror	Mixer		•		•		(•)								
	Tipper		•		•		(•)								
	Curtain		•		•		(•)								
Wide angle rear view mirror	Mixer	•	•	•	•	•	(•)	(•)							
	Tipper	•	•	•	•	(•)	•								
	Curtain	•	•	•	•	(•)	•								
Side close proximity mirror	Mixer								(•)		(•)				
	Tipper						(•)	(•)	•	(•)					
	Curtain								(•)	(•)					
Front projection mirror	Mixer										(•)		(•)		(•)
	Tipper								(•)	(•)	(•)				
	Curtain								(•)	(•)	(•)				
Windscreen	Mixer									(•)	(•)	(•)	(•)	•	•
	Tipper									(•)		(•)	(•)	•	•
	Curtain									(•)	(•)	•	•	•	•
Nearside side window	Mixer							(•)							
	Tipper														
	Curtain							(•)							
Rear cab window	Mixer	•		(•)	(•)		(•)								
	Tipper														
	Curtain														

When considering these findings, it needs to be remembered that the small sample of vehicles tested makes it difficult to generalise the findings to all construction vehicles. However the results can be taken as indicative of areas that warrant further investigation. In particular, the effect of vehicle height on direct lines of visibility (as with the tipper in this study) might be something that is worthy of further specific study, since this might be something that can be improved over the medium to long term through working with vehicle manufacturers. In addition, the finding of a true blind spot in front of the mixer lorry (arising from the positioning of the retrofitted front projection mirror) illustrates that technological interventions are not a guaranteed solution if the way in which they are fitted and used by drivers is not considered.

See section 5 of the technical report for a full description.

Specific finding 9: There is great potential for driver error and high driver workload in construction industry driving, and multiple changes will be needed to reduce this (see recommendations 4 to 10)

The cognitive task analysis revealed a number of points of possible failure, most of which are associated with a breakdown in visual awareness, and many of which may take place before the driver and cyclist arrive at a junction. The analysis suggested that only checking mirrors having reached the junction, or even on the immediate approach, is a risky strategy. The vehicle scans show that although there are few true blind spots on the vehicles assessed, the whole cyclist is rarely visible and, depending on their location, they may be barely visible. This makes cyclists difficult to spot, and even if drivers do see certain visual indications, it is not necessarily easy to recognise what is seen as being a cyclist or a hazard.

To achieve a high level of awareness of what is behind or beside the vehicle drivers must check their mirrors frequently. This usually results in them seeing a scene that is slightly different each time they view it, and piecing together the evidence to form, and continuously update, a mental representation of the world. This process is described in the following figure which shows a basic cyclical model of human action (Hollnagel, 2005).

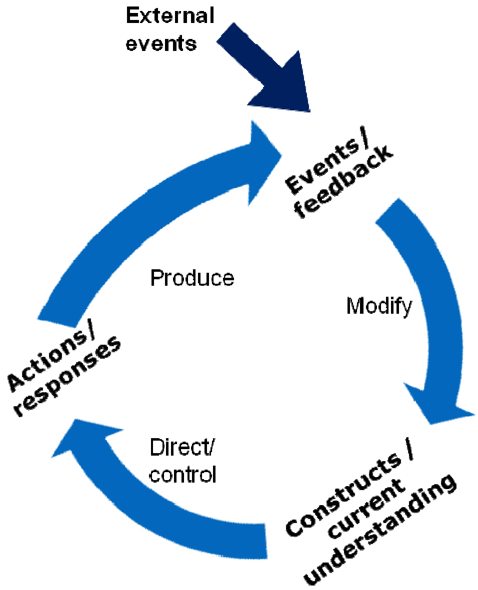


Figure 3-5: A basic cyclical model of human action (from Hollnagel, 2005)

The difficulty with this strategy is that vision is a constrained resource, which is in high demand while driving. It is not physically possible to fixate on all aspects of the road ahead simultaneously, let alone the instruments and the mirrors as well. Awareness is achieved by scanning different parts of the environment in turn. This mechanism is not perfect, as it is possible that key hazards will be missed when visual attention happens to be allocated elsewhere. Thus, although mirrors on large vehicles will be part of the solution to avoid blind spots, they are not the total solution; consideration needs to be given to how many sources of information drivers can realistically monitor, and to reducing other factors that will increase demand on visual attention.

A very broad range of factors can affect the likelihood of the driver errors that have been identified. These factors relate to the vehicle, the driving environment, the cyclist, the driver or the driver's organisation. Examples include:

- Driving to unfamiliar site locations – this is likely to lead to high demand, and a paucity of mental resource to allocate to visual attention or a reduction in normal road scanning behaviour.
- Narrow roads and tight corners – this is again likely to require considerable attention (specifically visual attention) from the driver, and again will lower the resource available to maintain awareness of hazards.
- Cyclists' behaviour not conforming to usual expectations – goal-directed looking behaviour dominates in skilled tasks such as driving, and a large part of this is led by expectation. This study has not attempted to describe what these drivers' expectations about cyclists are, but their comments on cyclist behaviour may hint at some scenarios where their expectations are violated. It is likely that several factors are involved. For example, drivers mentioned some cyclists not following a defined path and attempting to undertake vehicles indicating to turn left. The variability in manoeuvres and freedom of movement that cyclists enjoy (for example due to their small size) means that some drivers' expectations of typical

cyclist behaviour will be less reliable. If cyclists do not conform to expectations, then some drivers may fail to detect them if they look in places they expect to see cyclists, rather than where the cyclists actually are. Another factor relates to the frequency with which some construction vehicle drivers will encounter cyclists in their usual driving. Even with the high cyclist numbers seen in London, it is important to note that for a given journey undertaken by a construction vehicle driver (especially if the journey originated outside of London), cars will be encountered much more frequently than cyclists; thus the expectations of some drivers will be predominantly shaped by their encounters with cars, and this again makes their expectations with regards to cyclist behaviour less reliable.

- Time pressure (delivery time slots) – it is well known that there are time/error trade-offs in skilled tasks like driving. If drivers are trying to attain a given time schedule this is likely to result in more errors.

The analysis shows that there is unlikely to be one single 'human error' cause of vehicle collisions with cyclists during turning manoeuvres; rather, a range of factors exist and would need to be considered in addressing the problem. Possible solutions are given in Chapter 4, but it is clear that a holistic approach would need to be taken in applying them. For example, consideration would need to be given to the effects on the driver of any modifications to vehicles or company procedures, as solutions that result in an increase in workload or time pressure could ultimately have a detrimental effect on safety.

See section 6 of the technical report for a full description.

4 Recommendations

The recommendations associated with the findings described in Section 3 are organised under four headings; 'Raising the profile of work-related road safety', 'Improving work-related road safety management in the construction industry', 'Making construction vehicles and journeys safer', and 'Data improvements'. In addition, a final recommendation is given relating to the ownership of recommendations one to 11.

4.1 Raising the profile of work-related road safety

The first general finding of the current research was that road risk is frequently viewed as less important than general health and safety risk by construction organisations. In order to improve the safety of cyclists in relation to construction vehicles, it is necessary to tackle this issue as part of ongoing improvements to work-related road safety (WRRS), which are actually applicable to all organisations (even those outside of construction).

Recommendation 1: HSE should extend RIDDOR to include on-road collisions

Currently, work-related road collisions are not reportable to HSE, whereas on-site accidents resulting in seven or more days of absence, or a serious injury, are reportable under RIDDOR (HSE, 2012). To improve the perceived importance of work-related road risk, HSE must extend RIDDOR to include on-road collisions involving individuals driving for work. We recommend that HSE should extend RIDDOR to include on-road collisions as a matter of urgency. To improve the likely success of such a campaign, the Metropolitan Police Service, traffic commissioners, VOSA and other interested stakeholders should be involved.

It is likely that changes to RIDDOR of this magnitude will take a considerable amount of time to implement. In the shorter term, HSE could develop an Approved Code of Practice (ACoP) for work-related road safety (including the requirement to record on-road collisions), for use by all industry sectors, including the construction industry.

Recommendation 2: Adherence to a nationally recognised standard on work-related road safety (such as the ISO39001 standard on road traffic safety management) should be promoted

A new International Standard has recently been issued (ISO39001:2012). This specifies requirements for a road traffic safety management system, to reduce fatalities and serious injuries related to road traffic collisions. Organisations of five or more employees driving to or from construction sites within London should be required to achieve this standard[4], or a similar standard as determined by the industry. Consideration should be given as to how this standard would apply to companies of different sizes; the time and cost of achieving an ISO or similar standard for smaller organisations may be prohibitive; therefore we recommend that based on the ISO39001 standard (or equivalent national standard – see footnote below), and the HSE Driving for Work Toolkit

[4] Note that recently published research for the Metropolitan Police Service (Helman, Buttress & Hutchins, 2012) has suggested that ISO39001 might require support from a simple guidance document, ideally in the form of an HSE Approved Code of Practice regarding those risk factors that should be the focus of any interventions used within the wider management of road risk. Helman et al. also suggest that a standalone national standard could be developed in place of ISO39001, based on the TfL FORS template.

(INDG382), a checklist should be developed for any client or contractor subcontracting to small businesses, to ensure that they also adhere to recommended practice. TfL should extend CLP guidelines to support these activities.

To support the above activities, CLPs should be extended and mandated to ensure adherence to ISO39001 or a national standard (for organisations of five or more employees) or the TfL checklist (for smaller organisations). The principal contractor and/or client should demonstrate compliance to those managing the CLPs.

4.2 Improving work-related road safety management in the construction industry

There is potentially a lack of awareness within the construction industry of road risk, and also lack of ownership and management of the risk. It is therefore necessary to raise awareness within the industry of both the risks and how to manage them, and to put in place mechanisms to support organisations to manage road risk and functions to ensure this is achieved.

Recommendation 3: HSE should include off-site safety in the Construction Phase Plan (mandatory under the CDM regulations)

Organisations are not required to report on-road collisions to HSE. In addition, the CDM (construction design and management) regulations governing the construction industry do not require driving for work to be included in the construction phase plan; the construction phase plan is a requirement for all notifiable[5] construction projects, and outlines the arrangements for managing health and safety during construction work. Currently this only covers on-site health and safety. HSE should mandate inclusion of off-site safety (i.e. driving for work) in the construction phase plan. Under the CDM regulations the principal contractor takes ownership of the construction phase plan and therefore, if it were included, ownership of off-road risk.

Recommendation 4: Existing channels should be utilised more effectively to raise awareness of road risk within the construction industry

The importance of managing construction vehicle safety once the vehicle has left the construction site needs to be communicated within the construction industry, and guidance should be produced to assist with this. Content should include discussion of the extent to which cyclists are visible in different areas around the vehicle, highlighting the fact that mirror coverage does not mean cyclists will always be detected. It could also include awareness raising around the variability in cyclists' behaviour (see specific finding 9). The FORS network should be used to communicate these messages to the construction industry by the use of newsletters etc., however this may only influence those who already have some interest or involvement in road safety.

There are many associations within the transport sector, such as the Construction Equipment Association, the Construction Industry Council and the Mineral Products Association, who should use their networks to more widely promote road risk as a key topic. Events such as conferences, seminars and workshops would also be a valuable tool in improving knowledge of the issue and measures to improve road safety for

[5] Projects where construction work is expected to last more than 30 working days or involve more than 500 person days.

construction vehicle drivers. These could be organised via Brake/ROSPA/FORS/Roadsafe etc.

Recommendation 5: CLP guidance should be updated by TfL and its use promoted throughout London. CLP compliance should be monitored by TfL. This should be embedded into the planning application process for London-based construction projects

There needs to be a standard to which all organisations operating in the construction industry within London adhere. Updated CLP guidance which is used by all London boroughs for public and private construction work should be used for this.

The CLP guidance should be updated to make it more robust as a mechanism for ensuring each construction site has a means of managing road risk. Current CLPs should be updated to include topics such as ISO39001 and data reporting/recording of on-road collisions. Additionally, CLPs should require that once organisations have met the required standards, they are audited to ensure that they continue to meet these standards throughout the life of the project.

Other public bodies, especially Local Authorities, should be involved to ensure that CLPs are used for all public construction projects let in London, supporting Local Authorities in putting processes in place for their inclusion and management. Furthermore, working with Local Authorities, CLPs should be used for all construction projects in London, with Local Authorities having a role to play in implementing and monitoring compliance for all construction projects undertaken in their borough.

4.3 Making construction vehicles and journeys safer

Recommendation 6: Vehicle manufacturers should work to improve vehicle and mirror design

Of the vehicles examined, some had a much larger non-visible area (at ground level) than others; various aspects of vehicle design can be addressed to improve drivers' view of cyclists, and vehicle manufacturers should seek to identify and implement design improvements that might be made specifically for vehicles driving on London's streets. This could include changes to windscreen or dashboard design, as well as new technologies and improved mirror design. For example, the driving position in one of the construction vehicles studied in this research was higher off the ground, which may have resulted in an increased area directly through the side windows and windscreen that was not visible to the driver. Front and side windows which extend lower (towards the ground) would increase direct visibility to the front and side of these vehicles.

In relation to mirrors, the convex side close proximity mirror covers a wider area than an equivalent non-convex mirror, but the object in the view can become distorted. Further research is needed to ascertain which combination is preferable (i.e. a larger visible area with a distorted view, or a smaller area with a non-distorted view) and relevant bodies, e.g. the European Union, should be engaged with regarding approvals. Any technology that has a safety benefit, which is included in new vehicle design, should be retrofitted to existing vehicles where possible.

It is important that the introduction or modification of mirrors (or mirror configurations and combinations) does not result in an increase in driver workload; the best combination of mirrors needs to be identified which enables optimal visibility *and* workload. We understand that effecting industry-wide change in the longer term is likely to require changes to relevant directives. However in the short to medium term it will be useful to engage vehicle manufacturers in defining innovations and improvements that might be adopted specifically for London (see, for example, the development of the new 'Bus for London', TfL, 2012b).

Recommendation 7: A wider review of the blind spots in different construction vehicle types should be conducted

A wider, comprehensive review of vehicle blind spots and the challenges faced by drivers should be commissioned, using a broader range of vehicles and mirror configurations. The current research considered three vehicles of differing ages and produced by different manufacturers, and therefore was not representative of the range of tippers, mixers and curtain side vehicles available. A comprehensive review of vehicles used in the construction industry would greatly improve understanding of the extent to which mirrors afford drivers with views of cyclists in key risk areas around construction and goods vehicles, and would help to identify human factors issues associated with their use. The outcome of such a review would be a business case to use in demonstrating the need for regulatory change in the UK or EU.

Recommendation 8: Principal contractors and clients should use more realistic delivery time slots

Whilst the obvious measure to reduce driver pressure relating to meeting delivery time slots would be to eliminate them altogether, this would result in unnecessary pressures on-site (e.g. multiple concurrent deliveries requiring unloading) and vehicles queuing on local roads, causing other issues. An alternative is the use of more flexible and generous time slots, for example by allowing vehicles arriving either side of their allocated slot to enter the site where reasonable. Clients or principal contractors could insist on such measures at the procurement stage. Management should aim to record how frequently vehicles arrive outside of their allocated delivery slot, and to understand why they are arriving to site earlier or later than expected. This will enable any site-specific issues to be addressed, along with continual improvement of the delivery booking system.

CLPs should include consideration of how deliveries take place (e.g. length of time slot, use of holding bays in which vehicles can wait in a safe location before delivering to the site). The CLP audit should include a review of the effectiveness of any processes implemented.

Recommendation 9: CLPs must include the definition of safer routes to construction sites

As part of the mandatory CLPs, principal contractors should define safer routes to their site (within a set local radius, for example five miles), where possible avoiding risky areas such as schools, cyclist 'hotspots', narrow roads and difficult junctions, and in all cases attempting to minimise exposure to vulnerable road users. Such changes would help to address the potential problem of drivers being under greater cognitive workload in the vicinity of construction sites than they are used to in their usual driving. Principal contractors should also ensure that all drivers operating on their site are happy with the routes and understand the importance of using only the prescribed routes. Drivers should be encouraged to feed back to the principal contractor on the usability of the routes. A way to support this could be through TfL's Freight Journey Planner. On routes where high cognitive workload is unavoidable, extra training and other extra safety precautions should be considered.

In addition local authorities, when reviewing planning applications, could make CLP use a requirement for notifiable construction projects.

Recommendation 10: Further research should be conducted to understand the effects of pay per load contracts

There is a perceived risk that pay per load contracts encourage drivers to achieve a greater number of deliveries than can reasonably be expected of a safe driver. However no definitive evidence emerged in the current research to support this. Most instances of pay per load that were identified in the current research involved owner-drivers, and the removal of pay per load may be an unwelcome change which would greatly affect the industry's status quo, and therefore would need to be supported by a substantial body of evidence. Therefore at this stage, instead of eliminating pay per load, the umbrella organisation using these owner-drivers could be held responsible for their health and safety, including the hours they drive. However, this is an area in which further research is required in order to gain a better understanding of the use of pay per load and any impacts it has on driver behaviour.

4.4 Data improvements

Recommendation 11: Vehicle type 'construction vehicle' should be included in Stats19

The addition of a 'construction vehicle' category or other means of recording the involvement of vehicles used for construction on the Stats19 form is recommended. This would improve knowledge of the prevalence of collisions between cyclists (and other vulnerable road users) and vehicles used for construction.

DfT frequently hold a consultation to review and update the Stats19 form, although the review cycle is believed to currently be five to six years, with the latest changes made in 2011 (meaning that the changes would not be expected in the data until 2016-2017 on the regular cycle). The next Stats19 consultation should be responded to, with the suggestion of additional 'vehicle type' categories to enable identification of vehicles used for construction purposes. If a shorter timeframe is desired, the Metropolitan Police Service should be involved to see if changes can be made more quickly[6].

4.5 Ownership of recommendations

Recommendation 12: Recommendations 1 to 11 need to be addressed by stakeholders from across the industry, working with relevant regulatory bodies when necessary

Where possible, the ownership of the previous recommendations must lie with the relevant industry stakeholders, including regulators, the construction industry, and vehicle manufacturers. Without clear ownership there is a risk that the recommendations will not be addressed; the identification and engagement of relevant key stakeholders is crucial to ensure that the recommendations are taken forward and acted on appropriately.

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[6] There is a precedent for quick turnaround of changes to Stats19 data collection, when contributory factors were trialled and introduced in the 1990s. This is described in Broughton, Markey and Rowe (1998).

4.6 Limitations, and general considerations for future research

All research methods have their limitations. The current research has identified a number of issues using largely qualitative research techniques; the research considered specific examples in depth rather than 'surveying' the industry as a whole. For example the vehicle scanning considered only three vehicles used in the construction industry (and only one mirror configuration in each). Another example is the small sample of construction networks involved in the interviews; the responses given are unlikely to fully represent opinions across the industry as a whole, and it is not possible to generalise the findings in quantitative terms. For example, although one of the three networks accessed showed relatively good practice, this network was chosen specifically to represent an exemplar of what could be achieved when focused attention is placed on vulnerable road user safety in contracting and working practices. Therefore we would not conclude from these results the proportion of construction sites that we would expect to show good or poor practice. The true value of the findings is in identifying specific issues that deserve further investigation using more quantitative techniques on larger samples, and (in combination with other findings from the literature) in identifying high-level, strategic findings that can act as catalysts for change. Many of these are represented in the recommendations described in this section.

One additional general finding that has yet not been discussed in detail is the lack (before this project) of any research into the specific issue of construction traffic and cyclist risk. Some of the recommendations given above will require such research; for example recommendation 7 is likely to require some wider quantitative research into the prevalence of different vehicle heights, dashboard and windscreen designs on construction vehicles to understand if the lower levels of direct sighting through the windscreen seen on the Tipper vehicle in this study is indicative of a wider problem. Another example of further research that may be valuable is a survey of a wide range of construction and general logistics companies to establish how widespread the practice of pay per load is, and at what level of networks it is used.

A final point is that it is important that the effectiveness of any measures implemented to improve the safety of cyclists in relation to construction vehicles is well understood. A benchmarking exercise is recommended in order to support understanding of which measures have the greatest impact. Due to the low absolute number of KSI collisions involving cyclists and construction vehicles each year, any impact of implemented measures would not be discernible using Stats19 data only, and therefore proxy measures to support this analysis (for example observations of near misses) should be considered.

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