Taking a ‘7 E’s’ approach to road safety in the UK and beyond

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ABSTRACT

Road traffic accidents claim the lives of more than 1.25 million people each year, 90% of these deaths occur in Low-and Middle-Income countries (LMIC). The Socio Technical Approach to Road Safety (STARS) project brings together a consortium of four LMICs (Bangladesh, China, Kenya and Vietnam) and a leading Transport Research Group in the United Kingdom (UK) in order to tackle Road Safety. Traditional road safety research has been characterised by the ‘3 E’s’ of Engineering, Enforcement and Education. Although these have provided guidance to engineers and policy makers, they do not go far enough to providing a holistic and integrated approach to road safety and fail to consider fully the wider system factors that shape road user performance and outcomes. STARS intends to tackle road safety from a ‘7 E’s’ perspective, with the inclusion of Economics, Emergency response, Enablement, and the overarching ‘E’ of Ergonomics, i.e. applying contemporary socio-technical systems methods to develop systemic solutions to the seemingly intractable problem of road safety. This paper provides a status review of the ‘7 E’s’ of road safety from a UK perspective and the poster will contrast road safety across the five countries using the Actor Map component of the Risk Management Framework to model the road safety system.

KEYWORDS

Road safety, Accimaps, systems

Introduction

Road traffic accidents claim the lives of more than 1.25 million people each year, 90% of these deaths occur in Low-and Middle-Income countries (LIMC) (World Health Organisation (WHO), 2015). To put this in context, the recent Ebola outbreak claimed approximately 11,000 lives (Centre for Disease Control and Prevention, 2015). As the ninth global leading cause of death, road traffic injuries represent a major pandemic (WHO, 2015). LMICs have more than twice as many road traffic fatalities (per head of population) compared to high-income countries (WHO, 2015). Whilst these countries represent 82% of the global population, they only represent 54% of registered motor vehicles, thus they have a disproportionate number of deaths relative to their level of motorisation (WHO, 2015). To address this issue a consortium has been formed with four LMICs via the Socio Technical Approach to Road Safety (STARS) project. These countries represent a range of economic development: A least developed country (Bangladesh), a low-income country (Kenya), a lower-middle income country (Vietnam), and an upper-middle income country (China). The estimated road traffic death rate per 100,000 of the population in these countries is as follows: Bangladesh (13.6), Kenya (29.1), Vietnam (24.5) and China (18.8). In contrast, the rate for the UK is 2.9 (WHO, 2015). We do not set out to impose a westernised view of road safety; instead we seek to capture the current challenges facing these countries and, in collaboration with our LMIC partners, develop and evaluate relevant and realistic solutions. Traditional road safety research has been characterised by the '3 E's' of Engineering, Enforcement and Education. Although they have provided guidance to engineers and policy makers, they do not go far enough at providing a holistic and integrated approach to road safety and fail to consider fully the wider system factors that shape road user performance and outcomes. The STARS project will tackle road safety from a '7 E's' perspective, with the inclusion of Economics, Emergency response, Enablement, and Ergonomics. The overall aim is to reduce the number and severity of road accidents in LMICs through the underpinning philosophy of "local solutions for local problems". This paper will present a review of the '7 E's' of Road Safety from the UK perspective, applying the Actor Map component of the Risk Management Framework method to model the road safety system. Each LMIC partner country is currently undertaking the same status review, therefore the poster presentation will build on the UK perspective and compare and contrast the road safety systems across the four target LMICs.

Current status of road safety in the UK

The UK has some of the safest roads in the world; however, even one serious injury or death is a cause for concern. The UK has a well-established method for collecting data on road traffic incidents, and every year the Department for Transport (DfT) makes publicly available an annual summary of the data (Department for Transport, 2017). This series of annual reports goes back as far as 1926; however, it is from 1979 that the same set of definitions, detail of information, and method of data collection has been used via the STATS19 form. The majority of data comes from police records, however, some of the data used to complete the DfT's annual reports come from other sources, such as mortality, survey, and hospital data. General population and traffic data is also used in order to give context to the road casualty data. The most recent statistics come from the DfT's *Reported Road Casualties Great Britain: 2015 Annual Report* (Department for Transport, 2016).

In 2015, there were 1,730 road deaths, 22,144 seriously injured casualties, and 186,189 casualties of all severities in the UK. These figures represent a 3% decrease from the preceding year, despite an increase of 1.6% in traffic levels over the same period. To put this into an historical context, this represents a 45% reduction in fatalities since 2006, and a 68% reduction since 1986 (despite population growth of 15% across the same three decades). In 2015, 51% of fatalities occurred on non-built up roads (i.e. speed limits of 40-60mph), whereas 67% of serious injuries occurred on built up roads (i.e. 30mph speed limit or less). Motorways (speed limit of 70mph) account for just 5% of all road traffic accidents. Different road users have different levels of vulnerability. Car occupants represent the largest casualty group but make up 80% of the traffic. Calculating casualties per miles travelled results in vulnerable road users (e.g. motorbike drivers, pedal cyclists and pedestrians) having the highest casualty numbers. Different demographic groups have different levels of vulnerability and different exposure to the risk of becoming involved in a road traffic incident. For example, 17 to 24-year-olds are over represented in the casualty statistics. The rate of road deaths for Britain in 2015 stood at 27 per million people across all age groups, whereas there were 49 road deaths per million people aged between 17 and 24. Of the 314 deaths in this age group in 2015, 63% were motor vehicle drivers, compared to 54% across all ages. Older drivers are also over represented in the fatality statistics. For every million people aged 70 and above there were 45 road deaths. Yet this is not due to higher accident rates but due to the fact that older people are more likely to suffer fatal injuries than younger people.

In terms of experience on the road, the DfT does not separate age from years with a licence. Indeed, this separation is difficult to find in the published literature. It is the case that the vast majority of inexperienced drivers are also young, and the vast majority of young drivers are also inexperienced. McCartt et al. (2009) showed that both factors uniquely contribute to the elevated crash rates, with teenage drivers having dramatically higher accident rates than 25-year-olds, after controlling for licence length. Although the review looked primarily at US-based research, the results are likely to be generalisable to a certain degree. More work is clearly necessary in the UK and in other countries to establish the causal interactions in road safety.

The '7 E's' of road safety

The UK has, comparatively speaking, an excellent road safety record. This is partly because it has always strived, and still is striving to improve that record. In 2015 the UK government released its Road Safety Statement *Working Together to Build a Safer Road System* (DfT, 2015). It describes a number of policies it hopes to implement with the aim of further improving its road safety record. These approaches, as well as other existing measures, have traditionally been described in terms of the three 'E's of road safety; engineering, education, and enforcement. The STARS project extends this to the '7 E's' in order to address wider systemic factors that shape road user performance and outcomes.

Engineering

The engineering approach to road safety can be split into two principal categories; road environment engineering and vehicle engineering. In terms of road engineering, there are many ways of constructing the road environment to improve safety, from speed bumps to the layout of road crossings that ensure a pedestrian looks the right way to search for vehicles. An ostensibly simple example would be the humble street light. Built-in separation of different road users is another method of engineering safety into the road system. One example in London is the cycle super highway, the aim of this is to protect vulnerable road users, but encourages higher cycling rates, an inherently healthier travel choice, both for the user and for the people around (given the beneficial impact on air quality this has). In terms of crash barriers, guidelines have been in place for a number of years (e.g. DfT, 2011), including the notion that barriers should have a degree of flexibility to them, thereby minimising the chance for injury should collision occur. In terms of the vehicle, there are many ways in which safety is engineered into the system. New vehicles sold in the EU are built to high safety standards; all cars have air bags and seat belts and crumple zones for example; however, systems such as automatic emergency braking, collision avoidance systems, intelligent speed assistance, lane keeping assistance, headway maintenance assistance, antilock braking systems, active cruise control, etc. are necessary to get the highest safety ratings.

Enforcement

Many of the engineered safety systems are now legal requirements throughout Europe. Crumple zones, driver airbags, child restraints, seat belts, and general vehicle design all have strict and detailed laws governing them. Furthermore, in the UK, existing vehicles over three years old are required to pass an MOT test, an annual test of vehicle safety, roadworthiness, and exhaust emissions. If a fault with the vehicle is found, it must be rectified before a car can pass the test and be allowed back onto public roads. Laws are also used to encourage public transport use and cycling rates, most notably in London with its congestion charge. The charge, brought in during 2003, aims at reducing traffic in central London. Just as is the case for the vast majority of countries, the UK has many laws governing the behaviour of road users; such as laws concerning driving whilst under the influence of alcohol or drugs, the speed with which one drives, and the general safety of driving. To enforce these laws on motorways and inter-urban main routes the UK's police forces (split into constabularies with jurisdiction over specific areas) each have a road policing unit that specifically polices certain sections of roadway. Punishments for infringements of road laws vary from monetary fines to prison sentences. For laws to be effective, they must be enforced and this requires a police force to be consistent and honest. According to Transparency International (an international NGO that combats corruption), the UK was ranked 10th (with the top rank having the lowest corruption) out of 176 countries in terms of public perceptions of corruption (Transparency International, 2017). In 2012 Transparency International UK report into corruption in the UK gave the diagnosis ‘growing threat, inadequate response’ (Transparency International UK, 2012).

Education

Education for road safety can be split into two primary areas: education of the driver and education of the public. Education of the driver includes all driver training, from the pre-license training and testing that one must complete before gaining a driving license, to advanced driver courses aimed at improving the driving of those that already have licenses. Each road user is trained specifically for their vehicle, for example lorry drivers and bus drivers must pass additional tests in order to legally drive the larger vehicles. In relation to public campaigns, there have been a vast number of schemes over the past 140 years. In 1878 the Bicyclists Touring Club was formed. This campaigned for the rights of cyclists, in particular their safety. They were the first organisation to erect signs warning of tight bends and steep hills (DSA, 2017). Now called Cycling UK, this organisation still campaigns for increased cycling rates and better safety (see cyclinguk.org). The Automobile Club, later changed to the Royal Automobile Club (RAC), was formed in 1897, and has been closely involved in licensing and safety campaigns since its inception. The Royal Society for the Prevention of Accidents (RoSPA) was created after large increases in road accidents during the blackouts in London during the First World War and continues to be a leading campaigner for road safety issues. The UK government’s THINK! organisation is the primary outlet for information and currently have campaigns regarding driving on country roads, fatigue, motorcycling, speed, and horses, to name only a few. They provide links to educational websites and other resources, for students, safety professionals, or members of the general public.

Economics

Road safety has the potential to have a significant impact on the economy. In 2015 it was estimated that the value of the prevention of all reported road accidents was £15.3 billion, rising to £35.55 billion when taking into account unreported casualties (DfT, 2016). This primarily considers the cost of losses to the UK economy in productivity, in hospital and emergency response costs, financial losses to employers and organisations, and costs associated with congestion caused as a result of an accident. The UK is ranked fifth in the world in terms of Gross Domestic Product (World Bank, 2017). Nevertheless, the financial crisis had lasting repercussions on the economy, and funding for road safety campaigns was, like in many other sectors, cut dramatically. In 2010 funding for road safety campaigns dropped significantly following the government’s drive to reduce the nationwide budget deficit. The Road Safety Revenue Grant was reduced by 27%, from £77.3 million to £56.7 million, and there was an immediate abolition of a £17.2 million Road Safety Capital Grant (Amos et al., 2015). To keep the road network safe, it must also be well maintained. The road network is England’s most highly valued asset, estimated to be worth around £344 billion (National Audit Office, 2014). According to 2016 data, one in six roads may need to be replaced within the next five years, the one-time cost to catch up with all road maintenance is estimated at £12.06 billion, and there is a £730 million shortfall in annual road maintenance funding.

Emergency response

For emergency response to incidents, three primary organisations are involved; the Police, Fire Brigade and the Ambulance service. These three organisations work together to ensure interoperability, however, each one also has its own guidelines. Most people involved in an incident requiring ambulance call-out will then be transported to a hospital emergency department. The ambulance service comes under the National Health Service (NHS), a public health service available to all that need it. That improving care standards leads to reduced road fatality rates appeals to common sense; however, it has also been demonstrated statistically. Noland and Quddus (2004), using a fixed effects negative binomial regression model, showed that, in Britain, the fall in casualty rates from road traffic incidents across the years 1978 to 1998 can be explained, in part, by lower in-patient lengths of stay, higher per-capita levels of NHS staffing, and lower numbers of people per-capita waiting for hospital treatment (three proxies for improving medical care standards; see Noland & Quddus, 2004). The NHS is constantly striving for improved levels of service, for example seeing 95% of emergency patients within four hours, up from the 85% target of two years ago (e.g. NHS, 2017); one would therefore expect improvements in emergency response systems (both at the scene and in hospital) to continue playing a role in the reduction of road fatality numbers.

Enablement

Enabling road safety research and translating this into practice does not refer only to the level of funding available, but to the ease with which data is made available, the levels of communication and interoperability between agencies and research institutions, the general culture of support for research expenditure, and the governmental, public, academic, and commercial support for road safety initiatives. With regards to data availability, since 2013, the start of the Open Data Barometer project the UK has been ranked number one in the world (with currently 115 countries measured) in terms of a government's readiness of open data initiatives, implementation of open data programmes, and impact of open data on society. The UK Statistics Authority, a non-ministerial, independent statutory body, through the Office for Statistics Regulation and Office for National Statistics, as well as data.gov.uk and the statistics section of gov.uk, the main governmental website for the UK, all provide free access to regulated and managed data and are all funded by central government. The UK's Freedom of Information Act 2000 (brought into force in January 2005) ensures a general right of access to information held by bodies performing public functions. In terms of interoperability, the picture is mixed. For the emergency services, there exist a number of documents and governmental websites that discuss how the ambulance, fire, and police services work together when responding to incidents (e.g., NPIA, 2009; CFOA, 2012; APCCS, 2014; 2016). The SURVIVE Group (survivegroup.org), a partnership between Highways England, the National Police Chiefs' Council, vehicle insurers, the breakdown and recovery industry, and a number of other charitable, governmental, and research organisations (including the RAC, Transport Research Laboratory, and the government's Home Office), also exists as a means for supporting inter-agency collaboration. For other government agencies, however, official documentation on interdepartmental communication and sharing of information is far less easy to find. There does exist a cross-government campaign team aimed at championing issues of priority where cross-government effort is required, but there is no current road safety campaign.

Ergonomics

With regards to human factors and ergonomics research in road safety, focus has traditionally been on the individual driver (Parnell et al., 2017). Support for the systems approach has been less forthcoming, though this is beginning to change with the adoption of the 'safe systems' perspective. This road safety perspective has its roots in Sweden in the 1990s (see visionzeroinitiative.com) and one of its central themes is that humans are fallible and that responsibility for road safety should be moved away from road users and placed on road system design. The philosophy has evolved since its beginnings, and is supported in the UK by a variety of charitable organisations, for example the Parliamentary Advisory Council for Transport Safety (PACTS), SUSTRANS, Brake, and the Towards Zero Foundation. Though it has not yet been implemented nationwide across the UK, some individual councils have taken up the approach, for example in Bristol (Bristol City Council, 2015).

It is important to point out that the 'safe systems' approach is *not* synonymous with the sociotechnical systems approach (e.g. Scott-Parker et al., 2015). Although a variety of system actors are considered, the driver is still the centre of focus. As an example, in Bristol City Council's (2015:12) document on the safe systems approach it states that *"roads must be tailored to human limitations".* The emphasis is on designing a road system that tolerates the errors of the user, rather than designing a road system that takes into account the interaction of system components that influence system behaviours. Moreover, the scope of the safe systems approach is often limited to the immediate road environment; it does not often consider the system at higher levels of abstraction. Furthermore, although it is beneficial to move away from placing all blame on the road user, this should not be replaced by placing all blame solely on the system designer (see, e.g., Towards Zero Foundation, 2017). Accountability needs to be shared across *all* levels of a system, with multiple actors and organisations responsible for system outcomes. The safe systems approach is certainly a step in the right direction, but to enable change at all levels of the road system, with the aim of further reducing the numbers of killed or seriously injured people on the roads, an even broader perspective needs to be taken.

While there is a wide variety of sociotechnical systems models and analytical techniques (see, for example, Stanton et al., 2013), it is Rasmusen's (1997) Risk Management Framework (RMF) that has received the most recent attention in the road safety domain (e.g. Salmon et al., 2013; Newnam & Goode, 2015; Scott-Parker et al., 2015; Young & Salmon, 2015; Parnell et al., 2017). One of the main benefits of the framework is that it can be applied to any complex domain in which safety management is a concern. It considers accidents as emergent properties that arise from the interplay of individuals and organisations at various levels of abstraction in the system. Traditionally the RMF has been used to investigate accidents but in recent years the method has been applied to model system interactions in general (e.g. Young & Salmon, 2015; Parnell et al., 2017). The RMF provides a hierarchical description of a sociotechnical system on which an Actor Map (i.e. all organisations/actors involved in the system) and the Accimap (i.e. activities, processes and functions of the organisations and the associated interactions between them) is based.

The Actor Map graphically depicts the various organisations involved in a particular domain and is populated through the analysis of, for example, company manuals, government legislation, annual reports, commercial practices, and subject matter expertise. The purpose of the Actor Map is to identify the individuals that share responsibility for the performance of the system, at every level of abstraction. To date, an actor map of the UK Road Safety System has been created. At the top most levels are *International Committees* (e.g. European Union, World Health Organisation, World Bank) and *National Committees* (e.g. Transport Select Committee) which are independent of the Government and oversee/review policies and directives. This is followed by *Central Government*, i.e. the body that runs the country and the associated departments that define the laws relating to that country (e.g. Department for Transport, Office or Road and Rail, Ministry of Justice, Department for Health). The *Regulators and Associations* are concerned with implementing and enforcing laws and carrying out the functions of the central government (e.g. Highways England, National Health Service, Emergency Services and Driver and Vehicle Standards Agency). Below this, *Industry and Local Government* have national objectives to fulfil but within a more localised context and may face competing demands such as service provision with limited budget or personal agendas to serve such as profit (e.g. Local Councils, Research Centres, Coach Operators, Vehicle Manufacturers). *Resource Providers* implement the functions and services of the levels above them (e.g. Transport Planners, Emergency Call Operators, Traffic Police) and *End Users* represent the potential users of the road safety system (e.g. car drivers, cyclists, taxi drivers, motor bike riders etc.). The final level of the Actor Map details the *Environment and Equipment*, i.e. external and physical factors that impact the road safety system including traffic calming measures, different road types, vegetation, different vehicles etc.

Conclusions and future work

The STARS project aims to address global road safety through the application of the '7 E's approach', with particular focus on ergonomics and the systems perspective that this can bring. The Actor Map reveals that the UK road safety system is facilitated by over 120 organisations. This highlights the potential complexities that exist within the system, which will be demonstrated by completion of the Accimap, whereby the interactions between the organisations will be considered. The RMF will be applied to the road safety system in our four partner LMICs to enable a consistent comparison of the similarities and differences that exist within each system. This will enable improvements and countermeasures to be developed in line with a socio-technical systems-based perspective based on the local data.

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