An Enhanced Road Safety Information System for Western Australia

C-MARC

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September 2011

Report No. D10#158249

CURTIN-MONASH ACCIDENT RESEARCH CENTRE
DOCUMENT RETRIEVAL INFORMATION

Report No.	Project No.	Date	Pages	ISBN	Version
D10#158249	09-008RSC	September 2011	61	978-0-9871261-2-2	1

Title
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Abstract
The aim of this project was to identify and undertake the fundamental groundwork required prior to the establishment of a road safety database access system. Specifically, the project aimed to define the content and scope of an ideal road safety data system based on the current "Safe System" paradigm for developing road safety policy and countermeasures, to compare this with the current road safety data systems available in Western Australia and to map a path for translating the current system into the ideal one.

In order to fulfil the stated objective, the following tasks were undertaken: Development of a conceptual framework for defining an ideal, comprehensive and integrated road safety data system to support the Safe System paradigm; Determination of specific road safety data system requirements in the Western Australian context from the conceptual framework; Review of existing road safety data systems available in Western Australia including current linkages between these datasets; Identification of key requirements for moving from the current Western Australian road safety data system to the ideal system specified including additional data requirements and requirements for additional linkages; Development of requirements for a multi-user database access system based on the ideal data system proposed.

A comprehensive and integrated road safety data system would deliver numerous specific benefits including: The ability to easily monitor and report on key performance targets endorsed by Government as part of Western Australia's "Towards Zero" Road Safety Strategy 2008-2020; Facilitation of a range of new cutting edge research to inform Safe System practice capitalising on the enhanced scope and improved linkage of the available data; Assisting the development of new and highly informed road safety policy through the enhanced evidence base, additional reporting and improved data quality; The capacity to answer ad hoc queries by key agencies, researchers, policy makers and members of the public; The ability to be used for specific planning and research purposes beyond road safety including infrastructure and transport planning.

Keywords
Road Safety Information System, Western Australia, Data Collection, Data Linkage, Safe System

Contents

EXECUTIVE SUMMARY

The Road Safety Council (RSC) is interested in developing an online road safety database access system that would enable the use of data from multiple sources. A major objective to be achieved as part of developing such a tool is to improve the quality, relevance and timeliness of road crash and injury data collection, including the consistency of information from various sources and elimination of bias due to organisational responsibilities. Such a tool would also quickly answer current road safety questions and potential unasked queries and provide information on road crashes and injuries. It would also enable access to information on intermediate behaviours, road use, road safety program and other relevant agency inputs and socio-economic factors.

Before it is possible to develop a database access system, it is critical to define the scope and content of data that should be contained in the system to be accessed. Most road safety data systems currently in existence in Australia and around the world have been developed in an ad hoc system capitalising generally on administrative data systems that have been assembled for other purposes. The elements of the existing systems have often been assembled reactively in response to particular requirements dictated by road safety strategies and policies that have been operational at various points in time. In general, none of the current systems have been developed proactively with a forward vision to the types of data that will be required to facilitate the best possible strategy and policy development and to support the full range of research activities to support these developments. The general aim of this research initiative is to move towards developing a road safety data system for Western Australia that will meet the widest possible range of future needs in road safety policy, practice and research.

Key Aim and Tasks

The aim of this project was to identify and undertake the fundamental groundwork required prior to the establishment of a road safety database access system. Specifically, the project aimed to define the content and scope of an ideal road safety data system based on the current "Safe System" paradigm for developing road safety policy and countermeasures, to compare this with the current road safety data systems available in Western Australia and to map a path for translating the current system into the ideal one.

In order to fulfil the stated objective, the following tasks were undertaken:

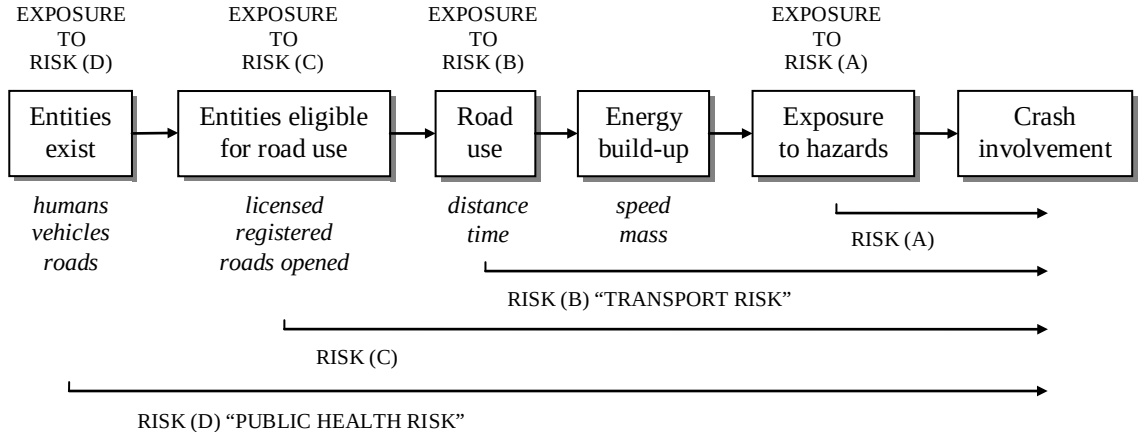
- Development of a conceptual framework for defining an ideal, comprehensive and integrated road safety data system to support the Safe System paradigm;
- Determination of specific road safety data system requirements in the Western Australian context from the conceptual framework;
- Review of existing road safety data systems available in Western Australia including current linkages between these datasets;
- Identification of key requirements for moving from the current Western Australian road safety data system to the ideal system specified including additional data requirements and requirements for additional linkages;

- Development of requirements for a multi-user database access system based on the ideal data system proposed.

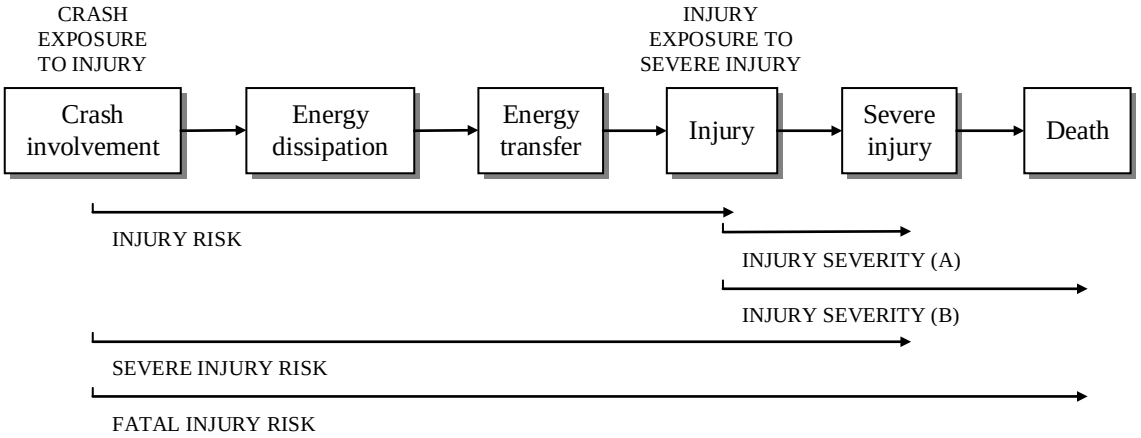
A Road Safety Data System for Western Australia

Western Australia's "Towards Zero" Road Safety Strategy 2008-2020 "Towards Zero" was developed using a Safe System approach, which aims to improve road safety through explicit consideration of four cornerstones: Safe Road Use; Safe Roads and Roadsides; Safe Speeds and Safe Vehicles. Fundamental to the effective translation of Safe System knowledge into action is the existence of underlying data systems consistent with this approach that can inform the strategy and policy development and facilitate the supporting research required. Important functions of a Western Australian data system include permitting assessment of the extent to which the Safe System has been applied across the road system, allowing for monitoring of the progress of road safety strategies created under the System and assisting road safety managers in developing future policy in accordance with Safe System principles.

The starting point for establishing a data system for Western Australia based on the Safe System approach involved defining an ideal, comprehensive and integrated road safety data system. At the core of the ideal system is the "Road Trauma Chain" shown in the figures below. It was originally created to assist in the development of road safety countermeasures through the identification of links where the chain leading to traumatic injury can be broken. The Chain defines steps at which measurements of the road system are required, and it shows the risks that can be measured having defined the steps. In other words, it defines the steps at which measurements of the road system are required to achieve a full understanding of risk on the road network.



The Road Trauma Chain (Pre-Crash)



The Road Trauma Chain (Crash and Post-Crash)

The Chain was enhanced to ensure that all elements of the "Road Safety Target Hierarchy" were included. The target hierarchy was developed within the context that jurisdictions across the world set road safety targets in order to quantify the results they wish to achieve. Key elements include Social Cost (the aggregate measure of all costs that crashes inflict on the community including both material losses and pain and suffering), Final Outcomes (fatalities, serious injuries, fatal crashes and serious injury crashes), Intermediate Outcomes (indicators that are used in addition to crashes or injuries to measure changes in road safety outcomes, with a demonstrated causal relationship between each intermediate measure and crashes or injuries) and Outputs (physical deliverables of road safety programs). The enhanced core was then partitioned by the key cornerstones of the "Safe System".

Definition of the Ideal Data System

The tables below define the elemental compartments of an ideal data system for the effective implementation of the Safe System approach. It is a matrix defined by the fusion of the Road Trauma Chain defining the vertical axis compartments with the Safe System cornerstones defining the horizontal axis compartments. Specification of the relevant data elements within each compartment of the matrix is derived from the Target Hierarchy. Relevant information and examples of measures that should be collected are shown, with items marked with an asterisk (*) relating to Safe Speeds.

	SAFE SYSTEM		
	SAFE ROAD USE	SAFE ROADS AND ROADSIDES	SAFE VEHICLES
Road Trauma Chain		* SAFE SPEEDS	
Pre-Crash			
Entities exist	Population	Length of roads	Number of vehicles/motorcycles
Entities eligible for road use	Number of licensed drivers/riders	Length of opened roads	Number of registered vehicles/ motorcycles
Road use	Vehicle Kilometres Travelled (VKT) by road user type	Vehicle Kilometres Travelled (VKT) by road type	Vehicle Kilometres Travelled (VKT) by vehicle type
Exposure to hazards	e.g. Number of pedestrian crossings		
INTERMEDIATE OUTCOME MEASURES	e.g. * Proportion of drivers/riders exceeding the speed limit	e.g. Proportion of VKT on non-Safe System roads	e.g. Average primary and secondary safety of the light vehicle fleet
OUTPUTS	e.g. * Number of speed-related infringement notices issued	e.g. Number of black spot sites treated	e.g. Level of advertising related to vehicle safety features

Definition of the Ideal Data System (Pre-Crash)

		SAFE SYSTEM		
		SAFE ROAD USE	SAFE ROADS AND ROADSIDES	SAFE VEHICLES
>	Road Trauma Chain	* SAFE SPEEDS		
	Crash and Post-Crash			
>	Crash involvement	Crash involvement by road user type e.g. Number of pedestrian crash involvements	Crash involvement by road type by region by crash type	Crash involvement by vehicle type
>	FINAL OUTCOMES Injury	Number of casualty crashes /Number of casualties by road user type	Number of casualty crashes /Number of casualties by road type	Number of casualty crashes /Number of casualties by vehicle type
>	Severe injury	Number of serious injury crashes /Number of persons seriously injured by road user type	Number of serious injury crashes /Number of persons seriously injured by road type	Number of serious injury crashes /Number of persons seriously injured by vehicle type
>	Death	Number of fatal crashes /Number of persons killed by road user type	Number of fatal crashes /Number of persons killed by road type	Number of fatal crashes /Number of persons killed by vehicle type
	OUTPUTS SOCIAL COST	e.g. Average response time of Emergency Services e.g. Total cost of crashes to the community		

Definition of the Ideal Data System (Crash and Post-Crash)

A fully populated road safety data system as defined would allow each of the risks defined by the Road Trauma Chain to be calculated for each cornerstone of the Safe System. A system defined as such would allow the articulation of the risk processes driving the final road trauma outcomes that are generally the principal target of road safety strategies, namely deaths, long term injuries and costs to the community. *For each cornerstone of the Safe System, it would be possible to identify whether trauma outcomes were driven by high exposure, high risk, high severity of outcome or a combination of two or more of these.* Gaining such understanding informs the size and drivers of the outcome and directs where efforts would be best concentrated to address the outcome and the likely benefits to be derived. Conversely, the consequences that missing information in various cells will have in preventing the risks defined in the Road Trauma Chain from being adequately measured will be made clear.

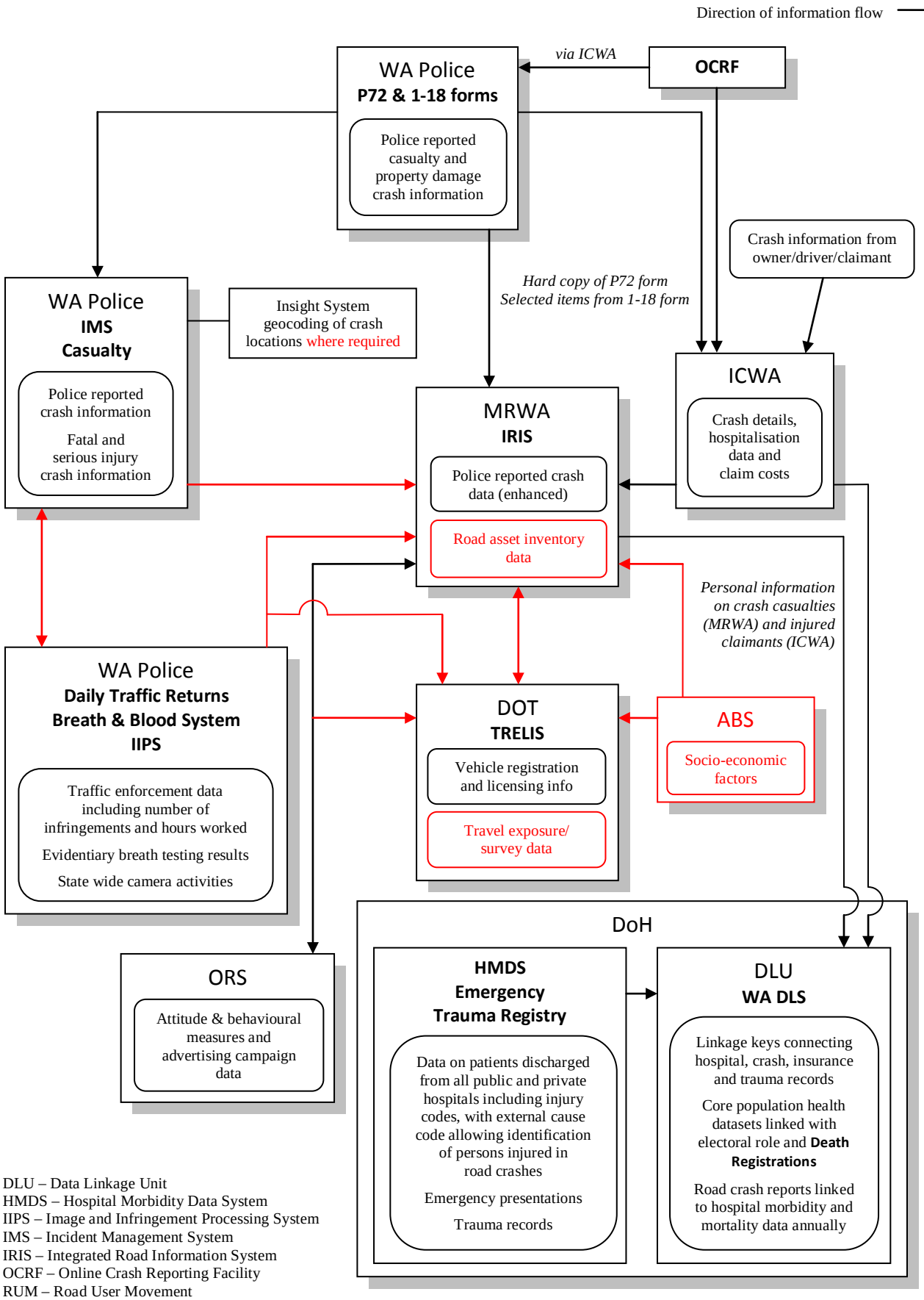
Determination of Road Safety Data System Requirements

The ideal data system as represented can be used to assist jurisdictions in determining their road safety data system requirements under the Safe System. It does this through outlining the information that is critical to informing the successful implementation of a Safe System approach thus allowing for identification of the data that is not collected and highlighting the importance of data that is. It also facilitates assessment of existing jurisdictional data systems and their interconnectivity in the context of content, linkage and access which should lead to enhanced usability and the ability to produce appropriate reports and derive relevant measures.

It was found that the collection of data on injuries and crashes (final outcomes) is reasonably adequate in Western Australia, i.e. the "exposure to injury" sections in the Road Trauma Chain are reasonably well populated. However many measures relating to "exposure to risk", including intermediate outcome measures, are not collected. Ultimately this lack of information means that in many instances it is not known whether final outcomes are a result of high exposure, high crash risk or high injury severity.

Review of Existing Road Safety Data System Elements in Western Australia

A review of the state of current road safety data systems in Western Australia was performed and involved examining the way in which road safety data is collected, enhanced, linked, stored, shared, accessed, analysed and reported on by the responsible Government agencies and the degree of interconnectivity between systems and agencies. The figure below shows the current state of data systems represented in black. The key agencies are shown with their respective datasets and/or data systems where appropriate, and content they hold of relevance to the aims of this project.



DLU – Data Linkage Unit
HMDS – Hospital Morbidity Data System
IIPS – Image and Infringement Processing System
IMS – Incident Management System
IRIS – Integrated Road Information System
OCRF – Online Crash Reporting Facility
RUM – Road User Movement
TEACEIS – Traffic Enforcement And Crash Executive Information System
TRELIS – TRansport Electronic Licensing Information System
WA DLS – Western Australian Data Linkage System

Road Safety Related Data Systems in Western Australia

Key Requirements for Moving to an Ideal System

The review of existing data systems led to the identification of key requirements for moving towards an ideal system and ultimately a road safety database access system for use by road safety managers and policy makers. Requirements include improved interconnectivity and access and the enabling of links based on geocoded, road user and vehicle information. The proposed requirements fall within the context of allowing for uncollected or un-established measures of interest to be made available. This includes assessing the feasibility of providing data in different forms, e.g. disaggregated into various categories.

Key requirements for moving to an ideal system encompass two broad areas. The first relates to the collection of new road safety data either from scratch or through the enhanced processing of existing data sources. The second relates to the linking of new and existing data sources to create a cohesive interactive system. The figure above highlights graphically in red the enhancements required to bring the current WA road safety data system to the ideal system. The red boxes and text indicate where major new data collection or processing activities are required whilst the red lines and arrows indicate where additional data linkage is required.

The major key requirements for further additional data may be summarised as follows:

- Travel and exposure data;
- Road asset inventory data (within a Safe System context);
- Socio-economic (from the ABS).

The following sets of data would need to be fully geocoded to enable the comprehensive linkage of data utilising spatial integration (linkage based on spatial or geographic location):

WA Police

- Incident Management System (IMS)
- Casualty
- Daily Traffic Returns
- Breath and Blood Alcohol System
- Image and Infringement Processing System (IIPS)

MRWA

- Integrated Road Information System – Enhanced crash data
- Road Asset Inventory Data

OTHER

- Travel and Exposure Survey Data

Major additional data linkages required are:

- DoT information system to MRWA and ICWA road crash data systems;

- WA Police enforcement and infringement data with MRWA and DoT data systems;
- WA Police enforcement and infringement data with WA Police IMS casualty data;
- Socio-economic data (from the ABS) with MRWA and DoT data and ORS attitudinal, behavioural and advertising data with DoT data.

The following datasets and data systems currently use person-based relational integration (linkage of text-based data based on a common variable or variables or linkage key) and would continue to do so:

DoT

- Transport Electronic Licensing Information System (TRELIS)

DoH

- Hospital Morbidity Data System
- Emergency presentations data
- Trauma Registry
- Western Australian Data Linkage System (WA DLS)

In general, both person and vehicle-based data would continue to use relational integration. This data includes hospitalisation injury data, licensing and registration information and infringement data. Linkage keys would be based broadly on location, vehicle, person and time.

General principles for data linkage recommended are:

- Geocoding of all data with location information;
- Spatial integration using GIS (Geographic Information System) tools whenever possible;
- Relational integration of person and vehicle-based information using privacy sensitive methods and with detailed validated linkage keys;
- Attaching aggregated personal information to crash data wherever appropriate.

Next Steps

It is expected that movement from the current road safety data system to an ideal system will best be achieved progressively over a period of time through a series of action plans rather than through one or two major steps.

Data Collection and Data Linkage

Data collection relates to the collection of new road safety data either from scratch or through the enhanced processing of existing data sources. Data linkage relates to the linking of new and existing data sources to create a cohesive interactive system.

Action Plan A: Allocation of Responsibility, Data Collection and Geocoding

As part of the first action plan, the following should initially occur:

1. Each agency should decide on the parts of the ideal data system it believes are worth developing in priority order and their individual level of responsibility.

2. Consensus by the agencies should then be reached on which parts of the system will be developed in priority order and potential time frames (short, medium or long-term).

3. Responsibility, individual or shared, should then be allocated according to which aspect of the ideal system is to be developed.

In general, Action Plan A should attempt to make progress where individual agencies are able take responsibility in the short-term and for which new inter-agency data sharing or linkage agreements aren't required. One such area is the collection of measures. Another key area is the geocoding of data.

Action Plan B: Preparation to Enable Data Linkage

The next stage in moving towards an ideal data system should address data linkage actions expected to be progressed once an appropriate data linkage framework has been agreed upon. The framework may leverage existing agreements between data providers already in place and would have as its overriding purpose the aim of ensuring good data governance for data linkage in Western Australia. To achieve good data governance such a framework could potentially be based on the "authorised integrating authorities" concept endorsed by the Australian government for integrating Commonwealth data. Alternatively the role of existing data linkage facilities could be expanded.

Action Plan C: Data Linkage Implementation and Additional Data Collection

Once an appropriate data linkage framework has been put into place and sufficient geocoding of data has been achieved to facilitate spatial integration, actions to implement data linkage should be agreed to by the agencies. The additional linkage of new and existing data sources will also enable the collection of new measures derived using linked data. Prioritisation of these measures and allocation of responsibility for their collection should then occur.

An Interim Dataset

It is proposed that an initial interim dataset, suggested as part of agency feedback, could form a good basis for the future database access system. As such, it is recommended that the actions that follow occur in the short to medium-term and should be viewed as being able to be progressed in parallel with those outlined above.

Action Plan D: Establishment of an Interim Dataset

Prior to the establishment of a multi-user database access system based on the ideal data system, an interim dataset could provide a basis for such a system and may also provide a starting point from which basic road safety queries could be addressed. It is anticipated that

the interim dataset, once sufficiently geocoded, could also promote progress on design of the spatial information system that would be an integral part of the database access system.

Action Plan E: Development of a Spatial Information System

If it is decided that an interim dataset should be used as the basis for developing a spatial information system, the agencies should:

- Investigate what is required to set up a similar project to HealthTracks, an online interactive mapping application that allows employees from the Department of Health to access basic information and includes as part of its functionality search tools, the mapping of demographic and health condition data and the ability to import, export and print data and maps, or alternatively investigate whether an expansion of the project to include road safety data is possible;

- Decide which agency would lead such a project;

- Discuss the manner in which data will be collated, spatially enhanced and distributed.

Key Benefits

The creation of an enhanced road safety information system for Western Australia leading to a multi-user database access system is critical to providing a solid foundation from which effective road safety management in Western Australia may be undertaken. It provides the basis on which to service the Safe System paradigm under which road safety policy and programs are developed. Generally, the data system will facilitate all stages of road safety management including problem identification, monitoring of relevant trends and outcomes, selection, formulation and implementation of appropriate countermeasures and countermeasure evaluation. Through these activities, the enhanced road safety information system will facilitate the translation of Safe System principles into practice.

Beyond these general benefits, a comprehensive and integrated road safety data system would deliver numerous specific benefits including:

- The ability to easily monitor and report on key performance targets endorsed by Government as part of Western Australia's "Towards Zero" Road Safety Strategy 2008-2020.

- Facilitation of a range of new cutting edge research to inform Safe System practice capitalising on the enhanced scope and improved linkage of the available data. The research would more readily be able to address issues in greater detail that cut across the multiple elements of the Safe System.

- Assisting the development of new and highly informed road safety policy through the enhanced evidence base, additional reporting and improved data quality.

- The capacity to answer ad hoc queries by key agencies, researchers, policy makers and members of the public.

- The ability to be used for specific planning and research purposes beyond road safety including infrastructure and transport planning.

1.0 Introduction

The Organisation for Economic Co-operation and Development (2008) report *Towards zero: ambitious road safety targets and the Safe System approach* notes that ambitious road safety targets have been set by many jurisdictions to reduce road trauma but that few are on track to achieve their targets. The report takes stock of recent developments and initiatives and highlights the types of changes required to implement effective interventions. A key element addressed is the requirement for data collection and analysis. Comprehensive data collection and analysis are described as being essential for designing effective road safety strategies, for setting achievable road safety targets, for developing and determining intervention priorities and for monitoring road safety program effectiveness. The report explains that good quality crash data is essential and needs to be complemented with socio-economic data and performance indicators that can also be used as intermediate targets and that in-depth analyses of such data enable past safety achievements to be understood and also allow target reductions in fatalities and injuries to be estimated on the basis of measured and expected trends. It was emphasised that these estimates are not just simple forward projections of past reduction rates but are based on a comprehensive understanding of all the underpinning factors and trends likely to impact on system safety. Data reliability, timeliness and quality combined with effective analysis are fundamental to building an understanding of risk and intervention effectiveness.

The Road Safety Council (RSC) is interested in developing an online road safety database access system that would enable the use of data from multiple sources. A major objective to be achieved as part of developing such a tool is to improve the quality, relevance and timeliness of road crash and injury data collection, including the consistency of information from various sources and elimination of bias due to organisational responsibilities. Such a tool would also quickly answer current road safety questions and potential unasked queries and provide information on road crashes and injuries. It would also enable access to information on intermediate behaviours, road use, road safety program and other relevant agency inputs and socio-economic factors.

A database access system would be available for use by the key Government agencies interested in road safety and road safety partners including Western Australia Police (WA Police), Main Roads Western Australia (MRWA), Department of Transport (DoT), Insurance Commission of Western Australia (ICWA), Department of Health (DoH), Western Australian Local Government Association (WALGA), Department of Education (DoE), Royal Automobile Club (RAC) and the Office of Road Safety (ORS). This would enable each of these agencies to provide a consistent response to public requests for information and requests by other Government agencies. It is important that the tool is reliable and up-to-date so it provides a credible source of evidence when used to support Government policy. The development of a road safety database access system would include setting up an on-going monitoring system and potentially a road safety literature access system. The ORS has also indicated that the online system should include a query tool designed for access by members of the public who may have limited knowledge of road safety.

Before it is possible to develop a database access system, it is critical to define the scope and content of data that should be contained in the system to be accessed. Most road safety data systems currently in existence in Australia and around the world have been developed in an ad hoc system capitalising generally on administrative data systems that have been assembled for other purposes. The elements of the existing systems have often been assembled reactively in

response to particular requirements dictated by road safety strategies and policies that have been operational at various points in time. In general, none of the current systems have been developed proactively with a forward vision to the types of data that will be required to facilitate the best possible strategy and policy development and to support the full range of research activities to support these developments. The general aim of this research initiative is to move towards developing a road safety data system for Western Australia that will meet the widest possible range of future needs in road safety policy, practice and research.

1.1 KEY AIM AND TASKS

The aim of this project was to identify and undertake the fundamental groundwork required prior to the establishment of a road safety database access system. Specifically, the project aimed to define the content and scope of an ideal road safety data system based on the current "Safe System" paradigm for developing road safety policy and countermeasures, to compare this with the current road safety data systems available in Western Australia and to map a path for translating the current system into the ideal one.

In order to fulfil the stated objective, the following tasks were undertaken:

- Development of a conceptual framework for defining an ideal, comprehensive and integrated road safety data system to support the Safe System paradigm;
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2.0 A Road Safety Data System for Western Australia

Western Australia's Road Safety Strategy 2008-2020 "Towards Zero" (Road Safety Council 2009) was developed using a Safe System approach, which aims to improve road safety through explicit consideration of four cornerstones: Safe Road Use; Safe Roads and Roadsides; Safe Speeds and Safe Vehicles. Fundamental to the effective translation of Safe System knowledge into action is the existence of underlying data systems consistent with this approach that can inform the strategy and policy development and facilitate the supporting research required. Important functions of a Western Australian data system include permitting assessment of the extent to which the Safe System has been applied across the road system, allowing for monitoring of the progress of road safety strategies created under the System and assisting road safety managers in developing future policy in accordance with Safe System principles.

2.1 CONCEPTUAL FRAMEWORKS DEFINING AN IDEAL DATA SYSTEM

The starting point for establishing a data system for Western Australia based on the Safe System approach involved defining an ideal, comprehensive and integrated road safety data system. At the core of the ideal system is the "Road Trauma Chain" enhanced to ensure that all elements of the "Road Safety Target Hierarchy" were included. This core was then partitioned by the key cornerstones of the "Safe System". Each of these conceptual frameworks is outlined below along with how they are blended to define the conceptual basis for a road safety data system.

2.1.1 The Safe System

The Safe System is a philosophy which addresses at its core the limited ability of humans to tolerate physical force. In Australia, the Safe System concept was first highlighted as an overarching national framework as part of the *National road safety action plan for 2005 and 2006* (Australian Transport Council 2004). This plan outlined the key road transport system components under the Safe System approach as Safer roads and roadsides, Safer speeds and Safer vehicles, with the foundation of the Safe System approach being Safer road users.

The Safe System framework is shown in Figure 1. The Safe System assumes that road users, when using the transport system, acknowledge the limits of their performance, their tolerance to physical force, their responsibility to use the system safety and to choose safe and sustainable transport options. Safer road user behaviour requires:

- Being alert and complying with the road rules – a commitment from road users to safer/driving/riding or pedestrian activity;
- Adherence to rules governing admittance to the system – obtaining and retaining a licence, and observing licence conditions such as graduations and sanctions;
- Being supported while driving and travelling via information and education, backed by enforcement, to minimise high-risk road user behaviour and to encourage community support for safer road use.

The other key supporting component of the Safe System is adequate and thorough analysis of crash risks.

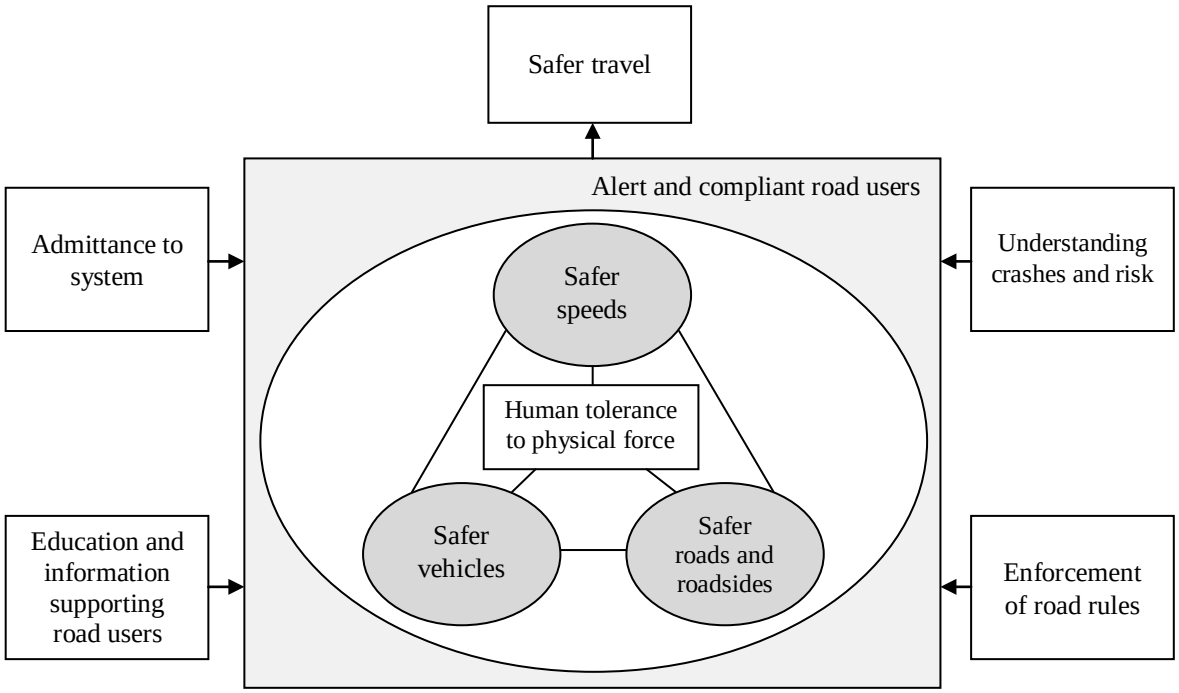


Figure 1: The Safe System Framework (Australian Transport Council, 2004)

The Safe System aims to manage the interaction between road users, roads and roadsides, travel speeds and vehicles. It recognises that at this point in time it is probably not possible to prevent all crashes due to the inherent propensity of humans to make errors of judgement but aims to prevent those that result in death and serious injury by managing the crash energies that lead to these outcomes. It recognises that human error in the system is inevitable so requires designers to provide a road system that increasingly prioritises safety outcomes to cater for the mistakes people make when using the road transport system within the parameters dictated by the regulations (Road Safety Council 2009).

2.1.2 The Road Trauma Chain

The Road Trauma Chain is shown in Figures 2 and 3. It was originally created by Cameron (1992) to assist in the development of road safety countermeasures through the identification of links where the chain leading to traumatic injury can be broken. It has also been used by Thoresen et al. (1992) to provide a framework to conceptualise the principal place(s) in the Chain which could be affected by each major economic, social and road safety factor considered to have influenced the Victorian road toll. Cameron (1992) describes how associated with various steps or links in the chain are probabilities or risks of one or more steps. In Figure 2, four different risks of crash involvement are shown depending on the starting point from where the risk is measured. The existence or participation of an entity at a starting point is known as “exposure to risk”. In Figure 3, the risks associated with the steps after the crash has occurred are shown. For the injury risks the starting point is crash involvement and this event represents “crash exposure to injury” risk. Another starting point is injury and here the risk is associated with severe injury or death and the exposure to this risk is called “injury exposure to severe injury”.

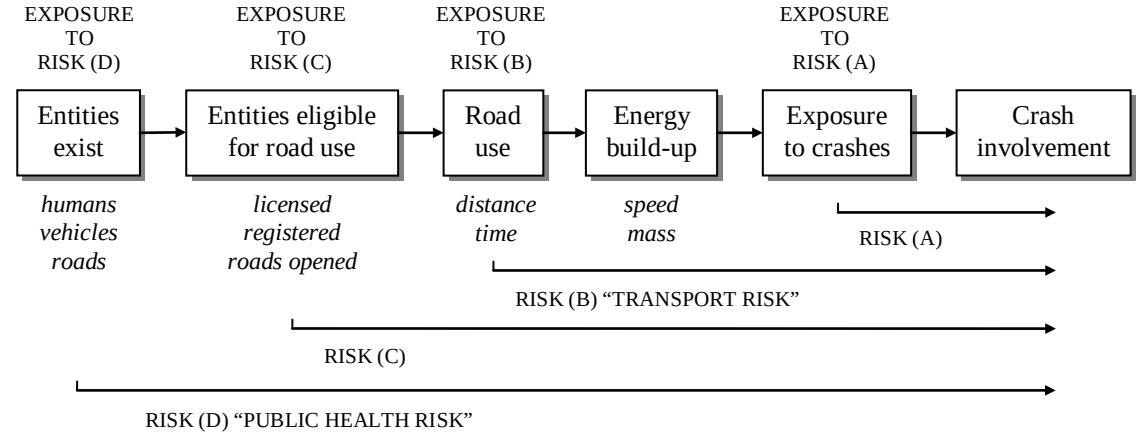


Figure 2: The Road Trauma Chain (Pre-Crash)

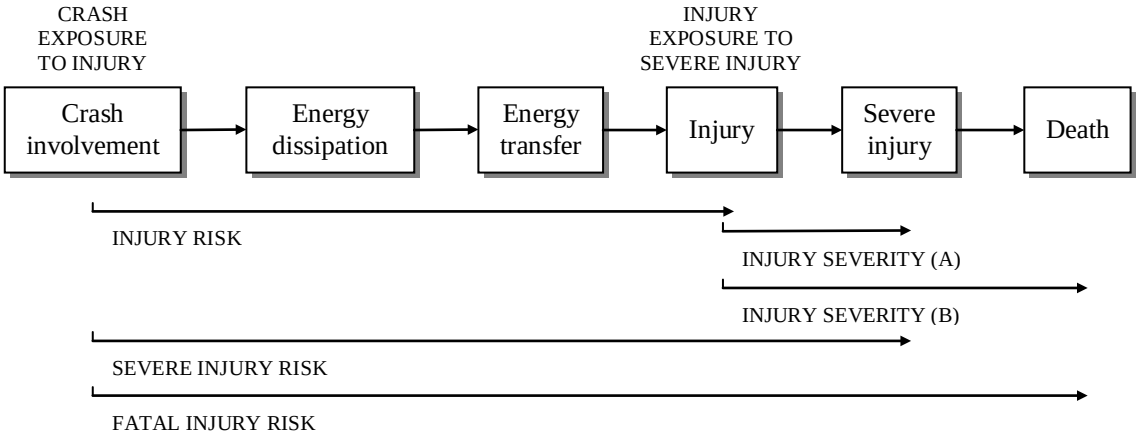


Figure 3: The Road Trauma Chain (Crash and Post-Crash)

The Chain defines steps at which measurements of the road system are required, and it shows the risks that can be measured having defined the steps. In other words, it defines the steps at which measurements of the road system are required to achieve a full understanding of risk on the road network.

2.1.3 The Road Safety Target Hierarchy

Jurisdictions across the world set road safety targets in order to quantify the results they wish to achieve. In addition to crash-based targets, some jurisdictions also utilise intermediate targets. An intermediate indicator is one that is used in addition to crashes or injuries to measure changes in road safety outcomes. There should be a demonstrated causal relationship between each intermediate measure and crashes or injuries.

The role of road safety targets was first illustrated in New Zealand's Road Safety Strategy 2010 consultation document (Land Transport Safety Authority 2000). Targets were defined as road safety outcomes that are accepted by the community and endorsed by government at the highest level. A basic target hierarchy was developed and the key elements are presented in

Figure 4. Targets at each level contribute to those at the next level up with social cost at the top. The consultation document defined each level as follows:

- Social Cost is the aggregate measure of all costs that crashes inflict on the community. It generally includes not just material losses but also pain and suffering.

- Final Outcomes consist of fatalities, serious injuries, fatal crashes and serious injury crashes. They are what is sought to be avoided and are the main components of social cost.

- Intermediate Outcomes are not desired for themselves but for what they entail – better final outcomes and a link between actions and outcomes. They include measures of behaviour and the environment such as average traffic speeds, the proportion of drunk drivers, the seatbelt-wearing rate, the physical condition of the road network, and the standard of the vehicle fleet. Intermediate outcomes are measured both because it is easy to do so and because they are generally reliable indicators of how well our road safety interventions are working.

- Outputs represent physical deliverables, for instance the number of Police patrols and the amount of advertising delivered. Alternatively they correspond to milestones showing that a specified task has been completed.

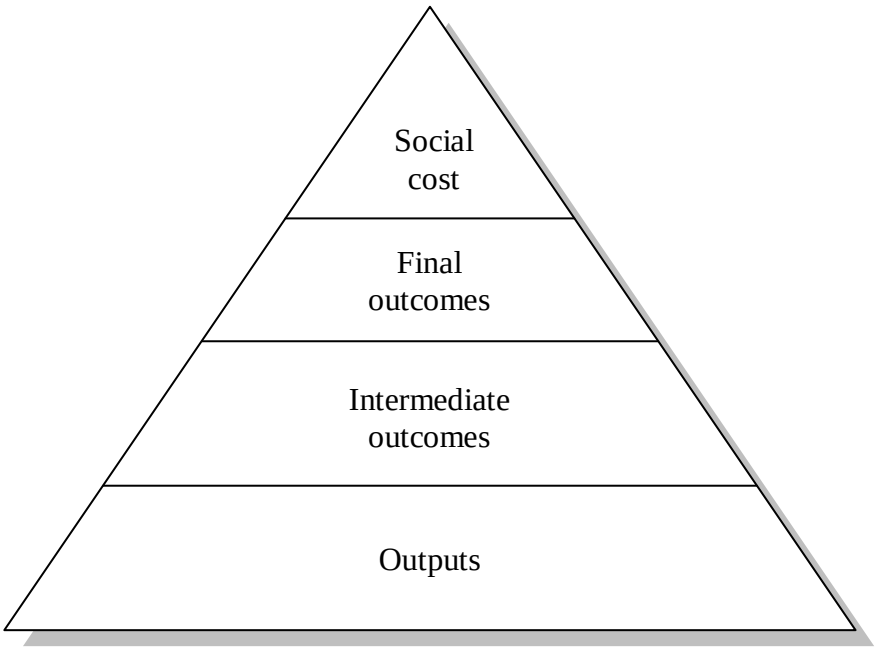


Figure 4: Target hierarchy developed for New Zealand's Road Safety Strategy 2010

Outputs are associated as much as possible with intermediate outcomes (e.g. alcohol, speed, restraints) that are necessary to achieve final outcomes (reductions in deaths and serious injuries). Social cost represents the total burden of injury, and can be broken down by road-user groups and regions. The Land Transport Safety Authority (2003) described this strategy as using an "outcomes management" framework that links what is done (outputs) to what is trying to be achieved (outcomes).

2.1.4 The Ideal Data System

Towards zero: ambitious road safety targets and the Safe System approach (Organisation for Economic Co-operation and Development 2008) examined the need for comprehensive crash and road safety performance data collection which it stated needs to include crash statistics, but should also extend to other factors including demographic data, traffic volume data, intermediate outcome measures (or Safety Performance Indicators) and infrastructure factors. This would provide the context by which change occurred or was impacted by. It stated that those countries that have already moved, or are currently moving, to a Safe System approach monitor an increasing range of indicators that are pivotal to achieving safe travel. This includes the proportion of drivers travelling at safe speeds, the occurrence of certain crash types and the severe crash outcomes in relation to road infrastructure characteristics, the levels of compliance with seat belt and helmet wearing requirements and blood alcohol limits by drivers and riders and the presence of specific safety features and levels of crashworthiness in the vehicle fleet.

These ideas highlight the need for a data system based on the Safe System approach addressed by the definition of an ideal system presented in this report. As stated earlier, at the core of the ideal system is the Road Trauma Chain. The Chain allows risk in the road system to be measured through the identification of links where the chain leading to traumatic injury can be broken. Data collected on this basis would enable a full understanding of risk on the road network and when partitioned by key cornerstones of the Safe System would allow road safety managers to monitor relevant trends and to respond with appropriate countermeasures. Such countermeasures would be implemented based on Safe System principles, and their effectiveness would also be monitored, thus the data system would facilitate the translation of Safe System knowledge into practice.

As described above, a comprehensive data system needs not only to collect crash statistics, but also other factors, the collection of which are critical for jurisdictions operating under a Safe System. Given the importance of jurisdictional target setting, an ideal data system should collect information at all levels of the Road Safety Target Hierarchy (Figure 4). The ideal system presented in this report, with the Road Trauma Chain at its core, was developed taking this into account. Before proceeding, the Chain was modified at Risk (A) from “Exposure to crashes” to “Exposure to hazards” (Figure 5). “Exposure to hazards” may also be described as exposure to hazardous situations, e.g. pedestrians crossing the road. In this case, the level of exposure on the road network would be measured as the total number of pedestrian crossings thus enabling the calculation of RISK (A) being the next step along the Chain from RISK (B) “TRANSPORT RISK” which is based on “Road use”, e.g. vehicle kilometres travelled. Modification of the Chain also allows for the inclusion of intermediate outcomes as broad measures of risk given they are linked causally to crashes. We note that RISK (B), (C) and (D) encompass the step “Energy build-up” which is not used as a starting point for measuring risk along the Chain due to difficulty of measurement. Similarly the steps “Energy dissipation” and “Energy transfer” (Figure 3) are encompassed by INJURY RISK.

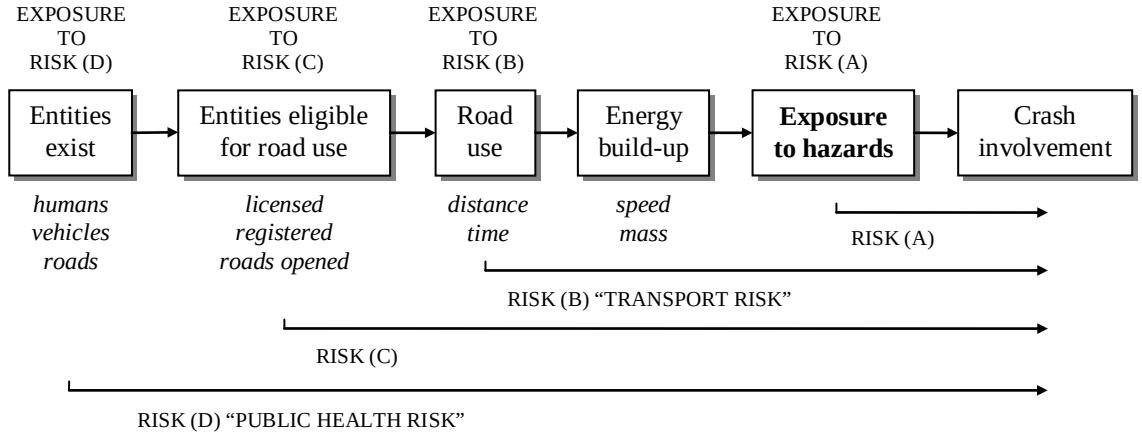


Figure 5: The Road Trauma Chain (Pre-Crash) – Modified

2.2 DEFINITION OF THE IDEAL DATA SYSTEM

Table 1 (Pre-Crash) and Table 2 (Crash and Post-Crash) define the elemental compartments of an ideal data system for the effective implementation of the Safe System approach. It is a matrix defined by the fusion of the Road Trauma Chain defining the vertical axis compartments with the Safe System cornerstones defining the horizontal axis compartments. Specification of the relevant data elements within each compartment of the matrix is derived from the Target Hierarchy defined in Figure 4. Relevant information and examples of measures that should be collected are shown in Tables 1 and 2. Items marked with an asterisk (*) relate to Safe Speeds. In addition to crash-related data, a review of the road safety literature identified many intermediate outcomes and outputs utilised as targets across various jurisdictions that could be used to populate the framework. This review is presented in Appendix A.

A fully populated road safety data system as defined in Tables 1 and 2 would allow each of the risks defined by the Road Trauma Chain in Figures 2 and 3 to be calculated for each cornerstone of the Safe System. A system defined as such would allow the articulation of the risk processes driving the final road trauma outcomes that are generally the principal target of road safety strategies, namely deaths, long term injuries and costs to the community. *For each cornerstone of the Safe System, it would be possible to identify whether trauma outcomes were driven by high exposure, high risk, high severity of outcome or a combination of two or more of these.* Gaining such understanding informs the size and drivers of the outcome and directs where efforts would be best concentrated to address the outcome and the likely benefits to be derived. Conversely, Tables 1 and 2 make clear the consequences that missing information in various cells will have in preventing the risks defined in the Road Trauma Chain from being adequately measured.

		SAFE SYSTEM		
		SAFE ROAD USE	SAFE ROADS AND ROADSIDES	SAFE VEHICLES
>	Road Trauma Chain	* SAFE SPEEDS		
	Pre-Crash			
>	Entities exist	Population	Length of roads	Number of vehicles/motorcycles
>	Entities eligible for road use	Number of licensed drivers/riders	Length of opened roads	Number of registered vehicles/ motorcycles
>	Road use	Vehicle Kilometres Travelled (VKT) by road user type	Vehicle Kilometres Travelled (VKT) by road type	Vehicle Kilometres Travelled (VKT) by vehicle type
>	Exposure to hazards	e.g. Number of pedestrian crossings		
	INTERMEDIATE OUTCOME MEASURES	e.g. * Proportion of drivers/riders exceeding the speed limit	e.g. Proportion of VKT on non-Safe System roads	e.g. Average primary and secondary safety of the light vehicle fleet
	OUTPUTS	e.g. * Number of speed-related infringement notices issued	e.g. Number of black spot sites treated	e.g. Level of advertising related to vehicle safety features

Table 1: Definition of the Ideal Data System (Pre-Crash)

		SAFE SYSTEM		
		SAFE ROAD USE	SAFE ROADS AND ROADSIDES	SAFE VEHICLES
>	Road Trauma Chain	* SAFE SPEEDS		
	Crash and Post-Crash			
>	Crash involvement	Crash involvement by road user type e.g. Number of pedestrian crash involvements	Crash involvement by road type by region by crash type	Crash involvement by vehicle type
>	FINAL OUTCOMES Injury	Number of casualty crashes /Number of casualties by road user type	Number of casualty crashes /Number of casualties by road type	Number of casualty crashes /Number of casualties by vehicle type
>	Severe injury	Number of serious injury crashes /Number of persons seriously injured by road user type	Number of serious injury crashes /Number of persons seriously injured by road type	Number of serious injury crashes /Number of persons seriously injured by vehicle type
>	Death	Number of fatal crashes /Number of persons killed by road user type	Number of fatal crashes /Number of persons killed by road type	Number of fatal crashes /Number of persons killed by vehicle type
	OUTPUTS SOCIAL COST	e.g. Average response time of Emergency Services e.g. Total cost of crashes to the community		

Table 2: Definition of the Ideal Data System (Crash and Post-Crash)

2.3 DETERMINATION OF ROAD SAFETY DATA SYSTEM REQUIREMENTS

The ideal data system as represented by Tables 1 and 2 can be used to assist jurisdictions in determining their road safety data system requirements under the Safe System. It does this through outlining the information that is critical to informing the successful implementation of a Safe System approach thus allowing for identification of the data that is not collected and highlighting the importance of data that is. It also facilitates assessment of existing jurisdictional data systems and their interconnectivity in the context of content, linkage and access which should lead to enhanced usability and the ability to produce appropriate reports and derive relevant measures.

Requirements for an ideal data system for Western Australia based on identified current international best practice knowledge are shown in Tables 3 to 5 for the Safe System cornerstones of Safe Road Use, Safe Speeds, Safe Roads and Roadsides and Safe Vehicles respectively. The literature review of collected measures across jurisdictions (Appendix A) was used as a guide to populate the intermediate outcome measures and outputs sections of each table. The performance indicators listed under Western Australia's *Towards zero: road safety strategy and Road Safety Council's recommendation to government* were also taken into account. These are shown in Appendix B (Tables B1 and B2 respectively) along with performance indicators from Western Australia's *Arriving safely: road safety strategy for 2003-2007* (Table B3). Socio-economic factors of relevance to the road safety field are shown in Table 6.

In addition to data requirements, Tables 3 to 5 show the agency responsible for the collection and processing of each item (as per Table B3). The current state of data collection is also shown with information identified as being collected (C) or having the status of uncollected, un-established or unknown (U) as far as was possible to be identified from the material available for review.

Table 3: Requirements for an Ideal Data System – Safe Road Use/*Safe Speeds

>	Road Trauma Chain	SAFE ROAD USE * SAFE SPEEDS	Responsible Agency /Agencies	Collection Status
	Pre-Crash			
>	Entities exist	Population	ABS	C
>	Entities eligible for road use	Number of licensed drivers/riders	DoT	C
>	Road use	Vehicle Kilometres Travelled (VKT) by road user type	ABS/MRWA	C
>	Exposure to hazards	Total number of motorcycle trips	DoT	U
		Total number of bicycle trips	DoT	U
		Total number of pedestrian crossings	DoT	U
		Number of bicycle movements on path routes	MRWA	C
	INTERMEDIATE OUTCOME MEASURES	**Speeding**		
		* Proportion of drivers/riders exceeding the speed limit (speed camera sites)	WA Police	C
		* Proportion of drivers/riders exceeding the speed limit (metropolitan representative monitoring sites)	MRWA	C
		* Proportion of drivers/riders exceeding the speed limit (regional representative monitoring sites)	MRWA	C
		* Proportion of drivers/riders exceeding the speed limit (remote representative monitoring sites)	MRWA	U
		* Offence rate per hour of camera enforcement	WA Police	C
		* Offence rate per hour of manual Police speed enforcement	WA Police	C
		* Changes to the excessive speed distribution (metropolitan representative sample)	MRWA	U
		* Changes to the excessive speed distribution (regional representative sample)	MRWA	U
		* Changes to the excessive speed distribution (remote representative sample)	MRWA	U
		Drink and drug driving		
		Proportion of drivers/riders impaired by alcohol	ORS	U
		Proportion of drivers/riders impaired by drugs	ORS	U
		Restraints		
		Proportion of vehicle occupants not wearing seat belts	ORS	C
		Proportion of child restraints incorrectly fitted	ORS	U
		Proportion of heavy vehicle drivers not wearing seat belts	ORS	U
		Other		
		Proportion of motorcyclists not wearing suitable protective clothing	ORS	U
		Proportion of motorcyclists not wearing helmets	ORS	U
		Proportion of bicyclists not wearing helmets	ORS	U
		Proportion of VKT by fatigued drivers	DoT	U
		Distribution of driver demerit points	DoT	U
		Proportion of licences currently suspended/disqualified	DoT	C
		Changes to community road safety attitudes and awareness	ORS	C
	OUTPUTS[1]	**Speeding**		
		* Hours of speed enforcement delivered	WA Police	C
		* Hours of speed camera operations	WA Police	C
		* Number of speed-related infringement notices issued	WA Police	C
		* Number of speed camera infringement notices issued	WA Police	C
		* Proportion of drivers who report having received a speeding ticket in the previous six months	ORS	C

[1] Outputs represent physical deliverables related to road safety activities and are associated as much as possible with intermediate outcomes and may sometimes be interpreted as such.

		* Level of speed-related advertising	ORS	C
		Drink and drug driving		
		Hours of random breath testing enforcement delivered	WA Police	C
		Number of random breath tests conducted	WA Police	C
		Number of random drug tests conducted	WA Police	U
		Proportion of drivers/riders exceeding the prescribed concentration of alcohol	WA Police	C
		Proportion of drivers who report having been random breath tested in the previous six months	ORS	C
		Level of advertising related to drink driving	ORS	C
		Level of advertising related to drug driving	ORS	U
		Restraints		
		Hours of enforcement related to restraints delivered	WA Police	C
		Level of advertising related to restraints	ORS	C
		Other		
		Hours of general road safety enforcement delivered	WA Police	C
		Level of advertising related to driver fatigue	ORS	C
		Level of advertising related to driver distraction	ORS	C
		Level of advertising related to rail crossing safety	ORS	C
		Level of advertising related to serious injuries	ORS	C
	Crash and Post-Crash			
>	Crash involvement	Crash involvement by road user type	ICWA/MRWA	C
		Number of motorcyclist crash involvements	ICWA/MRWA	C
		Number of bicyclist crash involvements	ICWA/MRWA	C
		Number of pedestrian crash involvements	ICWA/MRWA	C
		Number of property damage crashes	ICWA/MRWA	C
>	Injury	Number of casualty crashes	ICWA/MRWA	C
		/Number of casualties	DoH	C
		by road user type		
>	Severe injury	Number of serious injury crashes	ICWA/MRWA	C
		/Number of persons seriously injured	DoH	C
		by road user type		
		Number of serious injury crashes		
		* that involved speeding	ICWA/MRWA	C
		that involved excess alcohol	ICWA/MRWA	C
		that involved drug use	ICWA/MRWA	U
		that occurred during High Alcohol Hours	ICWA/MRWA	C
		that involved non-restraint use	ICWA/MRWA	C
		that involved fatigue	ICWA/MRWA	U
>	Death	Number of fatal crashes	ICWA/MRWA	C
		/Number of persons killed	DoH	C
		by road user type		
		Number of fatal crashes		
		* that involved speeding	ICWA/MRWA	C
		that involved excess alcohol	ICWA/MRWA	C
		that involved drug use	ICWA/MRWA	U
		that occurred during High Alcohol Hours	ICWA/MRWA	C
		that involved non-restraint use	ICWA/MRWA	C
		that involved fatigue	ICWA/MRWA	U
	OUTPUTS	Time from injury to adequate medical care	DoH	U
		Average response time of Emergency Services	DoH	U
		Number of hospital bed days resulting from road crashes	DoH	U
		Number of insurance claims	ICWA	C
		Total cost of crashes to the WA community (social cost) based on crash costs estimated by the Bureau of Infrastructure, Transport and Regional Economics	ORS/ICWA BITRE	C C

Table 4: Requirements for an Ideal Data System – Safe Roads and Roadsides

>	Road Trauma Chain	SAFE ROADS AND ROADSIDES	Responsible Agency /Agencies	Collection Status
	Pre-Crash			
>	Entities exist	Length of roads	MRWA	C
>	Entities eligible for road use	Length of opened roads	MRWA	C
>	Road use	Vehicle Kilometres Travelled (VKT) by road type	MRWA	C
>	Exposure to hazards			
	INTERMEDIATE OUTCOME MEASURES	Proportion of roads that are not Safe System compliant	MRWA	U
		Proportion of VKT on non-Safe System roads	MRWA	U
		Proportion of intersections that are not Safe System compliant	MRWA	U
		Proportion of the regional road network without:		
		- Road safety barriers	MRWA	C
		- Shoulder sealing	MRWA	C
		- Edge line marking	MRWA	C
	OUTPUTS	Hours of enforcement of road rules at intersections	WA Police	C
		Number of black spot sites treated	MRWA	C
		Total black spot expenditure	MRWA	C
		Number of intersections treated with Safe System improvements	MRWA	U
		Length of regional and remote routes treated with Safe System improvements	MRWA	U
		Length of regional roadside infrastructure installed including:		
		- Road safety barriers	MRWA	C
		- Shoulder sealing	MRWA	C
		- Edge line marking	MRWA	C
		Volume of traffic on the road network including metropolitan traffic flows	MRWA	C
	Crash and Post-Crash			
>	Crash involvement	Crash involvement by road type	ICWA/MRWA	C
		Crash involvement by metropolitan, regional and remote areas	ICWA/MRWA	C
		Crash involvement by crash type	ICWA/MRWA	C
>	Injury	Number of casualty crashes	ICWA/MRWA	C
		/Number of casualties	DoH	C
		by road type		
		by metropolitan, regional and remote areas		
		by crash type		
>	Severe injury	Number of serious injury crashes	WA Police	C
		/Number of persons seriously injured	WA Police/DoH	C
		by road type		
		by metropolitan, regional and remote areas		
		by crash type		
>	Death	Number of fatal crashes	ICWA/MRWA	C
		/Number of persons killed	DoH	C
		by road type		
		by metropolitan, regional and remote areas		
		by crash type		

Table 5: Requirements for an Ideal Data System – Safe Vehicles

>	Road Trauma Chain	SAFE VEHICLES	Responsible Agency or Agencies	Collection Status
	Pre-Crash			
>	Entities exist	Number of vehicles/motorcycles	DoT	U
>	Entities eligible for road use	Number of registered vehicles/motorcycles	DoT	C
>	Road use	Vehicle Kilometres Travelled (VKT) by vehicle type	DoT	U
>	Exposure to hazards			
	INTERMEDIATE OUTCOME MEASURES	Proportion of new vehicles without the highest ANCAP safety rating	DoT	C
		Proportion of new vehicles without ESC	DoT	C
		Proportion of new vehicles without side and curtain airbags	DoT	C
		Proportion of new vehicles without active head restraints	DoT	U
		Proportion of new vehicles without crash avoidance systems	DoT	U
		Average primary and secondary safety of the light vehicle fleet	DoT/MUARC	U
		Median age of passenger vehicles in the fleet	DoT	U
		New on-road/off-road motorcycle sales as a proportion of all new vehicle sales	DoT	U
		Proportion of new motorcycles fitted without ABS	DoT	U
		New rigid and articulated vehicle sales as a proportion of all new vehicle sales	DoT	U
		Proportion of heavy vehicles with brake defects	DoT	U
	OUTPUTS	Level of advertising related to vehicle safety features	ORS/RAC	C
		Level of advertising related to Used Car Safety Ratings	ORS/RAC	U
		Level of advertising related to ANCAP	ORS/RAC	C
	Crash and Post-Crash			
>	Crash involvement	Crash involvement by vehicle type	ICWA/MRWA	C
>	Injury	Number of casualty crashes	ICWA/MRWA	C
		/Number of casualties	DoH	C
		by vehicle type		
>	Severe injury	Number of serious injury crashes	ICWA/MRWA	C
		/Number of persons seriously injured	DoH	C
		by vehicle type		
>	Death	Number of fatal crashes	ICWA/MRWA	C
		/Number of persons killed	DoH	C
		by vehicle type		

Table 6: Relevant Socio-Economic Factors

Factor	Availability	Responsible Commonwealth Agency
Fuel sales	by State	Department of Resources, Energy and Tourism (RET)
Motor vehicle use (Survey)	by Vehicle Type	Australian Bureau of Statistics (ABS)
Unemployment rate	by Region	ABS
Gross State Product per capita	by State	ABS
Population	by Region, Sex and Age	ABS
Socio-economic indexes	by Geographic Area including Collection District, Postal Area	ABS
Rainfall and sunshine hours	by Weather Station	Bureau of Meteorology (BoM)

An examination of Tables 3 to 5 reveals that the collection of data on injuries and crashes (final outcomes) is reasonably adequate, i.e. the "exposure to injury" sections in the Road Trauma Chain are reasonably well populated. This is particularly the case in Western Australia where information on non-injury crashes is routinely collected and there is a nation-leading system of linking hospital admission records with crash data. However many measures relating to "exposure to risk", including intermediate outcome measures, are not collected. Ultimately this lack of information means that in many instances it is not known whether final outcomes are a result of high exposure, high crash risk or high injury severity. For example, with regards to vehicles it may not be known whether the problem lies at the level of overall vehicle exposure, exposure to hazardous situations, vehicle primary safety or vehicle crashworthiness. Clearly an understanding of where the problem lies is required if an effective solution is to be found. Quantifying risk requires that information at all steps of the Road Trauma Chain shown in Tables 3 to 5 is collected. This information is important as its allows risk associated with the road network to be monitored so that appropriate road safety countermeasures may be implemented in the short to medium-term in order for long-term road safety targets to be achieved. This requires Western Australia's road safety strategy to include target setting at all levels of the Target Hierarchy (Figure 4) and the collection of data based on the ideal system should enable this to occur.

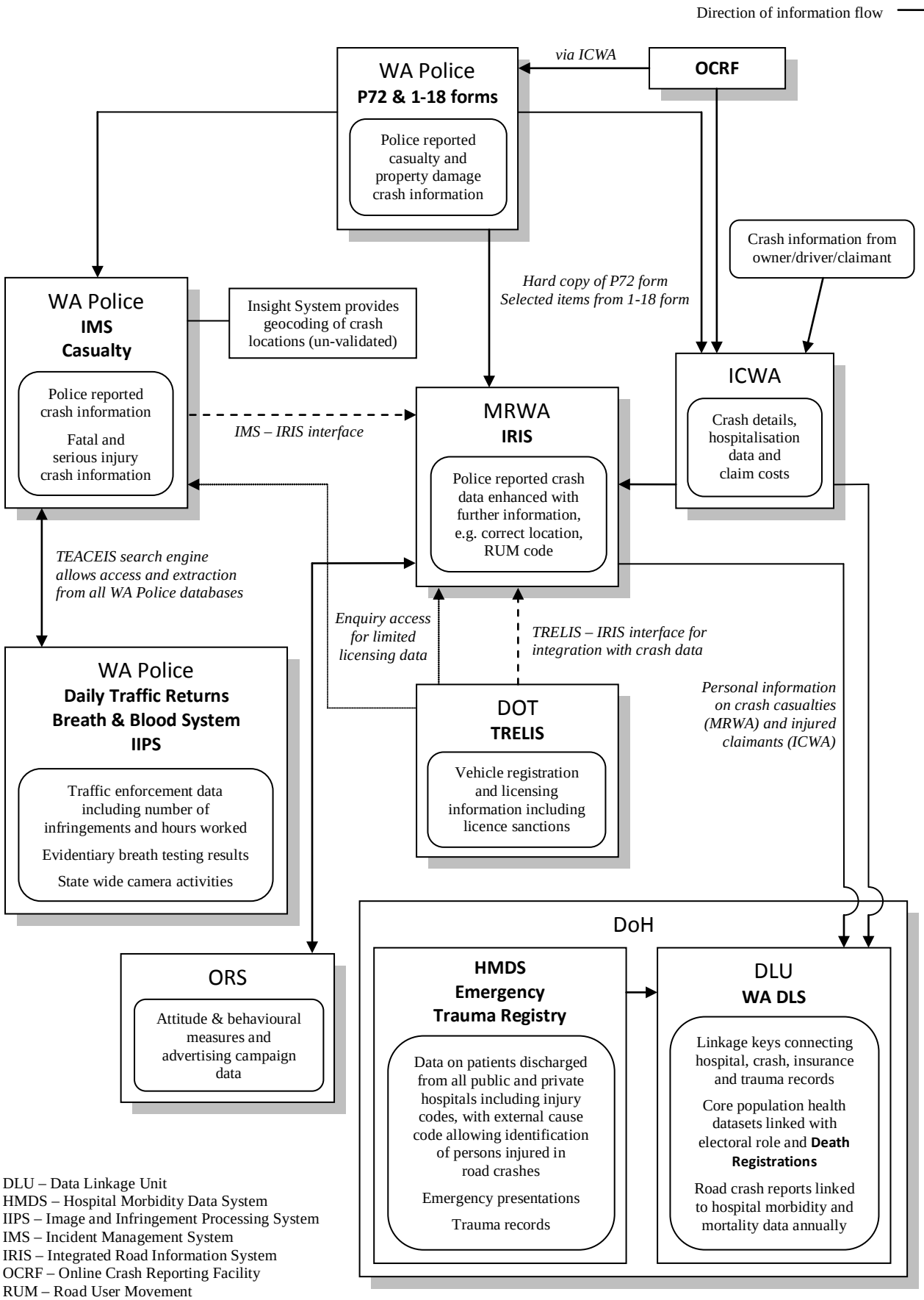
It is apparent that the data systems currently in place in Western Australia were not designed for the purpose of enabling a full understanding of the state of risk on the road network under a Safe System. The objective of this project was to undertake the fundamental groundwork required to put in place such knowledge, prior to the establishment of a road safety database access system. This was facilitated through application of the definition of the ideal system across collected data (Tables 1 and 2) leading to the identification of uncollected, un-established or unknown data items (Tables 3 to 5).

Another important part of the process of moving towards the ideal system is the development of appropriate links between datasets through the use of geocoded, road user and vehicle information. Such links enable information regarding all aspects of the road network to be accessed, for example every measure relating to a specific section of road, vehicle or road user, and allow for the construction of new measures. Prior to moving towards the ideal system however, a review of the discrete data systems that currently exist in Western Australia and the interconnectivity that exists between these systems was required.

3.0 Review of Existing Road Safety Data System Elements in Western Australia

The review of the state of current road safety data systems in Western Australia involved examining the way in which road safety data is collected, enhanced, linked, stored, shared, accessed, analysed and reported on by the responsible Government agencies and the degree of interconnectivity between systems and agencies. This review was informed by the 2004 discussion paper *Road crash data sharing between government agencies* prepared for the Road Safety Council (Western Australia Police Service et al. 2004) that described the situation with regards to the collection, processing, management, accessibility and sharing of data. More recent information was obtained online, from the custodians of several datasets (Appendix C) and through contact with relevant personnel.

Figure 6 shows the current state of data systems in Western Australia with regards to road safety related information. The key agencies are shown with their respective datasets and/or data systems where appropriate, and content they hold of relevance to the aims of this project. This "content" includes the enhancement of data, such as that which occurs at MRWA with regards to Police reported crash data, and the linkage of data as carried out by the DLU within the DoH. The primary source of Police reported crash information, namely the P72 Report of Road Traffic Crash form and the 1-18 form of 18 items about a fatal or critical injury crash, have been depicted as a dataset. In addition, Figure 6 demonstrates the way in which road crash related information is distributed between agencies, and highlights any additional interconnectivity such as inter-agency interfaces (dashed lines) and enquiry access (dotted lines).



DLU – Data Linkage Unit
HMDS – Hospital Morbidity Data System
IIPS – Image and Infringement Processing System
IMS – Incident Management System
IRIS – Integrated Road Information System
OCRF – Online Crash Reporting Facility
RUM – Road User Movement
TEACEIS – Traffic Enforcement And Crash Executive Information System
TRELIS – TRansport Electronic Licensing Information System
WA DLS – Western Australian Data Linkage System

Figure 6: Current State of Road Safety Related Data Systems in Western Australia

Road crash data collection and analysis at an aggregate level and through detailed studies is critical to risk identification, intervention selection, measuring final outcomes and assessing the effectiveness of interventions (Organisation for Economic Co-operation and Development 2008). Crashes required to be reported to Police include crashes involving injury and crashes in which property damage in excess of $3000 occurs (minor crashes may also be reported). If Police attend a crash, typically when an injury occurs, a P72 form is completed. For all other crashes, typically property damage crashes, the persons involved lodges a report at the local Police station. Alternatively, the relevant information can be provided online via the Online Crash Reporting Facility (OCRF), a joint initiative of the ICWA and WA Police launched in January 2009. For fatal or serious injury crashes Police complete the 1-18 form primarily to provide senior Police management with initial advice of the crash, however items 1-5, 9-13 and 16-17 are also provided to MRWA and the ICWA.

In general, information from crash forms are received at MRWA five weeks after crash dates however enforcement or coronial actions may delay this process significantly. Vehicle licensing details obtained from DoT via TRELIS serves to enhance the integrity of the data. In addition, the integration with crash data is important as it enables the supply of driver history information. Currently MRWA releases crash data once per year, typically at the end of March in the following year, so that extensive audits can be carried out to ensure the integrity of the data and its compatibility with WA Police information. However the further integration of Western Australian datasets and data systems would enable progressive audits and validation of the MRWA database leading to the release of crash data on a more frequent basis.

The review of existing data systems led to the identification of key requirements for moving towards an ideal system and ultimately a road safety database access system for use by road safety managers and policy makers. Requirements to be outlined in the next section include improved interconnectivity and access and the enabling of links based on geocoded, road user and vehicle information. The proposed requirements fall within the context of allowing for the uncollected or un-established measures of interest outlined in Section 2.3 to be made available. This includes assessing the feasibility of providing data in different forms, e.g. disaggregated into various categories. In addition, access to road safety information by external parties and the cross-validation of data held across all agencies will be reviewed.

4.0 Identification of Key Requirements for Moving to an Ideal System

A review of the current state of road safety related data systems in Western Australia was performed and has been described in Section 3. This section outlines key requirements and actions for moving to an ideal, comprehensive and integrated road safety data system from the current system. These include requirements for additional data, the establishment of new linkages between datasets based on geocoded, road user and vehicle information and the improvement of current linkages to enhance dataset interconnectivity. These new and improved linkages will enable information regarding all aspects of the road network to be accessed and desired measures of road safety to be constructed.

4.1 TYPES OF DATASET LINKAGE

The ideal road safety data system aims to be comprehensive and fully integrated through the linkage of a wide range of information including covering the breadth of the road trauma chain. This includes data on crashes, hospital presentation and admissions, injury outcomes, insurance claims, vehicle registration, driver licensing, road asset inventory, traffic enforcement and infringements, attitude and behavioural measures, road safety program outputs and travel and exposure data. A report by Cairney (2005) presented a snapshot of where Australian road authorities were with regards to data systems in place and links between them within the context of investigating the potential for integrated road safety management through linking road inventory, asset management and other databases to crash databases. Although the report has a focus on road asset inventory data, it highlighted the use of a Geographic Information System (GIS) as a primary linkage tool, including a literature review.

The review by Cairney (2005) found the asset and crash databases held by Australian road authorities were either relational, with a text-based or generated numeric linkage key, or spatial. Spatial systems are typically GIS-based or geocoded with a location based on a commonly employed coordinate system such as latitude and longitude. Some databases were coded both relationally and spatially. An example is Police reported crash information where crash locations have generally been geocoded but text based location descriptions also typically exist.

Cairney (2005) refers to the linkage of information held in different databases as being through relational, spatial or manual integration. Relational integration refers to the linkage of text-based data based on a common variable or variables (linkage key). The linkage of datasets on this basis allows for various matching options. However, the creation of a linkage key sufficiently unique to avoid multiple possible matches can be challenging. Spatial integration refers to linkage based on spatial or geographic location. It offers a convenient way to link data, not requiring the creation of a linkage key thus avoiding the problem of multiple possible matches. The dataset does require a geographic component however and specialised GIS software is needed for geocoding and linkage. Manual integration, whereby information is transferred from one dataset to the other manually, can be used to supplement relational and spatial linkage and may be necessary when adding data in hard copy form. This approach is time consuming and not feasible for large amounts of data.

It was stated that the method of integration will depend on the nature of the database to which road safety information is to be linked. It is clear that spatial integration offers advantages

over relational integration where geographic location is a key attribute, although a process whereby location data can be geocoded is required. Often GIS software is used to add geocoding coordinates to data with location information manually by plotting the information using the GIS database, for example. There is significant activity in Australian road safety agencies converting systems based on relational integration to the more precise spatial integration although the process is generally costly and time consuming. It does however highlight that spatial integration is considered to be the better option for data linkage and hence any ideal data access system should use spatial integration as the preferred linkage method for geographically based information.

For a range of road safety data geographic information is not relevant since the data item is not something with a necessarily fixed geographic location. Examples of such data include vehicle registration, and other person-based data such as driver licensing, and injury outcomes in crashes (although the address of a licensed driver or registered vehicle owner could be considered fixed). For linking data that has no specific geographical basis, it will be necessary to utilise relational integration. Most current road safety data systems contain data items to facilitate relational integration which are often employed for this purpose. Examples include driver licence number which can be used to link license details to crash data and infringements, and vehicle registration number which can be used to link vehicle data to crash involved vehicles.

Consideration of both relational and spatial integration will be necessary in defining the process to moving towards the ideal road safety data system in Western Australia.

4.2 ADDITIONAL DATA REQUIREMENTS AND LINKAGES

Tables 3 to 5 list data items considered essential to fulfil the requirements of an ideal road safety data systems. Figure 6 highlights the data systems from which the currently available data fields listed in Tables 3 to 5 are sourced as well as summarising the current linkages that exist between these data systems. An important aspect of Tables 3 to 5 and Figure 6 are that they also identify implicitly the additional data requirements and linkages to be established to arrive at the ideal data system. Two particular key broad areas of information identified are exposure data and road asset inventory data (within a Safe System context) although there are a number of other important data items and linkages that need to be established.

The next section describes requirements for the linkage of Western Australian datasets and additional data. Section 4.3 then discusses requirements for the inclusion of data not highlighted in Figure 6 in conjunction with a review of the status of the various measures listed in Tables 3 to 5 particularly those labelled U (uncollected, un-established or unknown) and which agency might collect this information. In addition it assesses how the creation of new linkages and further processing may enable the collection of these measures.

4.2.1 Requirements for Linking Western Australian Data

Figure 6 shows the current state of road safety related data systems in Western Australia. Review of the current linkages provides an inventory of how linkage between the datasets needs to be enhanced, particularly through the use of geocoded data, to transform the current system into the ideal system. Figure 6 shows that improvements can be made with regards to the linkage of a number of data systems. The following sets of data would need to be *fully* geocoded to enable the comprehensive linkage of data utilising spatial integration:

WA Police

- Incident Management System (IMS)
- Casualty
- Daily Traffic Returns
- Breath and Blood Alcohol System
- Image and Infringement Processing System (IIPS)

MRWA

- Integrated Road Information System – Enhanced crash data
- Road Asset Inventory Data

OTHER

- Travel and Exposure Survey Data

Geocoding of these datasets may occur after collection or, ideally, at the point of collection. For example, where crash data is collected by Police through attendance at the crash site, the use of GPS would assist in geocoding crash data directly. Where crashes are self-reported, for example online, the facility to enter the location onto a map, for example, should allow for fairly accurate determination of the crash location in addition to text-based location information, i.e. road name, suburb, closest intersection. Where geocoding has not occurred, which is likely for retrospective data, then conversion of the retrospective data to geocoded location format would need to be carried out by the responsible agency as part of an enhancement process. This is likely to be both time consuming and expensive dictating that the process must be carefully considered to ensure it is efficient as possible. Accordingly, it is likely due to budget constraints that priorities for geocoding amongst the existing retrospective data will need to be assigned based on the importance of the data to road safety analysis and research. A process for assigning importance will need to be established. Enhancement of the current data sets to include geocoding as a priority is important to minimise the need to post convert the data at a later time.

Geocoding traffic enforcement and infringement information, including the location of random breath tests and safety camera infringements would facilitate the linkage to MRWA enhanced Police reported crash data and road inventory data. This would facilitate powerful analysis of spatial analysis of enforcement distribution in relation to road types and the existing crash population. Relational linkage to attach Police enforcement data to vehicle registration and licensing data would provide the ability to relate crash outcomes to infringement history associated with either the vehicle or driver. Geocoding of automated enforcement types such as speed cameras would be relatively straight forward since the sites are either static or part of a list approved for usage. Manual enforcement and particularly those carried out from car or bus based operations are more problematic and would require the utilisation of on-board GPS technologies to geocode the data.

Ideally geocoding should occur at the time and place of the data collection. The implementation of a process whereby geocoding information is collected along with the data, although likely to be expensive, would have significant long-term benefits. In addition, the retrospective geocoding of text-based location information, although time consuming, would also be worthwhile and would be used in the linkage of data over many years. At present the

retrospective geocoding of crash locations is performed using WA Police's Insight System, however it is understood that this information is un-validated.

The following datasets and data systems currently use person-based relational integration and would continue to do so:

DoT

- Transport Electronic Licensing Information System (TRELIS)

DoH

- Hospital Morbidity Data System
- Emergency presentations data
- Trauma Registry
- Western Australian Data Linkage System (WA DLS)

In general, both person and vehicle-based data would continue to use relational integration with linkage based on a common variable or variables (linkage key). This data includes hospitalisation injury data, licensing and registration information and infringement data. Linkage keys would be based broadly on location, vehicle, person and time. Typical linking variables include:

Location

- Location description
- Postcode
- Local Government Area (LGA)

Vehicle

- Registration number

Person

- Name
- Address
- Date of birth
- Driver's licence number
- Medicare number or other health-related personal identifier

Ideal Linkage and Fallback Linkage

For each data system that is linked there is an ideal method of linkage, e.g. spatial integration. However, in the absence of sufficient information, or whilst the ideal linkage key was being established, a "fallback" linkage key may need to be considered. For example, where location has not been geocoded and the post-collection geocoding of data is not possible due to a lack of detail, a fallback method of linkage would use text-based location information and other common variables to form an appropriate linking key, i.e. relational integration. Where text-based location information is not available, the fallback process would provide linkage options at progressively lower resolution. For example, for traffic enforcement and

infringement information, location information may start at “Road” or “Suburb” or “Police Region” depending what the data system can provide.

4.3 COLLECTION OF MEASURES FOR MOVING TO AN IDEAL SYSTEM

In the ideal data system, all of the listed items in Tables 3 to 5 would be collected. This includes data items currently uncollected or un-established. It is anticipated that the collection of new data, establishment of new linkages and enhancement of current ones, and the further processing of information would enable the collection of many of the items listed. In particular, quantifying risk on the road network requires that information at all steps of the Road Trauma Chain shown in Tables 3 to 5 is collected. Most of the measures that are currently uncollected or un-established fall under “Exposure to hazards” which critically includes Intermediate Outcome Measures.

Firstly examining requirements for Safe Road Use/Safe Speeds (Table 3), it is clear that travel and exposure information should be collected for all types of road users. Key examples of exposure information relate to travel patterns and road user behaviour both typically collected by surveys. Travel pattern information includes recording starting and arrival location and time of trip, purpose, mode of transport. Kam (2003) demonstrated the use of a GIS to link crash data to a travel corridor defined from information derived from the Victorian Activity and Travel Survey (VATS) databases.

Much of the uncollected information on travel and exposure could be collected using either ongoing monitoring of a carefully chosen representative sample of the population or via regular large scale cross sectional travel surveys. It is anticipated that such data would be collected and collated by the DoT although other models of collection, including collaborative models across relevant government agencies, are possible. The use of GIS techniques to link travel survey information with crash data as described earlier would be particularly powerful in examining exposure and risk. Establishment of new or enhanced surveys would be required to collect other intermediate outcome measures listed in Tables 3-5. One example is the proportion of motorcyclists not wearing protective clothing, which could be collected by the ORS as part of the collection of attitude and behavioural measures shown in Figure 6 or may be collected as part of a larger observation survey.

Establishing tools for the measurement of travel and exposure are likely to be expensive and need to be developed with great care and consideration to ensure they meet the objectives of the ideal data system. There also needs to be ongoing commitment to keeping the information updated in order that it remains useful and timely. With the availability of cheap GPS based technologies, collection of high quality travel and exposure data is likely to be much cheaper than it has been in the past.

Other currently uncollected data in Tables 3-5 could be collected relatively simply through appropriate processing of existing data. For example intermediate outcome measures related to speeding, such as changes to the excessive speed distribution, could be obtained by re-processing the speed monitoring data currently collected by MRWA. Similarly many of the Safe Roads and Roadsides measures in Table 4 could be obtained by further processing further classification and processing of road infrastructure data held by MRWA to determine compliance with Safe System principles based on appropriate criteria. Required information in Table 5 on Safe Vehicles could be obtained through appropriate processing of vehicle registration data held in TRELIS by the DoT enhanced with information on vehicle safety

performance derived from the Australasian New Car Assessment Program and/or the Used Car Safety Ratings.

Figure 6 highlights other measures that could be created from the comprehensive linkage of information through spatial and relational integration. These include the linkage of licensing and registration information to MRWA enhanced Police reported crash data that would allow infringement information to be linked to driver history. Then, for instance, data on the crash details of disqualified or suspended drivers could be examined along with specific infringement information.

A final data source required in the ideal data system is socio-economic data. This includes population, employment, labour force, consumption, trade and productivity data, all of which have links to road safety outcomes. Nearly all of this data are available through the Australian Bureau of Statistics (ABS) at various levels of resolution from census collection district up to a state-wide level. The ABS can be contracted to provide information at the most appropriate summary level from the unit record data sets they hold. Frequency of update of the data varies from monthly for data such as trade and unemployment, to every few years for census based information. Updates of the data in the road safety system would be contingent upon the period of availability.

Making recommendations for setting priorities for collection of the currently uncollected or unprocessed measures listed in Tables 3 to 5 is difficult. Setting priorities depends on a number of factors including the perceived and actual usefulness of the additional data to key data users, the costs involved in establishing the data collection and the availability of appropriate resources to either undertake or facilitate the data collection. It is considered beyond the scope of this project to set the priorities for collecting the items note in Tables 3-5 since the priorities will be largely context specific. Instead it is recommended that feedback is sought from all stakeholders in the road safety data system to determine relative priorities for collection of new data items. Once priorities have been set, these should be compared against indicative cost estimates and required and available resources for collecting each data item to determine an action plan for expanding the range of collected data.

A similar process should be used for establishing priorities and actions for the additional data linkages identified. In addition to the above consideration, establishing new data linkages will have to take into account ethical and privacy issues that overlay all data linkage exercises. This can result in the need for supporting legislation to be passed through parliament to enable the linkage to occur as well as establishing or expanding specific processes or facilities to undertake the linkage and allow controlled access to the data which ensures its privacy and ethical use.

4.4 OVERALL SUMMARY OF KEY REQUIREMENTS

As outlined in this section, key requirements for moving to an ideal system encompass two broad areas. The first relates to the collection of new road safety data either from scratch or through the enhanced processing of existing data sources. The second relates to the linking of new and existing data sources to create a cohesive interactive system.

Figure 7 attempts to highlight graphically the enhancements required to bring the current WA road safety data system to the ideal system described in Section 3. The red boxes and text in Figure 7 indicate where major new data collection or processing activities are required whilst the red lines and arrows indicate where additional data linkage is required.

The major key requirements for further additional data may be summarised as follows:

- Travel and exposure data;
- Road asset inventory data (within a Safe System context);
- Socio-economic (from the ABS).

Major additional data linkages required are:

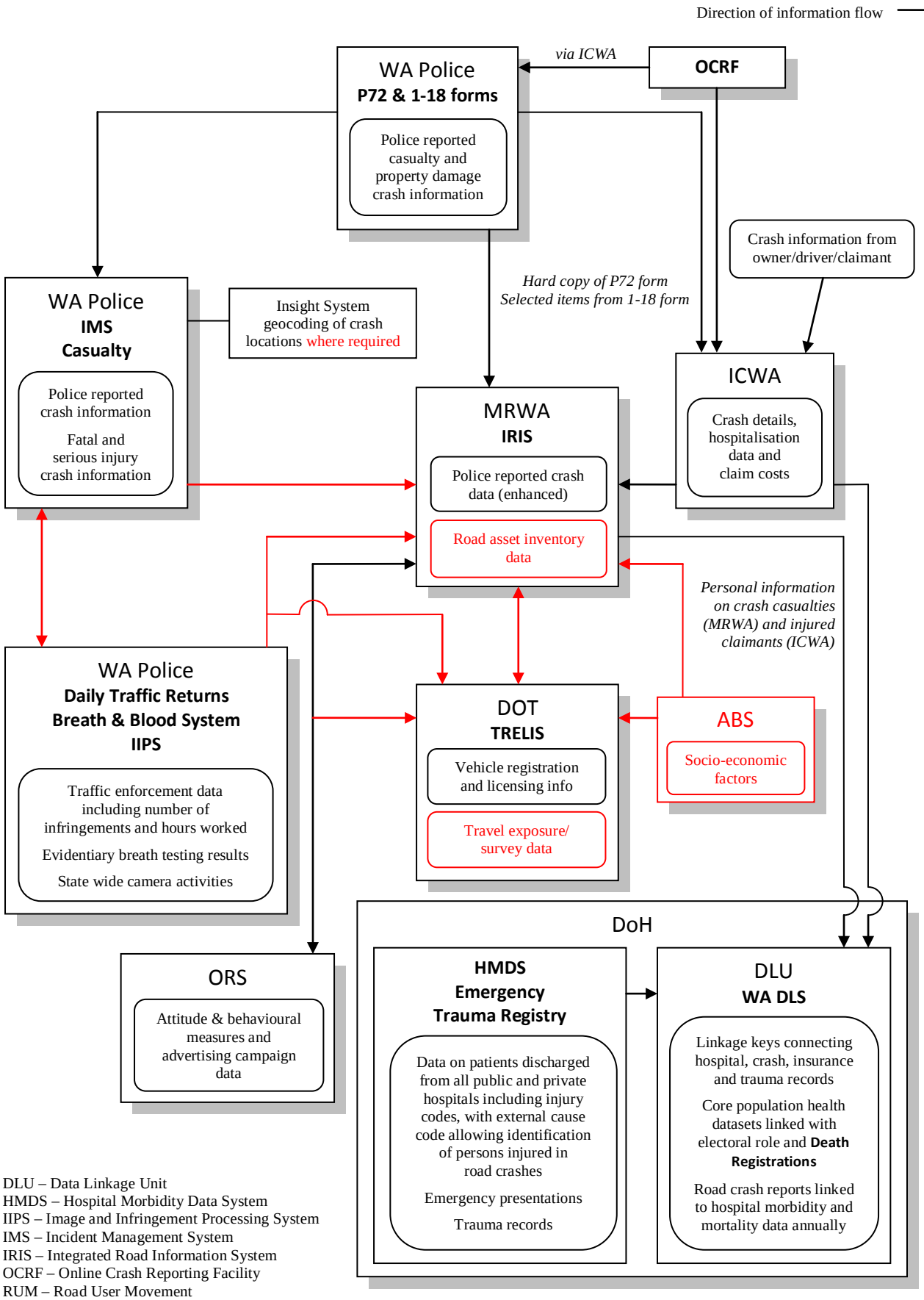
- DoT information system to MRWA and ICWA road crash data systems;
- WA Police enforcement and infringement data with MRWA and DoT data systems;
- WA Police enforcement and infringement data with WA Police IMS casualty data;
- Socio-economic data (from the ABS) with MRWA and DoT data and ORS attitudinal, behavioural and advertising data with DoT data.

General principles for data linkage recommended are:

- Geocoding of all data with location information;
- Spatial integration using GIS tools whenever possible (with fallback relational integration where necessary);
- Relational integration of person and vehicle-based information using privacy sensitive methods and with detailed validated linkage keys;
- Attaching aggregated personal information to crash data wherever appropriate.

Process issues to be considered in progressing to the ideal data system are:

- Prioritisation of the collection of measures and establishment of new linkages through consultation with data custodians and stakeholders and the full range of end users;
- Development of an action plan for instituting new data collection and linkages considering the priorities set in conjunction with financial and resources constraints;
- Explicit consideration of ethical, privacy and access control requirements for new data linkages.



DLU – Data Linkage Unit
HMDS – Hospital Morbidity Data System
IIPS – Image and Infringement Processing System
IMS – Incident Management System
IRIS – Integrated Road Information System
OCRF – Online Crash Reporting Facility
RUM – Road User Movement
TEACEIS – Traffic Enforcement And Crash Executive Information System
TRELIS – TRansport Electronic Licensing Information System
WA DLS – Western Australian Data Linkage System

Figure 7: Additional Elements for Western Australia's Road Safety Related Data Systems

5.0 Requirements for a Multi-User Database Access System

Section 2 outlined the definition of an ideal, comprehensive and integrated road safety data system for Western Australia. Section 3 then presented a review of existing data system elements in Western Australia whilst Section 4 identified key requirements for moving to an ideal system. This next section outlines requirements for a multi-user access system based on the ideal data system. These broad requirements form the blueprint that will ultimately allow construction of the physical road safety database system by a specialist IT provider in the long-term.

5.1 A DATABASE ACCESS SYSTEM

5.1.1 Road Safety Data Access Tools

A review of similar tools developed by other jurisdictions was undertaken. This included a consideration of key features, user type and level of access. The most relevant data access tools are listed below along with a description of relevant details pertaining to this project.

International

A *Road Safety Information System (RIS)* was developed in the 1990s by the SWOV Institute for Road Safety Research in the Netherlands primarily for monitoring and evaluation purposes, but also to contain information that supports other phases of the road safety policy cycle. The first phase includes information required to define problem areas. The second area deals with feasible measures and suitable mix of measures classified into infrastructure, vehicles and road users. The third phase refers to the road safety program and the quantitative targets set through plans, and the final phase (evaluation) includes indicators such as final outcomes, intermediate outcome measures and outputs. RIS aimed to integrate information from various sources, contain the most recent information relevant to policy and be easy to use with users able to obtain every required combination of data. It was proposed that the information system contain tables and text on selected themes and be complemented by an information desk with specialised staff.

CARE (Community database on Accidents on the Roads in Europe) is a database on road accidents resulting in death or injury for the European Union that provides a high level of disaggregation, i.e. it provides detailed data on individual crashes as collected by member states. The purpose of CARE system is to identify and quantify road safety problems, evaluate the efficiency of road safety measures, determine the relevance of community actions and facilitate the exchange of experience. An analysis of CARE aimed at exploring the possibilities of exploiting CARE data in a GIS suggested that two kinds of tools could be of interest to end users. For the general public this was a set of thematic maps in pdf format representing accident variables for European countries for different years. For the road safety expert a web GIS interface was developed and included standard geographical tools and tools for querying, printing, zooming to specific regions, displaying pre-defined maps or calculated new maps. These tools were designed to complement the reporting tools already in use.

FARS (Fatality Analysis Reporting System) was created by the National Highway Traffic Safety Administration (NHTSA) in the United States to provide an overall measure of highway safety, to help suggest solutions, and to provide an objective basis to evaluate the effectiveness of motor vehicle safety standards and highway safety programs. FARS contains

data on a census of fatal traffic crashes, specifically those involving a motor vehicle travelling on a road open to the public and resulting in the death of a person (vehicle occupant or non-occupant) within 30 days of the crash. FARS has been operational since 1975 and collects information on over 100 different coded data elements that characterise the crash, the vehicle and the people involved. Data is collected, coded and submitted into a data system and quarterly files are produced for analytical purposes to study trends and evaluate the effectiveness highway safety programs. This data is tabulated and provided to the public via the FARS Interface (www-fars.nhtsa.dot.gov/Main/index.aspx). This FARS Query System provides interactive public access to fatality data through via the web interface.

Australia

CrashStats is the Victorian accident statistics and mapping program. Terms of access state that CrashStats is provided to users by VicRoads for the purpose of supplying information about road crashes with the road safety initiative for educational purposes and to allow users to better understand some of the key issues about road crashes. The general public can access PUBLIC CrashStats whilst RESTRICTED CrashStats can only be accesses with a valid userid and password and contains cropped images of Police accident forms. Restricted access is granted by VicRoads after review of the project for which the data is to be accessed, how the analysis is to be reported and published and the credentials of the applicant.

Information on road crashes is available by location in particular municipality, suburbs, rural towns, regions and the whole of Victoria. Crash sites are then are then able to be selected and mapped including all sites, select sites and grouped sites, e.g. state government versus council roads. Queries are then able to be built for various time frames, levels of crash severity, road and environmental conditions, speed limit and vehicle, road user, DCA (Definitions for Classifying Accidents) codes, level of urbanisation and date. Simple analyses provide summaries by accident or person attribute and comparisons between regions are able to be performed. Data, charts and maps are able to be exported in different forms. Available information generally reflects the Police reported crash data enhanced by VicRoads including geocoded location information.

Only Police reported crash data are available for interrogation in CrashStats. The data re not linked to any other data sources such as road inventory, enforcement or infringement data. Furthermore, crash data only become available in the system between 5 and 9 months after the date of the last reported crash.

Western Australia

CRASHtool software is in use throughout Western Australia for the analysis of reported road crashes. It is available to state and local government road asset managers and consultants engaged to complete work on behalf of these agencies and requires training to use. It features reports for road sections and intersections and is able to produce simple reports showing crash patterns based on RUM (Road User Movement) codes, collision diagrams and extracts of crash numbers by severity along with information on road condition and the environment for different periods.

HealthTracks is an online interactive mapping application that allows employees from the Western Australian Department of Health to access basic information via interactive maps. Its

functionality includes search tools, the mapping of demographic and health condition data and the ability to import, export and print data and maps.

5.1.2 General Requirements for the Road Safety Database Access System

From the existing road safety data access systems reviewed, a number of general principles were defined for the requirements of the Western Australian system. A multi-user road safety database access system would allow access to road safety and related data across a broad spectrum of end users including researchers, policy makers, practitioners and members of the public. It would allow access to road safety related information at different levels of detail, for example in aggregated or unit record form, depending on authority and level of access approved. The level of access would require different approval requirements.

A database access system should be able to report on any points of the Road Trauma Chain and queries made to the system should be able to be made over time and location. It should contain information on all key outcomes including fatalities and injuries, intermediate outcome measures, and road safety program outputs all of which are described explicitly under Western Australia's Road Safety Strategy 'Towards Zero'. Importantly it should track where the strategy is heading in terms of these targets. In addition to data access, it should include tools that allow access to all road safety policy and strategy documents and relevant road safety research and literature especially those that detail results from various studies.

These general requirements are beyond the scope of any of the existing road safety database access systems. Only the RIS of the Netherlands even approaches the level of detail described. Consequently, development of the Western Australian system would require a significant amount in original development and would result in a world-leading system.

5.1.3 Database Access System Design and Outputs

Information derived from a database access system would be queried on a time and location basis. Time based queries could be made on any time, day, month or year basis. Spatial based queries could be made for specific locations or broader areas including road type, postcode, local government area or broad divisions of the state. It is envisaged that the central focus of queries would be on crash statistics which could also be linked to related information on exposure, infrastructure and enforcement. However, queries could also focus on any other point of the road trauma chain on the same time and location based specification. This would allow the system to be useful for those with interests beyond the crash and injury portion of the road trauma chain, for example those interested in study Police enforcement scheduling or road infrastructure quality and expenditure in relation to population or travel exposure.

The system should allow all geocoded data to be linked and either displayed on a map in some form or presented in aggregate based on mapping characteristics. Relational linked data should also be able to be queried and displayed based on characteristics of the relational linkage key which will be either person or vehicle-based. For example, the system should be able to handle queries on exposure and crashes involving certain vehicle types or people.

As mentioned earlier, WA Police's Insight System provides the un-validated geocoding of crash locations. The system provides a visual mapping function for road crashes (in addition to crime information) thus enabling personnel state-wide to identify trends in Western Australia with the aim of enabling an intelligence-led Policing approach. It is anticipated that the geocoding of crash data linked to other data as described in Section 4 would enable crash

and injury patterns to be studied in a timely manner. It follows that the linkage of the additional data to crash data should also be able to highlight underlying reasons behind crash and injury trends so that appropriate and thus effective countermeasures are able to be implemented. This includes crash characteristics comprising information the road, the vehicle, the person, socio-economic factors and calculated crash and injury risk based on exposure measures. Analysis would be performed by the system to enable the identification of areas of interest based on key criteria, e.g. black spots. This visual based system would be highly interactive with maps and other information easily able to be exported. Information should be available at any location (not just where a crash has occurred, e.g. exposure information for a stretch of road, by selecting a point on the map. Clearly much more information would be available at points where a crash has been identified as having occurred. Depending on level of access this could include information such as Police crash reports. Mullen & Miller (2010) put forward the idea of interactive maps (or a spatial information system) for road safety and proposed two possible scenarios for the collation and dissemination of data with spatial information attached which is consistent with the concept described.

In addition to map-based visual information, outputs from queries should be able to be presented in tabular and/or graphical (charts) forms. These will be on an aggregate report, unit record or case basis. Information in a unit record or case basis would only be available at the highest levels of access and issues of privacy and ethics would need to be resolved. Information should be able to be exported using an appropriate format.

5.2 ETHICS, PRIVACY AND LEVELS OF ACCESS

As noted, the creation of a database access system would require issues surrounding confidentiality to be resolved. Obtaining approvals regarding ethics and the resolution of issues surrounding privacy are beyond the scope of the project but will need careful consideration in realising the concepts put forward by this study. It is expected that these issues, in particular privacy ones, will need to be resolved at the highest levels of government however may leverage existing agreements between data providers already in place, for example that allows the linkage of core population health datasets.

Like other systems, the Western Australian road safety database access system would allow different levels of access. The level of access would require different approval requirements. For example, CrashStats allows members of the public to access crash information in an aggregated form and by region, however access to RESTRICTED CrashStats allows access to Police reports. This access is provided by VicRoads through an application process.

The Western Australian database system would have a wide range of users. This would include:

- Office of Road Safety (on behalf of Road Safety Council and government)
- Key agencies and road safety partners including Western Australia Police, Main Roads Western Australia, Department of Transport, Insurance Commission of Western Australia, Department of Health, Western Australian Local Government Association, Department of Education and the Royal Automobile Club.
- Road safety researchers and policy makers
- Local councils
- Members of the public

Levels of control on access to information would need to be set related to the resolution of the data and the potential for re-identifying and processed or aggregate information. It is clear that public access would only be allowed for highly aggregated information. At the other extreme, access to unit record data, and particularly that linked with other sensitive data sources, would need to highly restricted and subject to an access application, ethics approval and strict control over the use an publication of information derived from the data. The protocols for access would need to be considered once the actual content of the database was determined, recognising the need to comply with state and federal privacy principles, guidelines and legislation.

6.0 Next Steps

This report has outlined a conceptual framework for defining an ideal, comprehensive and integrated road safety data system. It determined specific road safety data system requirements in the Western Australian context from the conceptual framework and reviewed existing road safety datasets including current linkage between these datasets. It then identified key requirements for moving to the ideal system from the current system including additional data requirements and requirements for additional linkages. Finally it described general specifications for a multi-user database access system based on the ideal data system proposed.

Feedback was received from the Office of Road Safety and from representatives of the various other organisations responsible for road safety and for dealing with the consequences of road trauma including Western Australia Police, Main Roads Western Australia, the Department of Transport, Insurance Commission of Western Australia and the Department of Health. It is expected that movement from the current road safety data system to an ideal system will best be achieved progressively over a period of time rather than through one or two major steps. Section 4 identified that the key requirements for moving to an ideal road safety data system encompass two broad areas, namely data collection and data linkage. This section will discuss the recommended *next steps* to achieving an ideal road safety data system taking into account the key requirements and agency feedback. It includes consideration of the potential role of key agencies and an appropriate model for the creation of new linkages.

6.1 DATA COLLECTION AND DATA LINKAGE

With respect to key requirements identified, *data collection* relates to the collection of new road safety data either from scratch or through the enhanced processing of existing data sources. *Data linkage* relates to the linking of new and existing data sources to create a cohesive interactive system. Figure 7 highlights graphically the enhancements required to bring the current WA road safety data system to the ideal system. It shows where major new data collection activities and additional data linkage is required. Tables 3-5 show ideal data system requirements with respect to individual data items and the agency responsible for the collection and processing of each item along with the current state of data collection.

The following process issues were earlier highlighted for consideration in progressing to the ideal data system:

- Prioritisation of the collection of measures and establishment of new linkages through consultation with data custodians and stakeholders and the full range of end users;
- Development of an action plan for instituting new data collection and linkages considering the priorities set in conjunction with financial and resource constraints;
- Explicit consideration of ethical, privacy and access control requirements for new data linkages.

This section will now expand on these issues as far as possible through outlining a proposed series of action plans for addressing them.

Action Plan A: Allocation of Responsibility, Data Collection and Geocoding

As part of the first action plan, the following should initially occur:

4. Each agency should decide on the parts of the ideal data system it believes are worth developing in priority order and their individual level of responsibility.

5. Consensus by the agencies should then be reached on which parts of the system will be developed in priority order and potential time frames (short, medium or long-term).

6. Responsibility, individual or shared, should then be allocated according to which aspect of the ideal system is to be developed.

Once agency responsibility has been agreed, it is suggested that actions relating to individual agencies should be outlined. In general, Action Plan A should attempt to make progress where individual agencies are able take responsibility in the short-term and for which new inter-agency data sharing or linkage agreements aren't required. One such area is the collection of measures as outlined in Tables 3-5. For example, following prioritisation, the collection of new data or the enhanced processing of existing data may simply require the relevant agency to commit appropriate resources, such as personnel and/or funding, in order to collect items against which the organisation has been marked.

Another key area is the geocoding of data, requirements of which were outlined in Section 4. It was noted that geocoding may occur after collection, or ideally, at the point of collection. Before implementing a plan for geocoding, a prioritisation process should be undertaken taking into account the medium-term aim of data linkage through spatial integration and the long-term aim of creating a spatial information system (Action Plans B/C and Action Plan E respectively).

Action Plan B: Preparation to Enable Data Linkage

The next stage in moving towards an ideal data system should address data linkage actions including the linking of new or existing data sources as shown in Figure 7. It is expected that these would be progressed once an appropriate data linkage framework has been agreed upon. The framework may leverage existing agreements between data providers already in place and would have as its overriding purpose the aim of ensuring good data governance for data linkage in Western Australia. Feedback from the agencies suggested that in order to achieve good data governance such a framework could potentially be based on the "authorised integrating authorities" concept endorsed by the Australian government for integrating Commonwealth data (see the box below). It is stressed that the authorised integrating authorities framework is just one model for enabling data linkage and that the one ultimately used in Western Australia should accommodate local requirements. Another option may be to expand the role of existing data linkage facilities. The key issue is that when developing a framework, ethical, privacy and access issues should be explicitly addressed.

Integrating Authorities
Source: nss.gov.au

In 2009, Australian Government Portfolio Secretaries established a Cross Portfolio Statistical Integration Committee (CPSIC), jointly chaired by the Department of Health and Ageing and the Australian Bureau of Statistics, to create an Australian government approach to facilitate linkage of social, economic and environmental data for statistical and research purposes. An essential pillar of

establishing a safe and effective environment for data integration involving Commonwealth data is the nomination of an agency as the authorised integrating authority for each statistical data integration proposal. The integrating authority is responsible for the sound conduct of the data integration project and may work with other agencies to achieve components of the project, for example it might use another agency to undertake linkage or to support dissemination. The integrating authority has overall responsibility to ensure that risks have been assessed, managed and mitigated throughout the duration of the project, including regular reviews of ongoing projects.

The integrating authority ensures that appropriate governance is in place for the data integration project including: using an open approval process; documenting the proposal; considering the privacy impacts; examining the expected costs and benefits of the proposal; and considering the access arrangements and dissemination plans. The integrating authority is responsible for the ongoing management of the integrated data, ensuring it is kept secure, confidential and fit for the purposes for which it was approved.

Accreditation Process

For data integration proposals considered by custodians to pose a high systemic risk, nomination of an authorised and accredited integrating authority is required. An accreditation process will be established through the Cross Portfolio Data Integration Oversight Board to enable the endorsement of authorised and accredited integrating authorities with the capacity to deal with high risk data integration projects or families of projects involving Commonwealth data. An accreditation process including interim arrangements will be proposed through cross government consultation. It was expected that interim arrangements were to be proposed for discussion and endorsement by the Board in early 2011 with final arrangements agreed in early 2012.

The collection and linkage of data as described in this report not only has benefits for the area of road safety but would also be useful for transport, infrastructure and enforcement planning. Making progress towards an ideal data system provides the opportunity for collaborating and sharing data with other organisations and government agencies potentially leading to improved data consistency and reduced costs. It is expected that the creation of a data linkage framework based on an authorised integrating authorities concept or similar would facilitate this process. In addition, such a framework would provide a platform for the involvement of persons at the highest level of each organisation (ideally CEO or ministerial level) which should help drive system development.

In addition to putting in place an appropriate data linkage framework, the linking of new and existing data sources to create a cohesive interactive system will be best achieved after progress has been made with regards to the geocoding of data. As described in Section 4 a fallback method of linkage using text-based location information could be used, perhaps temporarily. However, linkage using geocoded data using GIS tools should be used whenever possible and will assist with the long-term aim of creating a spatial information system (Action Plan E).

Action Plan C: Data Linkage Implementation and Additional Data Collection

Once an appropriate data linkage framework has been put into place and sufficient geocoding of data has been achieved to facilitate spatial integration, actions to implement data linkage should be agreed to by the agencies. These actions will be dependent upon the structure of the data linkage framework, authorised integrating authorities concept or otherwise. The additional linkage of new and existing data sources will also enable the collection of new

measures derived using linked data. Prioritisation of these measures and allocation of responsibility for their collection should then occur.

6.2 AN INTERIM DATASET

As noted, it is not expected that movement from the current road safety data system to an ideal system will be achieved through one or two major steps, but progressively through a series of steps over time. Potential steps relating to key requirements for moving to an ideal system (Section 4) were outlined above through a series of action plans which should provide a practical way of progressing to the ideal system over time. This section outlines further actions that may be undertaken relating to requirements for a multi-user database access system (Section 5), the creation of which is a long-term aim requiring the involvement of a specialist IT provider. It is proposed that an initial interim dataset, suggested as part of agency feedback, could form a good basis for the future database access system. As such, it is recommended that the actions that follow occur in the short to medium-term and should be viewed as being able to be progressed in parallel with those outlined above.

Action Plan D: Establishment of an Interim Dataset

Section 5 provided broad requirements for a multi-user database access system based on the ideal data system. The requirements formed the blueprint that will ultimately allow construction of a physical road safety database access system by a specialist IT provider. Prior to its establishment, an interim dataset could provide a basis for such a system and may also provide a starting point from which basic road safety queries could be addressed. It is anticipated that the interim dataset, once sufficiently geocoded, could also promote progress on design of the spatial information system that would be an integral part of the database access system.

In order to set-up an interim dataset, the agencies should agree on whether a framework for data linkage (Action Plan B) should firstly be in place, or whether an initial dataset should be created based on the current data system linkages. An interim dataset could also be based on an existing crash-based data warehouse. Consensus on the scope and size of the interim dataset should then be reached based on an agreed purpose which at a minimum would include the ability to answer basic queries from government and the public and allow some basic access to data. Finally it must be decided whether a specific agency is responsible for the dataset or whether responsibility for its maintenance is shared.

It is expected that as more data is collected and new linkages are created, the ability of an interim dataset to answer broader questions would increase as it is enhanced over time. Such an enhancement process combined with an increase in geocoded data, enabling a spatial information system, could eventually lead to a multi-user database access system. The manner in which an interim dataset could be used to progress a spatial information system is explored in further detail below.

Action Plan E: Development of a Spatial Information System

Mullen & Miller (2010) put forward the idea of interactive maps (or a spatial information system) for road safety and proposed two possible scenarios for the collation and dissemination of data with spatial information attached. The first scenario was most consistent with the concept of an interim dataset described above and involves data from the agencies being collated by a nominated agency prior to secure delivery. The second scenario uses pre-

aggregated data delivered to the agencies via a web application. These scenarios were put forward as part of a presentation to the Towards Zero Outcomes Reporting Group on HealthTracks, an online interactive mapping application that allows employees from the Department of Health to access basic information and includes as part of its functionality search tools, the mapping of demographic and health condition data and the ability to import, export and print data and maps. More information on HealthTracks is provided in the box below.

HealthTracks

Source: crcsi.com.au

Policy makers in government departments, such as the Department of Health, require improved access to scientific evidence in a timely manner. Those responsible for health policy face additional challenges having to constantly protect patient confidentiality. The Cooperative Research Centre for Spatial Information (CRCSI) developed "HealthTracks" to maximise the efficiency of the population health budget spend.

HealthTracks demonstrates how spatial technology can improve the communication of complex statistical data by serving as a one-stop planning and evidence tool for health policy formulation. It allows seamless compatibility with Landgate's existing Shared Land Information Platform (SLIP) to merge health data with hundreds of environmental and other datasets from external agencies. (Landgate is Western Australia's primary source of land information and geographic data.)

The Department of Health led the CRCSI project having recognised the need for more informed planning and decision making. HealthTracks brings together map data from a range of sources using Open GIS standards and presents them in a highly usable interface for non-GIS users, using an intuitive and innovative map display. The information provided via HealthTracks is assisting those responsible for the on-ground delivery of health programs. When combined with information from epidemiology systems it is capable of identifying priority areas based on sound evidence and it ensures that limited budgets are targeted to areas of greatest need.

HealthTracks contributed to Landgate's objective to develop new and innovative ways of making land information available to further benefit government, business and the community. The CRCSI plans on rolling out modular enhancements to HealthTracks in areas of mental health, child health, environmental health, policy, country health service areas, and state-wide health planning.

Section 5 outlined requirements for a multi-user database access system, the creation of which is a long-term aim. Requirements included a consideration of database access system design and outputs, including map-based visual information, ethics, privacy and levels of access. It is expected that these requirements will be addressed when a decision to invest in such a system has been made.

The CRCSI HealthTracks project provides a good example of the type of collaboration required to create a spatial information system that would be an integral part of a multi-user database access system. A sufficiently geocoded interim dataset would provide a HealthTracks type project with an appropriate set of data to proceed. However the agencies must firstly decide whether a spatial information system is to be developed as part of such a project or whether it would be preferable to wait until the construction of a physical road safety database access system by a specialist IT provider. Advantages of proceeding in the medium-term include the opportunity to undertake fundamental groundwork in advance of a fully-fledged system using a similar funding model as for the HealthTracks project, and that a spatially enhanced interim dataset could provide a useful precursor to a fully-fledged system.

It would also provide the agencies with the opportunity to investigate and test requirements specified in Section 5 on a smaller scale.

If it is decided that an interim dataset should be used as the basis for developing a spatial information system, the agencies should:

- Investigate what is required to set up a similar project to the CRCSI HealthTracks project, or alternatively investigate whether an expansion of the project to include road safety data is possible;
- Decide which agency would lead such a project;
- Discuss the manner in which data will be collated, spatially enhanced and distributed.

7.0 Key Benefits

The creation of an enhanced road safety information system for Western Australia leading to a multi-user database access system is critical to providing a solid foundation from which effective road safety management in Western Australia may be undertaken. It provides the basis on which to service the Safe System paradigm under which road safety policy and programs are developed. Generally, the data system will facilitate all stages of road safety management including problem identification, monitoring of relevant trends and outcomes, selection, formulation and implementation of appropriate countermeasures and countermeasure evaluation. Through these activities, the enhanced road safety information system will facilitate the translation of Safe System principles into practice.

Beyond these general benefits, a comprehensive and integrated road safety data system would deliver numerous specific benefits including:

- The ability to easily monitor and report on key performance targets endorsed by Government as part of Western Australia's "Towards Zero" Road Safety Strategy 2008-2020.

- Facilitation of a range of new cutting edge research to inform Safe System practice capitalising on the enhanced scope and improved linkage of the available data. The research would more readily be able to address issues in greater detail that cut across the multiple elements of the Safe System.

- Assisting the development of new and highly informed road safety policy through the enhanced evidence base, additional reporting and improved data quality.

- The capacity to answer ad hoc queries by key agencies, researchers, policy makers and members of the public.

- The ability to be used for specific planning and research purposes beyond road safety including infrastructure and transport planning.

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Appendix A – Intermediate Outcome Measures and Outputs

LITERATURE REVIEW AND KEY PRINCIPLES

A review of the road safety literature identified a recently completed project that included a thorough examination of intermediate outcome measures or Safety Performance Indicators (SPIs)[2]. The SafetyNet project was funded under the Sixth Framework Research Program of the European Union. It involved 21 partners from 18 countries with the goal of developing a framework for the European Road Safety Observatory (Thomas et al. 2009). The observatory was described as a system that brings together harmonised accident and other safety data to support evidence-based decision making for European and national level road and vehicle safety policymakers. The data and knowledge can be accessed through a website (www.erso.eu). The project was started in May 2004 and completed in October 2008.

The final report of the SafetyNet project (Thomas et al. 2009) summarised achievements arising from the principal topic areas of the project which included the European road accident database (CARE), exposure data, safety performance indicators, in-depth data, a safety information system (website) and a review of statistical analysis tools. With regards to safety performance indicators the project reviewed the state of the art of SPIs (Hafen et al. 2005), developed guidelines for collecting SPIs (Hakkert & Gitelman 2007), produced comparisons of countries based on selected indicators (Vis & Eksler 2008) and made recommendations for future collection. A report outlining the theory behind the development of SPIs was also produced (Hakkert et al. 2007).

In describing safety performance indicators, Thomas et al. (2009) referred to the general acceptance that the safety plans and targets enacted by jurisdictions needs to be monitored periodically to verify the progress made and to adopt changes as necessary based on recent observed trends. It was noted that monitoring the progress of road safety is usually assessed in terms of crashes, injuries or their social costs, however that this does not usually offer enough insight into underlying processes. It was recommended that road safety managers take into account as many factors that affect safety as possible through safety performance indicators.

Towards zero: ambitious road safety targets and the Safe System approach (Organisation for Economic Co-operation and Development 2008) was another recent report that examined intermediate outcome measures. It stated that road safety targets quantify the road safety results a jurisdiction wishes to achieve and can be expressed in terms of final outcomes, intermediate outcomes and institutional outputs. The report provided a review of road safety performance and the targets set in many countries or by international organisations to reduce the future number of deaths and injuries.

The report also examined the need for comprehensive crash and road safety performance data collection which it stated needs to include crash statistics, but should also extend to other factors including demographic data, traffic volume data, intermediate outcome measures and infrastructure factors. It stated that those countries that have already moved, or are currently moving, to a Safe System approach monitor an increasing range of indicators that are pivotal to achieving safe travel. This includes the proportion of drivers travelling at safe speeds, the occurrence of certain crash types and the severe crash outcomes in relation to road

[2] These terms will be used interchangeably throughout this report.

infrastructure characteristics, the levels of compliance with seat belt and helmet wearing requirements and blood alcohol limits by drivers and riders and the presence of specific safety features and levels of crashworthiness in the vehicle fleet.

The Organisation for Economic Co-operation and Development (2008) report and SafetyNet project presented a thorough coverage of the latest concepts and developments with regards to the role of intermediate and other outcomes within the context of road safety monitoring. However the role of such targets was first illustrated in New Zealand's road safety strategy consultation document (Land Transport Safety Authority 2000). Here targets were defined as road safety outcomes that are accepted by the community and endorsed by government at the highest level. A basic target hierarchy was developed and the key elements are presented in Figure A1. Targets at each level contribute to those at the next level up with social cost at the top. The consultation document defined each level as follows:

- Social cost is the aggregate measure of all costs that crashes inflict on the community. It includes not just material losses but also pain and suffering.

- Final outcomes consist of fatalities and serious injuries. They are what we seek to avoid and are the main components of social cost.

- Intermediate outcomes are not desired for themselves but for what they entail – better final outcomes. They include average traffic speeds, the proportion of drunk drivers, the seatbelt-wearing rate, the physical condition of the road network, and the standard of the vehicle fleet. We measure intermediate outcomes both because it is easy to do so and because they are generally reliable indicators of how well our road safety interventions are working.

- Outputs represent physical deliverables, for example the number of Police traffic enforcement patrols and the amount of road safety related advertising delivered. Alternatively they correspond to milestones showing that a specified task has been completed.

Outputs are associated as much as possible with intermediate outcomes (e.g. alcohol, speed, restraints) which are necessary to achieve final outcomes (reductions in deaths and serious injuries). Social cost represents the total burden of injury, and can be broken down by road-user groups and regions. The Land Transport Safety Authority (2003) described this strategy as using an "outcomes management" framework that links what we do (outputs) to what we are trying to achieve (outcomes).

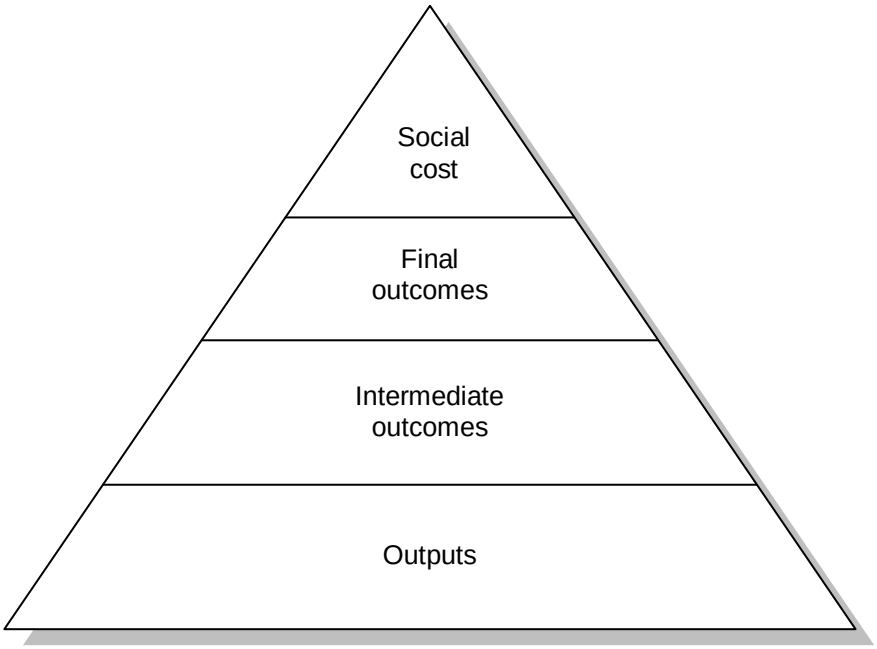

Figure A1: Target hierarchy developed for New Zealand's Road Safety Strategy 2010

The European Transport Safety Council (2001) provided further detail on the need for intermediate outcome measures and presented the above hierarchy of targets as essential elements of a "safety management system". Objectives of their study included explaining how SPIs can be used as one element of a rational safety management system; giving an overview of SPIs that can be used in addition to crash records to monitor safety trends and assess safety problems; and outlining best practice in the use of SPIs by identifying the most important indicators.

Since the target hierarchy (Figure A1) was first presented in the Land Transport Safety Authority (2000) report, further developments of the basic structure have occurred. In the SUNflower project report (Koornsta et al. 2002) the hierarchy was shown with an additional layer at the base of the pyramid called "Structure and culture". Wegman and Aarts (2006) referred to this adjusted structure in *Advancing sustainable safety* which outlined the Dutch National Road Safety Outlook for 2005-2020, and stated that the lower layer of the pyramid described structure and culture elements that may be important to implement road safety policy and measures.

The concept of structure and culture was further developed by Bliss and Breen (2008) in their World Bank report. The additional layer was expressed in terms of seven institutional management functions, namely Results Focus, Coordination, Legislation, Funding and Resource Allocation, Promotion, Monitoring and Evaluation, Research and Development and Knowledge Transfer. These functions relate to all government, civil society and business organisations that produce interventions and contribute to results.

Hafen et al. (2005) described the model of the road safety system shown in Figure A1 as measure-oriented following its logic from the bottom upwards. It stated that the model is not necessarily tied to the form of a pyramid, but that it could also be presented as a chain of

blocks. However the report also stated that the pyramid illustrates the interdependencies of the system with the size (width) of a level indicating the quantity of factors influencing the next higher level. Further development of the basic model was presented with the process considered from top to bottom, which was described as a problem orientation rather than an intervention orientation.

Following this top-down logic, it is convenient to portray the intermediate outcomes as *operational conditions of the road traffic system* and in this way reach an independence from safety interventions. Independent from any intervention, unsafe operational conditions of road traffic are responsible for accident and injury occurrences. Unsafe operational conditions may be pre-crash related indicating a need for accident prevention measures, crash related indicating a need for injury prevention in the event of an accident or post-crash related indicating a need for improved post-crash recovery and injury treatment. At the same time, different safety measures and interventions aim to influence the operational conditions of the traffic system, where direct impacts of these interventions are presented as outputs (Hakkert et al. 2007).

These developments ultimately led to the SafetyNet concept of the place of SPIs (or intermediate outcome measures) in a safety management system as shown in Figure A2 and described in the SPIs manual (Hakkert & Gitelman 2007). The manual stated that ideally, SPIs should reflect the unsafe operational conditions of the road traffic system and be sensitive to their changes. An example given was in the case of speeding where the unsafe operational conditions of the road traffic system (e.g. speeding) are affected by outputs from a road safety program or specific measures (e.g. speed enforcement). The outputs are the physical deliverables of the intervention (e.g. speed cameras in use), whereas the (intermediate) outcomes should be seen in improving the operational conditions (e.g. lower level of speeding), which can be measured by SPIs (or intermediate outcome measures). The improved operational conditions will result in accident or injury reductions, whereas the whole process should reduce the social costs.

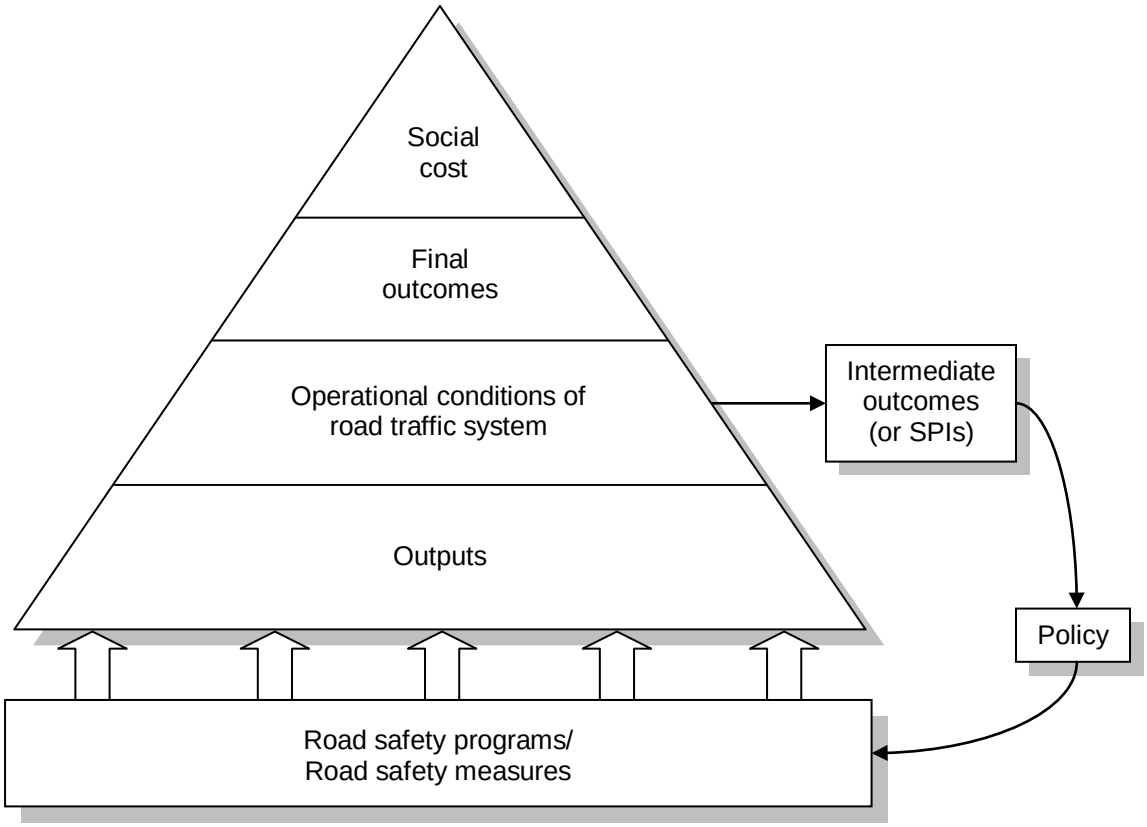

Figure A2: SafetyNet concept of the place of SPIs in the safety management system

A recent paper by Tingvall et al. (2009) described how some jurisdictions link intermediate outcome measures to targets and the actions necessary to achieve a certain level, hence use them mainly for management purposes. It was noted that Elvik (2008) and the Swedish Road Administration utilise intermediate outcome measures (or SPIs) in the broader sense to both set targets and to predict the outcome of improvements achieved in using an intermediate outcome measure. The paper aimed to understand the nature of intermediate outcome measures in more detail for both of these purposes and questioned some of the properties, for example statistical independence, assigned to SPIs.

INTERMEDIATE OUTCOME MEASURES AND OUTPUTS COLLECTED ACROSS JURISDICTIONS

This section provides a summary of the intermediate outcome measures and outputs that have been utilised or proposed for use across various jurisdictions as road safety targets. It was not the purpose of this activity of the project to outline targets set at the final outcomes level of the target hierarchy (Figure A1). Rather, the review only considered intermediate outcome measures and outputs. As earlier defined, intermediate outcomes measures (or SPIs) are any variables that are used in addition to accidents or injuries to measure changes in safety performance, but which are causally related to accidents or injuries. Outputs represent the physical deliverables of road safety programs or interventions.

New Zealand

New Zealand has set targets at both the intermediate outcome and output levels of the target hierarchy. For the intermediate outcome measures, targets were set in three priority areas, namely speed management, drink-driving and the use of restraints. Related targets for outputs were outlined in a review of New Zealand's road safety strategy.

Intermediate Outcome Measures

Speed	Mean (open road) 85th percentile (open road) Mean (urban road) 85th percentile (urban road)
Alcohol	Driver deaths with excess alcohol
Restraints	Vehicle occupants wearing safety belts (front) Vehicle occupants wearing safety belts (back) Children (under 15) restrained

Source: *Road safety to 2010* (Land Transport Safety Authority 2003)

Outputs

Speed	Hours of enforcement delivered Speed camera hours On-road offence and infringement notices issued Speed camera infringement notices issued
Alcohol	Hours of enforcement delivered Number of breath tests (country) conducted Number of breath tests (metropolitan) conducted Offence notices issued
Restraints	Hours of enforcement delivered Offence notices issued

Source: *Review of the road safety to 2010 strategy* (Breen 2004)

Norway

In Norway, 21 targets have been proposed for intermediate outcome measures for the year 2020 by the Public Roads Administration (listed below). They include 12 targets for road user behaviour, 6 targets for vehicle safety and 3 targets for the road system.

1. Share of traffic complying with speed limits
2. Seat belt wearing in built up areas
3. Seat belt wearing outside built up areas
4. Use of bicycle helmets among children below the age of 12 years
5. Use of bicycle helmets among older children and adults
6. Use of bicycle lights in the dark
7. Adult use of pedestrian reflective devices in the dark

8. Share of vehicle kilometres performed by drivers impaired by alcohol or drugs
9. Share of vehicle kilometres performed by fatigued drivers (based on self-reports)
10. (a) Hours of driver training; (b) Share of training during first half of training period
11. Share of vehicle kilometres performed by cars rated 4 or 5 stars in EuroNCAP
12. Share of vehicle kilometres performed by cars with electronic stability control
13. Share of vehicle kilometres performed by cars with autonomous cruise control
14. Share of vehicle kilometres performed by cars with enhanced neck injury protection
15. Share of vehicle kilometres performed by cars with e-Call (assuming it is made mandatory from 1 January 2009)
16. Share of heavy vehicles with no brake defects
17. Share of drivers of heavy vehicles complying with regulations concerning length of daily rest period (determined by checking tacographs)
18. Share of drivers of heavy vehicles complying with regulations concerning length of daily hours of service (determined by checking tacographs)
19. Safety standard of main road network
20. Safety standard of other national roads
21. Safety standard of regional and local roads

Source: *Road safety management by objectives: a critical analysis of the Norwegian approach* (Elvik 2008)

Canada

In addition to an overall target, Canada has in place a range of sub-targets that generally fit under the final outcomes category, i.e. are related to fatalities and serious injuries. However two of the sub-targets are intermediate outcome measures, namely:

- Proportion of seat belt and proper child restraint use
- Proportion of drivers who commit three high-risk driving infractions (two if they were alcohol related) within a two year time frame

Source: *Canada's road safety targets to 2010* (Transport Canada 2001)

Great Britain

In Great Britain, a range of targets and indicators have been proposed for a post 2010 strategy. One of the proposed indicators is an intermediate outcome measure, namely:

- Proportion of vehicles exceeding speed limits

Source: *A safer way: consultation on making Britain's roads the safest in the world* (Department for Transport 2009)

Sweden

The Swedish Road Administration has proposed new interim targets for road safety to be achieved no later than 2020. The intermediate outcome measures for which targets have been proposed are:

1. Proportion of vehicle kilometres on state roads taking place within current speed limits
2. Change in speed limit compliance on municipal streets
3. Proportion of vehicle kilometres driven by sober vehicle drivers (BAC below 0.02 per cent)

4. Proportion of drivers stating they have fallen asleep or nearly fallen asleep while driving during the previous 12 months
5. Proportion of drivers and passengers in passenger cars using seat belts;
6. Proportion of cyclists wearing helmets
7. Proportion of new cars having the highest safety class according to EuroNCAP (including new technology where active and passive safety is integrated)
8. Proportion of new heavy vehicles having emergency braking systems
9. Proportion of vehicle kilometres on roads with speed limits above 80 km/h taking place on traffic-flow separated roads
10. Proportion of safe pedestrian, bicycle and moped passages on the primary network
11. Proportion of safe junctions on the primary network
12. Time from injury to adequate medical care
13. Change on the index for answers to attitude questions about road safety

Source: *Management by objectives for road safety work – stakeholder collaboration towards new interim targets 2020* (Swedish Road Administration 2008)

European Union

In the European Union, intermediate outcome measures were developed around seven major areas central to the fields of activity in road safety in Europe. The fields of activity are considered the central themes necessary to bring about a significant improvement in road safety in EU countries. Each field is listed below along with examples, where appropriate, of intermediate outcome measures developed.

Alcohol and drugs

Speeds
- Mean speed
- 85^{th} percentile speed
- Proportion of drivers exceeding the speed limit

Protective systems
- Daytime wearing rates of seat belts (front seats, rear seats, children under 12 years old)
- Daytime usage rates of safety helmets (cyclists, moped riders, motorcyclists)

Daylight running lights
- Proportion of vehicles using daytime running lights

Passive vehicle safety
- Median age of passenger cars in the fleet
- Overall average EuroNCAP score in the fleet

Roads
- Distribution of EuroRAP stars (1-4) per road category (AAA-C)

Trauma management
- Emergency Medical Services (EMS) vehicles per 100 km road length of total public roads
- Average response time of EMS

Source: *Road safety performance indicators: theory* (Hakkert et al. 2007)

Appendix B – Performance Indicators

Table B1: Performance Indicators for Towards Zero: Road Safety Strategy to Reduce Road Trauma in Western Australia 2008-2020

SAFE SYSTEM CORNERSTONE	PERFORMANCE INDICATORS
Safe Road Use	▪ Number and percentage of people killed or seriously injured in crashes according to vehicle type (i.e. truck/heavy vehicles, car/light vehicles, motorcycles, and mopeds). ▪ Number and percentage of people killed or seriously injured in crashes that involved a person that had engaged in an illegal driving behaviour such as speeding, drink driving, drug driving or not wearing a restraint.
Safe Roads and Roadsides	▪ Number of people killed or seriously injured in crashes according to crash type (i.e. run-off road, intersection, head-on, other). ▪ Number of priority metropolitan intersections that have been treated with Safe System improvements. ▪ Number of kilometres of high volume regional and remote routes that have been treated with Safe System improvements.
Safe Speeds	▪ Changes in fatality and serious injury risk as estimated from observed changes in mean speed measures at a representative sample of metropolitan, regional and remote sites. ▪ Number and percentage of pedestrians and bicyclists killed or seriously injured in crashes.
Safe Vehicles	▪ Number and percentage of new vehicles sold in Western Australia that have at least a four star Australasian New Car Assessment Program (ANCAP) rating. ▪ Number and percentage of new vehicles sold in Western Australia that are fitted with specific safety features such as electronic stability control, side and curtain airbags, and active head restraints.

Source: *Towards zero: road safety strategy to reduce road trauma in Western Australia 2008-2020* (Road Safety Council 2009)

Table B2: Performance Indicators for Towards Zero: Road Safety Council's Recommendation to Government to Reduce Road Trauma in Western Australia 2008-2020

SAFE SYSTEM CORNERSTONE	RECOMMENDED PERFORMANCE INDICATORS
Safe Road Use	▪ Number and percentage of people killed and seriously injured in crashes that resulted from engaging in an illegal driving behaviour, such as speeding, drink driving, drug driving or not wearing a seat belt. ▪ Number and percentage of drivers and riders measured as compliant with the range of speed limits at a sample of metropolitan, regional and remote sites. ▪ Number and percentage of all people killed or seriously injured in crashes involving at least one driver or rider with a BAC > 0.05.
Safe Roads and Roadsides	▪ Number of priority metropolitan intersections that have been treated with Safe System improvements. ▪ Number of kilometres of high volume regional and remote routes that have been treated with Safe System improvements. ▪ Number of people killed or seriously injured on metropolitan, regional and remote roads resulting from run-off-road crashes. ▪ Number of people killed or seriously injured resulting from crashes at metropolitan, regional and remote intersections.
Safe Speeds	▪ Changes in fatality and serious injury risk as estimated from observed changes in mean speed measured at a representative sample of metropolitan, regional and remote sites. ▪ Number of pedestrians and cyclists killed or seriously injured in crashes.
Safe Vehicles	▪ Percentage of all new vehicles sold in the private and corporate fleet in Western Australia that have at least a four-star ANCAP occupant and/or pedestrian rating. ▪ Percentage of the WA vehicle fleet fitted with specific safety features such as electronic stability control, side and curtain airbags and active head restraints.

Source: *Towards zero: road safety council's recommendation to government to reduce road trauma in Western Australia 2008-2020* (Road Safety Council 2008)

Table B3: Performance Indicators for Arriving Safely: Road Safety Strategy for Western Australia 2003-2007

STRATEGY COMPONENT	PROPOSED PERFORMANCE INDICATORS	Responsible Agency
Overall Performance Indicators	Number of crashes of each level of crash severity	WA Police
	Number of persons injured at each level of injury severity	WA Police (Prelim) DoH
	Fatality rate per 100,000 population	ORS (via WA Police)
	Serious injury rate per 100,000 population	ORS (via WA Police/DoH)
	Cost to the community of road crashes	ORS/ICWA
Countering drink driving		
Crash-based measures	Number and percent of drivers and riders killed with BAC > 0.05	WA Police
	Number and percent of persons killed in crashes in which at least one driver or rider had BAC > 0.05	WA Police
	Number and percent of crashes that occur in High Alcohol Hours	WA Police
Intermediate measures	Number and percent of drivers tested who are over the legal BAC limit	WA Police
	Alcohol sales	DoH/Liquor licensing
	Number of alcohol outlets	DoH/Liquor licensing
Process measures	Number of random breath tests conducted	WA Police
	Number of random breath tests conducted during High Alcohol Hours	WA Police
	Number of random breath tests conducted as a proportion of all contacts	WA Police
	Percent of drivers who report having been random breath tested in the past six months	ORS
	Amount of drink driving advertising (e.g. audience reach)	ORS
	Extent to which enforcement and advertising measures are correlated	ORS/WA Police
Reducing speeding		
Crash-based measures	Number and percent of fatal crashes where speeding is judged to contribute	WA Police
	Number and percent of serious injury crashes where speeding is judged to contribute	WA Police
	Proportion of Police-reported crashes which resulted in fatality or hospital admission	WA Police
Intermediate measures	Distribution of vehicle speeds at a set of metropolitan and rural areas	MRWA
	Percent of vehicles measures as travelling over the posted speed limit or more than 10 km/h over the posted speed limit at a set of metropolitan and rural sites	MRWA

	Percent of vehicles measured as travelling over the posted speed limit or more than 10 km/h over the posted speed limit at speed camera sites	WA Police
	Percent of drivers surveyed who say that they travel over the posted speed limit or more than 10 km/h over the posted speed limit	ORS
Process measures	Number of hours of speed camera operations	WA Police
	Number of vehicles passing speed cameras	WA Police
	Percent of drivers who report having received a speeding ticket in the previous six months	ORS
	Amount of road safety advertising targeting speeding	ORS
	Extent to which enforcement and advertising measures are correlated	ORS/WA Police
Increasing restraint use		
Crash-based measures	Number and percent of fatal crashes in which a person killed was not wearing a seat belt	WA Police
	Number and percent of persons killed who were not wearing a seat belt (separately for drivers and passengers)	WA Police
	Number and percent of serious injury crashes in which a person seriously injured was not wearing a seat belt	WA Police
	Number and percent of persons seriously injured who were not wearing a seat belt (separately for drivers and passengers)	WA Police
Intermediate measures	Percent of drivers observed wearing a seat belt	ORS
	Percent of passengers (separately by position in vehicle) observed not wearing a seat belt	ORS
	Percent of passengers observed travelling in an open load space	ORS
	Percent of children in child restraints	ORS
	Percent of child restraints correctly fitted	ORS
Process measures	Amount of advertising of seat belt use	ORS
	Extent to which enforcement and advertising measures are correlated	ORS
	Number of persons detected by Police not wearing seat belt	WA Police
Improving the effectiveness of enforcement		
Intermediate measures	Number and percent of drivers and riders tested who are over the legal BAC limit in metropolitan areas	WA Police (as above)
	Number and percent of drivers and riders tested who are over the legal BAC limit in rural areas	WA Police (as above)
	Percent of drivers in metropolitan areas who say that they travel over the posted speed limit or more than 10 km/h over the posted speed limit	ORS

	Percent of drivers in rural areas who say that they travel over the posted speed limit or more than 10 km/h over the posted speed limit	ORS
Process measures	Number of Police traffic enforcement contracts in metropolitan areas	WA Police
	Number of Police traffic enforcement contracts in rural areas	WA Police
	Number of hours of Police random road watch activity	WA Police
	Percent of drivers in metropolitan areas who report that the amount of speed enforcement carried out by Police has increased	ORS
	Percent of drivers in rural areas who report that the amount of speed enforcement carried out by Police has increased	ORS
	Percent of drivers in metropolitan areas who report that the amount of random breath testing carried out by Police has increased	ORS
	Percent of drivers in rural areas who report that the amount of random breath testing carried out by Police has increased	ORS
	Extent to which enforcement and advertising measures are correlated	ORS/WA Police
	Percent of Police expenditure related to traffic enforcement activities	WA Police
Improving the safety of roads		
Crash-based measures	Number of fatal and serious crashes on each class of road each year	MRWA
	Proportion of WA fatal and serious crashes on each class of road each year	MRWA
	Serious crash rate (per 100 million vehicle kilometres travelled) on each class of road each year	MRWA
	Serious crash rate (per 100 million vehicle kilometres travelled) on divided and undivided roads each year	MRWA
	Serious crash rate (per 100 million vehicle kilometres travelled) on sealed and unsealed roads each year	MRWA
Intermediate measures	Percent of vehicle kilometres travelled that occurs on divided roads	MRWA
	Percent of vehicle kilometres travelled that occurs on sealed roads	MRWA
	Percent of vehicle kilometres travelled that occurs on roads with serious crash rates above the 1998/99 averages	MRWA
	Percent of vehicle kilometres travelled with speed limits greater than or equal to 70 km/h that occurs on divided roads	MRWA
	Percent of vehicle kilometres travelled that occurs on roads with roadsides that are “Safe” for the posted speed limit	MRWA
	Percent of intersections with vehicle speed >= 50 km/h that are roundabouts	MRWA

Protecting vehicle occupants		
Crash-based measures	Fatality rate per 100,000 population for car occupants (drivers and passengers)	WA Police/ORS
	Serious injury rate per 100,000 population for car occupants (drivers and passengers)	WA Police/ORS
	Percent of Police-reported car-car crashes which results in serious injury or death	WA Police
Intermediate measures	Average crashworthiness of cars registered in Western Australia	DoT
	Percent of new cars sold rated by New Car Assessment Program to pose minimal risk of injury to head, chest and legs for both driver and passenger	DoT
	Percent of new cars sold with good pedestrian protection (when this measure becomes available)	DoT
	Percent of new cars sold with seat belt interlocks as standard	DoT
	Percent of new cars sold with Intelligent Speed Adaptation	DoT
Reducing travel speeds		
Crash-based measures	Number and percent of fatal crashes that involve pedestrians and bicyclists	DoH
	Number and percent of serious injury crashes that involve pedestrians and bicyclists	DoH
	Proportion of Police-reported crashes which resulted in fatality or hospital admission	DoH
Intermediate measure	Distributions of vehicle speeds at a set of metropolitan and rural sites	MRWA
Process measures	Number of sites where speed limits have been reduced	MRWA
	Number of sites where perceptual countermeasures to reduce travel speeds have been installed	MRWA/WALGA
Safer modes of travel		
Crash-based measures	Number of fatal and serious injury crashes that involve pedestrians accessing public transport	?
	Proportion of Police-reported crashes which resulted in fatality or hospital admission	WA Police
Intermediate measure	Number of journeys undertaken using public transport in the metropolitan area	DoT
Process measures	Amount of money spent on improving access to public transport	DoT
	Amount of publicity regarding the relative safety of different modes of travel	DPT
Planning a Safer system		
Intermediate measure	Number of new accident black spots identified	MRWA
Process measure	Number of activities undertaken to educate planners and other professionals about road safety	ORS/MRWA

Source: *Road crash data sharing between government agencies* (Western Australia Police Service et al. 2004)

Appendix C – Dataset Information

CASUALTY

NAME OF DATABASE / HOST ORGANISATION	Casualty -WA Police
PRIMARY CONTACT FOR DATABASE MANAGEMENT AND DESIGN	No current contact.
AVAILABILITY OF DATA DICTIONARY FOR DATABASE	YES / NO (Please attach if available) No
INCLUSION CRITERIA FOR EVENTS / RECORDS STORED IN DATABASE	Fatal and serious injury traffic crashes sourced from 1-18's
TIMESPAN OF RECORDS IN DATABASE	1994 to present, data quality for pre 2000 records is not currently verifiable
ORIGINAL INTENT OF DATABASE	To record the key characteristics of all fatal and serious injury traffic crashes
MAIN USES OF DATABASE BY HOST ORGANISATION	Tool for counting road toll, analysis of crashes, tool for finalising recording process of crash reports.
MAIN USES OF DATABASE BY EXTERNAL STAKEHOLDERS (SPECIFY IF UNDER MOU)	Research purposes, Road Toll
MAJOR CONCERNS REGARDING DATA QUALITY, RELEVANCE OF OR TIMELINESS OF DATA	Casualty is the primary source of timely fatality and serious injury data. Data as interpreted by Attending Officer at scene, with some elements updated following investigation and file closure.
MEANS BY WHICH CONCERNS ARE IDENTIFIED	
MAJOR PAST DEVELOPMENTS / CHANGES AND DATES WHEN THIS OCCURRED	Unknown
RECENT DEVELOPMENTS / ISSUES UNDER CONSIDERATION	None
SCHEDULED / PROPOSED FUTURE IMPROVEMENTS	None
RELEVANCE / COMPATIBILITY OF DATABASE WITH A STATEWIDE DATABASE ACCESS SYSTEM (SDAS)	Unknown
OTHER COMMENTS	

TRELIS

NAME OF DATABASE / HOST ORGANISATION	Trelis - DPI or DOT ORACLE 10.2 495GB
PRIMARY CONTACT FOR DATABASE MANAGEMENT AND DESIGN	Elias Santimano
AVAILABILITY OF DATA DICTIONARY FOR DATABASE	YES / NO (Please attach if available) Please find attached the schema design document. (ADS)
INCLUSION CRITERIA FOR EVENTS / RECORDS STORED IN DATABASE	Vehicle, Driver, Client Plates, Demerits, Sanctions, FERS, Firearms, POA card, Learner Permits, Temporary Licenses, Extra Ordinary Licences, Cannabis Infringments
TIMESPAN OF RECORDS IN DATABASE	Original records in the database were migrated from the WA Police mainframe at go-live 2004, and as such, the oldest records date back to the original manual licensing system.
ORIGINAL INTENT OF DATABASE	Implementation of a new licensing system. Previous licensing system was 20 years old, running on a mainframe system owned by the WA Police that was to be decommissioned.
MAIN USES OF DATABASE BY HOST ORGANISATION	Use of the TRELIS application to maintain and manage WA's motor drivers licence, vehicle, client, plates registration records.
MAIN USES OF DATABASE BY EXTERNAL STAKEHOLDERS (SPECIFY IF UNDER MOU)	MQ - Enquiry access for ICWA - Updates and Enquiries for DOTAG (Fines Enforcement Registry) - Updates and Enquiries for Traffic Enfringements, Stolen Vehicles, Drivers and vehicle records - Updates for Driver and Vehicle Data from and to NEVDIS (National Exchange of Vehicle and Driver Information) HTTP - Updates to Department of Commerce for the register of encumbered vehicles (REVS) AS400 Dealer Network - Allows vehicle dealers to register/transfer/dispose of vehicles directly Other external stakeholders have enquiry access for limited licensing data via the TRELIS client. Examples include fisheries, WAPOL, Main Roads. Organisations under MOU/SLA: Dealer Network, Agents includes local governments and APO, ICWA, DoTAG, WAPOL, Salmat, Leigh Mardon and Licensys.
MAJOR CONCERNS REGARDING DATA QUALITY, RELEVANCE OF OR TIMELINESS OF DATA	Data quality managed via Business Systems / DQI. Duplication, Multiple input sources, No validations,
MEANS BY WHICH CONCERNS ARE IDENTIFIED	Data quality managed via DQI. Stakeholders, Internal users
MAJOR PAST DEVELOPMENTS / CHANGES AND DATES WHEN THIS OCCURRED	July 2004 - TRELIS System implemented / Data take-up from WAPS (now WAPOL) October 2007 - License Sanctions/Demerits takeover from WAPOL October 2008 - Migrated to new SUN hardware January 2009 PCI compliancy for Web payments
RECENT DEVELOPMENTS / ISSUES	Ongoing updates, enhancements via TRELIS Application Support Team.

UNDER CONSIDERATION	Access and Release of Information and the CCC report. Archiving of Information. Embarking of Data Quality and Integrity research analysis followed by procurement.
SCHEDULED / PROPOSED FUTURE IMPROVEMENTS	Ongoing weekly minor releases or updates. Ongoing quarterly major releases or updates. Novice Driver, Direct Debits, WAPOL requirements, BPay, Vehicle Re-engineering, Plates Cleansing and Refactoring, Sanctions takeover, cleansing and remigration Trelis development program already projected until the end of 2010/11.
RELEVANCE / COMPATIBILITY OF DATABASE WITH A STATEWIDE DATABASE ACCESS SYSTEM (SDAS)	Current database is an Oracle 10G Release 2 database running on Sun Microsystems hardware SPARC architecture using Solaris 10 OS. From an end-user standpoint the database is accessed through external interfaces such as Websphere MQ and other client software.
OTHER COMMENTS	Nil.

HMDS

NAME OF DATABASE / HOST ORGANISATION	Hospital Morbidity Data Collection
PRIMARY CONTACT FOR DATABASE MANAGEMENT AND DESIGN	Dr Paul Stevens
AVAILABILITY OF DATA DICTIONARY FOR DATABASE	http://www.datalinkage-wa.org.au/sites/default/files /ExtractionSpecifications2011.doc
INCLUSION CRITERIA FOR EVENTS / RECORDS STORED IN DATABASE	all hospital admissions in WA
TIMESPAN OF RECORDS IN DATABASE	1970 to current
ORIGINAL INTENT OF DATABASE	DoH statistical reporting
MAIN USES OF DATABASE BY HOST ORGANISATION	various and extensive – it covers all admissions to hospital
MAIN USES OF DATABASE BY EXTERNAL STAKEHOLDERS (SPECIFY IF UNDER MOU)	various and extensive – it covers all admissions to hospital
MAJOR CONCERNS REGARDING DATA QUALITY, RELEVANCE OF OR TIMELINESS OF DATA	Used extensively for national reporting, statistical uses in WA and research purposes
MEANS BY WHICH CONCERNS ARE IDENTIFIED	
MAJOR PAST DEVELOPMENTS / CHANGES AND DATES WHEN THIS OCCURRED	DoHWA
RECENT DEVELOPMENTS / ISSUES UNDER CONSIDERATION	DoHWA
SCHEDULED / PROPOSED FUTURE IMPROVEMENTS	In line with local and national data dictionaries
RELEVANCE / COMPATIBILITY OF DATABASE WITH A STATEWIDE DATABASE ACCESS SYSTEM (SDAS)	External causes of injury in road crash
OTHER COMMENTS	

EMERGENCY

NAME OF DATABASE / HOST ORGANISATION	Emergency Department Data Collection
PRIMARY CONTACT FOR DATABASE MANAGEMENT AND DESIGN	Ms Michele Russell
AVAILABILITY OF DATA DICTIONARY FOR DATABASE	http://www.datalinkage-wa.org.au/go/access-and-application/wa-data-application-form
INCLUSION CRITERIA FOR EVENTS / RECORDS STORED IN DATABASE	Emergency presentations
TIMESPAN OF RECORDS IN DATABASE	2002 to current
ORIGINAL INTENT OF DATABASE	DoH statistical reporting
MAIN USES OF DATABASE BY HOST ORGANISATION	various
MAIN USES OF DATABASE BY EXTERNAL STAKEHOLDERS (SPECIFY IF UNDER MOU)	various
MAJOR CONCERNS REGARDING DATA QUALITY, RELEVANCE OF OR TIMELINESS OF DATA	Used extensively for national reporting, statistical uses in WA and research purposes
MEANS BY WHICH CONCERNS ARE IDENTIFIED	
MAJOR PAST DEVELOPMENTS / CHANGES AND DATES WHEN THIS OCCURRED	DoHWA
RECENT DEVELOPMENTS / ISSUES UNDER CONSIDERATION	DoHWA
SCHEDULED / PROPOSED FUTURE IMPROVEMENTS	In line with local and national data dictionaries
RELEVANCE / COMPATIBILITY OF DATABASE WITH A STATEWIDE DATABASE ACCESS SYSTEM (SDAS)	
OTHER COMMENTS	

DEATH REGISTRATIONS

NAME OF DATABASE / HOST ORGANISATION	Death Registrations
PRIMARY CONTACT FOR DATABASE MANAGEMENT AND DESIGN	Ms Diana Rosman (BDM Registrar is Brett Burns)
AVAILABILITY OF DATA DICTIONARY FOR DATABASE	http://www.datalinkage-wa.org.au/go/access-and-application/wa-data-application-form
INCLUSION CRITERIA FOR EVENTS / RECORDS STORED IN DATABASE	Death registrations
TIMESPAN OF RECORDS IN DATABASE	1970 to current
ORIGINAL INTENT OF DATABASE	DoH statistical reporting
MAIN USES OF DATABASE BY HOST ORGANISATION	various
MAIN USES OF DATABASE BY EXTERNAL STAKEHOLDERS (SPECIFY IF UNDER MOU)	various
MAJOR CONCERNS REGARDING DATA QUALITY, RELEVANCE OF OR TIMELINESS OF DATA	Used extensively for statistical uses in WA and research purposes
MEANS BY WHICH CONCERNS ARE IDENTIFIED	
MAJOR PAST DEVELOPMENTS / CHANGES AND DATES WHEN THIS OCCURRED	DoHWA
RECENT DEVELOPMENTS / ISSUES UNDER CONSIDERATION	DoHWA
SCHEDULED / PROPOSED FUTURE IMPROVEMENTS	In line with local and national data dictionaries
RELEVANCE / COMPATIBILITY OF DATABASE WITH A STATEWIDE DATABASE ACCESS SYSTEM (SDAS)	
OTHER COMMENTS	