iRAP Star Rating and Investment Plan Data Analysis and Reporting Specification

Mar 2016

RAP-SR-3.1

PRINT WARNING – printed copies of this document or parts thereof should not be relied upon as a current reference document.

Always refer to the electronic copy for the latest version at:

http://downloads.irap.org/docs/RAP-SR-3-1_Supporting_data_analysis_and_reporting_specification.pdf

Document Scope

This specification document is to be used by project teams undertaking the data analysis and reporting services associated with an iRAP Star Rating and Investment Plan project. The contents have been specifically designed such that they can be directly inserted into a client organisation's tender documents to allow the commercial procurement of the iRAP Star Rating and Investment Plan data analysis and reporting services if desired.

It is recommended that the supporting data, analysis and reporting processes are carried out by the same supplier. However, where different suppliers are used the relevant sections of this document should be amended accordingly.

It is expected that items highlighted in red text should be amended to reflect individual project requirements.

This document contains the minimum specifications required to achieve the level of accuracy and repeatability for the application of iRAP Star Rating and Investment Plan protocols. It is intended that data collected will be used for road safety assessment and Star Rating, and it should meet or exceed the specific requirements as detailed in this document.

About iRAP

The International Road Assessment Programme (iRAP) is a charity dedicated to saving lives through safer roads. Our vision is for a world free of high-risk roads.

iRAP works in partnership with government and non-government organisations to:

- Inspect high-risk roads and develop Star Ratings and Safer Roads Investment Plans
- Provide training, technology and support that will build and sustain national, regional and local capability
- Track road safety performance so that funding agencies can assess the benefits of their investments.

Road Assessment Programmes (RAP) are now active in more than 70 countries throughout Europe, Asia Pacific, North, Central and South America and Africa.

iRAP is financially supported by the FIA Foundation for the Automobile and Society and the Road Safety Fund. Projects receive support from the World Bank Global Road Safety Facility, automobile associations, regional development banks and donors.

National governments, automobile clubs and associations, charities, the motor industry and institutions such as the European Commission also support RAPs in the developed world and encourage the transfer of research and technology to iRAP. In addition, many individuals donate their time and expertise to support iRAP.

For more information

For more information on using the *iRAP Star Rating and Investment Plan - Analysis and Reporting Specification*, refer to the iRAP online training resource RAPcapacity at http://capacity.irap.org

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To find out more about the programme, visit www.irap.org. You can also subscribe to 'WrapUp', the iRAP e-newsletter, by sending a message to icanhelp@irap.org.

Version

Version	Update
Jan 2013	Document created
Feb 2014	Clarification in section 5.3 and 5.3.2 – inspection system driven speed should not be used for operating speed data. Addition of section 5.5.3 Appendix A - Attributes and categories removed, since duplicated in other documents
Mar 2016	Correction of courses offered in RAPcapacity

Contents

The document can be copied directly in to local tender documents as required, or used directly by the agency undertaking the Star Rating activity as a specification of the process required.

1 Introduction

Deaths and injuries from road vehicle crashes are a major and growing public health epidemic. Each year 1.3 million people die and a further 50 million are injured or permanently disabled in road crashes. Road crashes are now the leading cause of death for children and young people aged between 10 and 24. The burden of road crashes is comparable with malaria and tuberculosis and costs 1-3% of the world's GDP.

In low and middle income countries, road crashes represent a major health concern. More than 85% of the global death toll and serious injuries occur in developing countries. Whereas road deaths are expected to fall in high-income countries, they are likely to increase by more than 80 per cent in the rest of the world.[1]

The International Road Assessment Programme (iRAP - www.irap.org) has drawn upon the extensive knowledge base of the developed world's Road Assessment Programmes (EuroRAP, AusRAP and usRAP), with the generous support of the FIA Foundation, to develop a road survey methodology for low and middle income countries. This Star Rating methodology does not require detailed crash data and works directly from road surveys.

1.1 Star Ratings Overview

Star Ratings are an objective measure of the likelihood of a road crash occurring and its severity. The focus is on identifying and recording the road attributes which influence the most common and severe types of crash, based on scientific evidence-based research. In this way, the level of road user risk on a particular network can be defined without the need for detailed crash data, which is often the case in low and middle income countries where data quality is poor. Research shows that a person's risk of death and serious injury is highest on a one-star road and lowest on a five-star road.

Star Ratings are also particularly useful in order to objectively quantify the level of risk associated with new road designs (where crash data is not present) enabling evidence based decisions and also for use in high-performing countries where the relatively low frequency of crashes limits the ability of crash analysis to influence performance monitoring and investment prioritisation. Further information on iRAP Star Rating methodology and access to training courses can be found on RAPcapacity[2].

[1] World Health Organisation, *Global Status Report on Road Safety. Time for Action*, 2009

[2] RAPcapacity: http://capacity.irap.org

2 Project

2.1 Programme Background

Details of the iRAP programme governance in (COUNTRY) is provided at http://vida.irap.org by clicking on the appropriate country on the ViDA home page. The programme governance provides for local leadership and management of RAP assessments in that country. For the purpose of this project the key stakeholders are:

PROGRAMME NAME	[iRAP Mexico]
Programme Lead:	[SCT]
Technical Lead:	[IMT]
Communications Lead:	[FIA Mexico]

2.2 Project Background

[Replace the example below with background information on the current project.]

The World Bank is preparing two transport projects in Mexico: Veracruz Highway Project (VHP) and Second Zacatecas Transport Project (ZTP-II). VHP will include the upgrading of 1100km and maintenance of 500km of roads and ZTP-II will include the upgrading of 350km of roads following the upgrading of 657km that took place under ZTP-I.

The World Bank (the Purchaser) intends to undertake a road safety assessment on these roads to assist the state road authorities and engineering consultants in ensuring that the safety of all road users is adequately addressed in the detailed designs of the rehabilitation and maintenance contracts of these roads. This assessment will be funded via the Global Road Safety Facility.

The project will include the assessment of existing roads and the setting of minimum three-star standard for all new road designs.

PROJECT MANAGEMENT	[World Bank]
Project Manager:	Juan Carlos Mallorca
Email:	[ ]
Phone	[ ]

PROJECT STAKEHOLDERS

For example • [Road Authority (PWD)] • [Automobile Association] • [Treasury] • [Police]	• [Ministry of Transport] • [Ministry of Health] • [Lead University / Research Group] • [Third-party insurer]

2.3 Project Objectives

[Replace the example below with objectives from the current project]

The objectives of this project are to:

- Survey 1600km of roads managed by Veracruz Roads and Buildings Department and 350km managed by Zacatecas State Transport Project and code the video survey data according to the International Road Assessment Program (iRAP) Survey and Coding specification.
- Collect crash data, traffic flow and speed data for the network in both States according to the iRAP Data Analysis and Reporting specification.
- Produce an iRAP input file which includes all road attributes and collected data.
- Produce Star Rating results and Safer Roads Investment Plan to identify areas of high risk and to shape future road safety investment.
- Produce a detailed technical report in accordance with iRAP Data Analysis and Reporting specification
- Support the setting of design standards and the commitment of funds to implement the recommendations.

2.4 Project Schedule

Table 1 provides the project tasks and anticipated schedule. The road survey and coding component is subject to a separate supplier contract. Refer to RAP-SR-2.1 Star Rating and Investment Plan - Road survey and coding specification[3] for details.

Table 1. Project schedule

Project task	Anticipated start	Duration
Commencement mission and official project launch		
Road Survey		
Road coding and training		
Background data		
Star Rating and Safer Roads Investment Plan Analysis		
Preliminary results training and review		
Reporting		
Launch of results		
Implementation and on-going support		

[Complete the project schedule]

[3] RAP-SR-2.1: http://downloads.irap.org/docs/RAP-SR-2-1_Road_survey_and_coding_specification.docx

2.5 Road Network

Table 2 details the roads to be surveyed under this project.

Table 2. Project road network

Road name	Section	Start location	End location	Road Length (km)	Carriageway length (km)[1]

[1] For iRAP assessments both sides of dual carriageway roads are assessed individually.

[Complete the table with details of the road network to be inspected]

3 Scope of this Specification

The iRAP Star Rating and Investment Plan protocol requires the survey and coding of the road network in accordance with *RAP-SR-2.1 Star Rating and Investment Plan – Survey and Coding Specification*[4] and *RAP-SR-2.2 Star Rating coding manual*[5].

This Data Analysis and Reporting Specification document relates to the collection of supporting data, data analysis and reporting components of the iRAP Star Rating and Investment Plan protocol. The other components of the iRAP Star Rating and Investment Plan protocol are described in the series of documents listed below:

RAP_SR_1.1	Star Rating and Investment Plan - Project Management Guide
RAP_SR_2.1	Star Rating and Investment Plan – Survey and Coding Specification
RAP_SR_3.1	Star Rating and Investment Plan – Data Analysis and Reporting Specification
RAP_SR_4.1	Star Rating and Investment Plan – Implementation Support Specification
RAP_SR_4.2	Star Rating and Investment Plan – Theory

3.1 iRAP Accreditation and Training

To be qualified to undertake the supporting data collection, data analysis and reporting components of the iRAP Star Rating and Investment Plan protocol the supplier must have successfully completed the following RAPcapacity training courses that are available for on-line education and accreditation at http://capacity.irap.org and subsequent refresher training as required.

- Getting started and accessing results
- Star Rating and Investment Plans from Inspection course
- Road attribute coding course - optional

A list of suppliers who have undertaken the courses and have maintained accreditation are available at http://www.irap.org/en/resources/accredited-suppliers

[4] RAP-SR-2.1: http://downloads.irap.org/docs/RAP-SR-2-1_Road_survey_and_coding_specification.docx

[5] RAP-SR-2.2: http://downloads.irap.org/docs/RAP-SR-2-2_Star_Rating_coding_manual.docx

3.2 Deliverables

The supplier is asked to submit a proposal to deliver the following tasks:

1. OPTIONAL: Political engagement – The iRAP vision is for a world free of high-risk roads. The aim of iRAP assessments and monitoring is to provide road agencies and other stakeholders with an objective benchmark of the performance of the road network and the investment business case for safer roads. The ultimate upgrading of the road network will require the support and backing from the Treasury and Road Agency responsible for the road network being assessed and close political engagement is recommended as part of all iRAP assessments. The iRAP philosophy is that a life is not saved until a road is upgraded. The supplier undertaking the analysis and reporting will be required to support some key elements of the political engagement activities.
2. **Technical engagement** – In each country a designated iRAP member oversees the local leadership, application and communication of results in relation to RAP assessments undertaken in that country (refer section 2.1). These organisations are typically the Government road agency or Ministry of Transport, the FIA affiliated automobile association or local non-profit centre of road engineering technical expertise. The supplier shall maintain contact with the programme technical leadership to ensure local awareness and ownership of results.
3. **Supporting data collection** – the supplier shall collect all necessary data as detailed in RAP-SR-3.2 Supporting data template[6] and Section 5 of this document Supporting Data Specification. This is to include the following: vehicle volume, motorcycle volume, pedestrian and bicyclist volume, crash data (number of fatal injuries and serious injuries by road user type and crash type), local construction and maintenance costs for countermeasures considered in the iRAP methodology. The supplier will verify the data and provide realistic estimates where needed (e.g., accounting for underreporting of casualties etc). Also, the supplier will collect all necessary data to estimate the economic cost of a fatal injury and serious injury. RAP-SR-2.4 Star Rating and Safer Roads Investment Plan Quality Assurance Guide[7] contains further advice and guidance on the supporting data needed for a typical project.

[6] RAP-SR-3.2: http://downloads.irap.org/docs/RAP-SR-3-2_Supporting_Data_Template.xlsm

[7] RAP-SR-2.4: http://downloads.irap.org/docs/RAP-SR-2-4_QA_Guide.pdf

4. **Processing and Analysis** – the supplier is required to combine both the coded survey data and the supporting data into the RAP-SR-3.3 Upload file specification[8]. The file is to be uploaded to the iRAP online software[9] and analysed in accordance with Section 6 Processing and Analysis Specification. The supplier shall undertake a quality assurance review of the iRAP upload file, Star Rating results and Safer Roads Investment Plan and undertake any amendments as required. In addition, the supplier shall undertake an in-country review of the preliminary results with local stakeholders. For guidance on undertaking quality reviews see RAP-SR-2.4 Star Rating and Safer Roads Investment Plan Quality Assurance Guide.[10]

5. **Reporting** – In addition to the standardised reports that can be generated within the iRAP online software (ViDA[9]), the supplier shall produce two formal reports in accordance with Section 7 Reporting Specification. The first shall be a detailed technical report providing details of the project background and objectives, project tasks and road network. The full technical report is to include the source of all supporting data collected along with any assumptions made. Recorded road attributes, Star Rating results and details of the Safer Roads Investment Plan are also to be included.

   The second report shall consist of a project summary report and will include a summary of the project description, and a review of the Star Rating results and Safer Roads Investment Plan.

3.3 License

The successful supplier will be licensed to use the appropriate iRAP protocols, technology and methods for the duration of the project.

[8] RAP-SR-3.3: http://downloads.irap.org/docs/RAP-SR-3-3_Upload_file_specification.xls

[9] ViDA.irap.org Access to the software will be provided by iRAP on request.

[10] RAP-SR-2.4: http://downloads.irap.org/docs/RAP-SR-2-4_QA_Guide.pdf

3.4 General Requirements

1. The supplier shall acknowledge that iRAP has a zero tolerance policy towards bribery and corruption and hereby agrees to adopt the same approach as described in the iRAP *Anti-bribery and Corruption Policy*[11] with all parties with whom it deals in relation to this work.
2. iRAP assessments are typically focussed on the highest risk roads in a country and the supplier shall ensure they are informed and manage all risks associated with the completion of the project. The supplier will ensure that operational working hours, road travel, inspections and data collection, country specific requirements including immunisations and security arrangements, training and all other required operational activities are conducted in a safe manner. The supplier shall be responsible for the safe undertaking of the project deliverables. A written project health and safety plan shall be provided by the supplier to the client.
3. Incidental costs (such as charges for data collection or release, customs duties, fuel, insurance, and vehicle operating costs, accommodation, staff allowances and permits) shall be covered by the supplier.
4. Mobilization and demobilization costs associated with the project shall be covered by the supplier.
5. All data, reports, plans, manuals, processes specific to the project and all documents or reports prepared or developed as part of the project shall be the property of insert name. The intellectual property of such documents belongs to insert name. The supplier can make use of or refer to such documents for marketing and/or other project purposes after obtaining written consent from insert name. The insert name shall issue the consent to all reasonable requests.
6. Other documents including data, maps and reports supplied to the supplier by insert name or other organizations to assist with the study shall be returned to insert name at the end of the project.
7. No public communication of results shall be undertaken without the express written approval of the programme lead for [COUNTRY] (as identified in Section 2.1 above).

[11] Anti-bribery and Corruption Policyhttp://www.irap.net/about-irap-3/annual-reports-and-governance?download=65:anti-bribery-and-corruption-policy

4 Political and Technical Engagement

The primary political and technical governance arrangements are covered in RAP_SR_1.1 Star Rating and Investment Plan - Project Management Guide. The supplier undertaking the analysis and reporting of iRAP results plays an important role in ensuring transparency and understanding of the analysis, assumptions and use of the results. In relation to the political and technical engagement activities the supplier shall support the following activities:

[Replace the example below with activities from the current project]

The supplier is expected to support the following political engagement activities:

- Meetings with the Prime Minister and relevant Ministers to discuss the project background and results.
- Attend the launch of the results and Steering Committee meetings during the analysis and reporting stages of the project.

The supplier is expected to support, and lead where required the following technical engagement activities:

- Participate in all technical working group meetings (estimated 5 in total) and lead the reporting on iRAP Star Rating and Investment Plan results and technical discussions
- Undertake 2 x technical training courses of local engineers and stakeholders to ensure the iRAP model and results is understood
- Respond to queries on the iRAP analysis as required
- Provide input to ongoing capacity building plans

5 Supporting Data Specification

To ensure the iRAP Star Rating and Investment Plan project outcomes reflect local conditions, practice and experience, a range of supporting data is required in addition to the road survey and coding data. The supplier will be required to work with road authorities, their district offices, police and local stakeholders to secure the necessary data.

This supporting data should include, but is not limited to, the following: vehicle speed data, vehicle volume, motorcycle vehicle volume, pedestrian and bicyclist volume, crash data (number of deaths and serious injuries by road user type and crash type), local construction and maintenance costs for countermeasures, plus the necessary data needed to estimate the economic cost of a death and serious injury, as per the iRAP methodology.

The template for this data is provided in RAP-SR-3.2 Supporting data template[12] and guidance on collecting supporting data is provided in RAP-SR-2.4 Star Rating and Safer Roads Investment Plan Quality Assurance Guide.[13]

5.1 Supporting Data – Economics Data Requirements

The supplier shall collect the following data to enable the economic analysis. Ideally the data sourced should permit the completion of the "**Demographics and Economics**" template provided as part of RAP-SR-3.2 Supporting data template[12]. A summary of the data to be collected includes:

[12] RAP-SR-3.2: http://downloads.irap.org/docs/RAP-SR-3-2_Supporting_Data_Template.xlsm

[13] RAP-SR-2.4: http://downloads.irap.org/docs/RAP-SR-2-4_QA_Guide.pdf

Demographic and Economic Data

Country name:

About this data

The data collected in this tab is used for economic evaluation and reporting

				Example: Malaysia
Setup tab	Category	Units / Description	Data	Data
Project setup	Current year		2013	2013
Project setup	Assessment Year	Year the analysis was carried out in.		2007
Project setup	Side of the road driven on	left or right		right
Economics	National Currency Unit	Local currency (e.g. ZAR, RM)		MYR
Economics	National Currency Symbol	Local currency , e.g. £, $, €		RM
Economics	National Currency Rate (to USD)	1 USD = "x" times local currency		0.313187
Economics	Analysis period	Years - default 20 years		20
Economics	GDP per capita	In local currency (current prices)		19500
Economics	Discount rate (%)	%		4
Economics	Minimum attractive Rate of Return	Discount Rate / 100		0.12
Economics	Value of Life Multiplier	Default 70	70	70
		In local currency - Official National Figure or (GDP per capita * Value		

1. Side of the road driven on: is either left or right to reflect the side of the road that vehicles drive on For example: left in South Africa, right in Mexico.
2. Analysis Period: The number of years over which the economic benefits of the Safer Roads Investment Plan is calculated (note this is not the treatment life of individual treatments – refer Countermeasure Costs). The default analysis period is 20 years although the number can be updated to reflect local client requirements as needed.
3. Gross Domestic Product (GDP) per capita, current prices, in national currency for year of survey. Refer to IMF World Economic Outlook Databases.[14]. This figure is used to estimate the economic value of life in the event that there is not an official value of life used in the country.
4. Discount rate (%): is used to estimate net present values. The discount rate is typically set to 4% however this can be adjusted depending on the usual practice in each country.
5. Minimum attractive rate of return: is the minimum rate of return that the government or road owner is willing to accept before investing in the various road engineering countermeasures. The default is provided as the discount rate divided by 100.
6. Internal Rate of Return: The internal rate of return (IRR) is a measure of the profitability of investments. The minimum Internal Rate of Return threshold may be used in iRAP assessments to determine whether a countermeasure is included in the Safer Roads Investment Plan.
7. Value of life multiplier: The iRAP research paper *The True Cost of Road Crashes* provides an estimate of the value of life in a country based on a multiplier of GDP per capita recorded above. This provides the basis of all economic assessments and is recommended as 70x where an official figure for value of life is not available.
8. Value of life: The figure should reflect the official national or jurisdiction value of life if available. If not available the default value of GDP per capita x Value of Life multiplier can be used.
9. Value of serious injury multiplier: The iRAP research paper *The True Cost of Road Crashes* provides an estimate of the value of serious injury in a country based on a multiplier of the value of life recorded above. This provides the basis of all economic assessments and is recommended as 0.25 x Value of Life where an official figure for value of life is not available.
10. Value of serious injury: The figure should reflect the official national or jurisdiction value of serious injury if available. If not available the default value of 0.25 x Value of Life multiplier can be used.
11. Serious injury to fatalities ratio: is the number of serious injuries to each fatal. The default is 10. This may be changed based on supporting evidence.

[14] http://www.imf.org/external/data.htm

The Safe Road System comment fields are optional and are provided to allow a discussion and appreciation of the key factors influencing all aspects of the safe road system. Comments on Data Systems and Crash and Traffic Records, Speed Limit and Behaviour, Alcohol and Drug Driving, Helmet Wearing, Seat Belt Wearing, Vehicle Fleet Standards and Post Crash Care and Trauma Response can be documented. This may help understand and explain the varying crash performance experienced on road networks or sections of similar star ratings from one country to another.

5.2 Supporting Data – Vehicle Volume Requirements

The total volume of all motorised vehicular traffic within a 24hr period is required for each 100 metre record. The data is required in Annual Average Daily Traffic (AADT) format and should not be adjusted to passenger car equivalent (PCU) volumes. AADT is the total volume of vehicular traffic of a road for a year divided by 365 days. The vehicle volume data requirements are as follows:

1. Vehicle volume data shall distinguish between motorcycle and vehicle traffic and as a minimum include a percentage estimate of heavy vehicles (>2 axles).
2. The supplier shall collate recent detailed traffic volume data from the relevant road authority, or other reliable source, for each of the road corridors within the project network.
3. The supplier shall provide traffic volume data for each designated road section detailed below as a minimum requirement. Where available, additional existing traffic count data shall be utilised to provide greater detail of the variation in traffic volume along the surveyed network.
4. If recent existing traffic volume data is not available to the required level of detail, the supplier may apply an appropriate growth factor to existing historical data in order to estimate current volumes or agree with local road authority traffic engineers the volumes to be applied along the relevant sections of the network. This may be based on local experience and knowledge and can be supplemented by the video data collected as part of the survey component of the project.
5. Where the road agency agrees that new traffic volume data should be collected the specification of the data required shall be reviewed prior to proceeding. For the purpose of iRAP assessments in maintaining a relatively low-cost approach to data needs the use of short-term traffic counts using either an automated traffic counter or by manual traffic count can be adopted. The following approach is provided as initial guidance:
    a. Divide the project road network into homogeneous traffic volume sections and determine the count locations needed to adequately cover the network in consultation with the client.
    b. Ensure that data collection surveys are conducted during a 'neutral', or representative period to account for variability in the traffic stream and to avoid seasonal and day-of-week bias. Abnormal traffic periods should be avoided, including national, local and school holidays.
    c. The survey duration should be sufficient to estimate the AADT. Counts of less than 24-hour duration shall be adjusted to represent a full 24-hour period, using adjustment factors based on existing available data for road sections with similar characteristics. See *FHWA Traffic Monitoring Guide* at http://www.fhwa.dot.gov/ohim/tmguide/index.htm for further guidance.
    d. The data is to be recorded as a numeric value of the total traffic flow of the road in both directions, regardless of whether the road is physically divided or not.

6. A report recommending any additional traffic volume count sites shall be submitted to the client highlighting the existing data available, any assumptions made and any recommendations for additional count sites subject to the schedule of rates in section 8.

Road name	Section	Locations[1] (if specific sites required)	Minimum Number of traffic counts required
Statue Street	Baird St to 5th Avenue	N/A	10
Trucha Parade	Launch Rd to Bailar St	N/A	4
Long Street	Grain St to Rice Ave	N/A	1
Mon Starr Highway	Queretaro to Durango	Maximum 50km apart	12

[Complete the table with details of the minimum traffic volume counts required]

[1] Count sites shall be located to capture major changes in volume along the road length (e.g. between major junctions with significant turning volumes or origin / destination points)

5.3 Supporting Data - Speed Data Requirements

Vehicle speed influences both the likelihood of a crash occurring and its severity. Speed is therefore a critical aspect of managing a safe road system, and influences iRAP's Star Ratings and Safer Roads Investment Plans.

For the purpose of Star Ratings the maximum of 85th percentile and the speed limit is utilised. The 85th percentile speed is therefore critical for the Star Rating and also consistency from one iRAP assessment to another. As 85th percentile speed is highly variable the purpose of the speed data collection is to generate appropriate adjustment factors to adopt across the network when considering 85th percentile speeds.

For the purpose of fatality estimations mean speeds is utilised. This reflects that in many highly congested roads the traffic volume may be high but associated Fatal and Serious Injury outcomes are significantly affected as the speeds travelled are very slow during the high volume peak periods.

The outcome is to deliver the following for use across the network being assessed. Refer to RAP-SR-3.2 Supporting data template[15].for full template.

It is not intended that vehicle operating speeds be changed at the 100 metre level. Speed survey sample data is to be used to make appropriate estimates of operating speeds to adopt across homogeneous sections of the road network with both average and 85th percentile operating speeds allocated according to the mandatory speed limit, area type and adjacent land use, see RAP-SR-3.2 Supporting Data Template.

The same vehicle operating speed can then be used along the entire road section, changing as necessary only where a new road section begins or where the area type changes or a new speed limit is present.

85th percentile and mean speed adjustment sample

85th percentile and mean speed adjustment

Country name:

About this data

The data collected in this tab is used in estimating the 85th percentile amd mean speed adjustment factors that are applied to recorded posted speed limits across the network being assessed.

SPEED MEASURE — RECORD "85th percentile" or "Mean" as required

Location	URBAN AREAS			RURAL AREAS		
Recorded Speed Limit	Land Use Code 1,2,5 (undeveloped, farming, not coded)	Land Use Code 3,6,7 (residential, educational, industrial)	Land Use Code 4 (commercial)	Land Use Code 1,2,5 (undeveloped, farming, not coded)	Land Use Code 3,6,7 (residential, educational, industrial)	Land Use Code 4 (commercial)
<30km/h						
35km/h						
40km/h						
45km/h						
50km/h						
55km/h						
60km/h						
65km/h						

Note: The form should be used once for 85th percentile speed and once for mean speed adjustments for use across the network. Many fields may be blank if those speed limits or land-use categories are not applicable. Miles per hour categories are provided below km/h.

5.3.1 Collection of existing speed data

The supplier shall liaise with the road agency, toll road operator, police or other agencies that may hold mean and 85th percentile speed data across the road network being assessed. This data may be available from asset management departments, safety departments or enforcement agencies and all possible sources shall be explored.

5.3.2 Collection of new speed data

If existing vehicle speed data is unavailable on the project road network, the supplier shall collect primary vehicle speed data using established speed survey methods such as radar speed meter or inductive loop

[15] RAP-SR-3.2: http://downloads.irap.org/docs/RAP-SR-3-2_Supporting_Data_Template.xlsm

method or in conjunction with traffic counts. See *Design Manual for Roads and Bridges (UK) – Technical Advice Note on Vehicle Speed Measurement on All Purpose Roads DMRB Vol.5 Sec.1,TA 22/81* for further details.

Some road survey systems have the ability to record the speed of the survey vehicle during the inspection. Although useful, this data should not be relied upon to estimate operating speeds. In order to capture adequate images for coding the survey vehicles are often collecting data during daytime hours when operating speeds may be lower due to traffic congestion, effective police enforcement or higher levels of speed limit compliance. Survey vehicles should not exceed the mandatory speed limit while other vehicles may do. It is therefore not recommended that the speed of the survey vehicle be used for estimating mean operating speeds for use in the upload file as this data is from a sample of one and not representative of all vehicles using the road.

Speed surveys shall be undertaken in consultation with the local road authority, in accordance with the following specifications:

1. The number of sites at which speed data is collected must be sufficient to describe with confidence the operating speed characteristics of rural and urban sections of the road network as outlined in the table above
2. For each speed record, the following data is required:
    a. Site number
    b. Road name
    c. Road section
    d. Location description
    e. Area Type (urban or rural)
    f. Latitude
    g. Longitude
    h. Date
    i. Start time
    j. End time
    k. Surveyor name
    l. Recorded speed (km/h)
    m. Vehicle type (car, truck or motorcycle)
    n. Travel direction
    o. Posted speed limit (km/h).
3. For each site, choose a location to measure speeds that is level and tangent, if possible.
4. For rural sites, choose a speed measurement location that is away from development and intersections.

5. For urban or suburban sites, choose a speed measurement location that is well away from traffic signals; the location may be near driveways or minor intersections, but do not measure speeds of vehicles when another vehicle is turning.
6. Document the speed measurement location and the roadway characteristics on the data form including, if possible, GPS coordinates (latitude and longitude). If GPS coordinates are not available, describe the location precisely (such as on Route 5 at 4 km west of a particular town intersection).
7. Locate vehicles, personnel, and equipment in a concealed location that does not attract the attention of drivers or affect their speeds. Ideally, drivers should not know their speeds are being measured as they approach the speed measurement location.
8. Measure speeds of at least 100 motor vehicles at each location and record the speeds. Do not record speeds for bicycles or other non-motorized vehicles. At sites with very low vehicle volumes, the collection of speed data may be ended after 4 hours, even if 100 vehicles have not yet been measured.
9. Measure speeds only for vehicles that are not being delayed by another vehicle.
10. Record speeds separately for cars, trucks and motorcycles.
11. Select the vehicle to measure in an unbiased way, so that the vehicles selected are representative of the vehicle stream.
12. At most sites, measure speeds for vehicles travelling in only one direction of travel. The direction of travel for which vehicle speeds are measured should be recorded on the form as northbound, southbound, eastbound, or westbound. At sites with very low vehicle volumes, speeds of vehicles may be measured for both directions of travel so that it will take less time to get speed data for 100 vehicles.
13. Take a photograph of each site facing in the direction of travel for which speeds are measured. Include the site number in the file name for the photograph.

The collection of speed data shall be targeted across the surveyed road network in accordance with the following table.

[TABLE TO BE FILLED OUT BY CLIENT]

MANDATORY SPEED LIMIT	URBAN	RURAL
<40km/h	Not applicable	Not applicable
40km/h	Average of 2 sites	Not applicable
50km/h	>2 sites	Not applicable
60km/h	>20 sites	Not applicable
70km/h	>5 sites	Not applicable
80km/h……	>20 sites	>20 sites

90km/h	Not applicable	>5 sites
100km/h	>20 sites	>20 sites
110km/h	Not applicable	Not applicable

5.4 Supporting Data – Pedestrian & Bicycle count Requirements

Vulnerable road users account for a significant proportion of global road deaths and many of the world's road network do not adequately and safely cater for pedestrian and bicycle movements. Detailed pedestrian and bicycle count data is rare in most road agencies and in many cases the iRAP project may represent the first occasion where estimates of pedestrian flows are undertaken at a network wide level.

The pedestrian and bicycle flow data does not directly impact the Star Rating of the road for pedestrians or cyclists, with the Star Rating representing the safety of the location for an individual pedestrian or cyclist. The pedestrian or bicycle flow may however have a significant impact on the Star Rating policy target for a location. The flow data will directly impact the final allocation of fatalities across the network and the subsequent estimate of benefits associated with upgrading pedestrian and bicyclist provision at a location.

The iRAP coding process undertaken as part of the road survey includes an assessment of where pedestrians and cyclists are observed. As this video-based assessment represents only a single point in time the data should only be viewed as one of many inputs to the final decision on pedestrian and cyclist peak-hour flow.

For the purpose of the iRAP assessments an estimate of the pedestrian and bicycle peak hour flows must be determined for every 100 metre segment along the road network. With the data grouped into relatively large categories frequent changes of the peak hour flow data range are not generally expected except where there is a significant change in pedestrian demand. For example, a commercial shopping centre may have the same peak hour flows (26-50) for the full length, with a spike in crossing flows adjacent to a major passenger train station.

Local specifications should be referred to if available or alternatively refer to PBIC Data Collection Case Study or the Highway Capacity Manual or similar peak document for guidance on assessment methodology.

USEFUL RESOURCES

http://toolkit.irap.org

http://pedbikeinfo.org

RAP-SR-2.4: http://downloads.irap.org/docs/RAP-SR-2-4_QA_Guide.pdf

5.4.1 Collection of existing pedestrian and bicycle flow data

The supplier shall liaise with the road agency, toll road operator, police or other agencies who may hold pedestrian and bicycle flow data across the road network being assessed. This data may be available from pedestrian and cycling planning departments, asset management departments, safety departments or local government agencies and all possible sources shall be explored.

Pedestrian flows may vary significantly during the day and for the purpose of the iRAP model the peak hour flow is used.

5.4.2 Estimation of new pedestrian and bicycle flow data

For the purpose of estimating pedestrian peak hour flows across a road network the following tasks shall be undertaken:

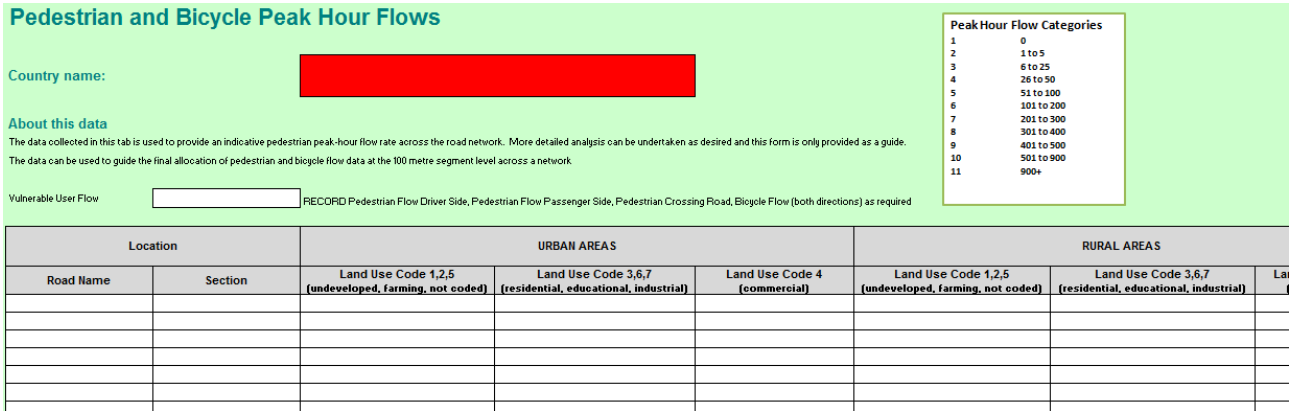
1. Undertake an initial sample of actual pedestrian and bicycle counts across the road length or network being assessed. This should be timed to coincide with expected peak hour flows (e.g. beginning of business day, school start times, major events). An outline of sites to be initially inspected is highlighted below. This data helps to ensure the later estimation of flows across the network is based on some objective data.

[TABLE TO BE FILLED OUT BY CLIENT]

Road	**Section**	**Land use type**	**# sites urban**	**# sites rural**
Road X	x-y	Code 1,2,5 (undeveloped, farming, not coded) Code 3,6,7 (residential, educational, industrial) Code 4 (commercial)	2 2 4	5 1 1
Road Y			5	2
…				

The results of any surveys undertaken can be entered in the "Ped and Bike Flows" sheet RAP-SR-3.2 Supporting data template[16] if desired. The ultimate decision of pedestrian and bicycle peak hour flows must be entered in the input data file as required (refer Section 6).

Ped and Bike Flows Data Sheet Sample



Pedestrian and Bicycle Peak Hour Flows

Country name:

About this data

The data collected in this tab is used to provide an indicative pedestrian peak-hour flow rate across the road network. More detailed analysis can be undertaken as desired and this form is only provided as a guide.
The data can be used to guide the final allocation of pedestrian and bicycle flow data at the 100 metre segment level across a network

Vulnerable User Flow — RECORD Pedestrian Flow Driver Side, Pedestrian Flow Passenger Side, Pedestrian Crossing Road, Bicycle Flow (both directions) as required

Peak Hour Flow Categories

1	0
2	1 to 5
3	6 to 25
4	26 to 50
5	51 to 100
6	101 to 200
7	201 to 300
8	301 to 400
9	401 to 500
10	501 to 900
11	900+

Location		URBAN AREAS			RURAL AREAS		
Road Name	Section	Land Use Code 1,2,5 (undeveloped, farming, not coded)	Land Use Code 3,6,7 (residential, educational, industrial)	Land Use Code 4 (commercial)	Land Use Code 1,2,5 (undeveloped, farming, not coded)	Land Use Code 3,6,7 (residential, educational, industrial)	La

2. The supplier is required to provide an estimate of the pedestrian and bicycle peak hour totals for each road corridor each 100 metres. The data to be estimated includes:
    a. Pedestrians walking along the driver side of the road (relative to the road survey),
    b. Pedestrians walking along passenger side of the road,
    c. Pedestrians crossing the road, and
    d. Bicycle volumes travelling along the road (both directions).
3. The detailed specification of flows across the network should be completed in conjunction with local engineers responsible for that section of road. The outcome must be an agreed peak hour flow for each 100 metre segment across the network and all assumptions documented. The recommended steps are:
    a. Review the site count data collected above and determine patterns of demand that can be extended across the network being assessed (e.g. rural village pedestrian peak hour flows are typically 6 to 25, and cyclists 1 to 5). This should be completed with the local engineer/expert, and include estimated base flows for area types (rural/urban) and different road functions, adjacent land use and environments as appropriate for the network being assessed.

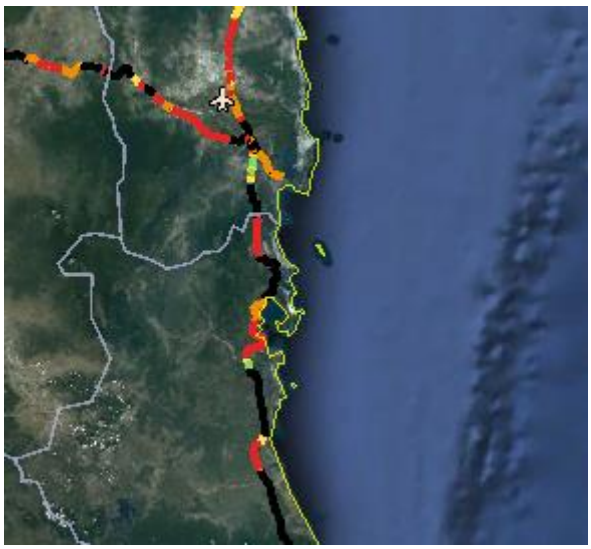
[16] RAP-SR-3.2: http://downloads.irap.org/docs/RAP-SR-3-2_Supporting_Data_Template.xlsm

b. Prepare a map or similar tool to allow review of the “pedestrian and bicycle present” data coded by the coding team (Refer to RAP-SR-2.2 Star Rating coding manual[17])

c. Using suitable mapping software or physical maps of the road network highlight the peak-hour flow ranges to be entered across the network (e.g. see map below).

d. Convert the data to 100 metre interval information that can be used to update the data input file for the agreed peak-hour flows to be used across the network

e. Document all assumptions.



Provided for demonstration purposes only

[17] RAP-SR-2.2: http://downloads.irap.org/docs/RAP-SR-2-2_Star_Rating_coding_manual.docx

5.5 Supporting Data – Crash Data Requirements

The iRAP Star Rating and Investment Plan protocol is designed to work within the known limitations of crash data availability. For countries with limited or no crash data the experience from other iRAP countries and/or global data sources can provide an indication of likely death rates. Where more detailed crash data is available that should be collected and analysed to determine appropriate deaths across the network being assessed.

5.5.1 Collection of Existing Fatality Data

The existing crash data available for the project is summarised below:

[CLIENT ENTERED : a summary of the availability of crash data in the country / for the road network should be provided – who holds it and its accessibility and any costs of accessing the data]

The existing crash data holdings are summarised below:

- Data is held by the Police with summary data managed by the Ministry of Transport – key contact details are…….
- No costs are applicable for release of crash data
- Accurate location-based data for fatalities is available based on death at the scene
- Serious injury and/or Hospital data outlining fatalities within 28 days or serious injuries is not available
- Reliable data records exist for the years 2008 onwards.

The supplier shall contact the relevant authorities and collate the available crash data on the network. Ideally the data sourced should permit the completion of the fatality data template provided as part of RAP-SR-3.2 Supporting data template[18]

The key data fields required across the surveyed road network are:

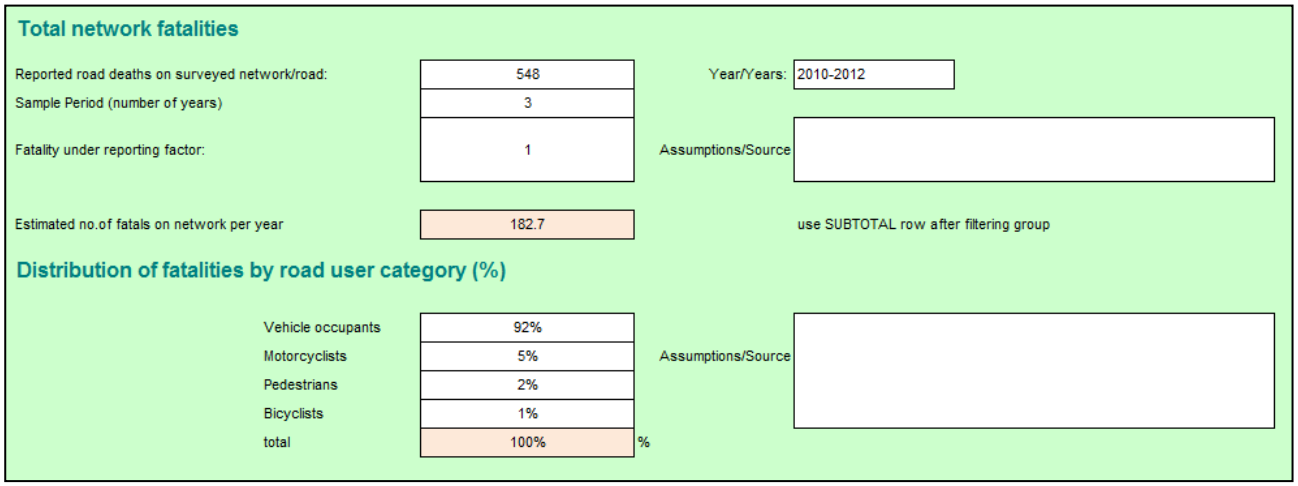
- Crash outcome (fatality, serious injury – crash severity definitions used should be documented)
- Crash user types (vehicle, motorcyclist, bicyclist, pedestrian)
- Crash type (head-on, run-off road, intersection, rear/end side/swipe, hit cyclist, hit pedestrian)
- Crash type detailed (overtaking, loss of control, crossing road etc.)
- Sample Period (3 years data, 5 years data)

[18] RAP-SR-3.2: http://downloads.irap.org/docs/RAP-SR-3-2_Supporting_Data_Template.xlsm

5.5.2 Estimation of Fatality Data

Where the quality of available crash is insufficient then the supplier shall engage with suitable experts in country to develop reasonable and well-documented assumptions to enable the completion of The "**Fatality Data Summary**" sheet provided in RAP-SR-3.2 Supporting data template[19].

Sample of Fatality Data Summary Sheet



Sources of information include but are not limited to:

- The available crash data with adjustments made as required
- Consultations with Police, road safety professionals and health professionals
- The latest version of the "Global Status Report on Road Safety" published by the World Health Organisation.
- Data on average fatal and/or serious injury crash rates from within the country or similar countries
- Experience from iRAP assessments around the world

5.5.3 Modelling fatalities

The number of estimated vehicle occupant and motorcyclist deaths is reduced by one third prior to distributing them across the surveyed network during the fatality calibration. This step is taken because the model does not, and cannot, account for all crashes and crash types and therefore for the purpose of calculating crash savings from remedial measures, a reduced number of deaths is used. In high income countries, typically

[19] RAP-SR-3.2: http://downloads.irap.org/docs/RAP-SR-3-2_Supporting_Data_Template.xlsm

about 20% of rural road fatalities are not related to the Star Rating Scores (SRS). The proportion is likely to be higher in lower and middle income countries. In iRAP projects, two-thirds of the four-wheel vehicle fatalities and the motorcycle fatalities are counted in the road death estimation for countermeasure evaluation. For the present, all pedestrian and bicycle fatalities are considered for potential reduction.

5.6 Supporting Data – Countermeasure Cost Requirements

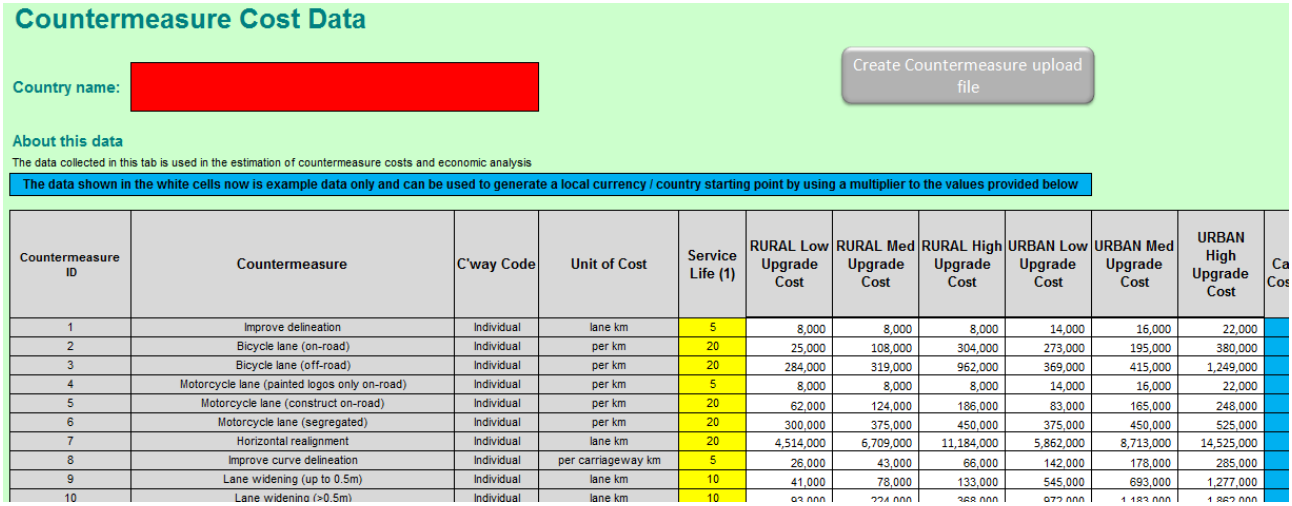
The supplier shall collect countermeasure cost data in consultation with the local road authority. Details on the cost and treatment life of various countermeasures is recorded within the Countermeasure Costs worksheet within RAP-SR-3.2 Supporting data template[20]. This data must meet the following criteria for upload to ViDA:

- Format: CSV file
- Costs in local currency
- Columns:
    1. Countermeasure ID (a unique code assigned to the countermeasure type)
    2. Countermeasure name (a unique name assigned to the countermeasure type)
    3. Carriageway code (reflects whether the treatment is specific to an undivided road only, an individual carriageway can be treated in isolation, or the treatment is generally applied to and impacts both / multi carriageways)
    4. Unit of cost (the basis for determining costs for each countermeasure. This allows the costs to reflect the actual site conditions e.g. lane widening will apply to each lane and is costed per lane km)
    5. Service life (the length of time that the countermeasure will last before requiring replacement or full refurbishment)
    6. Rural low upgrade cost – the cost for treatments at rural locations where the **upgrade cost** field as defined in RAP-SR-2.2 Star Rating coding manual[21] has been recorded as low**.**
    7. Rural medium upgrade cost – the cost for treatments at rural locations where the **upgrade cost** field as defined in RAP-SR-2.2 Star Rating coding manual[21] has been recorded as medium**.**
    8. Rural high upgrade cost – the cost for treatments at rural locations where the **upgrade cost** field as defined in RAP-SR-2.2 Star Rating coding manual[21] has been recorded as high**.**
    9. Urban low upgrade cost – the cost for treatments at urban locations where the **upgrade cost** field as defined in RAP-SR-2.2 Star Rating coding manual[21] has been recorded as low**.**

[20] RAP-SR-3.2: http://downloads.irap.org/docs/RAP-SR-3-2_Supporting_Data_Template.xlsm

[21] RAP-SR-2.2: http://downloads.irap.org/docs/RAP-SR-2-2_Star_Rating_coding_manual.docx

10. Urban medium upgrade cost – the cost for treatments at urban locations where the **upgrade cost** field as defined in RAP-SR-2.2 Star Rating coding manual[22] has been recorded as medium**.**
11. Urban high upgrade cost – the cost for treatments at urban locations where the **upgrade cost** field as defined in RAP-SR-2.2 Star Rating coding manual[22] has been recorded as high**.**
12. Divided carriageway cost multiplier – A cost multiplier that defaults to 1, but allows for a cost multiplier to be applied to site-specific "Multi-carriageway" treatments like intersections and pedestrian crossings that have triggered on divided roads and where the fact the road is divided will significantly increase the costs as compared to a treatment on an undivided road.
13. Hide – Where the treatment is triggered but the results are hidden as the effects are uncertain or do not warrant reporting until further investigation (e.g. speed management)
14. Ignore – The treatment is deemed inappropriate in a certain jurisdiction or project and it is removed from the analysis completely such that it will not trigger or be considered for implementation anywhere across the network.



Countermeasure Cost Data

Country name:

Create Countermeasure upload file

About this data

The data collected in this tab is used in the estimation of countermeasure costs and economic analysis

The data shown in the white cells now is example data only and can be used to generate a local currency / country starting point by using a multiplier to the values provided below

Countermeasure ID	Countermeasure	C'way Code	Unit of Cost	Service Life (1)	RURAL Low Upgrade Cost	RURAL Med Upgrade Cost	RURAL High Upgrade Cost	URBAN Low Upgrade Cost	URBAN Med Upgrade Cost	URBAN High Upgrade Cost	Ca Cos
1	Improve delineation	Individual	lane km	5	8,000	8,000	8,000	14,000	16,000	22,000	
2	Bicycle lane (on-road)	Individual	per km	20	25,000	108,000	304,000	273,000	195,000	380,000	
3	Bicycle lane (off-road)	Individual	per km	20	284,000	319,000	962,000	369,000	415,000	1,249,000	
4	Motorcycle lane (painted logos only on-road)	Individual	per km	5	8,000	8,000	8,000	14,000	16,000	22,000	
5	Motorcycle lane (construct on-road)	Individual	per km	20	62,000	124,000	186,000	83,000	165,000	248,000	
6	Motorcycle lane (segregated)	Individual	per km	20	300,000	375,000	450,000	375,000	450,000	525,000	
7	Horizontal realignment	Individual	lane km	20	4,514,000	6,709,000	11,184,000	5,862,000	8,713,000	14,525,000	
8	Improve curve delineation	Individual	per carriageway km	5	26,000	43,000	66,000	142,000	178,000	285,000	
9	Lane widening (up to 0.5m)	Individual	lane km	10	41,000	78,000	133,000	545,000	693,000	1,277,000	
10	Lane widening (>0.5m)	Individual	lane km	10	93,000	224,000	368,000	972,000	1,183,000	1,862,000	

[22] RAP-SR-2.2: http://downloads.irap.org/docs/RAP-SR-2-2_Star_Rating_coding_manual.docx

6 Processing and Analysis Specification

The supplier shall be required to process the data using the following steps. RAPcapacity[23] provides guidance as part of the Star Rating data handling module of the Star Rating from Inspection course.

1. Convert the coded data into iRAP upload file format (as defined in RAP-SR-3.3 Upload file specification[24]).
2. Create road sections in accordance with iRAP methodology and in consultation with client and road authority.
3. Add vehicle flow and the motorcycle percentage, plus speed data to the upload file.
4. Estimate the pedestrian and bicycle flow and compare with pedestrian and bicyclist vehicle volume data collected in the supporting data. Enter the flow data into the upload file.
5. Set up a project within the iRAP online software[25], completing the project setup, initial fatality estimation variables, economic variables and countermeasure costs.
6. Upload data set to iRAP online software.
7. Calibrate the fatality estimation in line with crash data collected for the network and reprocess the data.
8. Analyse results and amend upload file and reprocess the data as necessary.

The supplier shall undertake a quality assurance review of the iRAP upload file, Star Rating results and Safer Roads Investment Plan, for guidance see RAP-SR-2.4 Star Rating and Safer Roads Investment Plan Quality Assurance Guide.[26]

[23] RAPcapcaity: http://capacity.irap.org

[24] RAP-SR-3.3: http://downloads.irap.org/docs/RAP-SR-3-3_Upload_file_specification.xls

[25] ViDA: http://vida.irap.org access to the software will be provided by iRAP on request.

[26] RAP-SR-2.4: http://downloads.irap.org/docs/RAP-SR-2-4_QA_Guide.pdf

In addition, the supplier shall undertake an in-country review of the preliminary results with local stakeholders and amend the results based on this review as necessary. Typically, the local stakeholders who participated in the road coding process will also participate in the review. The purpose of this review is to ensure that:

a) Stakeholders learn to use the iRAP online software[27].

b) Stakeholders are familiar with iRAP results.

c) Stakeholders understand the iRAP methodology, limitations and required engineering action.

d) The proposed countermeasures are feasible (both in terms of engineering and applicability to the country).

e) The proposed countermeasure costs are reasonable.

f) The vehicle volumes and pedestrian estimates are reasonable.

g) The potential need for complementary road safety education and enforcement initiatives is identified.

In order to complete the project analysis the supplier must have undertaken the Introduction to iRAP, Star Rating from inspection and the Safer Roads Investment Plan courses on RAPcapacity[28]. Suppliers responding to this specification who have not completed such training should make provision for completing these courses in their proposal

Upload file must completed in accordance with RAP-SR-3.3 Upload file specification[29].

The preliminary results must be submitted to [NAME] for review prior to results being provided to local stakeholders. The supplier should be prepared to amend and reprocess the data should the independent quality review identify errors or deficiencies. As a guide, suppliers should allow approximately ten days for the analysis of a typical 3,000km network.

[27] ViDA: http://vida.irap.org access to the software will be provided by iRAP on request.

[28] RAPcapcaity: http://capacity.irap.org

[29] RAP-SR-3.3: http://downloads.irap.org/docs/RAP-SR-3-3_Upload_file_specification.xls

7 Reporting Specification

The supplier shall produce two formal reports, a full technical report and a summary report. Both reports shall be produced using appropriate branding to be agreed with client and following iRAP branding guidelines[30]. The full technical report shall include:

1. Full details of project background, tasks and objectives
2. A list of the surveyed road network
3. Details of recorded road attributes
4. Details (inc. source) of all supporting data used along with any assumptions made
5. Star rating table
6. Star rating maps
7. Safer Roads Investment Plan
8. Details of training provision, workshops and demonstrations performed during the project

The summary report shall include:

1. A brief description of the project background and objectives
2. A list of the surveyed road network
3. Star rating table
4. Star rating maps
5. Safer Roads Investment Plan

Sample reports are available to use as a guide and are provided as part of the RAPcapacity training resources.

iRAP Vietnam Technical Report[31]

iRAP Vietnam Project Summary[32]

[30] iRAP Brand guidelines: http://downloads.irap.org/docs/iRAP_Brand_guidelines iRAP.pdf

[31] iRAP Vietnam Technical Report: http://downloads.irap.org/docs/iRAP_Vietnam_Technical_Report.pdf

[32] iRAP Vietnam Project Summary: http://downloads.irap.org/docs/iRAP_Vietnam_Summary_Report.pdf

8 Cost Schedule

The following cost schedule shall be submitted by the supplier.

	TASK	RATE	Provisional Amount	PRICE (Currency)
1	Political and Technical Engagement	Lump Sum		
2a	Supporting Data Collection (including all supporting data except for additional traffic volume, speed and pedestrian and bicycle flows not specified herein)	Lump Sum		
2b	Supporting Data Collection Traffic Volume - <3 hour counts Traffic Volume – 24 hour counts Traffic Volume – 7 day counts Speed data (100 veh counts) Pedestrian & Bicycle Peak-hour counts	Schedule of Rates Per site Per site Per site Per site Per site	 [DEFINE] [DEFINE] [DEFINE] [DEFINE] [DEFINE]	
3	Processing and Analysis	Lump Sum		
	TOTAL			

Appendix A – Crash Estimate Guide

To assist countries with poor crash data iRAP has compiled typical fatal and serious injury crash rates to form a starting point for an analysis or estimation of fatalities on an existing road network being surveyed.

Fatal and Serious Injury indicative crash types by road type / star rating

	Low – Middle Income countries	High Income countries*
Motorway (high standard 4 or 5 star rating)	10-20 FSI's per billion vkt *(16-32 FSI's per billion vmt)*	5-10 FSI's per billion vkt *(8-16 FSI's per billion vmt)*
Dual Carriageway (low 4 or high 3 star rating)	30-60 FSI's per billion vkt *(48-96 FSI's per billion vmt)*	15-20 FSI's per billion vkt *(24-36 FSI's per billion vmt)*
Single Carriageway (low 3 star or high 2 star rating)	80-160 FSI's per billion vkt *(128-256 FSI's per billion vmt)*	30-40 FSI's per billion vkt *(48-64 FSI's per billion vmt)*
Low standard Single Carriageway (low 2 star or 1 star road)	200-600 FSI's per billion vkt *(320-960 FSI's per billion vmt)*	60-80 FSI's per billion vkt *(96-128 FSI's per billion vmt)*

(FSI = Fatality and serious injury outcomes; vkt = vehicle kilometres travelled; vmt = vehicle miles travelled)

* High income variance is typically related to road user behaviour and vehicle standard related issues

To apply the estimates across an existing road network the following steps are recommended:

1. Review the typical crash rates above with local data and knowledge and adjust as required
2. Undertake the iRAP star rating analysis in ViDA and generate the "core data" download file
3. Based on the vehicle star rating results record the relevant crash rate as determined in step 1 (e.g. using a lookup table)
4. Using the traffic volume (AADT) from the download file multiplied by the segment length determine the equivalent vehicle kilometres (miles) travelled) for each segment
5. Multiply the vehicle kilometres travelled by the relevant crash rate determined in step 3
6. Sum the total fatalities and serious injuries across the network.

7. To convert to fatalities only divide result by 11 (that is for every fatality there is 10 serious injuries as outlined in the True Cost of Road Crashes[33] paper

[33] True Cost of Road Crashes, Dahdah, McMahon 2005 : http://www.irap.net/about-irap-3/research-and-technical-papers?download=45:the-true-cost-of-road-crashes-valuing-life-and-the-cost-of-a-serious-injury-espaol