Abstract
The road sector is experiencing an unprecedented convergence of physical and digital spheres. This is being reflected by regulatory frameworks that are both responding to technological innovation within the road sector as well as increasingly developing and employing digital regulatory mechanisms in their compliance frameworks. The shift towards digital regulation presents unique opportunities and challenges which are explored in this paper. The authors’ intention is to ask questions as a means of exploring these issues and provoking discussion.

Key words: Digital regulation, digital monitoring and enforcement, heavy vehicle transport policy, standards and regulations (including enforcement, infrastructure access, size and weight regulation)
1. Introduction

The road freight industry is a diverse sector that is attuned to technological innovation and pressures to be competitive. Changing vehicle designs, diversification in relation to types and lengths of trips, complex loads and pressures to improve efficiency characterise the work of heavy vehicle operators and firms. In this shifting setting traditional forms of regulation and enforcement are becoming increasingly outdated (Padula, 2009). Road side compliance and enforcement tactics that solely penalise drivers of vehicles are no longer viewed by many in the industry and regulatory agencies as the most effective or appropriate means of regulation. Forms of digital regulation are increasingly being considered as a possible tool for monitoring and increasing compliance in the road freight industry. This shift towards digital regulation presents both opportunities and challenges for industry and regulatory bodies. What are these possibilities and what strengths and weaknesses do they involve? In a situation characterised by technological innovation, what role do modes of digital regulation have to play in monitoring and ensuring compliance? This paper will explore these questions, engaging with both contemporary examples of digital regulation being utilised and future-orientated planning. Rather than providing clear answers to queries around digital regulation, this paper will ask questions, prompting consideration and discussion around these topics. To begin, the regulatory context will be outlined, followed by the methodology utilised in this investigation. Following this is a discussion of the opportunities and challenges presented by digital regulation. Speculative reports produced by the National Transport Commission (Australia) and the International Transport Forum looking at how transport regulation may be carried out using digital technology in the coming decades will be discussed. Present-day regulatory schemes that employ digital technology will also be examined, specifically the Intelligent Access Program developed in Australia.

2. Regulatory Context

Regulatory governance and intervention by the state is often considered ‘when a problem is serious enough to justify intervention, where the community requires the certainty provided by legal sanctions or when universal application is necessary’ (NTC, 2017c, 23). Although heavy vehicles and trucks represent a relatively small proportion of vehicles on road networks (in the Australian contexts this represents 2.4% of the total vehicle fleet (ABS, 2014)), the presence and behaviour of the industry significantly impacts upon other road users and the community. For example, of the 5 million tonnes of freight moved within Australia per day, trucks transport around 70 per cent (by weight) (BITRE, 2016). Therefore, the impact of heavy vehicles on infrastructure wear and tear is significant, and when involved in accidents these vehicles are more likely to have a dramatic impact on the ongoing operation, safety and efficiency of the road network. Regulation of the industry that focuses on safety, protection of infrastructure and compliance is therefore very relevant to the broader community.

Regulation of the road transport sector has traditionally involved direct roadside enforcement and prescriptive legislation. These strategies include road side checks and random police intervention, methods that have been criticised for solely penalising the driver when several players along the supply chain may be responsible for the infringement that has occurred. Over the past 30 years punitive approaches that target the driver have also been criticised for their inefficiency and their general inability to change the behaviour of drivers and the attitudes of managers in key organisations linked to the transport chain (Padula, 2009, ITF, 2017). In response to these findings more recent regulatory strategies have been developed to address the concept of chain-of-command and in the Australian context, to introduce a
uniform national approach to industry regulation and standards, which previously differed between each state and territory.

The institutional landscape of the Australian road transport sector comprises various regulatory bodies that address different areas of regulation. To briefly outline these bodies, the National Transport Commission (NTC) is responsible for a broader national policy overview, developing and introducing the Heavy Vehicle National Law (HVNL) in 2014. The National Heavy Vehicle Regulator (NHVR) is responsible for a defined program of legislation and regulatory administration, administering and managing the HVNL and other national regulatory programs that address vehicle standards, fatigue management, and mass, dimension and loading limitations. State and Territory road and transport agencies carry out a range of services, including heavy vehicle registration, driver licensing, vehicle standards inspections, accreditation of vehicle inspection stations and approval of vehicle examiners. They also perform compliance and on-road enforcement and maintain authority, along with local councils, to make decisions regarding road access. The work of these bodies is increasingly engaging with and utilising different forms of digital regulation, for example, electronic work diaries. In the Australian context, the regulatory body most involved with digital regulation is Transport Certification Authority (TCA). TCA is a statutory body that manages and delivers a national framework of regulatory telematic services in road transport. It works to provide accreditation, advice and administrative services for initiatives in the Australian road transport sector that involve telematics and related intelligent technologies (TCA, 2017). The organisation was established to assist state and territory transport agencies achieve robust safety and efficiency standards in road transport through the use of telematic technologies (Hill, 2016). TCA’s approach aims to synchronise governments and policy-makers engagement with telematics technologies to avoid a fragmented approach that can lead to policy duplications, delays and unnecessary expenditure of funds (TCA, 2017). In a sector closely entwined with technological developments and innovative ideas, TCA is a major player in managing the increasing use of and possibilities of digital forms of regulation.

The national and state based regulatory bodies share an interactive working relationship, with each possessing distinct yet at times overlapping realms of regulation that comprise various roles, responsibilities and areas of focus. They have created and managed various regulatory schemes that move away from traditional enforcement tactics towards models that represent examples of co-regulation and voluntary self-regulation. Examples of this include the National Heavy Vehicle Accreditation Scheme, managed by the NHVR and the Intelligent Access Program (IAP), developed and managed by TCA. The IAP will be discussed in more detail shortly. These programs are examples of how regulatory strategies are continuing to develop with an increasingly close engagement with technology and digital advances. These advances are mirrored by what is occurring in the road sector more generally, with technological developments impacting on vehicle designs and the future make-up of transport more generally.

3. Methodology

This paper will draw from a variety of sources to develop questions that address the shifting and developing nature of digital regulation and the impact of technological advances on heavy vehicle regulation. Reports from the National Transport Commission, Governmental agency reports, Australian Bureau of Statistics publications, reports published by the International Transport Forum and academic literature are engaged with and analysed. Informal interviews with representatives from regulatory agencies have been carried out, providing insights into
potential future digital regulatory strategies from a regulator’s point of view. More formal semi-structured interviews have also been carried out with actors from telematics companies involved in the Australian regulatory realm. These interviews involved a series of open-ended questions and gave the participants an opportunity to discuss any topics or issues they perceived as relevant. These qualitative research techniques will provide data that can be analysed in order to develop relevant and informed questions, exploring the possibilities of digital regulation in the road transport sector.

4. Discussion

4.1 The Need for Regulation

Within industry and government there is a growing awareness that developments in technology and changing business models will significantly alter Australia’s transport system (NTC, 2017a, TCA, 2016a). In anticipation of these changes it is governments’ role to create the regulatory framework this transformed systems will work within. Part of this project involves removing or altering regulatory barriers to automated road and rail vehicles (NTC, 2017c). Another part involves designing and implementing new institutional and regulatory structures that give priority to good policy rigour and effective and appropriate standards. In a context in which technological advancements and related changes to business models can occur at a rapid pace, the prioritising of regulation can be a difficult task (Hill, 2017). In a context that involves the ‘unprecedented…convergence of the physical and digital spheres’, it is necessary for regulators to expand their knowledge base to engage with areas not traditionally involved with the transport and automotive sector (TCA, 2016a, ii). Decisions made now regarding policy design are of a fundamental nature as they will set the standards for digital regulation for the upcoming decades (TCA, 2016a). In this scenario action needs to be taken quickly with regulatory bodies responding to rapid technological change (BITRE, 2017). In relation to digital regulation, this is one of the challenges present in this shifting context. Further challenges will be discussed in greater detail shortly.

4.2 Opportunities

The convergence of physical and digital spheres also presents opportunities for regulation of the road transport sector, with the potential for both positive market and policy outcomes to be achieved. For example, ‘big data’ represents an opportunity to improve the efficiency of the road network (NTC, 2017b). With an increasing amount of vehicles, both heavy vehicles and passenger vehicles having electronic sensors installed (as well as the sensors embedded in personal devices such as phones), a ‘cloud’ of data is being created (NTC, 2016, ITF, 2017). According to the NTC (2016, 12), this ‘cloud’, or ‘big data’, could be used to enable ‘analytics and services to be based on real-time knowledge’. The innovative ways ‘big data’ can be used represent developments that could significantly change road and transport systems. For example, data from connected vehicles could ‘work together as a virtual network manager to improve overall efficiency and direct scarce resources to address the most urgent needs’ (NTC, 2016, 13). The International Transport Forum (2017, 6) claim that big data ‘creates an opportunity for more data-driven policy making’. This prospect may be a means of addressing a gap recognised by the ITF between regulatory frameworks and their underlying policy objectives. This gap could be addressed with ‘more targeted and more flexible regulatory frameworks as well as more efficient enforcement mechanisms’ (ITF, 2017, 6).
Digital advancements may provide regulators with a ‘superior tool’ for detecting infringements and non-compliance in relation to the market-based, driver-based and vehicle condition rules (ITF, 2017, 11). The Australian IAP program is already making progress in this regulatory space.

The Intelligent Access Program (IAP) is a national voluntary program for heavy vehicles administered by Transport Certification Australia (TCA). Utilising the Global Navigation Satellite System (GNSS), participating vehicles are monitored for route, speed and time. In return for permitting 24/7 monitoring of vehicles, transport operators gain regulatory concessions such as improved access to the road network for high-risk vehicles. These might be heavier and longer vehicles, or involve unique vehicle configurations and transport routes that deliver significant productivity advantages to trucking and transport operators. IAP allows regulatory agencies to more effectively manage risk by linking 24/7 electronic monitoring with high risk road users. Through the IAP system both the productivity and efficiency of the road system is maximised while risks (non standard vehicles and loads) are constantly monitored.

Under the IAP system transport operators must have an electronic device installed in their vehicles that transmits information regarding compliance to their chosen IAP Service Provider. As Figure 1 illustrates, the IAP involves the interaction of different actors that each possess defined roles and responsibilities (TCA, 2016c). TCA are responsible for certifying and auditing IAP Service Providers. IAP Service Providers are responsible for supplying and operating IAP services to transport operators, including installing the in-vehicle units. Transport operators pay a fee for the services delivered by their chosen IAP Service Provider. Road authorities specify access conditions and entitlements that transport operators are expected to adhere to. This information is shared with TCA and included in the IAP framework of conditions accessed and monitored by IAP Service Providers. Although participating vehicles are monitored constantly, only data pertaining to a breach of specified access conditions is of interest to road authorities. In the event of noncompliance, for example a transport operator travels off an approved route or is detected not adhering to the speed limit in a specific location, a report is electronically generated by the IAP Service Provider and sent to the relevant road enforcement authority. The receiving road authority will analyse this report, assessing whether action or a penalty for the offending transport operator is warranted. The IAP is an example of how digital technologies can be utilised in the task of monitoring driver behaviour and with the objective of ensuring improved on road safety, the protection of infrastructure and delivering greater compliance.
One interviewee, a representative from a telematics company involved in the IAP, described the present moment as being “on the precipice of a very, very interesting time in transport, particularly around the use of regulatory telematics and the IAP…there is a lot of interest in what the future holds for these types of programs” (Int02). A development around digital technologies and how this impacts upon the regulatory landscape is evident in the case of the IAP. In the IAP functioning model, private telematics companies play an essential role, providing drivers and transport operators with the TCA accredited IAP device. Telematics companies work closely with drivers as their clients, as well as with regulators. In some instances they can be considered as a regulatory intermediary, representing a middle player between truck operators and regulators. One interviewee working for an IAP telematics company described his position as the Regulatory Program and Partner Manager. He explained that in this position he works closely with road managers around Australia as well as with TCA and the National Heavy Vehicle Regulator. The existence of this position and the work that is described shows that, with a move towards digital regulation, in this instance in the form of employing GNSS and Information and Communication Technologies (ICT), regulatory processes and policies increasingly involve and are becoming dependent on the services provided by private tech companies. This development gives rise to a number of questions, including asking what impact the involvement of private parties will have in the regulatory realm? Does the involvement of private companies and individualised technology provide a more accessible point of contact for drivers to engage with regulatory frameworks? How does the involvement of private companies influence the objectives of regulatory policies? These are just some of the questions that are raised in relation to the increasing use of telematics technology in the regulation of the heavy vehicle sector.

The technology that will largely contribute to the regulation of driver-based rules will include on-board and remote recording equipment (ITF, 2017). Additionally, on-board systems like cameras, GPS and other on-board sensor data could contribute to the monitoring and regulation of driver behaviour. For example, a study carried out by the Swedish National Road and Transport Research Institute VTI used passive eye trackers to monitor the eye movements of heavy vehicle drivers (Kircher et al., 2009). By observing ocular activity, researchers can study driver distraction, drowsiness and intoxication. Using this technology with the distraction detection algorithm, VTI is developing a warning strategy that can be employed with the goal of reducing driver distraction and preventing on-road accidents (Kircher et al., 2009). This development, along with other projects underway at VTI, has the

Figure 1: The IAP Operational Framework (TCA, 2016b)
potential to be a part of future regulatory policy and strategies aimed at monitoring driver behaviour.

Vehicle conditions could also potentially be monitored through a combination of data sourced from the vehicle and from infrastructure. The ITF (2017, 19) believes that this could create a ‘digital and data-rich enforcement paradigm’ that would ‘generate and transmit considerable data on checked vehicles and detected infringements of the rules’.

A variety of approaches to regulation that employ digital technologies are possible. Some of these approaches already exist, while others are speculative. Examples of systems already functioning include:

- distance-based road user charging systems for freight vehicles;
- monitoring the movement and use of larger and heavier vehicles;
- platooning and vehicle automation;
- Platform-based freight matching systems (ITF, 2017, 20).

The ITF (2017, 21-22) also outlines new approaches for regulating road freight. These include:

- systems for network access and vehicle tracking (for example, the IAP);
- combining slot management and geo-fencing into “geo-timing”;
- potential application of the blockchain technology and;
- realising and utilising the potential of big data in the transport industry

The opportunities for regulation that utilise digital advancements are mirrored in the road transport sector more broadly, with the use of Intelligent Transport Systems and ‘big data’ offering a range of possibilities for industry. Briefly outlined, the ITF (2017, 13-14) proposes that these could include:

- improved designs for axle load protection;
- specific and unique dimension restrictions for certain infrastructure;
- new approaches for enforcement of weights and dimensions and;
- location specific in-vehicle messaging systems that could communicate customised traffic rules related to the specific design and load details of vehicles, and more.

If this large number of approaches that employ digital technologies both in the road transport sector and regulation are to be realised, certain changes must be made. For example, the ITF suggests that in the present moment systems are ‘too fragmented’ in terms of ‘integration and interoperability’ and geographic implementation (ITF, 2017, 12). To address this fragmentation communication between different sectors and levels of government needs to improve so that standardised and interoperable systems can be developed. Speaking on behalf of a regulatory agency, one representative claimed that if digital regulation and technological advancements were to improve the functioning of the transport sector then different sectors needed to communicate with each other. In doing so they could form a more united engagement with technology, ensuring that policy ideas are not driven by technology and the market but are led by controlled regulatory standards and good policy.

4.3 Challenges
As well as exciting opportunities that offer to improve and change the road transport sector significantly, the use of digital innovations and techniques involves a number of unique challenges. For example, security concerns relating to the collection and use of ‘big data’ are prevalent. Participation from transport operators requires a ‘high level of trust, reliability, consistency and continuity’ in the agencies and companies that will be collecting and storing this data (ITF, 2017, 7). Whether the protection necessary to prevent data-breaches and online hacks is currently sufficient is unclear. During interviews with representatives from regulatory agencies and telematics companies, a number of participants mentioned a resistance by some trucking operators to what they perceived as “big brother” type surveillance (Int05; Int11). A concern around constant monitoring and collection of data around driver behaviour and location was expressed. Potential data mining and data breaches resulting in specific information being accessed by unauthorised parties, for example, insurance companies, is a possibility that must be contended with by regulatory agencies planning on utilising digital forms of regulation (ITF, 2017).

Another challenge relates to the diverse nature of the road sector with its composition of small-end drivers to large trucking fleets. Larger companies tend to have more capacity to engage with the compliance regime and the developments that develop within it. They are also more readily able to financially commit to and engage with regulatory schemes than small operating firms. This range presents a potential governance challenge as it may require the existence of a ‘two-tier system… to allow both high- and low-tech players similar access to the market and guarantee a level playing field’ (ITF, 2017). How will the increasing implementation of digital regulation, some forms of which can be a major cost for smaller scale truck operators, impact upon competition in the heavy vehicle road sector? How can regulatory schemes that utilise technology to achieve greater compliance ensure equal access to the diverse range of players in the sector? These are just some of the questions surrounding competition and fair access that accompany the increasing use of digital regulation.

As discussed above, the development and increasing use of digital technologies in forms of regulation frequently depend on the involvement of private technology companies. This involvement can advance regulation in ways not possible for government agencies working on their own. As well as these advantages, the presence of third-party companies can also present challenges. For example, it is necessary to question whether this development will further open up regulatory structures and processes to pressures of neoliberalism and market forces. In relation to the functioning of the IAP, one representative from a regulatory agency expressed that telematics companies are an “integral cog” (Int01). He also recognised however that “they aren’t Government and they have their own business interests which is good but also problematic” (Int01). For this reason, telematic companies are excluded from strategic discussion which the interviewee described as “right and proper because they’ll try and drive an outcome in their own interests” (Int01). These comments point to the tensions that exist in relation to the increasing involvement of private third-parties in the regulatory realm. Within a neoliberal paradigm this tension is not unique to the road sector but is one experienced in many different sectors. With the increasing use of digital technologies provided by third-party companies in regulatory frameworks, how can this issue be managed? How will the business objectives and self-interests of private companies interact with regulatory and compliance and regulatory objectives? Will they complement each other, clash or compete, or a mixture of these relations?

Earlier, the situation in which digital and physical spheres are converging in an unprecedented fashion was described. With rapid technological advancement, the technicalities and details of which can be difficult to understand for non-IT workers, regulators must ensure that the
opportunities made available are taken with care and consideration for good policy (NTC, 2017b). For regulators that do not possess the expert knowledge of tech companies, a risk exists that policy-makers may commit to technologies and arrangements that have unexpected consequences. In the words of a representative from a government regulatory agency, within this context the biggest regulatory challenge is ensuring that regulators and government do not get “blindsided” by technology providers (Int01). This involves expanding knowledge and understanding of the technical aspects of digital products put forward to avoid a situation in which regulators respond to the pressure of rapid technological change without careful consideration and the capacity to make informed commitments (TCA, 2016a, ii). At the same time governments and regulators need to make timely decisions so that they may employ up to date technology and avoid investing in products that will soon become obsolete. The regulation that responds to and accompanies the current paradigm shift must act as ‘safeguards’ that ‘protect the public interest and enable innovation in equal measure’ (TCA, 2016a, ii). Getting the balance right is of utmost importance as the standards and rules developed and implemented in the present will underpin and direct the use of digital technologies as regulatory tools for the foreseeable future (TCA, 2016a).

5. Further Questions

These challenges and opportunities present compelling points to consider in relation to different forms of regulation. As technology continues to develop it appears to be inevitable that road sector regulation will increasingly implement and employ compliance frameworks and regulatory mechanisms that utilise digital technologies. As regulators and policy-makers continue to both grapple with and embrace technological innovation it remains pertinent that thoughtful and considered decisions are made, and that the regulatory objectives of safety, protection of infrastructure and compliance remain as priorities. There are many more questions to consider in relation to regulation on the road in the digital age. Will the use of innovative digital technologies and systems be employed in prescriptive, co-regulation or self-regulation models? What new variations or combinations of these categories will emerge? Will governments maintain, increase or decrease the role they play in the regulation of the road transport sector? What role will private companies (both within and outside the transport sector) play in this rapidly changing environment? These questions and those presented in this paper are intended to provoke critical thought and discussion in relation to the potentiality of digital technologies and regulation in the road transport sector. It is a timely and essential discussion to be having, and one that is relevant to many sectors across society.
Reference List


