

# Fatal and Serious Pedal Cycle and Truck Collisions in the UK: A Systems Approach

Authors: Rachel Talbot, Patrick Waterson, Giulio Spuzlo, Ashleigh Filtness

## ABSTRACT:

Collisions between cyclists and trucks are a concerning contributor to road traffic crash fatalities within the UK. This paper applied a systems approach using the accimap method of analysis to probe deeper into contributory factors involved in cyclist/truck crashes occurring in London. In a single example case study of a cyclist/truck collision it is apparent that high level systems factors such as road design and vehicle regulations play a contributory role in such crashes. Considering the physical process and actor activates from 27 crashes it is apparent that decisions made by both the cyclist and truck driver have individual and interacting effects on crash causation. Overall, accimaps appear to be an appropriate method for considering the contributory factors of cyclist/truck collisions, however, it is acknowledged that the robustness of findings is limited by the scope of information included in the original incident reports.

## 1 INTRODUCTION

In 2014, 113 cyclists were killed in Great Britain (1). Although there has been a longer term reduction in fatalities of all road users, the number of pedal cycle fatalities in Great Britain has fluctuated between 100 and 120 since 2009 with some evidence of a slight upwards trend (1,2). This has led to an increased focus on cycle safety in the UK – especially in areas such as London where there has also been an increase in the number of pedal cyclists on the road (3).

Pedal cyclists, are considered to be “Vulnerable Road Users” as compared with the occupants of motorised vehicles they have very few opportunities for protection and injury mitigation. Casualty reduction measures for this group generally have a focus on collision avoidance. Trucks also represent a particular risk to this user group. In Great Britain, trucks make up 5% of the traffic and are associated with 2% of pedal cyclist casualties but in contrast, 23% of pedal cyclist fatalities relate to a collision involving a truck (2).

Cyclist versus truck crashes are a particular issue in London (4,5).

The objectives of the present study are to better understand how collisions involving pedal cycle fatalities and serious injuries occur and how these collisions and the resulting injuries can be prevented. In order to do this we draw on recent work which applies a 'systems approach' to road safety.

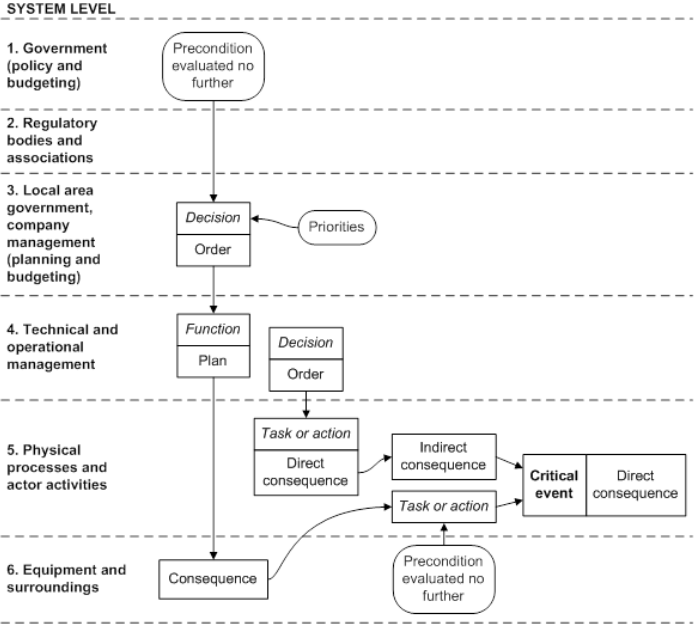
## ***1.1 The systems approach and road safety***

The last few years have seen a number of calls emphasising the advantages of applying a systems approach to road safety (e.g., (6,7)). The systems approach draws on previous research within human factors and safety science which emphasises that crashes occur as a result of the emergent and non-linear properties of complex socio-technical systems such as rail and road transportation (8). The approach is underpinned by an understanding that everyone in the system (not just the driver) impacts safety, recognition that crashes are caused by multiple factors and appreciate that countermeasures which focus on changes to the system (rather than individuals) are most effective. Traditional approaches towards accident analysis (e.g., root cause and fault tree analysis), whilst acknowledging the role played by multiple contributory factors in crashes, often fail to provide detail covering the interaction between these factors and causal inter-relationships. The advantage of systemic accident analysis techniques is that they provide a holistic or 'big picture' view of crashes (9), whilst at the same time facilitating detailed examination of causality.

### **1.1.1 Accimaps**

Accimaps (figure 1) represent one example of a growing family of systemic accident analysis methods (10). Accimaps typically focus on failures across six levels of analysis: government policy and budgeting; regulatory bodies and associations; local area government planning & budgeting (including company management, technical and operational management); physical processes and actor activities; and equipment and surroundings. According to Rasmussen (11) each systemic level is involved in safety management via the control of hazardous processes through laws, rules, and instructions. For systems to function safely decisions made at high levels should promulgate

down and be reflected in the decisions and actions occurring at lower levels. Conversely, information at the lower levels (e.g. staff, work, equipment) regarding the system’s status needs to transfer up the hierarchy to inform the decisions and actions occurring at the higher levels. Without this so called ‘vertical integration’, systems can lose control of the processes that they are designed to control (12).



**Figure 1: Accimap diagram format (adapted from (13), p. 21)**

Accimaps have been used across a range of application domains (14) including road safety (young driver road safety, (7); beach driving, (15)).

### 1.2 Aims and objectives

In this paper we report the findings from a study which aimed to carry out a socio-technical systems analysis (10) to explore some of the contributory factors leading to fatal and serious pedal cycle and truck collisions that occurred in London. Our overall aim was to explore the potential of using a systems-based accident analysis method (Accimaps) to analyse truck and cycle crashes. A second aim was to outline some of the strengths and

weaknesses of the approach.

## 2 METHOD

### 2.1 Incident data and data collection

The contributory factors discussed in this paper form part of the results of a study that was conducted on behalf of Transport for London. The study examined fatal along with a small number of very serious injury pedal cyclist crashes that occurred in London between 2007 and 2011 (5). In the UK, specialist police officers, who are trained in road traffic crash investigation methodologies, attend crashes that are fatal or considered to be life threatening. They conduct detailed investigations and where possible reconstructions to gain as thorough as possible understanding about the crash and how it occurred. Data was collected from the resulting police files that were accessed in paper form at a London police station under conditions of a confidentiality agreement. A simple database was used to store data collected from the police collision investigation reports, driver interview transcripts and witness statements. Scene and vehicle photographs and scene plans were also collected for each crash. A case review approach was adopted to analyse the crashes whereby the complete dataset (including the database variables, scene plan, photos) for each crash was reviewed by a group of 2-5 researchers with expertise in crash investigation, human factors and crash and injury causation to identify factors that contributed to the crash. This exercise resulted in a list of contributory factors for each crash.

### 2.2 Procedure

The procedure for constructing the accimap broadly followed, with some alterations, the guidelines set out by Branford et al. (16) – table 1.

**Table 1: Steps used to construct the Accimap (adapted from (16))**

Step number	Details
1	Sections were made on a large sheet of paper, with the headings of the various levels on the left-hand side
2	The appropriate level for each of the contributory factors previously generated (see section 2) was identified.
3	The contributory factors were written on a sticky note and then placed at the appropriate level on the sheet

**Table 1: Steps used to construct the Accimap (adapted from (16))**

Step number	Details
	of paper
4	The causal links were inserted, linking the factors and hence demonstrating the systemic errors
5	Using Microsoft Visio, the factors were rearranged such that that related and causes leading to the same outcome(s) were placed close to each other, whether in the same level or in the level(s) below

### 3 Findings

Two types of accimap were constructed. Figure 2 shows an example output illustrating some of the high level ('macro') factors involved in one truck-cycle collision. In line with previous systems-based accounts of road safety, figure 2 illustrates the interaction between multiple components and causal factors contributing to the crash. Aspects of the road design and infrastructure (junction complexity), the design of the truck (mirror type) and the actions of the cyclist and truck driver acted in combination to produce the accident. Figure 3 summarises the analysis from the complete set of incidents for the single system level "Physical process and actor activities" I ('micro'). This provides an in depth focus on the interaction between truck drivers and cyclists. The number of incidents containing each contributory factor is provided in brackets. The dotted lines in the accimap indicate relationships between the factors. For example, undertaking on the part of cyclists was associated with drivers not seeing, or seeing late, that a cyclist was present. Similar relationships are hypothesised to exist between risky cycling behaviours and an element of surprise on seeing the cyclist by truck drivers.

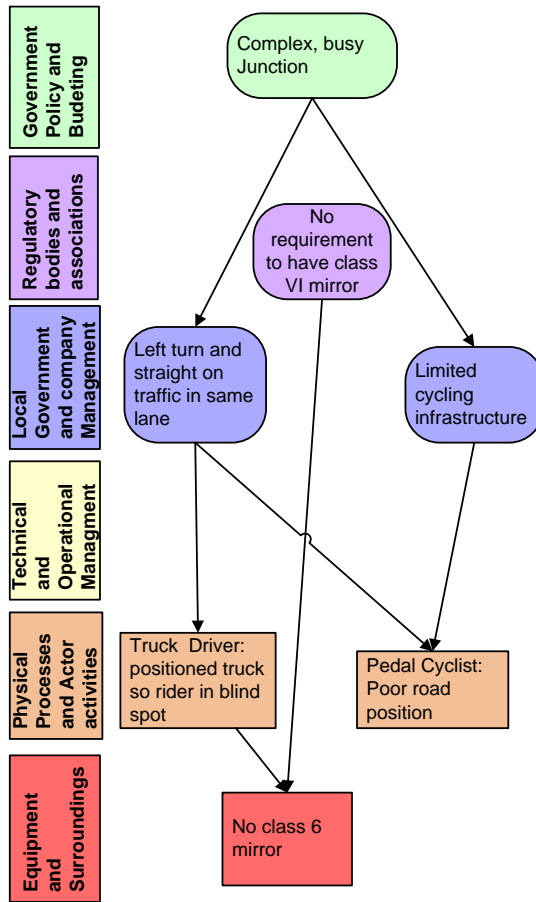


Figure 2: Example Accimap for 1 pedal cycle vs truck crash (macro detail)

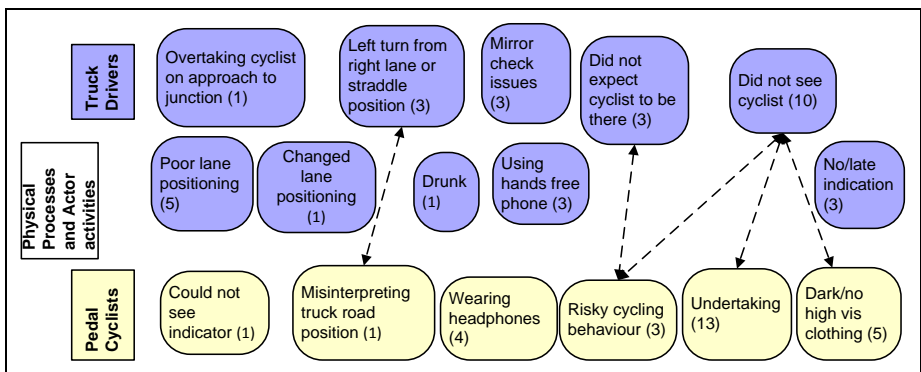


Figure 3: Accimap extract (micro detail) – Physical Processes and Actor activities, n=27. Relationships between contributory factors shown with dotted lines, number of crashes in brackets

## 4 Discussion and future work

The work reported in this paper is exploratory and for reasons of space we have only reported limited set of findings from our data. Nethertheless, we believe that applying a systems approach to the truck-cyclist data has several advantages compared to 'traditional' methods of examining road crashes (e.g., the 'road user' approach – (6,17)). Firstly, systems analysis shifts the focus of attention away from the actions of one or two actors within the crash (e.g., drivers, cyclists) and seeks to emphasise the role played by multiple elements (e.g., road design, car design). Secondly, systems analysis facilitates consideration of the network of interactions and interdependencies which exist within road safety. This is particularly important when considering the extreme physical differences between cyclists and trucks. Both user groups have different requirements of the same road network which leads to conflict and failure to interact safely within the system. Understanding the interactions which lead to crashes is a first step in identifying potential areas to improve road safety. For example, in Figure 2 it is clear that the likelihood of collision could have been reduced by countermeasures introduced at a variety of system levels, e.g. regulatory requirement to have class VI mirrors. Similarly, it is apparent that the behaviour of the truck and the cyclist interacted to form crash casual factors (Figure 3).

The advantages stated above have both theoretical and practical implications for the study of road safety and crashes. In terms of theory, systems analysis helps to understand the interaction between 'macro' and 'micro' components (18) within the wider road system and to help formulate hypotheses about possible causal relationships. These hypotheses can then be used to carry out further investigation and help identify previously overlooked causal associations. Practically, systems analysis may also be useful in identifying countermeasures, as well as scoping the design of interventions designed to reduce crashes. We also note that systems analysis methods such as Accimaps may also have some disadvantages over existing methods (e.g.,

the reliability of outputs, (14). In our future work, we hope to expand the analysis described in this paper, as well as provide a fuller account of the strengths/weaknesses of systems analysis.

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