Better Roads Without Endangering Lives: Using Road Safety Audits to Maximise Development Impacts

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Abstract

The World Bank and other donors have long recognized that road safety is a critical issue for transport projects in developing countries. Inadequate consideration of road safety disproportionately affects the less well-off members of the population; the very groups which development institutions are attempting to lift from poverty.

One way that road safety can effectively be addressed is through road safety audits (RSA). However, the systematic use of RSAs is often lacking, and when done, RSAs are often completed too late in the project for their potential to be fully realised.

To address these challenges, the World Bank with support from the Global Road Safety Facility (GRSF) recently trialled the systematic application of multi-stage RSAs on several projects in the Pacific Islands. These projects integrated road safety into the project design from the outset, undertaking RSAs at feasibility, detailed design and post construction stages.

This innovative multi0stage audit approach helped to overcome the design inertia which has been observed, that is a reluctance by stakeholders to revisit designs to incorporate safety features due to the cost and effort associated with rework.

This paper presents a case study from the Kiribati Road Rehabilitation Project which provided an ideal scenario to prove the concept given the large number of vulnerable users and historically poor road safety performance. The risk to pedestrians was expected to increase as a result of the improved road condition, particularly from drunk drivers and speeding vehicles. The case study shows how improvements in road condition need not create roads which threaten the lives and wellbeing of the poorest members of society.

Adopting a comprehensive auditing approach from project initiation helped ensure that any investments incorporated safe features, effectively maximising the development impact.

1 Introduction

1.1 Road Safety in Developing Countries

In 2010, more than 100 countries co-sponsored a landmark resolution by the UN General Assembly – the Decade of Action for Road Safety. While short on numerical targets, it had the ambitious goal of stabilising then reducing global traffic fatalities by 2020 (United Nations, 2010).

This was a particularly challenging target for developing countries where rapid urbanisation and motorisation of their populations created much larger populations using the roads, and therefore an increased risk of trauma from road accidents. For example, from 1980 to 2010, road fatalities as a share of population rose by more than 75 percent in developing East Asia (including China) and by 66 percent in South Asia (including India) (Bose, 2015).

In developing countries, the annual cost of road crashes is estimated at 5 percent of GDP, a total sum of one trillion USD (Bose, 2015). This represents a tremendous drain on the economies of developing countries, not to mention a public health burden, with road trauma clearly a significant barrier to economic development.

1.2 Role of International Organisations

International organisations tasked with reducing global poverty are well aware of the importance of addressing road safety, with the inclusion of a road safety goal in the UN's 2015 Sustainable Development Goals seen as acknowledgement of its critical importance (United Nations, 2015).

International development organisations like the World Bank frequently make investments in transport infrastructure, which has proven to be an effective way of improving access to basic services and addressing poverty. However, these investments may cause harm through road trauma to the very population they are trying to lift from poverty. For example, while rehabilitating a road provides access and reduces travel times and vehicle operating costs, it also creates road safety risks through the higher speeds and traffic volumes it encourages. These risks also disproportionately affect the vulnerable users who are typically poorer, such as pedestrians, cyclists and motorcyclists. Development organisations are conscious of these risks, and often use road safety tools to ensure investments are as safe as possible, minimising the harm caused by their investments.

1.3 Road Safety Auditing

One such tool is road safety auditing, which helps to ensure infrastructure is as safe as possible. Road safety audits (RSAs) are a formal examination of the safety performance of an existing or future road by an independent, multidisciplinary team. Audits qualitatively estimate and report on potential road safety issues, identifying opportunities for improvement in safety for all users (FHWA, 2006).

Audits can be conducted at various stages of the project life including feasibility, preliminary design, detailed design and pre-opening or post-construction stages (refer Figure 1). The general wisdom is that the earlier a road is audited within the design and development process, the better as it allows for adjustments to be made in the design with minimal risk of design or physical rework.

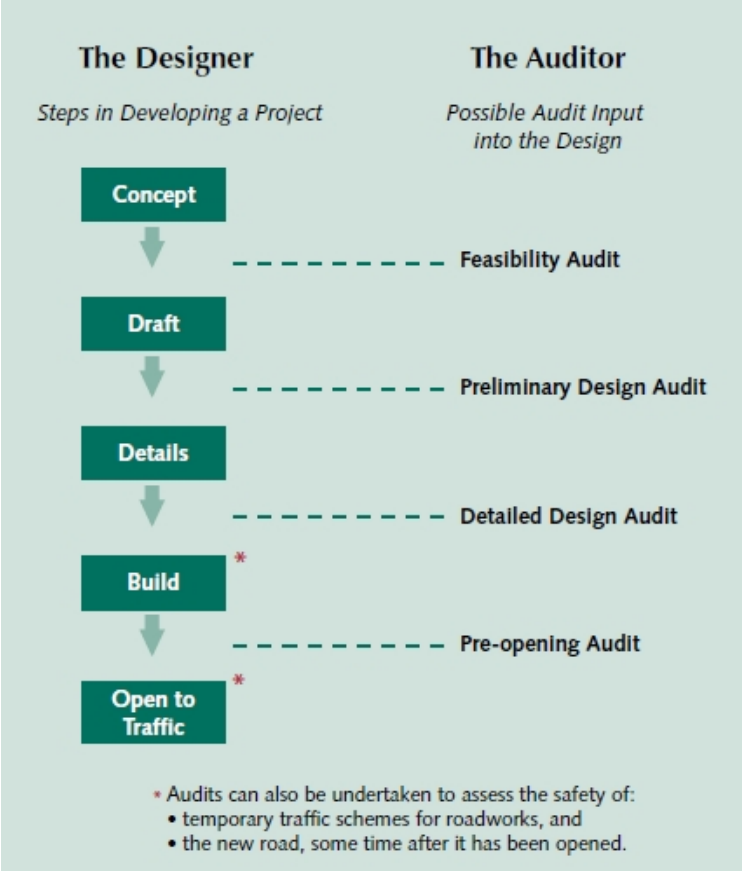


Figure 1 – How audits fit in to planning, design and development processes (AUSTROADS, 2009)

Despite this, it is typical in development projects for RSAs to be conducted only at the detailed design stage. At this stage, auditors consider the detailed design documents including specifications and drawings together with the road context to make safety recommendations to reduce the risk of trauma.

The challenge with auditing only at the detailed design stage is that road safety features which fundamentally affect the design approach cannot be fully considered. The opportunity to introduce innovative road safety solutions is missed, with design concepts developed to such an extent that modifications for road safety may significantly delay the project, and/or increase the costs. For design teams working on lump sum contracts there is also reticence to do anything that could be construed as rework.

An alternative approach is to conduct auditing at multiple stages. In particular, integrating feasibility audits into project preparation creates a very clear basis for ensuring that any design properly addresses road safety. This paper documents the benefits of multi-stage road safety auditing on road development projects through a case study from the Kiribati Road Rehabilitation Project. This demonstrates how adopting a comprehensive approach with audits at feasibility, detailed design and post-construction stages leads to a road which is much safer overall.

2 Case Study

2.1 Project Background

2.1.1 Country Context

Kiribati, with an estimated population of 110,000, is a small, remote country on the equator comprised of 33 atolls and reef islands, of which 21 are permanently inhabited. The total land area is

only 726 square kilometres spanning approximately 3.5 million square kilometres of ocean (refer Figure 2) (Central Intelligence Agency, 2016).

Figure 2 – Kiribati location and road layout (World Bank, 2011)

Approximately 60,000 of Kiribati's population reside in the capital of South Tarawa which is a magnet for internal migration from the outer islands, growing at more than 5 percent a year. South Tarawa provides employment opportunities, as well as access to education and social services not available elsewhere in Kiribati. The United Nations Development Program (UNDP) noted that South Tarawa has a high incidence of basic needs poverty which affects one quarter of the population (UNDP, 2010).

2.1.2 Road Infrastructure

In South Tarawa, the community is linked by a single main two-lane sealed road and four causeways that run east to west (refer Figure 2). For the majority of its length, the road passes through ribbon development comprising residences, businesses, schools and hospitals, all located within the confines of the atoll, which is generally no more than three meters above sea level and has an average width of only 450 meters. Virtually the entire population lives close to, and is affected by, the road's condition.

In 2010 the road system consisted of about 36 km of bituminous sealed main roads (including causeways), about 20 km of secondary roads (half of which are sealed and half unsealed); and about 40 km of unsealed feeder roads. Road use on South Tarawa was growing rapidly: in central Bairiki, traffic volume on the main road has reached 6,000 vehicles per day, growing at an average rate of 4 percent per year (PRIF, 2009). The estimated pedestrian traffic was 60,000 per day, so this vulnerable group is by far the largest road user group.

While approximately 7 km of main road in Betio in the west of South Tarawa was rehabilitated in 2008 using finance from Japan, some 29 km of paved roads had received no major maintenance for over twenty years. The high traffic levels on the road combined with persistent heavy rainfall caused extensive damage, with long sections losing their surface completely and reverting to an unpaved surface.

The state and condition of the roads in Kiribati had significant economic and social repercussions; particularly with regards to the health and safety of the population. The traffic speed was reduced in places to 20 km/h or less as a result of the damage, and driving conditions were hazardous, particularly after rain (refer Figure 3). Further, during the dry season the dust from unpaved sections of the road contributed to upper respiratory problems among local residents.

Figure 3 – Poor condition of the South Tarawa Road

2.2 Project Objective

Recognising that the poor condition of the South Tarawa road was a key contributor to poverty in Kiribati, the World Bank together with the Asian Development Bank and the Australian Agency for International Development (now the Department of Foreign Affairs and Trade) prepared a project called the Kiribati Road Rehabilitation Project (KRRP). With a development objective of improving the condition of South Tarawa's main road network and helping to strengthen road financing and maintenance capacity (World Bank, 2011), a comprehensive investment and reform project was prepared. Current funding to the project is approximately US$76 million including both the physical works and associated activities for road maintenance and safety (Asian Development Bank, 2016). Physical works started in July 2013, and were completed in December 2016.

2.3 Road Safety Approach

In South Tarawa there was concern regarding the growing incidence of road accidents due to increased traffic, the age and condition of vehicles and dangerous driving behaviour. Perversely, the poor condition of the road probably contributed to reducing the number of serious accidents due to its influence on vehicle speeds. However with the road improved, speeds and the risk of serious accidents could be expected to increase significantly. The project addressed road safety through a multi-faceted approach including RSAs at feasibility, detailed design and post-construction stages.

The cost of these RSAs for KRRP was approximately US$15,000, which was grant funded through the support of the Global Road Safety Facility (GRSF). This was a mere 3.3 percent of the World Bank's project preparation and supervision costs (to works commencement in July 2013), and only 0.2 percent of the total project value. A paucity of accurate crash data makes it difficult to determine the economic benefits of the road safety infrastructure improvements resulting from audits. However, the safer infrastructure which resulted will significantly reduce fatalities as well as serious injury crashes which are a significant burden on health services. In similar developing countries the economic cost of road trauma is estimated at 5 percent of GDP (Bose, 2015), and even if RSAs only reduce a fraction of this cost, the benefits are significant. Clearly for the low cost of RSAs and the large potential benefits, safer infrastructure will make a large contribution to reducing harm to road users and lowering cost to the Government of Kiribati.

In addition to RSAs, the project provided support for road safety education and enforcement, and the preparation of a road safety action plan and strategy for the country. Implementation of key actions

in the plan was also supported through the project.

2.3.1 Feasibility RSA

During the early stages of the World Bank's project preparations, prior to design commencing, the team sought the expertise of a specialist road safety auditor to conduct a feasibility stage RSA assessing the existing conditions along the South Tarawa road. It consisted of several day time and night time site inspections with findings and recommendations compiled in a report. This included a table of issues and recommendations for action by the designers (Jordan, 2010). An example of a safety issue raised regarding a clear zone, and the subsequent recommendation is provided in Figure 4. This report was then provided to the engineering designers to ensure that the road safety issues were fully addressed from the commencement of the design stage.

No.	SAFETY CONCERN	RISK	RECOMMENDATION
3.2	There are numerous trees and houses shops, and other fixed objects within the clear zone along this road. There are too many to individually highlight, and it is expected that removal of the trees will not be a favoured option. The installation of crash barriers is not recommended – such barriers will not fit in some parts because of inadequate widths for offsets and deflection. They will also cause "innocent hits" when buses/cars pull too close.	HIGH	• Design the road with suitable line marking and associated delineation to minimise the risk of a vehicle leaving the road. • Take into account especially the locations at each end of the causeways (where speeds will be highest) and ensure that delineation of the curves is excellent. • At selected locations install 2-3 chevron alignment markers (CAM's) to delineate a sharp curve. • Consider developing a program of tree removal to remove only those trees few that are closest to the road in the high risk locations (blackspots) at the end of the causeways.

The bridge on the Betio causeway is narrower than the road cross section. The footpath and the bridge railing are road side hazards that present a risk to any vehicle that is a metre or two off path.

The Betio port road runs beside the sea – it requires crash barrier to prevent a vehicle from dropping 4m into the sea.

Figure 4 - Example of feasibility RSA findings showing safety concerns and recommendations (Jordan , 2010)

Summary of RSA findings

This feasibility stage RSA found the following major issues with the existing road which required action in the design:

- Provision of footpaths in densely populated villages to reduce risk to pedestrians
- Provision of bus-stops for better traffic management and to promote safer bus driving
- Provision of pedestrian crossings at schools and other busy areas
- Provision of proper signage and pavement markings
- Improved intersection designs
- Provision of street lighting to improve safety at night in busy pedestrian areas
- Speed control measures such as speed humps to mitigate the likely increased risk of speeding as a result of improved road conditions.
- Speed limits of 30 km/h through villages and 60km/h through un-developed areas.

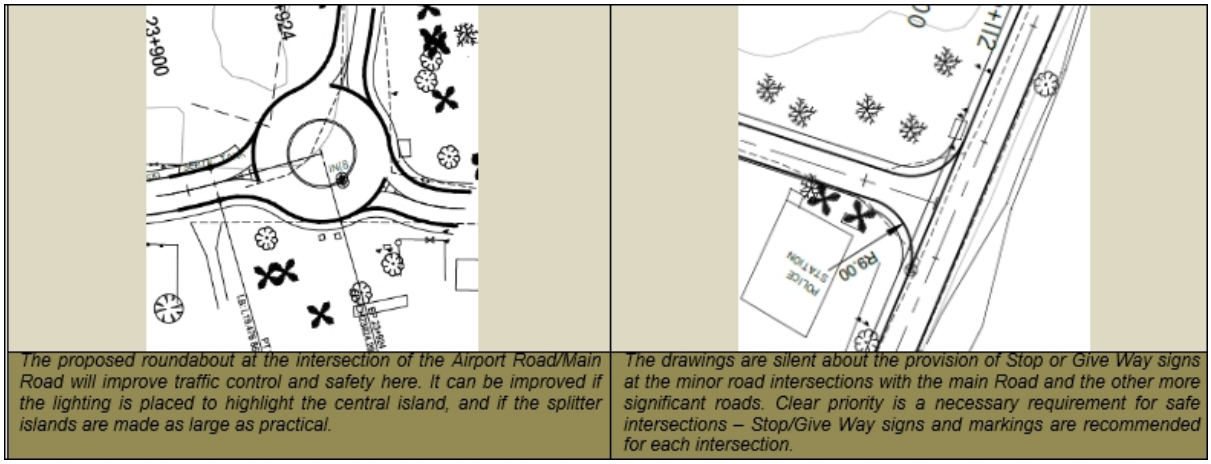
In addition to this, the donors supported the auditor's recommendation to reduce the road width

from seven to six metres so as not only to ensure that there was sufficient space for footpaths and shoulders, but also to increase 'friction' and reduce speeds.

The designers considered these recommendations during the detailed design, and conscious of the importance of road safety to both their client the Government of Kiribati, and the financers of the project, they made commendable efforts to address as many of the recommendations as possible.

2.3.2 Detailed Design RSA

Next, a RSA was conducted on the detailed design by the same engineer. The auditor was the same individual who undertook the feasibility RSA for consistency of input, with an updated issue table prepared to assist the designers with refining the design (Jordan, 2011) – refer Figure 5 for an example. A dialogue was also established between designer and auditor to facilitate the process of agreeing final details, with comments and responses tracked and reviewed by Government and donors.



The proposed roundabout at the intersection of the Airport Road/Main Road will improve traffic control and safety here. It can be improved if the lighting is placed to highlight the central island, and if the splitter islands are made as large as practical.

The drawings are silent about the provision of Stop or Give Way signs at the minor road intersections with the main Road and the other more significant roads. Clear priority is a necessary requirement for safe intersections – Stop/Give Way signs and markings are recommended for each intersection.

Figure 5 - Example of detailed design RSA findings

Summary of RSA findings

The detailed design RSA focussed on refining the details of road safety features that had been recommended previously including:

- Details for signage and line markings including chevrons for delineation, direction and warning signs, speed restriction signage
- Provision of crash barriers and end terminal details
- Details of street lighting including frangible poles
- Intersection details including spitter islands at roundabouts, centrally placed lighting and channelization of other intersections

It also separately raised new recommendations for inclusion in the final design including:

- Road cross section including raised kerbs and sealed shoulders
- Pavement for bus stopping areas
- Sealing of side roads back from junctions
- Minimising use of crash barriers
- Consistent specification of speed humps (flat top type)
- Gateway treatment details at entrances to villages
- Location of stopping areas

The RSA also made recommendations to expand the scope of the project to address other high risk safety issues. However, the Government chose not to action these due to budgetary limitations.

These recommendations were provided to designers with the requirement that they include them wherever possible. Given the design was based on the feasibility RSA, it already included many safety features such as speed humps, a narrow carriageway and gateway treatments.

Often designers and even some Governments are reluctant to add safety features when only detailed design RSAs are conducted, with a desire to avoid rework fuelling this. However, because the design for KRRP included extensive safety features from the concept stage, the risk of rework to add safety features was reduced.

Highlights of the road safety detailing included paved footpath for the length of the road (on both sides) -refer Figure 6, roundabout intersections and gateway signage (refer Figure 7). The end result of these and other features was an overall safe design for the road rehabilitation, particularly for pedestrians who were the most numerable but also most vulnerable road users.

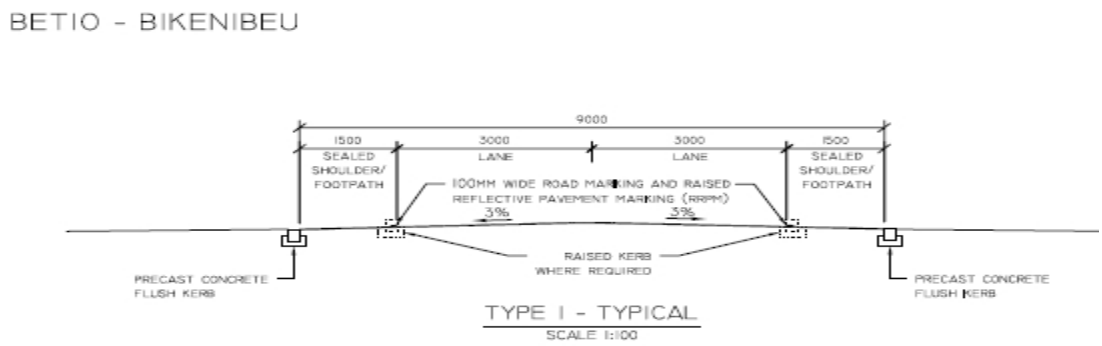


Figure 6 – Typical road cross section for KRRP - Betio to Bikenibeu (Roughton International, 2011a)

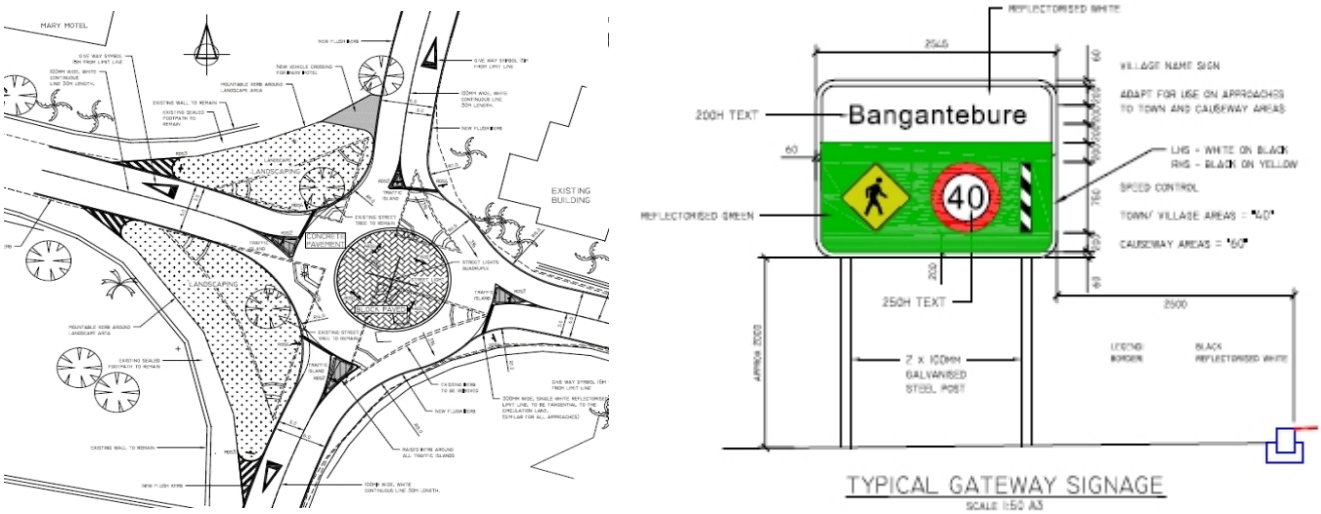


Figure 7 – Bairiki roundabout and gateway signage detail (Roughton International, 2011b)

2.3.3 Post-Construction RSA

With the design finalised, it was tendered and after a lengthy procurement process was awarded to an Australian civil construction contractor McConnell Dowell who mobilized to Tarawa in July 2013. During construction, the supervising engineer provided clarifications to the contractor in the form of contract instructions, including many to ensure road safety features were correctly constructed. Close to completion of the works, a post-construction RSA was undertaken. This time, the auditor was a staff member of the World Bank who had experience with KRRP having visited regularly since the commencement of construction. The auditor was independent as required, but due to the constraints of timing, their RSAs were conducted over two visits, prior to the completion, and again once outstanding works including line marking and signage installation were complete.

Summary of RSA findings

The post-construction RSA found a number of hazards, the majority of which were considered low risk. Hazards were classified as relating to signage, roadside hazards, intersections, lighting and other. The most common issues related to signage, which the feasibility RSA noted was almost completely absent from the road prior to rehabilitation. A particular issue was the obstruction of newly installed signage by vegetation (refer Figure 8) which could have been resolved by ongoing trimming of vegetation as part of routine maintenance (Whalley, 2017). The few high risks issues raised related to roadside hazards (including uncompleted elevated manhole risers) and bypassing of speed humps in a few locations.

While recommendations were made for addressing all hazards, the RSA observed that the road infrastructure provided was a significant improvement on the conditions observed in the feasibility audit. If actioned, the recommendations would serve to improve safety even further.

In general, the auditor observed the standard of both design and construction of road safety features to be good (refer Figure 8 and 9). The RSAs at feasibility and detailed design stages resulted in a very safe design, leaving mostly minor construction issues which were relatively simple to address in line with the recommendations of the post-construction RSA.

Figure 8 – Example of obscured signage issue

Figure 9 - Completed road showing safety features including signage,

line marking, lighting, speed humps, footpaths and drainage.

2.3.4 Road Safety Action Plan

Recognising that infrastructure makes up only a part of a safe road system, the KRRP assisted the Government of Kiribati with the development and implementation of a multi-sectoral road safety action plan. This was completed in January 2015 and adopted by the Government soon after (Selby, 2015). The Kiribati Road Safety Task force committee were tasked with implementing the prioritised actions in the areas of:

- Leadership and coordination/capacity building
- Speed management
- Bus passenger safety
- Road safety education and awareness
- Driver testing/licencing
- Vehicle testing/registration
- Crash data system
- Drink driving

The Government has since made significant strides in implementing this plan, particularly in the areas of driver licencing, vehicle testing and enforcement of speeding and drunk driving. To improve enforcement in the key risk areas of speeding and drunk driving, the project has supported the Kiribati Police Service (KPS) with new equipment including radar speed detectors and breathalysers, calibration support and training by New Zealand and Queensland Police service counterparts. Revised legislation and regulations were also prepared to allow more effective enforcement in these areas, with the Government adopting the former and currently deliberating on the latter.

One of the priority actions under the plan was the implementation of a crash data system as the current traffic accident statistics for Kiribati are unreliable. An improved data collection and management system will allow for better monitoring of the impact of any road safety interventions, allowing for informed decision making to address risks. One option is for Kiribati to consider using the World Bank's open source software platform DRIVER (Data for Road Incident Visualization, Evaluation, and Reporting) which was developed in the Philippines and adopted successfully elsewhere (World Bank, 2016).

3 Conclusions

Clearly the multi-stage road safety auditing approach adopted for the KRRP resulted in excellent safety outcomes. From this case study there are lessons learnt which hold value for the preparation of new road rehabilitation projects, particularly those where there is a large proportion of vulnerable users as in Kiribati. The following key lessons were learnt from the project.

Involve road safety auditors early for best outcomes. One of the great benefits of the project's approach was the fact that the feasibility stage RSA provided a clear set of recommendations as an input to the design, before the designers had even commenced. This placed safety at the forefront of the designer's consciousness, with safety given a high priority as for technical aspects such as pavement and geometric design. While it required a larger upfront commitment from donors to organise and fund an audit, this cost is considered small compared with the overall investment and indeed the benefits from reduced road trauma which can be realised. Therefore it is recommended that feasibility stage RSAs be conducted on all major road rehabilitation projects.

Commitment required from all stakeholders. From the outset of the KRRP, all parties involved displayed an excellent commitment to making the road in Kiribati safer. While the early involvement of auditors required donor support and funding from the GRSF, the Government of Kiribati were also committed. They too showed foresight and were willing to accept the likely higher cost of a road design with extensive safety features, knowing that this would have long term benefits from reduced road trauma. The designers also showed commitment to making the road as safe as possible within the constraints, and while having the feasibility RSA provided to them steered them in this direction, in some cases they went beyond the recommendations of the auditor.

High risk projects should have multi-stage audits. The typical approach on development projects is to conduct audits only at detailed design stage, if at all. Unfortunately this approach often comes up against design inertia, with designers and Government unwilling to revisit designs and specifications to include safety features for fear of re-work or increasing the cost beyond the available funding envelope. In high risk situations such as Kiribati where vulnerable pedestrians were by far the biggest road user, the best practice approach is to conduct RSAs at feasibility, detailed design and post-construction stages. This approach minimises the risk of rework and results in early estimates being developed with full cognisance of the cost implications. The detailed design RSA is required to ensure any features are correctly detailed. Finally, the post-construction RSA serves as an independent check of whether the previous RSA stages have performed well, and as for KRRP should typically should only result in minor remedial work to enhance safety.

Infrastructure is only a part of a safe road system. The multi-stage road safety approach resulted in a road with comprehensive road safety features, particularly to protect vulnerable pedestrians. However this is only part of creating a safer road system. In line with the UN's decade of action (2010), enforcement, education, post-crash care and management should all be addressed in order to minimise trauma resulting from any road improvements. The KRRP recognised this by preparing a road safety strategy and action plan for the road improvements. The Government, with support of the project has made progress towards addressing priority actions in this plan.

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