What can Australian road safety strategies learn from systems thinking and TQM?

Jacqueline Hicks

2104939

Word count 2986 (excluding citations and references)

Management of road safety has deservedly been given a lot of attention across the world, with the risks of the road creating one of the biggest public health problems in the world (Hughes, Newstead, Anund, Shu, & Falkmer, 2015). This essay will examine Australia's road safety strategy in the context of urban environments, and how well it aligns with the principles of Systems thinking and Total Quality Management (TQM). While road safety has been explored through the lens of systems thinking (Hughes, Anund, & Falkmer, 2015; Salmon & Lenné, 2015; Scott-Parker, Goode, & Salmon, 2015), the use of TQM to inform road safety strategies is novel. I argue that, while current transport safety management does incorporate elements of systems thinking and TQM, there is still much to be learnt from these management tools (Hughes, Anund, et al., 2015; Litman, 2017; May, Tranter, & Warn, 2011). I then consider how the adoption of certain TQM principles could lead to potential improvements.

For this essay road safety management is considered at the level of the community rather than within particular organisations responsible for road safety. This essay also limits the definition of quality in road safety to the reduction of risks related to crashes or other defective manoeuvres by vehicles that result in injury. While it's acknowledged that there are other risks related to roads, this definition is in line with most road safety research, policies and programs, including Australia's road safety strategies, and this presents a complex challenge to manage in itself.

Road safety management has evolved drastically over the last century. Up until the 1960s all crash prevention measures attempted to change road user behaviour through driver training, pedestrian education and punishment of traffic rule violations (D. Mohan, 2019). The recognition of broader factors including the safety of vehicles came under scrutiny by safety researchers in the 1960s and with Nader (1965) writing the book "Unsafe at any speed". Innovation in car manufacturing and safety standards followed. Since this time there has been a focus on engineering, education and enforcement to improve road safety (McIlroy et al., 2019). Over the last two decades attempts at more holistic understandings of road safety have been incorporated into strategies which attempt to accept human error as part of the system (Hughes, Anund, et al., 2015). This is in line with research that has shown that more than half of the deaths on the road result from risk factors in road systems that don't involve extreme behaviour (Wundersitz, Baldock, & Raftery, 2014). This is reflected in the safe systems approach developed in Scandinavia which was encompassed in Sweden's Vision Zero and adapted in the Netherland's sustainable safety (Wegman, Aarts, & Bax,

2008). The safe systems approach has become an important part of transport safety policies and programs around the world, including Australia (*National Road Safety Action Plan 2018-2020*, 2018; *Road Safety Plan 2021*, 2018).

The safe systems approach acknowledges that responsibility for road safety is distributed across a range of factors in a system. It aims to create a forgiving system where it is understood that road users will make mistakes but that the system should be designed to limit the damage caused by mistakes, particularly respecting the fragility of the human body (Wegman et al., 2008). To achieve this, it moves away from a driver-centric approach by focusing on four elements of the road system called 'cornerstones' in Australia's national strategy (*National Road Safety Action Plan 2018-2020*, 2018) that need to become safer: roads and roadsides; vehicles; road users; and speeds. In this way, the safe systems approach focuses on the immediate road environment and the flows and control of vehicles through it. It is argued this approach fails to use systems thinking in a number of ways: through a lack of consideration of relationships; of the broader influences on road safety; and of the immediate factors that are outside of these four 'cornerstones' (May et al., 2011).

By compartmentalising the safety priorities into the four elements of roads, speeds, vehicles and users, it is possible to overlook potential interactions between these elements. It is noted that descriptions of relationships were missing in the road safety strategies of Sweden, UK, Netherlands and Australia (Hughes, Anund, et al., 2015) and these relationships are important in systems thinking. An example of such a relationship is that between vehicle and road user. If one drives a vehicle that offers the occupants better protection, there is the potential for adverse consequences as the driver may compensate for this risk reduction, brought by the safer car, by driving with less regard for safety (Stetzer & Hofmann, 1996). This has consequences for the overall risk of the road environment, particularly for active transport users who cannot reduce their risk substantially through protection and rely more on reducing the potential for and intensity of crashes. Indeed, safer vehicles for occupants don't always translate to being safer for other road users with most of ANCAP's (Australialian New Car Assessment Program) criteria related to occupant protection, with only a smaller number of criteria related to the safety of other road users ("ANCAP safety," 2020). These rating systems don't consider harm minimisation in impacts with cyclists (Wegman 2012) and don't encourage smaller cars that may create more risk for occupants but less for other road users (Noland, 2005). A systems approach would take these relationships into account and help mitigate the unintended consequences associated with vehicle safety.

This brings about another issue as to whether there are factors missing from the cornerstones, one being "safer modes of transport". It is noted that the first goal in safety management should be to eliminate the danger, which in the case of road safety implies a reduction in car use as they engender a combination of kinetic energy and unpredictability that creates danger in cities (Wegman, Zhang, & Dijkstra, 2012). It is argued that solutions that build on the acceptance of car use and hence aim to reduce the negative effects of cars within the paradigm of dominant car use, perpetuate the continuation of the use of an inherently dangerous mode of transport and therefore miss the potential of a more comprehensive road safety strategy (Whitelegg 1983 cited in May et. al. 2011). For

examples, it has been shown that the safety of the road improves with an increased use of buses (Tay, 2003) or an increased use of bicycles (Jacobsen, 2015). Therefore, modal shift and reduction in travel demand could all be considered as part of road safety management (Litman, 2017).

Following from these considerations, systems thinking allows us to contemplate non-linear relationships and could help identify leverage points which could offer major gains including virtuous feedback loops in road safety. Such a feedback loop could be safer cycling conditions leading to more people cycling, which in turn makes the road safer as mentioned previously, and continues to reduce people's fear of cycling (Horton, 2007) and increase cycling numbers. A number of tools that help identify important elements and relationships in systems have been developed and applied in road safety research. These include Rasmussens RMF (Risk Management Framework) and the associated AcciMap (Salmon & Lenné, 2015). These identify relevant actors and develop a causal diagram similar to those used in TQM practices which considers the hierarchy of actors and associated decision making. The lack of attention of broader, higher level influences on road safety is made evident by the use of the AcciMap to understand influences on young driver road safety (Scott-Parker et al., 2015). There was a severe lack of research on the influences of higher-level actors such as government policy and budgeting on the safety of young road users.

Comprehensive mapping of the actors that influence road safety could lead to strategies that encompass more institutions within society, including media that can influence the public as consumers, as citizens and as road users. Indeed, recent research has shown the way crashes are reported in the media can influence how people perceive issues around road safety (Goddard, Ralph, Thigpen, & Iacobucci, 2019). It is noted that this can influence the behaviour of car drivers around people riding bicycles and can reduce safety (Laker & Porter, 2020). Other examples of how higher-level decisions affect cornerstones of the Australian strategy include the way time pressures of modern life and city structure affect speeds. Time pressure and city structure are a result of numerous forces but a reassessment of how our daily life is structured and how our cities are planned is recommended to have a holistic approach to road safety (May et al., 2011; Dinesh Mohan, 2008).

In line with systems thinking, TQM offers a number of principles that could be of interest in the context of road safety. Some of these have been considered as part of the road safety strategies in Australia and others can be observed in projects overseas or as recommendations from research. I examine the roles of quality improvement, training and education, involvement of the community, and the importance of focus on process rather than a focus on results and inspection, which are part of TQM (Howley, 2020). While we are transferring TQM to community management, it is acknowledged that road safety strategies can gain from adopting effective models from organisational studies, particular those with a systems approach to safety (Hughes, Newstead, et al., 2015).

With trust in other actors in the system a fundamental part of road safety, it's recommended that quality improvement be justified through evidence-based management, which includes systematic reviews of the scientific evidence for policies, initiatives and standards of road safety (D. Mohan, 2019). Consideration of evidence-based initiatives and road safety data collection and use is emphasised in Australia's road safety strategies and is

in line with TQM principles. The datasets for road safety are quite extensive, reflecting consideration of the contextual factors of incidences. However, the focus on deaths and injuries limits the utility of the data to the problems that have occurred rather than considering other indicators of risk on the road. Examples of these indicators include a data on near misses (beyond crashes with no causalities), mapping potential hazardous spaces and scenarios, measurement of different road users' sense of comfort and safety on the road, or whether people avoid active travel because of safety concerns (although this is used separately by active transport departments). A TQM approach could widen the scope of this data collection to develop more process-oriented action plans which integrate better with strategies in other areas.

The focus on fatalities also affects the goals of the strategies, leading to numerical targets with associated slogans such as NSW's 'Towards Zero' or Sweden's Vision Zero, which is a target that is questioned by experts (May et al., 2011). The targets are often based on the difference between the current year's statistics and a baseline. This is at odds with TQM principles which avoid results-based management and understands natural variability and observes trends using appropriate charts and statistics instead of focusing on the last data points (Howley, 2020). Beyond this, the framing of fatalities and injuries affects how strategies are developed. If statistics are collated based on the victims of road trauma, it can focus the attention of road safety plans on the victim rather than the other road users, vehicles and other elements that cause the danger (te Brömmelstroet, 2020). A better understanding of not only the victims of the crashes, but also how the risk was developed and distributed is critical in developing safer roads. Rectifying how we report crashes and how data is collated and analysed may lead to more emphasis on danger reduction rather than increasing protection or regulation of potential victims (Davis & Pilkington, 2019).

The direction of improvements in road safety is driven by industry as well as by public policy and research and it doesn't always follow from robust scientific evidence with consideration of the improvements to the whole road safety system. Technological innovation has been central to the improvement of the cornerstone of safer vehicles. However, these technologies are developed to be marketable to the public, rather than to improve the overall road safety. How innovation could better focus on the whole system will depend on standards, regulations and other policy interventions as well as better aligning people's expectations with that of the overall safety of the road system. This is particularly important at this moment where technological innovation in vehicles is accelerating. Better aligning people's expectations can occur through embracing a number of TQM's other principles, including education.

Australia's road safety strategies emphasise training and education. There are well-developed training and licensing systems for motor vehicle users in all states across Australia with improvements to the system correlating with reductions of deaths and injuries in young road users (*Road Safety Plan 2021*, 2018). In addition, high levels of educational material and information are provided to the public both through schools and various mass media and social media channels. Nevertheless, it is worth questioning whether this is sufficient in light of TQM principles which stress comprehensive, dedicated and ongoing training as well as broad education which is seen as an investment. Should it be questioned that many learner drivers practice with their parents, who do not necessarily

have a correct understanding of the road rules and responsibilities or they may even have unsafe habits or attitudes. After the initial licensing process, there is no further training or testing until you are elderly, or you are required to undertake training because of certain traffic violations. This can lead to a number of undesirable outcomes, with people forgetting rules or not learning newly established rules and adopting potentially dangerous norms based on what they see on the road. With the importance of continual education in TQM, the potential for further education and training, particularly for parents, could be worth further examination.

Education and training are limited for public transport and active transport users, particularly for pedestrians and cyclists in Australia. Various programs have been set up around the world, with more comprehensive programs in countries such as the Netherlands, Denmark, England and Germany (Wegman et al., 2012). However, it has been shown that the evidence base for educational programs is not well-developed (Hamann & Conrad, 2019) and the effects on road safety have not been thoroughly researched. This is also reflected in the limited educational material developed in Australia which is often focused on training rather than education. For example, the road safety library bag for children starting school in NSW is very car-centric, with the limited material on active travel focusing on personal protection and avoiding interaction with the road system ("Kindergarten Orientation Days and Road Safety," 2020). One could argue this limits the opportunity for children to train as emerging road users and is in contrast to the system in Switzerland which encourages independent active travel to school from a young age with prior training from a police officer and parents accompanying their children the first few times (Fisher, 2020). It has also been proposed that appropriate education could delay or prevent teenagers from driving cars and therefore improve road safety through mobility management of a high risk group (Ward, Lewis, & Weiss, 2020). A TQM approach could lead to a better appreciation of where training and education is lacking, and new programs could be developed, such as a lesson for school students which facilitates analysis and debate around how we use road spaces.

In TQM, the relationship between the people (workers or in this case the broader community) and management is one of trust and collaboration. It could be argued that Australia's road safety strategy doesn't build this level of trust with its strong emphasis on regulation and enforcement. Australia's strategies include systems of licensing people and registering vehicles, which could be argued are necessary to set safety standards. However, the focus on enhancing enforcement of road rules with roads being a highly regulated space is a strong theme in the strategies. The enforcement of road rules parallels inspection within an organisation with the behaviour of the road users being inspected and potentially penalised. The penalties can include demerit points which can lead to the loss of one's license. This contradicts Demming's philosophy of driving out fear. One may argue that in broad communities, encompassing all road users, management needs to use fear, but this need has been contested (Bregman, 2020). It is a delicate area, as enforcement helps the population trust their fellow road users, but process-oriented road safety management which builds trust could be more beneficial.

There is evidence to suggest that collaborative approaches to road safety could result in positive outcomes (El-Serafy, 2020). 'Naked Streets' are roads that are stripped of their

marks and signage and allow the community to negotiate the street co-operatively. There is evidence to suggest that Naked Streets improve the overall efficiency and safety of urban roads and intersections (although there are issues for blind people) (El-Serafy, 2020). It's interesting to consider how the public could also play a more important role in the management of road safety through enhanced communication between the public and transport authorities. While consultation plays a role in the development of strategies, it could be argued that there is limited collaboration compared to that which Demming advocates for. We are left to question how we could better tap all the knowledge of the citizens who use roads on a regular basis.

There is little doubt that road safety management has benefited by the incorporation of elements of systems thinking which acknowledged the shared responsibility of road safety and the complexity and gravity of the problem. However, road safety strategies still lag behind research in taking the opportunities to use systems thinking and there are only dispersed examples of initiatives that align with potentially interesting TQM principles. Exploring systems thinking and TQM in relation to road safety has identified potential innovative practices and questioned some dominant approaches such as reliance of regulation and enforcement. It has shown that while there are some steps in the right direction with the safe systems approach, there could be greater benefits to safety by exploring the possibility of deeper changes to the system (May et al., 2011).

This essay has only skimmed the surface of the possibility of using TQM and systems thinking in road safety, but it has raised further questions for research. Could more studies be directed to higher-level and broader influences on road safety outcomes? Is there capacity within the road system to improve safety through a more holistic, nurturing, co-operative, and trusting management? Could this lead to better co-ordination between road safety efforts and those related to urban planning, slow living, modal shift and promoting more independence for our children and more trust in our community? As road safety professionals and researchers negotiate the treacherous territory of managing the most dangerous spaces people frequent regularly, it can be hard to contemplate major shifts. However, with appropriate staging and the development of a strong evidence base for TQM aligned safety strategies, potentially the urban road networks could become places all road users feel safe, empowered and considerate.

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