



Establishment of Rural Road Research Capacity in Myanmar/**RDU Business Plan for First Five Years of Operation**

B. VERHAEGHE

February 2018

Final Version



Source: Asian Development Bank



Table of Contents

List of Abbreviations	(iv)
List of Tables	(v)
List of Figures	(v)
Abstract	(vi)

	Page
1. Introduction	1
2. Vision, Mission and Strategic Objectives	2
2.1 Vision	2
2.2 Mission	2
2.3 Rationale	2
2.4 Value Proposition	3
2.5 Goal and Strategic Objectives	3
3. Governance	5
3.1 Strategic Oversight	5
3.2 Institutional Structure	5
3.3 Sources of Funding	7
3.4 Key Performance Indicators and Targets	8
3.5 Strategic Relationships and Linkages	10
4. Research, Development and Implementation Plan	11
4.1 Role and Responsibilities of the RRRTC	11
4.2 Rural Road Research Strategic Plan	12
4.3 Technical Committees and Working Groups	23
5. Operations	24
5.1 Human Resources	24
5.2 Research Infrastructure	28
5.3 SHEQ Management	31
6. Knowledge Management	32
6.1 General	32
6.2 Information Centre	32
6.3 Virtual Collaboration Platforms	34
6.4 Web-Based Knowledge Portals	35
6.5 Information and Technology Transfer	35
6.6 Records Management Activities	36
7. Indicative Budget	37
7.1 Cost structure for Year 1	37
7.2 Five-year cost structure of the RDU	38

Appendices	Page
Appendix A/ Draft Memorandum of Understanding for national and international partnerships	39
Appendix B/ Good Research Practice Guide	46
Appendix C/ RDU Establishment Support	58

List of Abbreviations

AsCAP	:	Asia Community Access Partnership
ADB	:	Asian Development Bank
ARRB	:	Australian Road Research Board
CSIR	:	Council for Scientific and Industrial Research
DDG	:	Deputy Director General
DFID	:	Department for International Development
DG	:	Director General
DMH	:	Department of Meteorology and Hydrology
DOB	:	Department of Bridges
DOH	:	Department of Highways
DRD	:	Department of Rural Development
DRRD	:	Department of Rural Road Development
EIFL	:	Electronic Information for Libraries
EU	:	European Union
JICA	:	Japan International Cooperation Agency
KfW	:	Kreditanstalt für Wiederaufbau
MES	:	Myanmar Engineering Society
MOALI	:	Ministry of Agriculture, Livestock and Irrigation
MOBA	:	Ministry of Border Affairs

MOC	:	Ministry of Construction
MOTC	:	Ministry of Transport and Communications
MTU	:	Mandalay Technological University
PBANRD	:	Progress of Border Area and National Races Development
R&D	:	Research and Development
RDI	:	Research, Development and Implementation
RDU	:	Research and Development Unit
RRRTC	:	Rural Road Research Technical Committee
RTAD	:	Road Transport Administration Department
SDG	:	Sustainable Development Goals
SET	:	Science, Engineering and Technology
TRL	:	Transport Research Laboratory
YTU	:	Yangon Technological University

List of Tables

Table 1: Critical Success Factors and Key Performance Indicators for Establishment of RDU	8
Table 2: Critical Success Factors, Key Performance Indicators and Targets for the RDU	9
Table 3: Initial human resources requirements for research delivery	25
Table 4: Test Equipment	29

List of Figures

Figure 1: Institution Location of the RDU within the structures of MOC and DRRD	6
Figure 2: Initial Structure of the RDU	7

Abstract/

This document presents the Business Plan for the first five years of operation of the Research and Development Unit (RDU) of the Department of Rural Road Development (DRRD). The Business Plan is expected to evolve over time in line with the shifting views and expectations of the DRRD under the Ministry of Construction (MOC), and the realities associated with the physical establishment of the RDU. The Business Plan addresses: (a) the vision, mission, goal and strategic objectives of the RDU; (b) governance issues, including the role and responsibilities of the Steering Committee, the institutional and physical location of the RDU, sources of funding, key performance indicators, and strategic relationships and linkages; (c) the short to medium-term research agenda of the RDU, which future revisions will be guided by a Rural Road Research Technical Committee (RRRTC); (d) capacitation of the RDU in terms of human resources and research infrastructure; and (e) knowledge management, inclusive of information transfer. In addition to the above, an indicative budget is proposed that will have to be reassessed following the physical establishment of the RDU.

1. Introduction

This document outlines the 5-Year Business Plan for the Research and Development Unit (RDU) of the Department of Rural Road Development (DRRD) under the Ministry of Construction (MOC). The Business Plan will guide the establishment of the RDU and assist the RDU in fulfilling its mandate and achieving its strategic objectives as set by DRRD and endorsed by the Steering Committee. The overall aim of the Business Plan is to provide the basis for strengthening the long-term capacity of Myanmar to undertake relevant and high quality research relating to the improvement of rural accessibility in Myanmar.

The business plan has been structured as follows:

- **Chapter 2** presents the vision, mission and strategic objectives of the RDU;
- **Chapter 3** deals with Governance issues, including the role of the Steering Committee, the location of the RDU within the institutional structure of DRRD under MOC, the physical location of the RDU, preliminary recommendations on sources of funding, critical success factors and key performance indicators, as well as strategic relationships and linkages, both nationally and internationally;
- **Chapter 4** presents the research, development and implementation plan, in which the role of the Rural Road Research Technical Committee (RRRTC) is presented, as well as the Rural Road Research Plan. This chapter also outlines the importance of establishing working groups and technical committees to support and add value to the activities of the RDU;
- **Chapter 5** deals with critical operational issues that could impact on the performance of the RDU, including both the human resource and research infrastructure requirements for the RDU to sustain its operations in line with the Rural Road Research Plan. It addresses issues such as the implementation of a research career ladder; recruitment of staff; the skills development plan; research equipment requirements, and supporting infrastructure;
- **Chapter 6** deals with knowledge management, inclusive of information transfer, the importance of holding seminars and workshops, and the importance of realising demonstration projects for the uptake and embedment of new knowledge;
- **Chapter 7** presents a tentative cost structure for the RDU, which may be used for preliminary planning and budgetary purposes. However, the cost structure will have to be reviewed and adjusted in line with the outcomes of the physical establishment of the RDU.

The development and implementation of the Business Plan is supported by the Research for Community Access Partnership (ReCAP). ReCAP is a programme of applied research and knowledge dissemination funded by a grant from the UK Government through the Department for International Development (DFID). The overall aim of ReCAP is to promote safe and sustainable rural access in Africa and Asia through research and knowledge sharing between participating countries and the wider community. There are two components under ReCAP: The Africa Community Access Partnership (AfCAP) and the Asia Community Access Partnership (AsCAP).

The Business Plan presented in this document is expected to evolve over time in line with the shifting views and expectations of both DRRD and the Steering Committee, and the realities associated with the physical establishment of the RDU. The Business Plan should therefore be updated biannually.

2. Vision, Mission and Strategic Objectives

2.1 Vision

To provide scientific, engineering and technological leadership to effect sustainable improvements in the quality and effectiveness of rural access in support of socio-economic development imperatives and the attainment of Myanmar's Sustainable Development Goals.

2.2 Mission

Through research, development, implementation of research outcomes and capacity building, to enhance rural connectivity and to ensure transportation of people, goods and services in a safe, economic and sustainable manner, contributing to economic, social and cultural development in Myanmar.

2.3 Rationale

A sound rural road network is an essential ingredient of a country's social and economic development and well-being. Throughout the developing world, the lack of adequate road infrastructure and the long travel time required to access markets and essential services (e.g. schools, hospitals) have been a major concern for rural communities. The role of rural transport in increasing access to and participation in these markets has been emphasised by numerous governments of developing countries as well as multilateral organisations such as the Asian Development Bank, World Bank and the International Fund for Agricultural Development.

There is a strong link between the socio-economic development and livelihoods of rural communities, and the provision of rural access. The provision of basic road infrastructure enhances livelihood and income generation activities in rural areas. Rural roads can play a meaningful role in improving rural income, fostering consumption, spurring infrastructure development and reducing poverty. Improved rural access equates to, among other things, reduced travel time and costs, better use of resources leading to higher incomes, the development of small businesses in rural areas as well as growth in tertiary activities and public sector employment.

An effective rural road network is thus of key importance since it acts as a catalyst for sustained economic growth and social development. The RDU will support Myanmar in addressing the following Sustainable Development Goals (SDGs) which the Government of the Republic of the Union of Myanmar has committed itself to achieving:

- **SDG #1 related to poverty reduction** – Rural roads have been proven to provide access to employment opportunities outside the villages, while simultaneously providing access to markets for selling produce and purchasing inputs, and facilitating access to education to improve future income earning opportunities.
- **SDG #2 related to hunger reduction** – Rural roads have been proven to lead to higher incomes and related food consumption, while also facilitating access to knowledge and inputs necessary for increasing agricultural produce
- **SDG #3 related to improved health** – Rural roads have been proven to facilitate access to health facilities and services and to health education, leading to improved health standards within rural areas.
- **SDG #4 related to improved education** – Rural roads have been proven to facilitate year-round access to education facilities which leads to lead to improved education standards, a reduction in education costs and drop-out rates, as well as an overall reduction of all other difficulties associated with obtaining an education.
- **SDG #8 related to improved employment opportunities** – Rural roads have been proven to increase and facilitate access to employment opportunities both outside villages, as well as increasing income earning opportunities within villages.
- **SDG #9 related to building resilient infrastructure** – Rural roads are increasingly being built to an all-season standard that provides year-round access, while sustainability is ensured both through appropriate designs that are adapted to climate impacts, and proper maintenance to prevent road deterioration and damage.

- **SDG #10 related to reduced inequalities** – The increased access to services and facilities resulting from rural roads has been proven to lead to a reduction in inequalities between (remote) rural areas and the rest of the country.

2.4 Value Proposition

The establishment of the RDU is a high priority for the DRRD to support rural development in Myanmar. Once established and fully operational, the RDU will add value to Myanmar through the provision of:

- a multidisciplinary skills and expertise base in rural road and transport engineering, which could include specific competences in geometric design; structural design of roads and road-related structures; road performance evaluation and modelling; road materials design and optimisation; construction and maintenance methodologies; quality control/assurance; asset management; road safety; traffic management; transport services; advanced data analysis, and decision support systems;
- core competences to support the development or updating of guidelines, norms and standards for rural roads;
- when the RDU material testing laboratory is established, access to research infrastructure;
- access to several technology and software platforms that will provide technical support to the roads sector and support advanced research;
- an information resource centre that will be a repository for, among others, text books, local and international conference proceedings and journals, research reports, technical guidelines, norms and standards, all of which would be accessible to all stakeholders; and
- capabilities for developing solutions and products that will address rural road and transport-related problems that impact on the national priorities of Myanmar, including socio-economic development and public service delivery, thus leading to socio-economic impact and public good.

2.5 Goal and Strategic Objectives

The goal of the RDU is to serve the rural road engineering and transport needs of the public and private sector of Myanmar through the development, application and dissemination of best practices and new knowledge, and the development of human capital.

It will strive to provide practical, innovative and cost-effective R&D based solutions that:

- address the current and future rural road and transport needs of the country;
- support sustainable development and asset preservation; and
- enhance socio-economic impacts.

It will provide innovative engineering solutions for:

- the design, construction, maintenance and management of rural road infrastructure, and
- efficient and safe transport operations based on applied research supporting the provision of a sustainable and cost-effective road network.

In order to achieve these goals over the next five years, the RDU will focus on:

2.5.1 Science, Engineering and Technology (SET) Base

- Developing a road research agenda for the country, guided by the Rural Road Research Technical Committee (RRTC) and endorsed by the Steering Committee;

- Establishing (year 1), strengthening (year 2) and broadening (year 3 and beyond) the SET base of the RDU in line with the research priorities of the country and in support of the service delivery priorities of DRRD;
- Establishing the required research infrastructure to support the research agenda.

2.5.2 Human Capital Development

- Attracting, nurturing and retaining local capacity to undertake research;
- Establishing a customised research career ladder for staff of the RDU;
- Developing and implementing capacity building programmes to develop research skills and establish a research culture;
- Cooperating with universities, offering opportunities for students to participate in the research programme of the RDU.

2.5.3 Relevant Knowledge Generation and Transfer

- Developing innovative local, cost-effective solutions for local problems;
- Adapting appropriate technology and solutions from elsewhere to satisfy local conditions;
- Build capacity to conduct forensic investigations to understand causes and mechanisms of problems identified, and to support activities to prevent their recurrence;
- Coordinating long-term, demand-driven research activities to maximise benefits to the country;
- Drafting and/or updating of guidelines, norms and standards;
- Establishing an information resource centre to house, among others, books, local and international conference proceedings and journals, research reports, technical guidelines, norms and standards;
- Managing technology transfer through press releases, publications, lectures, workshops, seminars and conferences in order to advance knowledge within the road and transport sector;
- Assessing the contribution and impact of the activities and outcomes of the RDU on socio-economic growth, poverty reduction and social development through improvements made in design, construction, maintenance and management of rural road assets.

2.5.4 General

- Establishing sustainable (i.e. long-term) local sources for funding of research and development activities;
- Establishing strong linkages with relevant stakeholders nationally, and liaising and entering into cooperation agreements with similar road research centres internationally.

3. Governance

3.1 Strategic Oversight

A rural road research Steering Committee will provide overarching strategic oversight of the RDU. The role and responsibilities of the Steering Committee will include the following:

- To steer the establishment and operations of the RDU and assess the adoption of ‘good governance’ principles;
- To endorse the priority research, development and implementation projects recommended by the RRRTC and identify and/or endorse allocation of funding to projects;
- To support the appointment of project champions and teams;
- To provide overarching project management and output quality reviews;
- To monitor effective technology transfer and implementation of outcomes.

Ideally, the Steering Committee should convene at least twice a year, but probably more frequently during the establishment phase of the RDU.

The membership of the Steering Committee will comprise of senior representatives of organisations that include:

- the Ministry of Construction (MOC):
 - Department of Rural Road Development (DRRD)
 - Department of Highways (DOH)
 - Department of Bridges (DOB)
- the Ministry of Transport and Communications (MOTC):
 - Road Transport Administration Department (RTAD)
- the Ministry of Border Affairs (MOBA)
 - Progress of Border Area and National Races Development (PBANRD)
- The Ministry of Agriculture, Livestock and Irrigation (MOALI)

Representatives of development partners, such as the Asian Development Bank, the World Bank, the German Development Bank (KfW), the EU, JICA and DFID, could be invited to witness the proceedings.

The Director of the RDU, in his/her capacity as the Chairperson of the RRRTC, should also be a member of the Steering Committee.

3.2 Institutional Structure

3.2.1 Institutional Location and Reporting Structure

Institutionally, the RDU will be located as a Directorate in the Department of Rural Road Development under the Ministry of Construction (see Figure 1). The RDU will operate as an entity that will support all Directorates of DRRD on an equitable basis. The Director of the RDU will report to one of the Chief Engineers, who in turn will report to the Deputy Director General of Implementation in DRRD.

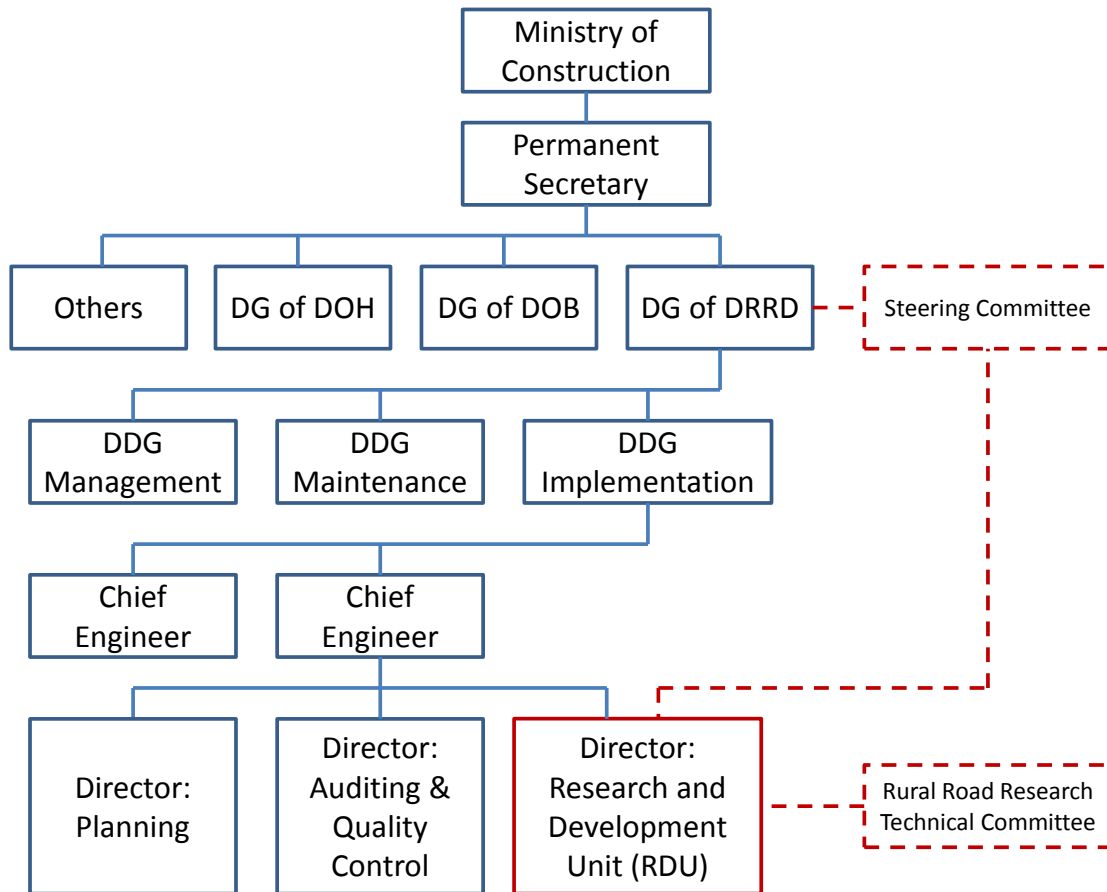


Figure 1: Institutional location of the RDU within the structures of MOC and DRRD

3.2.2 Physical Location

The RDU will be physically located in Nay Pyi Taw, the seat of Government. Initially, the RDU will rely on the DRRD Mobile Laboratory for both laboratory and field testing, or could make use of government-approved private laboratories. These should be able to provide the necessary research infrastructure to support the operations of the RDU while the RDU is establishing its own laboratories and procuring the necessary field testing equipment.

The RDU laboratories will be established in Nay Pyi Taw which is centrally located and thus ideally positioned from a logistics perspective to undertake national laboratory and field testing for not only research and development purposes, but also for forensic investigations and for quality control and assurance (i.e. the testing facilities could operate as a national reference laboratory).

3.2.3 RDU Organogram

The organisational structure of the RDU will evolve over time. Initially, while it has a fairly small complement of researchers, a structure such as the one proposed in Figure 2 could be considered:

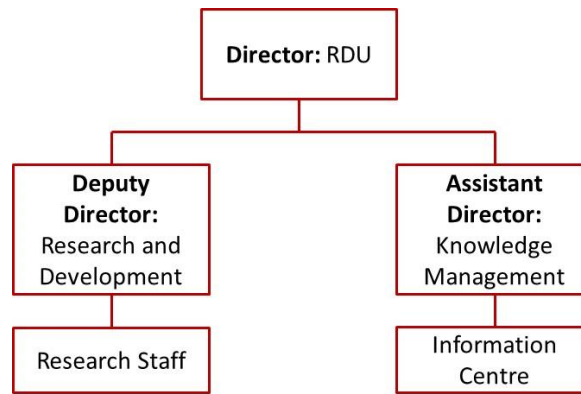


Figure 2: Initial structure of the RDU

The Director of RDU would report directly to the Chief Engineer, who in turn reports to the Deputy Director General: Implementation. The RDU will be supported by two subgroups, namely a *Research and Development* Group and a *Knowledge Management* Group. A third group would be added at a later stage (*Laboratories*). As mentioned above, the RDU would have to rely on the DRRD mobile laboratory and services rendered by government-approved private laboratories to support the initial RDU’s research activities until the RDU has established its own laboratories.

At first, grouping all research engineers and scientists together in the *Research and Development* Group would have the advantages of supporting shared learning and more effective and efficient capacity building, while also creating commonality of purpose amongst all researchers. As the RDU evolves over time, it may become necessary for the RDU to divide the existing *Research and Development* Group into two or more new Groups, each addressing specific fields of study (e.g. Materials and Construction, Pavement Engineering, Structures, Transportation, etc.).

The Information Centre would serve the technical information needs of the RDU researchers, DRRD and the roads sector in Myanmar as a whole. The strategy for the establishment of the Information Centre is presented in Chapter 6.

3.2.4 Shared Resources

Shared services refers to the provision of a service by one part of an organisation where that service would otherwise be found or duplicated in more than one part of the organisation. Thus the funding and resourcing of the service is shared and the providing department effectively becomes an internal service provider. The key is the idea of 'sharing' common or similar types of services within an organisation.

Since the RDU will form an integral part of DRRD and the permanent staff of the RDU will be employed by DRRD, the RDU will share the functions of Human Resources, Finance, Legal Services and Facility Management with DRRD. Hence, there would be no need to duplicate any of those services in the RDU.

3.3 Sources of Funding

The RDU will require long-term guaranteed funding for at least five years, but preferably ten years after its establishment, i.e. its operational costs and overheads should be fully funded by DRRD. The initial focus of the RDU will be on establishing and deepening the science, engineering and technology (SET) base, including the capacitation of its staff and yielding early returns in terms of research outputs benefitting the sector. From the outset, the RDU should have a strong technology focus and its functions should therefore not be diverted to sourcing and securing funding.

Hence, the DRRD would have to carry the costs of the RDU, possibly through a special dispensation from the MOC, who could, for instance, raise capital for sustaining the RDU by charging a levy on road construction projects. The returns that the DRRD and MOC will yield from supporting the RDU financially are multi-faceted and include: more cost-effective and longer-lasting rural infrastructure; improved rural access; more efficient deployment of limited

resources; strengthening of the SET skills base of Myanmar and of the DRRD in particular; early solution for problems on site; and easy access to technical information through the Information Centre.

The RDU should also be able to attract funding from Development Partners, such as the ADB, World Bank, KfW, DFID, JICA, etc. to supplement its own funding. Similarly, the RDU should be able to recover costs from other institutions, both public and private, for which research or training is undertaken or specialist assistance is provided.

3.4 Key Performance Indicators and Targets

Key performance indicators allow the conversion of the quantitative and qualitative criteria for evaluating the critical success factors of the RDU into objective and measurable values. Since the RDU is in many respects a greenfield venture, two sets of critical success factors and key performance indicators are required, namely those required for appraising whether the formal establishment of the RDU is on track to satisfy the short-term institutional objectives, and those required for gauging whether the RDU is on course to fulfil its goals and operational objectives in the short to medium term.

The critical success factors and indicators for establishing the RDU, and their progress in achieving those, are listed in Table 1. Since the RDU Business Plan is a 'living' document, progress will have to be updated on a regular basis.

Table 1: Critical Success Factors and Key Performance Indicators for Establishment of RDU

Critical Success Factors	Key Performance Indicators	Target date	Achieved/Outstanding
Establishing Good Governance Principles for the RDU	Institutional location of the RDU finalised	Aug-17	<input checked="" type="checkbox"/>
	Physical location of the RDU finalised	Sep-17	<input checked="" type="checkbox"/>
	Linkages with key stakeholders in Myanmar established	Oct-17	<input checked="" type="checkbox"/>
	Steering Committee established	Dec-17	<input checked="" type="checkbox"/>
	RDU Business Plan accepted by Steering Committee	Dec-17	<input checked="" type="checkbox"/>
	Linkages with international R&D centres established	Jun-18	<input type="checkbox"/>
Establishing an RDU Research Agenda	RRRTC established	Jun-17	<input checked="" type="checkbox"/>
	Research needs identified	Jun-17	<input checked="" type="checkbox"/>
	Research needs prioritised	Jun-17	<input checked="" type="checkbox"/>
	RDU Strategic Research Plan accepted by RRRTC	Sep-17	<input checked="" type="checkbox"/>
	Research proposal format accepted by RRRTC	Feb-18	<input type="checkbox"/>
	Detailed research proposals prepared	May-18	<input type="checkbox"/>
Operational Requirements for Establishing the RDU	Human resource requirements for RDU identified	Nov-17	<input checked="" type="checkbox"/>
	Staffing plan for RDU accepted	Dec-17	<input checked="" type="checkbox"/>
	Job descriptions for RDU staff accepted	Dec-17	<input checked="" type="checkbox"/>
	Training and capacity building plan accepted	Mar-18	<input type="checkbox"/>
Operationalisation of the RDU	RDU offices (including IT, etc.) allocated	Dec-17	<input checked="" type="checkbox"/>
	RDU staff recruited	Jan-18	<input type="checkbox"/>
	Supporting RDU databases established	May-18	<input type="checkbox"/>
	Supporting documentation for RDU available	May-18	<input type="checkbox"/>
	RDU researchers capacitated	Jul-18	<input type="checkbox"/>
	Laboratory established	Sep-18	<input type="checkbox"/>
	Information Centre established	Sep-18	<input type="checkbox"/>
	Laboratory functional	Dec-18	<input type="checkbox"/>
	Information Centre (guidelines et al) resourced	Dec-18	<input type="checkbox"/>

The critical success factors and key performance indicators to gauge whether the RDU will be on course to fulfil its pre-set goals and operational objectives in the short to medium term (i.e. within the first five years) are listed in Table 2. The key performance indicators address the following four critical success factors:

- R&D portfolio efficiency and effectiveness;
- Ensuring effective transfer of technology to practice;
- Strengthening the skills base of the RDU; and
- Ensuring good governance.

Table 2: Critical Success Factors, Key Performance Indicators and Targets for the Operations and Management of the RDU

Critical Success Factors	Key Performance Indicators	Targets				
		Year 1	Year 2	Year 3	Year 4	Year 5
R&D portfolio efficiency and effectiveness	No. of RRRTC meetings held	3	2	2	2	2
	Compliance with RRRTC directives	100%	100%	100%	100%	100%
	No. of research projects in active development	2	4	6	8	12
	No. of projects secured with private sector funding	0	0	1	2	4
	No. of projects secured with Development Partners contribution	1	2	3	4	6
	No. of projects successfully completed	1	2	4	6	9
	% Milestones met (i.e. % R&D objective achievements)	100%	100%	100%	100%	100%
	Released vs. planned deliverables (%)	100%	100%	100%	100%	100%
	Portfolio yearly spending against budget (%)	100%	100%	100%	100%	100%
	Cost savings attributable to R&D	Report	Report	Report	Report	Report
Stakeholder satisfaction with research outcomes	70%	70%	75%	80%	85%	
Ensuring effective transfer of technology to practice	No. of conference papers presented	1	2	3	5	7
	No. of journal articles published	0	1	2	3	3
	No. of industry workshops held	2	4	6	8	8
	No. of industry guidelines and manuals published	0	1	2	2	3
	No. of norms and standards published	0	1	1	2	3
	No. of demonstration projects successfully completed	1	2	2	3	4
Strengthening the skills base of the RDU	No. of Doctorates	1	1	1	2	2
	No. of Masters	1	1	3	3	4
	No. of staff classified as researchers	4	4	6	8	10
	No. of technical staff (laboratory/field testing)	1	2	4	7	7
	No. of staff studying towards a PhD	1	1	1	1	2
	No. of staff studying towards a Masters	2	2	3	3	4
	No. of staff inducted at international R&D centres	1	1	1	1	1
	Average % time spent by research staff on R&D projects	60%	60%	65%	65%	70%
	Average % time spent on administration/management	20%	20%	15%	15%	15%
	Average % time spent on capacity building	15%	10%	10%	10%	5%
Average % time spent on industry events (e.g. workshops)	5%	10%	10%	10%	10%	
Ensuring good governance	No. of Steering Committee meetings held	2	2	2	2	2
	Compliance with Steering Committee directives	100%	100%	100%	100%	100%
	Adherence to standards of good corporate governance	100%	100%	100%	100%	100%
	ISO 9000 quality system implementation	-	initiate	initiate	comply	comply
	Adherence to health, safety and environment standards	100%	100%	100%	100%	100%
	Collaboration with universities: No. of projects with universities	0	1	2	3	3
	International R&D collaboration: No. of MoUs signed	0	2	3	4	4

Table 2 should be (re)assessed at the end of each financial year.

3.5 Strategic Relationships and Linkages

A description of potential entities that could be targeted by the RDU are listed below. A draft Memorandum of Understanding that will assist the RDU to enter into agreements with both national and international entities once the RDU is formally established is provided in Appendix A.

3.5.1 Within Myanmar:

The RDU should have strong links with other institutes that carry out research within Myanmar.

Cooperation agreements with universities in Myanmar, such as the Mandalay Technological University (MTU) and the Yangon Technological University (YTU), will also be beneficial for the RDU. Some of the research activities may be supported by graduate students, which may contribute to the development of practical skills in a work environment and, in some cases, become a starting point for a research career. Reciprocal arrangements for RDU staff to further their qualifications should also be negotiated.

The RDU will also establish cooperation links with other major players in the field of road engineering, such as professional associations and consultants, through their participation at the RRRTC.

3.5.2 International Linkages and Alliances:

The RDU should have strong linkages with similar international organisations, such as research institutes (e.g. CSIR in India and South Africa, TRL in the United Kingdom, ARRB in Australia), and universities in South Asia. Memorandums of Understanding should be signed between DRRD/RDU and relevant international organisations and institutions to promote cooperation between these entities.

Through the Asia Community Access Programme (AsCAP) and funding provided by DFID, several new road research centres will be established in countries such as Nepal and Bangladesh. It is important for the RDU to establish formal linkages and networks between those emerging and other road research centres as well as universities that have been in existence for a number of years. Those formal linkages and networks will facilitate the sharing of best practices; the provision of scientific input to regional and national government policy on rural transport and road engineering; the creation and preservation of an efficient and safe road network in South-East Asia; the stimulation of innovation in road construction; improving the cost-efficiency of rural road engineering (and operations); and the protection of the environment and the improvement of quality of life. They will also assist in avoiding duplication of research and/or facilitating combined projects.

4. Research, Development and Implementation Plan

4.1 Role and Responsibilities of the RRRTC

The Rural Road Research Technical Committee (RRRTC) was constituted on 27 June 2017 to provide technical guidance and direction to the RDU and to advise the Steering Committee on the nature and scope of research, development and implementation activities to be or being undertaken in the rural road infrastructure engineering domain. Its membership comprises the following technical experts (finalised at the second meeting of the RRRTC held on 29 September 2017):

- U Khin THet DRRD,MOC
- U Myint Oo DRRD.MOC
- U Wunna Zaw DRRD,MOC
- U Win Thein DRRD,MOC
- Daw Kyi Kyi Thway DRRD, MOC
- Daw Tin Moe Myint DRRD, MOC
- U Soe Tun Naing DRRD, MOC
- Dr Tun Myint Aung DRRD, MOC
- Daw Aye Aye Soe DRRD, MOC
- U Soe Soe Oo DRRD, MOC
- Daw Yin Min Htut DOB, MOC
- Daw Htar Zin Thin Zaw DOH, MOC
- U Aung Thway Win DOH, MOC
- U Ko Ko Naing DOH, MOC
- U Tay Zar Nay Myo DRD, MOALI
- Daw Ei Kay Khaing MOTC
- U Zaw Hlaing Win MOBA
- U Myo Thant MOBA
- A/Prof Htay Win Civil, YTU
- Prof Kay Thwal Tun Civil, MTU
- U Win Pe Than Myanmar Engineering Society (MES)
- Environmental Expert Department of Meteorology and Hydrology (DMH), MOTC
- Development Partners (as observers)

The Director of the RDU, U Soe Tun Naing, will be the Chairperson of the RRRTC.

The role and responsibilities of the RRRTC are to:

- Advise on research, development and implementation (RDI) needs and priorities;
- Assist with technology foresight studies;
- Advise on strategic plans and research portfolio plans for the RDI programme;
- Assist with project portfolio analysis;

- Assist in review of research proposals in line with the strategy;
- Assist in the review of outputs and outcomes of RDI projects;
- Assist in assessing the impact of RDI activities.

Through the discharge of their key responsibilities, the RRRTC should enhance the development of rural road and transport research policy, encourage multidisciplinary research, stimulate innovation in rural road construction technologies, and support the promotion of best practices in Myanmar. The RRRTC decision-making process on research, development and implementation should reflect the national strategic plan in the rural road sector.

The RRRTC will convene at least two times a year, but during the establishment phase of the RDU at least three times a year.

4.2 Rural Road Research Strategic Plan

4.2.1 Process

In association with the RRRTC, the RDU needs to prepare an annual Rural Road Research Strategic Plan (RRRSP) to direct its research and development operations and plan its deliverables. This Plan needs to be endorsed by the Steering Committee before it is implemented.

Progress against the RRRSP will be reported at the meetings of the RRRTC, and the Plan needs to be updated after each meeting to incorporate recommendations made by the RRRTC. Any significant changes made to the Plan needs to be presented to the Steering Committee for their endorsement.

The following **process** is recommended for the identification, prioritisation and execution of a portfolio of research projects associated with *Rural Roads and Transport*¹:

1. Prepare a database of all current and past research undertaken on rural roads and transport in Myanmar (once-off, but to be updated continually) [responsibility: RDU Knowledge Management];
2. Identify new R&D needs internally, and externally through interaction with key stakeholders [responsibility: RDU R&D];
3. Relate the needs identified to any current and previous R&D undertaken [responsibility: RDU R&D];
4. Cluster the research needs according to theme or subject area and draft preliminary motivations for each of the identified themes, as well as potential outputs and benefits to be derived by addressing the identified themes, creating a plan [responsibility: RDU R&D and RDU Knowledge Management];
5. Organise an RRRTC meeting to table the identified themes with the main needs in a structured manner [responsibility: RDU R&D];
6. Identify additional research themes (also focussing on the positioning of the DRRD to address future challenges), discuss the merits of each, and follow a structured process/ procedure for prioritising the R&D themes and needs [responsibility: RRRTC members] – these processes and procedures could assume any one of the following proposed formats or a combination of these:
 - a. Debate all R&D themes and needs and prioritise topics by consensus;
 - b. Allow each member of the RRRTC to rate only the top five research themes according to the critical importance to undertake projects to resolve them as soon as possible *on a scale of 1 to 5* (Rating of 5: most important topic of the top five selected; Rating of 1: least important topic of

¹ The *responsibilities* indicated in square brackets (e.g. [RDU R&D] and [RDU Knowledge Management]) refer to Heads of the RDU subgroups (and their support teams) as shown in Figure 2.

- the top five selected) – this process would require a significant number of RRRTC member responses (> 20) to be statistically significant;
- c. Allow each member of the RRRTC to rate all research themes using the following coding:
 - i. **A-Rating:** topics that are considered to be of *High Priority*; topics that are of critical importance and that should be undertaken as soon as possible
 - ii. **B-Rating:** topics that are considered to be of *Medium Priority*; topics that are still important but it is not essential that they be undertaken immediately
 - iii. **C-Rating:** topics that are considered to be of *Low Priority*; they are of less immediate importance and could be placed 'on hold' for now
 - iv. **Leave blank (no response):** There is no interest in the topic
 7. Process the outcomes of the RRRTC prioritisation process; develop concept notes for the priority projects within each theme while addressing overlaps and synergies between themes; estimate the costs for their execution, and consolidate in a multi-year Rural Road Research Strategic Plan (RRRSP; to be updated annually) [responsibility: RDU R&D];
 8. Submit the RRRSP to the RRRTC for evaluation and (provisional) acceptance [responsibility: RDU R&D and RRRTC];
 9. If 'provisional', incorporate recommendations of the RRRTC, resubmit to members of the RRRTC for their final approval, and on approval by the RRRTC submit the RRRSP, inclusive of a proposed implementation plan, to the Steering Committee for endorsement [responsibility: RDU R&D];
 10. Evaluate and (provisionally) endorse the RRRSP and prioritise themes/projects, and identify (potential) sources of funding [responsibility: Steering Committee];
 11. If 'provisional', incorporate recommendations of the Steering Committee, resubmit to members of the Steering Committee for their final approval, and on approval by the Steering Committee members finalise the implementation plan, inclusive of sources of funding;
 12. Mobilise the RDU research team (potentially in partnership with other R&D providers identified/ appointed by the RDU and/or Development Partners) to implement the prioritised projects of the RRRSP in line with the Steering Committee's endorsement [responsibility: RDU R&D];
 13. Manage the execution of projects so as to ensure that they are delivered on brief, on budget, on time, and to the required level of quality [responsibility: RDU R&D];
 14. Ensure that the projects will deliver the outputs required to fully address the identified needs and that the mechanisms are in place to uptake the solutions provided (through for instance training courses, workshops and seminars) and their embedment in guidelines, manuals, standards and specifications, where appropriate [responsibility: RDU R&D and RDU Knowledge Management];
 15. Monitor the uptake and embedment of the project's outputs [responsibility: RDU Knowledge Management];
 16. Conduct impact assessments by monitoring a pre-defined set of indicators over time so as to determine the trend of the uptake and eventual impact of the research programme.

The above may have to be further customised in line the procedural and organisational requirements and imperatives of the DRRD.

4.2.2 Prioritisation of Research Needs and Research Projects

This section presents an overview of research projects that could be implemented by the RDU. It is based on the outcomes of a Scoping Study completed by ReCAP in 2016² and the research needs prioritised by the Rural Road Research Technical Committee, who held their first meeting on 27 June 2017 at the offices of the Department of Rural Development (DRD) in Nay Pyi Taw and their second meeting on 29 September 2017 at the offices of the Department of Rural Road Development (DRRD) in Nay Pyi Taw.

The RRRTC prioritised ten projects from a list of potential projects. The following research projects, in order of priority, were recommended by the RRRTC for endorsement by the Steering Committee:

1. Rural road and bridge standards and development of a low-volume rural road design manual³
2. Road protection measures (drainage and slope protection)
3. Geometric design guidelines for rural roads
4. Road surfacing trials
5. Asset management:
 - Rural road and bridge inventory and database
 - Road selection and prioritisation
6. Climate adaptation of rural road networks
7. Best practice guidelines for the maintenance of rural roads
8. Guidelines for the optimum utilisation of local materials in rural roads
9. Complementary access infrastructure (i.e. footpaths, footbridges)
10. Integration of road safety considerations into land use planning decisions and investment decisions on rural road infrastructure

Brief outlines of the ten projects are presented in the sections below. The projects have been categorised in the following three clusters:

- High priority ‘quick win’ and/or ‘Immediate Need’ projects that have the potential to be viewed as “breakthrough projects” on their completion, addressing pressing needs, yielding high impact and demonstrating the value of the RDU to its stakeholders early in its existence;
- High priority ‘quick win’ or medium to longer-term projects with a similar high impact, but which are not perceived to be ‘Immediate Need’ projects, although these projects would be expected to yield benefits similar to those of the former group of projects; and
- Cross-cutting high priority activities that can be developed and implemented in association or in parallel with projects in the other two categories.

² Cartier van Dissel, S. *Myanmar Research Programme Planning with the Department of Rural Development: Phase I Report*. Asia Community Access Partnership (AsCAP), MYA2080A, August 2016.

³ This project has already been initiated with financial support from DFID through the ReCAP programme.

4.2.3 High Priority, 'Quick Win' and/or 'Immediate Need' Research Projects

4.2.3.1 Road protection measures (drainage and slope protection) [Priority 2]

Project Objectives

The aim of this project is to identify suitable low-cost measures to improve the drainage and slope protection in rural areas, two aspects that cause significant damage to rural roads and obstruct access of rural villages, and to develop model designs and technical standards. In order to achieve this goal, the project has been subdivided into four proposed main tasks with specific activities:

The objective of the **first** task is to review the status of current road protection measures and design standards in Myanmar. Evaluation of the current infrastructure will require onsite inspections to structures such as culverts, drains, filters, retaining walls, slopes, etc. to assess their condition and identify aspects requiring improvement (e.g. appropriateness of the designs, construction standards, maintenance practices, etc). As part of these forensic investigations, the common modes of failure should be identified, as well as their likely causes. For slopes, for instance, these could include deforestation, encroachment of human habitat, steep unprotected slopes, poor soil composition, lack of drainage, seismic activity, lack of reinforcement, etc.

The objective of the **second** task is to identify most likely solutions or methods of addressing the most probable causes of failure identified in task 1. Ideally locally sourced solutions should be sought to resolve these problems. This should include a review of international best practices and identify those practices that will be appropriate for Myanmar. As part of this task exchange visits to a country in the region that has implemented good practices.

The objective of the **third** task is to develop model designs, comprehensive guidelines (or updates to any guidelines available) and technical standards. This will ensure that engineers have a set of uniform guidelines that may be implemented for road protection measures across the country, thereby minimising risks to life or damages to rural road infrastructure.

The objectives of the **fourth** task are (a) to disseminate the guidelines/standards through training courses and seminars, (b) to demonstrate the proposed improvements through the construction and performance monitoring of a series of trial sections. These trials should also be used for hands-on training of practitioners.

Expected Benefits

The benefits of implementing appropriate standards and guidelines to improve drainage and slope protection in rural areas will ensure that road damages and loss of access resulting from inadequate drainage systems or slope protection will be reduced, positively impacting on road budgets and safeguarding communities and road users.

Estimated Duration and Resource Inputs

- Estimated duration: 9 to 12 Months for Tasks 1, 2 and 3 (short term), and 3 to 4 years for Task 4 (long term)
- Estimated Man-days: 230
- Estimated total cost (excluding the costs of trial sections):
 - USD 230,000 (if undertaken by international consultants)
 - USD 35,000 (if undertaken by RDU research staff)

4.2.3.2 Geometric design guidelines for rural roads [Priority 3]

Project Objectives

The purpose of this project is to produce a manual/guideline that will be used as a standard for the geometric design of low volume rural roads in Myanmar (earth roads, gravel roads, low-volume paved roads, etc.). The generation of a geometric design manual/guideline for rural roads will improve aspects associated both with current road infrastructure as well as the delivery of more efficient and safer roads. It will provide engineers with

multivariable aspects of design and thought processes to deliver roads that satisfy mobility, accessibility and safety concerns and objectives. For example, the guideline could provide a method for determining lane widths of rural roads based not only based on traffic volumes but also on various other aspects that may impact on rural communities (e.g. a narrow lane may allow lower volumes of traffic to pass but they may provide safer crossing distances for pedestrians as well as prescribe lower speed limits which is safer to pedestrians who are known to travel across roads in rural communities).

The project could consist of three tasks. **Task 1** will be a critical assessment/review of the status of existing guidelines, including an assessment of all factors impacting on geometric standards (i.e. traffic estimates, traffic composition, design vehicle, design speed, sight distances, cross section elements, horizontal and vertical alignment, at-grade junctions, road furniture and markings, etc.). A review of international best practices for low-volume rural roads should also be undertaken as part of Task 1, including the benchmarking of current Myanmar guidelines against those. **Task 2** will consist of field work to identify typical shortcomings and problems, including an assessment of black spots (high accident zones) to identify those aspects that are a regular cause of accidents and that can be attributed to geometric design standards. The preparation of a new geometric design manual/guideline will be undertaken in **Task 3**. A Working Group should be established that will be used as a sounding board and a discussion forum to support the development and finalisation of the manual/guideline. Once finalised, the new manual/guideline should be disseminated through a series of courses.

Expected Benefits

A number of benefits will be achieved by improving the geometric design of rural roads. As mentioned, the methodological aspects addressed by geometric design may provide roads that are safer for use, promote improved mobility and accessibility, and are more sustainable over the long term. The inclusion of improved aspects of safety in the guidelines will reduce risks of loss of life in the form of reduced vehicular and pedestrian accidents.

Estimated Duration and Resource Inputs

- Estimated duration: 12 Months
- Estimated Man-days: 100
- Estimated total cost:
 - USD 95,000 (if undertaken by international consultants)
 - USD 6,000 (if undertaken by RDU research staff)

4.2.4 Strategic Longer-Term Research Projects

4.2.4.1 Road surfacing trials [Priority 4]

Project Objectives

The ultimate goal of this project is the development and implementation of protocols for establishing and monitoring trial sections in a systematic way. In order to achieve this goal, the project has been subdivided into three main tasks with specific activities.

The objective of the **first** task is to evaluate the nature and quality of information available from the existing trial sections established on rural roads (e.g. trials established through KfW funding in flat terrain near Taunggyi). An in-depth review of the existing trial sections should be undertaken. The objective of the **second** task of the project is to develop guidelines/protocols to ensure that the establishment of trial sections and collection of performance data are standardised. The objective of the **third** task is to establish new trial sections on rural roads, and to collect data on previous and new trial sections on a continuous basis over a number of years according to the monitoring processes provided in the guidelines/protocols developed as part of Task 2.

Expected Benefits

The benefits of properly established and well managed trial sections include the development of basic knowledge on the behaviour and performance of rural road pavements subjected to traffic and the environment, which ultimately will result in the development of specifications for innovative material use and/or construction methods, or improved specifications for existing materials, and will thus contribute towards better performing and more cost-effective rural roads.

The analysis of the collected data will assist the RDU to establish correlations between construction quality and performance as well as to assess the cost-effectiveness of specific construction methods and materials. The availability of quality data will also assist the RDU to undertake future studies, enabling them to hone in on specific issues to support the development of sustainable solutions.

Estimated Duration and Resource Inputs

- Estimated duration: 12 Months for Tasks 1 and 2 (short term), and 4 Years for Task 3 (long term)
- Estimated Man-days: 200
- Estimated total cost:
 - USD 190,000 (if undertaken by international consultants)
 - USD 10,000 (if undertaken by RDU research staff)

The above costs exclude the physical establishment of new trial sections. It is envisaged that trials could form part of existing or new projects/programmes funded by, for instance, the World Bank and ADB.

4.2.4.2 Best practice manual for the maintenance of rural roads [Priority 7]

Project Objectives

The ultimate purpose of the project is to produce a manual that will be used as a standard for low volume road maintenance in Myanmar. The project context and expressed need for the development/revision of existing maintenance manuals means that the manual should not only introduce a systematic procedure for improving maintenance quality of rural roads, but should also be a mechanism through which the cost of maintenance of rural roads can be reduced. It should be noted that no matter how good the maintenance to a rural road is, if the materials are of inadequate quality and the construction quality was poor, the road will perform poorly.

For instance in the case of unpaved rural roads, the specifications for such roads generally require limits for grading, plasticity, material strength and aggregate strength. However, many areas of Myanmar may only have local gravels available with grading and plasticity properties that could indicate potentially poor performance. Examination of a number of these gravels, where used for local roads, could indicate that they can provide satisfactory service if appropriately maintained, certainly for lower volume unpaved roads, but work needs to be done to identify the exact specifications needed for their classification and use [there may be potential linkages to **Priority Project 8**].

The project will thus assess existing ('best practice') information and rural roads currently in service and develop an improved manual and specification criteria for the maintenance of rural roads, which should also include the use of 'marginal' materials either in a natural state or after improvement using mechanical or chemical stabilisation. The project will also provide specific guidance for the maintenance of rural roads and/or improvement in the methods of using locally available gravels.

Expected Benefits

A number of benefits will be achieved by introducing a manual and procedures for rural road maintenance. Introduction of timely maintenance programmes will lead to better performing rural roads, increase the cost-effectiveness of operations, and result in environmental and sustainability benefits. Better performing rural roads will reduce vehicle operating (and overall road user) costs through a better riding quality, reduce accidents and improve accessibility. While poorly maintained rural roads impact on accessibility during certain periods of the year,

well maintained rural roads will lead to improved mobility and access to towns, villages and farms. All of these will have a direct impact on the socio-economic development of rural and peri-urban areas.

The use of even a rudimentary rural road management system [Priority Project 5] will assist in budgeting and prioritising maintenance work and result in significant improvements to the rural road network.

Estimated Duration and Resource Inputs

- Estimated duration: 18 Months
- Estimated Man-days: 160
- Estimated total cost:
 - USD 150,000 (if undertaken by international consultants)
 - USD 10,000 (if undertaken by RDU research staff)

4.2.4.3 Guidelines for the optimum utilisation of local materials in rural roads [Priority 8]

Project Objectives

The main objectives of the project are to identify which local materials can potentially be used for road construction, improve their properties through laboratory and field studies, and where necessary develop appropriate specifications for their use. Two different aspects will be investigated: the use of local materials for unpaved roads and their use for paved roads.

i. Unpaved roads

The specifications for unpaved roads generally require limits for grading, plasticity, material strength and aggregate strength. However, many areas of Myanmar may only have local materials available with grading and plasticity properties that could indicate potentially poor performance. Examination of a number of these materials where used for rural roads may, however, indicate that they can provide adequate service, certainly for lower volume paved roads, but work needs to be done to identify the exact specifications needed for their classification. At the same time, work also needs to be done to explore means by which the performance attributes of these materials can be improved, for instance through modification or stabilisation.

ii. Paved roads

Similar to the unpaved roads, the use of non-traditional, local materials in the structural layers of paved roads can have significant cost benefits. Both natural and treated materials need to be assessed.

The project will thus focus on existing information and roads currently in service, ways by which to improve local materials and the development of specification criteria for the use of the materials in their natural form and/or through improvements.

Expected Benefits

A number of benefits will be achieved by being able to use materials not traditionally used for road construction but still be able to meet basic requirements such as all-weather accessibility. The use of such materials should contribute to lower construction costs, environmental and sustainability benefits, reduced vehicle operating costs through a better road network riding quality, reduced accidents and improved mobility and access. All of these would have a direct impact of the economic development of Myanmar. In addition to the above, the uptake of alternative materials in road construction (e.g. by-products from agricultural produce) could potentially support enterprise development and job creation.

The nature of this project would also assist in developing researchers of the RDU by developing areas such as the use of the Scientific Method, field and laboratory testing, product development, statistical analysis, and analysis and interpretation of test results.

Estimated Duration and Resource Inputs

- Estimated duration: 36 Months
- Estimated Man-days: 210
- Estimated total cost:
 - USD 200,000 (if undertaken by international consultants)
 - USD 15,000 (if undertaken by RDU research staff)

4.2.4.4 Complementary access infrastructure (i.e. footpaths, footbridges) [Priority 9]

Project Objectives

The purpose of this project is to produce a guideline manual that: (1) will assist local engineers with the design and supervision of the construction of footbridges, footpaths and other basic infrastructure that can be used by pedestrians and even motorcycles to access the road network; and (2) will assist technologists and artisan on the proper procedures for constructing these. In the case of footbridges these could include stone/brick arch bridges, timber bridges and rope suspension bridges. In the case of footpath, and from the perspective of all-weather access, these could include block paving in its widest sense (i.e. including setts, cobble stones, etc.) but could also include bamboo reinforced soils and others.

Expected Benefits

A number of benefits will be achieved by being able to introduce appropriate standards for the use of locally available natural materials in the construction of footbridges and footpaths for communities. These include:

- The generation of more semi-skilled workers and significant employment creation;
- The development of small-contractors with minimal outlay required on plant and equipment;
- The use of more local materials and a reduced reliance on industrial materials such as, for instance, steel girders, reinforced concrete, cement, crushed aggregate and steel plates that have to be imported at high cost for conventional bridge construction;
- The ability to carry out rapid and effective repairs of localised failed areas by either re-using materials or replacing them with minimum additional skills requirements;
- The construction can be done by local artisans that are abundantly available at village level.

Construction of footbridges and all-weather footpaths is a relatively simple skill that can be easily learned and transferred. It is especially relevant to villages and remote area where labour costs are relatively low, high-tech equipment is expensive and the practice is highly sustainable.

A significant amount of learning can be (and has to be) captured from local communities on how they have addressed community access historically, which best practices should be captured in the guideline document. For instance, the lessons learnt in Chin State should be captured and built upon.

Estimated Duration and Resource Inputs

- Estimate duration: 18 Months
- Estimated Man-days: 120
- Estimated total cost:
 - USD 130,000 (if undertaken by international consultants)
 - USD 15,000 (if undertaken by RDU research staff)

4.2.5 Cross-cutting High Priority Activities/Projects

4.2.5.1 Asset management [Priority 5]:

Project Objectives

This project has two components: (A) Establishment of a rural road and bridge inventory and database; and (B) Rural road selection and prioritisation.

Component A will build on the current efforts of KfW and ADB to collect information on existing rural roads and bridges, as well as the needs for upgrading roads to all-season standard and constructing additional roads to connect remaining villages. This area will involve significant data collection, which may also include a revision of visual assessment methodologies to achieve greater consistency, and GIS mapping, as well as the development of a database to store the data. To support this, the DRRD may have to invest in simple survey equipment, and establish databases for the collection of data in support of the overall Road Asset Management System. Collaboration would have to be sought with KfW and ADB as well as World Bank and other Development Partners.

As part of Component A, there may be a need to improve the consistency of subjective visual assessments and secondly to identify appropriate objective surveillance equipment suitable for use in Myanmar, as mentioned above. It should be noted that in many cases, equipment suitable for use on paved roads may be unsuitable for use on unpaved roads and attention will need to be paid to which types of equipment can best serve the needs of Myanmar.

As part of the project, existing international information on visual and automated surveys may have to be consulted, evaluated and considered for adoption in Myanmar. Many countries have visual assessment manuals and copies of each of these should be obtained and assessed. Those sections relevant to Myanmar can then be combined into a local standard, bearing in mind that terminal condition and failure criteria may differ from country to country. These manuals need to be devised such that calibration of assessors can be carried out using them and the resulting data collected by different assessors in different areas are comparable.

For the surveillance equipment, again it must be noted that certain equipment is highly sophisticated electronically and not suitable for use on certain types of road. Other equipment is robust and not sensitive to excessive dust and rough roads and may be far better suited to local conditions. All of this equipment needs to be calibrated on a regular basis and one of the duties of the DRRD may be to operate the standardised calibration sections.

Component B will build upon the current piloting of the methodology for identifying and prioritizing road construction and upgrading needs being developed by ADB. It will assist the DRRD in developing the core road network approach in order to prioritize rural road investments, and will work together with ADB and other development partners in applying the approach throughout Myanmar with the aim of having a comprehensive overview of the construction and upgrading needs in the country. The process would have to work closely with the district and township staff of the DRRD.

Expected Benefits

The end result of this project will be the ability of Myanmar to operate an effective road management system based on the necessary input data that will be acquired in a repeatable and valid manner, as well as methodologies for road selection and prioritisation.

The project is thus geared towards the provision of improved operational efficiency in assessing and monitoring the condition of road structures and the interpretation of condition data using appropriate analysis tools and techniques to make decisions on road prioritisation for construction, upgrading and maintenance. A number of direct benefits can be expected from this project, including:

- Improved characterisation and monitoring of the road assets;
- Improved data quality and consistency, using quality standards based on international best practices;
- Standardisation of asset condition assessment methods and improved ability to compare data sets objectively;

- Improved data quality and consistency, which together with more convenient analysis and reporting tools will result in better management decisions;
- Improved methodologies to make decisions on investment priorities in line with budget constraints.

In addition to the above, the project will also yield indirect benefits, such as those associated with the strengthening of the skills base in road asset management within the DRRD.

Estimated Duration and Resource Inputs

- Estimate duration: 24 Months
- Estimated Man-days: 580
- Estimated total cost:
 - USD 370,000 (if undertaken by international consultants)
 - USD 40,000 (if undertaken by RDU research staff)

4.2.5.2 Climate adaptation of rural road networks [Priority 6]

Project Objectives

Climate resilience is the extent to which a natural or social system is not sensitive to climate variability and change and has the capacity to adapt. Recent climate events in parts of Myanmar, resulting in flooding and landslides, have shown that current vulnerability levels are high and levels of climate resilience low. A systematic approach is thus required to define risks and assess the consequences thereof at network level, and to initiate the development of strategies and adaptation plans to mitigate these risks in a cost-effective manner.

The primary aim of this project is to model and understand the ramifications of climate effects, especially abnormally high rainfall for the rural road network, thereby providing information and guidance that may be used for future planning, preparedness and risk mitigation.

The objectives of the project are therefore to develop and to initiate the implementation of a climate resilience strategy for rural roads, as well as associated action plans, guidelines and manuals, for:

- Assessing the vulnerability of road pavements to adverse climate effects (i.e. quantifying the risk profile);
- Identifying and prioritising adaptation measures for rural road infrastructure that could be implemented immediately or phased in over time, so as to avert the negative consequences of adverse climate effects on the serviceability of the rural road network;
- Uptake through capacity building and embedment in policies, strategies, plans, standards and guidelines.

Expected Benefits

An implementable and accepted climate resilience and adaptation strategy will result in climate risk being considered as a normal part of decision-making and will therefore augment its effectivity, allowing the DRRD to reflect their risk preferences just as they would for other risk assessments. In this sense, it will prevent adaptation strategies to fail if they continue in the long run to be seen in a 'silo' separate from other dimensions of strategic planning and risk management. To reach this point will require a period of awareness raising, the development of vulnerability maps - also to better understand the scope and magnitude of the problem - and the development of adaptive engineering solutions and applying them in practical situations. This is a preferred path in developing public policy in 'new' fields. The first step, however, is to identify policy and engineering priorities.

The implementation of a climate resilience and adaptation strategy, with accompanying vulnerability maps, guidelines and manuals, will increase the adaptive capacity of the DRRD, and reduce the sensitivity of rural road infrastructure assets to their exposure to abnormal climate events and their effects. This would yield significant direct and indirect benefits in the medium to long term through a reduction in the cost of having to deal with

premature failures and emergency repairs, and a reduction in economic losses on account of road closures isolating communities from socio-economic opportunities.

Estimated Duration and Resource Inputs

- Estimated duration: 36 Months
- Estimated Man-days: 750
- Estimated total cost:
 - USD 700,000 (if undertaken by international consultants)
 - USD 65,000 (if undertaken by RDU research staff)

4.2.5.3 Integration of road safety considerations into land use planning decisions and investment decisions on rural road infrastructure [Priority 10]

Project Objectives

Traffic growth and population encroachments associated with the increased functionality of rural road networks can have significant detrimental consequences on rural communities, such as increased traffic accident and traffic-associated fatality rates, increased noise pollution, localised congestion, etc. The purpose of this project is to better align land use practices with road functionality and safety objectives, and ensure/promote alignment with broader socio-economic imperatives. A key manner in which this should be achieved is through the integration of land use practices with road and transport investment decisions relating to planned rural road infrastructure. In order to mitigate the harmful effects, the project aims to deliver successful integration of road safety into decision making through the following tasks and activities:

The **first** task is the development of road safety consideration addendums into policies that address concerns relating to rural road infrastructure such as land use policies, transport policies, environmental policies, infrastructure planning, pricing policies, subsidies, guidelines and regulations. These policies then need to be aligned in the context of road safety considerations, among others, to enable integrated approaches and mechanisms for planning and investment decisions of rural road projects.

The **second** task of the project is to develop Standards of Procedures (SOPS) that integrate safety considerations which may be used by engineers involved with the provision of rural road infrastructure. SOPS will ensure that engineers are guided in exercising judgement for rural road infrastructure in the context of road safety without the need for special training. For example, a SOP may have a checklist for an engineer to follow that enables him to consider the different safety considerations found in the policy addendums to be developed in task 1, as part of the planning phase of a project. This will ensure that road safety considerations are integrated directly into the rural road infrastructure and do not only reflect on policy level or amongst single level decision makers.

Expected Benefits

The integration of road safety concerns into land use planning decisions and investment decisions relating to planned rural road infrastructure may have significant benefits to rural communities. This may be provided in the form of various direct and indirect benefits such as overall safer rural transport networks (less accidents and fewer pedestrian injuries), greater economic benefits (more sustainable roads that have greater lifespan), social benefits (communities are less affected by losses of life or health risks such noise and air pollution), and land-use benefits (e.g. road infrastructure is rendered more safe).

Estimated Duration and Resource Inputs

- Estimate duration: 2 Years
- Estimated Man-days: 120

- Estimated total cost:
 - USD 100,000 (if undertaken by international consultants)
 - USD 8,000 (if undertaken by RDU research staff)

4.3 Technical Committees and Working Groups

Technical committees and working groups will have to be established to, among others, mobilise the intellectual capital of Myanmar road engineers to identify sustainable solutions for addressing current problems; to review, discuss and resolve technical issues, including the acceptance of new or changes to existing norms and standards; to establish a platform for sharing knowledge and building capacity; to identify areas requiring further R&D; and to resolve and endorse implementable outcomes of R&D.

These committees and working groups can be project-specific, could be constituted as sub-committees of the RRRTC or could be formed in response to a resolution made at an industry forum.

Based on the projects identified in Section 4.2, it is recommended that the following technical committees and working groups be established to support the R&D activities of the RDU and the achievement of the envisaged end-products, subject to the approval and implementation of these R&D projects:

Working Groups:

- Working Groups on road protection measures (drainage and slope protection)
- Working Group on geometric design guidelines for rural roads
- Working group for setting up procedures and guidelines for road surfacing trials
- Working group on the establishment and implementation of rural road maintenance guidelines
- Working Group to develop guidelines for complimentary access infrastructure (i.e. footpaths and footbridges)
- Working Group to explore the optimisation in the use of local/marginal materials in roads

Technical Committees:

- Technical Committee on rural road and bridge standards and development of a low-volume road design manual
- Technical Committee on asset management
- Technical Committee on adaptation to climate change (from drafting of policies to implementation of climate adaptation standards and guidelines)
- Technical Committee to provide directives on land use planning vis-à-vis road provision and traffic safety

5. Operations

5.1 Human Resources

5.1.1 Research Career Ladder

It is proposed that the RDU introduces a research career ladder to support career development and to underpin a reward and recognition system for those staff members whose role is to generate new knowledge: they undertake predominantly directed basic and applied research, and experimental development with little routine “consulting”.

Research and experimental development comprises creative work undertaken on a systematic basis in order to increase the stock of knowledge, and the use of this stock of knowledge to devise new applications. A researcher, in this context, is a person whose primary duty it is to perform research and/or experimental development based on “good science” and to effectively transfer these findings to stakeholders.

The proposed career ladder for researchers could have four clear rungs. These are:

- **Candidate Researchers (Level JE 3)** – researchers who would be required to work under supervision
- **Researchers (Level SAE)** – competent professionals who work independently within a given field
- **Senior Researchers (Levels SSAE)** – seasoned professionals with a track record in research and development, who are able to guide others and lead projects
- **Principal Researchers (Level AE)** – specialists whose sustained track record has led to widespread recognition within their field, and who are able to lead research and development programmes (groups of related projects), often integrating approaches across fields (could be appointed at salary levels of Assistant Director, Deputy Director or Director based on their level of expertise)

The use of titles by researchers should be formally subject to their placement on the above ladder. These titles should be used in external correspondence and on business cards.

The position of a researcher on the proposed career ladder will be based on a number of important inputs and outputs. Each of the inputs and outputs will be defined in broad terms with regard to levels of capability, and capability indicators will be suggested to help in the assessment of the capability of an individual and will be customised to the needs of the RDU. A researcher’s position on the ladder will be established by determining the weighted sum of their levels of competence with regard to inputs and outputs.

The inputs could include:

1. Required qualifications; and
2. Leadership and the ability to provide strategic direction to R&D activities.

The outputs could include:

1. Knowledge generation and dissemination;
2. Human capital development; and
3. Generating impact.

Each of the inputs and outputs would contribute to an overall score against which the appropriate rung for any given researcher would be determined. Remuneration levels would be according to the different rungs.

Additional guidance on how to rate researchers on the above proposed scale can be provided if and when requested.

5.1.2 Short to Medium Term Staffing Requirements

The initial staff complement of the RDU should be based on budgetary constraints but should also be aligned with the research priorities identified by the RRTC and endorsed by the Steering Committee.

It is anticipated that the RDU would be staffed initially with approximately eight technical professionals, with the potential to grow to at least 20 staff members in five years' time. In addition to the Director, the Deputy Director and the Assistant Director, the research staff would comprise three researchers, one technician and an information specialist in Year 1.

Indicative staff positions, inclusive of the RDU managerial positions, are shown in **Table 3** below (total complement of eight staff members for Year 1, excluding administrative staff):

Table 3: Initial human resources requirements for research delivery (Year 1 –excluding administrative staff)

Staff Category	Competency – Qualification Level	No. of staff required in Year 1
Director: RDU	<p>Key tasks:</p> <ul style="list-style-type: none"> • Strategic direction and business planning • Budgeting and financial monitoring and control • Identification and securement of sourcing of funding for R&D programme and knowledge dissemination • Stakeholder management (inclusive of RRRTC and Steering Committee management) • Quarterly and annual performance reporting • Operational Policy • Human resource management 	1
Deputy Director: Research & Development	<p>Key tasks:</p> <ul style="list-style-type: none"> • Technology foresight studies • Sector analyses • Needs determination • R&D strategy development and submission to RRRTC • R&D theme and focus definition and submission to RRRTC • Project proposal development and approval • R&D progress monitoring • Output evaluation and monitoring • Uptake evaluation and monitoring in association with AD: Knowledge Management • Performance indicator development and performance trends analysis 	1
Assistant Director: Knowledge Management	<p>Key tasks:</p> <ul style="list-style-type: none"> • Assess information requirements of its stakeholders • Collection, compilation and processing of data, information and knowledge needs within the DRRD structure • Facilitate access of DRRD staff to (electronic) information sources and services, in cooperation with DRRD/RDU's Library • Review of Terms of Reference of R&D projects and R&D proposals received (in conjunction with DD of R&D Management) to ensure that, if and where required, uptake of R&D outputs are included, and plan accordingly • Monitoring and management of R&D outcomes to ensure their uptake (through, for instance, training courses, workshops, seminars) and embedment (in standards, specifications, manuals and guidelines) 	1

Staff Category	Competency – Qualification Level	No. of staff required in Year 1
	<ul style="list-style-type: none"> • Cooperation and facilitation within networks for rural road and transport information and knowledge exchange within Myanmar and on the regional and international level (scope to be broadened when the RDU is fully established) • Organisation of classroom and hands-on training courses, workshops, seminars and forums in association with RDU’s Training Centre • Organisation of the publishing of newsletters and projects briefs to keep the DRRD staff and external stakeholders informed on the RDU activities and outputs • Management of data archiving 	
AE: Principle Researcher	Should be an individual with excellent analytical capabilities with at least fifteen years of experience in all appropriate fields of road engineering (materials; structures; design; maintenance). Ideally, the individual should have at least an Honours degree in engineering, but preferably a Master’s degree or ideally a higher degree (PhD).	1
SSAE: Senior Researcher	Should be an individual with excellent analytical capabilities with at least ten years of experience in all appropriate fields of road engineering (materials; structures; design; maintenance). The individual should have at least an Honours degree in engineering, but ideally a Master’s degree.	1
SAE: Researcher	Civil/pavement engineer with good analytical capabilities with at least five years in road structures; materials; design; construction; maintenance. Ideally, the individual should have an Honours degree in engineering.	1
JE(3): Candidate Researcher	<p>Civil/Pavement Engineer: Entry research level with some knowledge in road engineering. It is expected that the individual will have a minimum of a BEng degree.</p> <p>The individuals should also have the ability to organise and carry out materials sampling in the field, organise and understand laboratory testing and compile data reports. Some mechanical and electronic experience would be useful.</p>	1
Information Specialist (at least on an SAE level)	The individual should have well-developed networking abilities, technical competence in electronic information management and gaining access to information, and be well versed in the principles of knowledge management. Ideally, the individual should have an Honours degree in Library and/or Information Science and ten years’ work experience in a similar position.	1
Total number of research/technical staff required:		8

Laboratory and field testing will have to be outsourced initially. Consequently, laboratory technicians and assistant-technicians are not reflected in the staff composition of the RDU (with the possible exceptions of the JE(3) appointment).

One information specialist would be required to establish, manage and operate the Information Centre. As the RDU grows and/or the demand for information increases, consideration should be given to employing an Assistant Information Specialist.

5.1.3 Recruitment Plan

Recruitment of RDU staff is expected to be progressive. The following process could be followed, and actions undertaken, to recruit staff for the RDU:

1. Agree on staff composition of the RDU;
2. Draft detailed job descriptions for each position;
3. Agree on a schedule for recruitment;
4. Identify and approach suitably qualified DRRD staff who could be assigned to the RDU;
5. Advertise vacant positions and interview short-listed applicants;
6. Appoint suitably qualified persons for the RDU;
7. Implement an Induction Programme for researchers to familiarise them with the research environment. It is important that they change their fundamental thinking from that of a client/consultant (those from within the DRRD) to that of a researcher, i.e., from “why the status quo should be followed” to “how can we do it differently”.

5.1.4 Skills Development Plan

Growth of human capital and retention of skills are crucial for the purposes of sustaining a strong SET base to enable the RDU to fulfil its mandate. Professional growth of research staff, knowledge generation through a culture of learning and sharing, and the creation of opportunities for young researchers are fundamental to sustain a strong SET base.

As a knowledge-centred entity, the RDU will have to ensure that ongoing, sustained learning opportunities are made available to its staff, as well as support for its workforce, in the form of time and incentives for example, to take advantage of those opportunities.

Traditional, formal learning opportunities (workshops, lectures, conferences) - while still very important - will not be enough to sustain a workforce in a knowledge-based age. The RDU should therefore structure its work environment for rich, ongoing, informal learning as well. In short, learning must be deeply embedded in communities of work practices.

Well-established, open, and accessible communication infrastructures also facilitate learning while encouraging collegial interaction and improving access to information. Collaboration beyond the walls of the RDU must also be encouraged. Such outside influences are critical not only for the influx of new ideas but as an avenue for "marketing" local knowledge as well. Such sharing is important for establishing the RDU's reputation for innovation.

The RDU needs to implement a Skills Development Plan to guide the growth and development of its staff. This Plan should address aspects such as:

- **Induction training of new staff** to familiarise them with the research environment, which should include training on the standards that RDU staff will be expected to meet when doing research, addressing topics such as: application of the scientific method; research processes; identifying research needs; designing studies; understanding what is already known (in order to prevent duplication); peer review processes; keeping of records, including data storage and archiving; analysis of data and drawing of conclusions; communication of findings; implementation of research products; and ethics. Induction on the above could be done in line with the *Good Research Practice Guide* provided in Appendix B.
- **Specific courses** on topics such as:
 - How to conduct field investigations and perform technical audits and forensic investigations;
 - Data collection, data management and statistical analysis of research data;
 - Pavement engineering topics (e.g. geometric design; structural design and analysis of low-volume roads; materials design; etc.);
 - Transportation topics (e.g. transport planning; traffic safety; transport operations; etc.).

- The establishment of a **mentorship programme** and the linking up of mentors with mentees with the objective of providing moral and technical support to young researchers, monitoring their progression on the research career ladder, supporting their academic progression, and providing them exposure both within and outside the organisation (e.g. invite the mentees to meetings and support their attendance of appropriate industry forums, workshops, committee meetings, seminars and conferences, and assist them in the preparation of presentations as well as their delivery).
- The necessity to develop a **career development plan** for each staff member outlining the short and long-term goals of each individual and the path towards the achievement of these goals. The individual career development plans should form part of the Key Results Areas against which a staff member's performance can be measured.

5.2 Research Infrastructure

5.2.1 Research Facilities

The RDU will be established in Nay Pyi Taw, on the premises of the DRRD. No new building will be required for the offices of the RDU in the short to medium term. The RDU will be allocated offices within the existing buildings of the DRRD.

While initially the RDU will rely on the Mobile Laboratory of the DRRD and, if required, on services rendered by government-approved private laboratories, it is foreseen that the RDU will have to establish its own laboratory. Draft plans for the establishment of a Public Works and Transport Training Centre were developed in 2015, which should be adapted to accommodate the RDU laboratory. In these plans, provision was made for:

- An aggregate testing laboratory (18 m²);
- A soil and bitumen testing laboratory (116 m²);
- An asphalt testing laboratory (12 m²);
- A concrete working area;
- Several stores and offices, and a lecture room.

It is anticipated that if the RDU were to operate a fully-functional R&D centre and at the same time operate as a Reference Laboratory for the DRRD District Laboratories, the RDU laboratory would have to increase its size at least three-fold from what is proposed above for the Training Centre while still maintain the lecture rooms for capacity building and training purposes. In addition to the lecture room, consideration should also be given to the provision of a 150-200 seater conference room that could be used by DRRD/RDU for technical meetings, workshops, seminars and regional conferences.

It is recommended that appropriate guidance on the layout for an optimal research facility (including training/conference facilities) should be provided by experienced external parties prior to implementation. Section 5.2.2 should also provide an indication of short to long term requirements for space.

5.2.2 Research Equipment

The DRRD Mobile Testing Laboratory includes testing equipment for bitumen, asphalt, cement, concrete, aggregates and soils, which should be made available for R&D purposes.

In addition or complementary to what would be required for an R&D facility, Table 4 presents a list of the main testing equipment needed for the RDU, also indicating whether these items should ideally become available in the short, medium or longer term.

Table 4: Test equipment

Type of equipment	Description	Schedule
General laboratory apparatus	Ovens, Testing machines (press), Scales, Thermometers, glassware, drying tins, etc.	Short term
Soils and aggregates	Basic soil identification (sieves, Atterberg limits, sieve shakers)	Short term
	Crushing and mixing equipment, rifflers, etc.	Short to medium term
	Binocular and petrographic microscopes	Short term
	Chemical analysis of soils (organic matter content; sulfates; chlorides; carbonates; pH)	Short term
	Expansion index (swell) of soils	Short term
	Compaction equipment (AASHO and Proctor)	Short term
	CBR equipment (including testing machine)	Short term
	Shear test device (shear box and/or vane shear)	Short term
	Permeameter	Short term
	Oedometer test device	Short term
	Unconfined compression test device	Short term
	Density, specific gravity and water absorption	Short term
	Characterization of fine aggregates (sand equivalent or Methylene blue)	Short term
	Coarse aggregate shape (Shape index, flakiness)	Short term
	Characterization of filler for asphalt mixtures (Rigden)	Short term
	Aggregate strength (Aggregate Crushing, 10%Fines Aggregate crushing and Aggregate Impact value tests and Los Angeles Abrasion,)	Short term
	Tests for aggregate durability (Micro Duval, Slake Durability, Durability Mill Index)	Medium / Long term
	Accelerated Polishing of aggregates (PSV or equivalent)	Medium / Long term
Triaxial testing device (monotonic and repeated)	Medium / Long term	

Type of equipment	Description	Schedule
	X-ray diffraction / X-ray fluorescence for chemical analysis (access only – too expensive and specialized for full time use by RDU)	Long term
Bitumen bound materials (*)	Basic characterization of paving grade bitumen (Needle penetration, Ring & Ball)	Short term
	Basic characterization of bitumen emulsions (Distillation, setting characteristics)	Short term
	Determination of soluble binder content (centrifuge or other) or asphalt analyser by ignition	Short term
	Impact compactor and Marshall stabilometer	Short term
	Ageing of bitumen binder (Rolling Thin Film Oven Test or RTFOT)	Medium / Long term
	Fatigue testing machine for asphalt mixtures	Medium / Long term
	Wheel tracking device for asphalt mixtures	Medium / Long term
	Binder recovery apparatus	Medium / Long term
Hydraulic bound aggregates and soils (*)	Compressive strength and Indirect tensile strength testing equipment	Short term
	Elastic Modulus testing equipment	Medium / Long term
	Accelerated carbonation and ICS tests	Medium term
Field testing	Soil sampling equipment	Short term
	Sand Replacement Method equipment (In-situ Density Determination)	Short term
	Nuclear Soil Moisture-Density Gauge	Short term
	Pavement core drilling machine	Short term
	Light Falling Weight Deflectometer	Short term
	Dynamic Cone Penetrometer (DCP)	Short term
	Other tests for in situ characterization of solid strength (SPT, CPT, CPTU, DPSH, FVT) (only required if geotechnical investigations are to be carried out)	Short term
	Plate loading test or a suitable alternative	Short term

Type of equipment	Description	Schedule
	Spot characterization of skid resistance and macrotexture (British Pendulum Tester and sand patch)	Short term
	Profiling equipment (Brink and Bruin)	Short term
	Seismic refraction tests	Medium / Long term
	Falling Weight Deflectometer (FWD)	Medium / Long term
	MERLIN and/or bump integrator in the short term, and possibly a Road Surface Profilometer in the long term	Short term
	Equipment for continuous measurement of skid resistance	Medium / Long term

(*) In addition to soil and aggregate testing equipment

5.2.3 Supporting Infrastructure (ICT)

Each researcher will require the necessary computer resources, mostly desk-top computers, but laptops are preferred for those staff spending extended periods in the field. Good back-up facilities will be essential and a management programme to ensure backups are routinely made by all staff at fixed intervals. Secure off-site storage of selected backup media must be arranged.

Various software packages for analysing pavement performance data and behaviour should be obtained as the need arises. A strong statistical analysis package also needs to be available in the short to medium term, preferably those that is relatively simple to use, although in the longer term more powerful packages should be investigated (note that these more powerful/sophisticated packages would require considerable training for their optimum use).

When established, the laboratories will require interfaces and software to collect, store and process test results as necessary. The software should be such that processed results (as well as the raw data) are directly accessible to all of the researchers through the local area network.

All data on the Information Centre database must be directly accessible to the researchers.

5.3 SHEQ Management

Safety, Health, Environment and Quality (SHEQ) is a collective responsibility and is guided by the policies and procedures of the DRRD, which the RDU will also have to comply with.

Laboratory work carried out by outside organisations will also need to comply with these requirements, which should be the same as the DRRD. However, areas such as bitumen laboratories may have special requirements as a result of the toxic/harmful nature of some of the chemicals used in this type of laboratory. This will require the need for special risk assessment procedures and training measures to be implemented so that a safe working environment is maintained and present at all times.

6. Knowledge Management

6.1 General

Knowledge management refers to any initiative that focuses on knowledge as a primary resource of the organisation, and attempt to make it more productive by increasing access to it, developing it, capturing it in databases, or applying it to enhance processes, products, and services⁴. Knowledge management is a managerial activity aimed at enhancing the organisation's capability of creating and integrating its information and knowledge in support of its business strategy. It refers to the organisational optimisation of knowledge to achieve enhanced performance, increased value, competitive advantage, and return on investment, through the use of various tools, processes, methods and techniques⁵.

The above is in line with the definition of knowledge management adopted by ReCAP for the purpose of its *Knowledge Management and Communications Strategy, Sep 2015*: 'Knowledge management is the systematic management of an organization's knowledge assets for the purpose of creating value and meeting tactical & strategic requirements; it consists of the initiatives, processes, strategies, and systems that sustain and enhance the storage, assessment, sharing, refinement, and creation of knowledge'⁶.

Knowledge management activities supporting the above include:

- The establishment of an Information Centre to provide library and information services (Section 6.2);
- Provision of virtual collaboration platforms in support of collaborative research activities (Section 6.3);
- Development of internal and external web-based knowledge portals to enhance knowledge dissemination, both inside and outside the organisation (Section 6.4);
- Formulation of an information and technology transfer strategy to increase the visibility and impact of RDU research (Section 6.5);
- Records management activities (Section 6.6).

6.2 Information Centre

6.2.1 Introduction

Library/information services associated with research centres range between the following three options:

- The very traditional service focussed on the library as an accessible information and documentation storage facility providing reactive support services
- A hybrid service where the library is both an accessible storage platform but also participates in the activities of its user community
- A fully digitised platform for innovation, integrated into the activities of the research centre and focussed on pro-active support.

⁴ Davenport TH and Prusak L. 1998. *Working knowledge: how organisations manage what they know*. Boston, Massachusetts: Harvard Business School Press.

⁵ Kamara JM et al. 2002. A CLEVER approach to selecting a knowledge management strategy. *International Journal of Project Management*, vol. 20(3), p. 205-211.

⁶ Frost A, MSc. 2010. In *Knowledge Management and Communications Strategy, Sep 2015*, ReCAP, Cardno Emerging Markets (UK).

Whereas the three options mentioned above should be seen as markers on a sliding scale the final choice of information service will be determined by user requirements, the funding available as well as the associated infrastructure.

Taking into consideration the assumed activities of the users as well as the infrastructure available the hybrid information service will in all probability be the option that would be most useful. It is therefore this option which is planned for in more detail below.

6.2.2 Strategy

The activities of the information centre should be focussed on four service streams:

- Negotiating and providing access to reliable information resources (both commercial and open access content) through subscription, document ordering and inter library loan services
- Preserving and making accessible (both internally as well as externally to the organisation) the intellectual property created by the RDU. Services should include records and archival services as well as an institutional repository accessible through the internet
- Information specialist intermediary services focussed on the detailed scientific, business and management information requirements of the RDU and the DRRD staff as well as user enablement through training
- The facilitation of knowledge exchange, scientific interaction and networking within the organisation through a dedicated facility where RDU staff, DRRD staff and external stakeholders can interact on both a formal and informal basis.

It is also suggested that the strategy would need to focus on electronic products – for both items created internally and items sourced from outside the organisation. Given the context of the research focus areas, much information may be sourced in paper format but provision should be made to transfer such items to electronic format so that the items could be made available to all users (research staff and clients) simultaneously and quickly. At the same time the design should make provision for ethical conduct and adherence to copyright law.

An alternative would be to establish a virtual service which could be managed by an external institution such as a local university.

6.2.2.1 Infrastructure

To support the proposed service streams, the infrastructure needs to make provision for:

- Library technical services such as purchasing, acquiring and managing documents and publications for the research staff;
- Library network services for borrowing from and supplying material to peer institutions nationally and internationally;
- Intermediary services to conduct literature searches and preliminary scoping work on behalf of researchers;
- Records and document management services to ensure accessibility for staff but also the dissemination of quality products to the wider research and client networks;
- Various physical spaces required by knowledge workers and information centre staff:
 - A reading area with work stations
 - A conference room as well as smaller meeting areas
 - Office space for the information centre staff
 - Storage facilities
 - A small restaurant/ coffee shop to encourage staff interaction

Access to the Internet with sufficient bandwidth and a reliable supply of electricity is an essential prerequisite for the service.

Electronic systems and storage should allow for the effective management of digital objects. In this instance 'management' includes the indexing and organisation of material for easy access, the reliable long-term storage of the objects – so that they remain retrievable, and the preservation of the digital objects to ensure that the items remain accessible and reliable.

Policies and procedures should then allow for the systematic and reliable collection and management of internally generated information as well as for reliable access to relevant external information.

Agreements with local sources of relevant information (universities, national archives, libraries, etc.) should be put in place to facilitate maximum benefit from existing information.

6.2.2.2 Finances

Sustainable funding will in all probability be the most important factor to negotiate. Access to reliable information resources could be expensive and access has to be reliable and sustainable. The usual library maintenance formula for funding is 50 percent for resources and 50 percent for HR costs.

Similarly one would need to make provision for a library system licence as well as a maintenance agreement. The amount set aside for purchasing access to archived commercial material as well as system maintenance fees will need to be scoped and budgeted for separately.

If rapid growth is planned during years 2 to 5 of the RDU it is anticipated that additional staff may become necessary.

6.2.2.3 Marketing / Promotion / Client focus

There is a bare minimum infrastructure essential to ensure that a library service is possible no matter what the size of the client grouping is. Once established it is, however, easy and usually requires no (or very little) additional costs to further expand the client grouping. It is essential to decide up-front whether the clients to be served will be employed from a number of different, independent institutions or affiliated with only one institution as this aspect has serious implications on the access licences to be negotiated.

Again – if services are provided electronically and the infrastructure allows for easy communication with all stakeholders it would be relatively easy to service an extended community. The less reliable the infrastructure, the fewer researchers obviously could be served.

6.2.3 Way Forward

In the next phase of the establishment of the RDU, the ReCAP Project Team could provide assistance at any one of three levels:

- Advise on the recruitment and appointment of a suitable candidate who would then have the responsibility to establish and operate the service;
- Establish the service, implement the necessary systems and policies, negotiate access to information resources and then assist with the recruitment and appointment of a suitable candidate to manage the service;
- Establish and manage a service remotely from, say, a local university.

Each of these options would need to be scoped and the details of the financial implications would have to be calculated before it would be possible to indicate what the financial impact would be.

6.3 Virtual Collaboration Platforms

Research is increasingly done collaboratively in teams, both within the organisation and between organisations, and is often interdisciplinary of nature. It is foreseen that RDU research projects will be achieved through a combination of delivery mechanisms involving external stakeholders such as academic institutions, consultants and other national and international research centres. While the final research outputs of these collaborative research projects will be captured in the Research Outputs Database, access to web based collaboration platforms will be required to allow file sharing and collaborative report writing between team members during project duration.

6.4 Web-Based Knowledge Portals

Both internal and external web portals are required. An intranet will serve as a portal for staff to find organisational information and to learn about developments and news about the organisation. It will afford staff quick and efficient access to the information and operational systems. The external website will provide a snapshot of the organisation to the outside world and will contribute to its knowledge dissemination efforts. A sustainable, easily accessible knowledge portal providing a clear description of the RDU's purpose and services will assist it in building a strong reputation in the rural road and transport sector. It will also make research output accessible to external stakeholders through the institutional repository and thereby support research uptake. As such it is an important marketing and communication tool for the organisation.

6.5 Information and Technology Transfer

6.5.1 Publication Strategy

To establish the RDU as a reputable research entity and to promote knowledge dissemination and uptake, its researchers should be encouraged and supported to publish their research in high standing, peer-reviewed journals and to present their research at conferences. Publishing further provides the opportunity to influence policy and practice through academic channels. The RDU should however ensure a balance between academic publication and information intended for decision makers. The organisation's communication strategy should also consider newsletters and website content in which research outputs are transformed into targeted information products such as technical briefs synthesising best practice in key areas; policy briefs targeted at decision makers in which the policy implications of research are documented; and abstracts summarising new knowledge.

6.5.2 Seminars/Workshops

A regular programme of events during which new documents and research findings are presented should be established. All new manuals and research findings can be introduced at such events and in many cases it could be useful to hold workshops or feedback sessions prior to releasing final documents so that stakeholders can contribute to the content before finalisation of the documents takes place.

Such events are essential to ensure dissemination of the research findings, to increase awareness of the RDU and to establish its credibility and status among practitioners.

6.5.3 Training Interventions

A learning platform needs to be established to inform and teach DRRD staff about latest developments, especially those emanating from the development of new approaches, procedures, guidelines, manuals and standards (i.e. the products of R&D). Such a learning platform should cater for both classroom and hands-on training in order to maximise impact and retention of knowledge, and to build and enhance the competencies of DRRD staff.

Learning events should also be used for the sharing of best practices and experiences among learners, and for entrenching and stimulating technical leadership in resolving challenges in the operational environments of DRRD. It could also include Master Classes on specific topics, presented by local or international domain specialists.

In addition to the above, consideration should be given to send RDU staff on sabbaticals at international universities or research centres to master skills in R&D project execution and management, and in knowledge management.

All above learning events should be customised for DRRD staff in order to strengthen their capacity and capabilities in line with their line responsibilities.

6.5.4 Demonstration Projects

Several full-scale road experiments have been or will be carried out in Myanmar. These should be used as demonstration projects, for periodic site visits and workshop discussions.

As research progresses, novel technologies, applications and/or approaches will be developed, which should be prototyped by the RDU. Experimental sections are ideally suited for this purpose, enabling these novel technologies,

applications and/or approaches to be verified and proof-tested, and also to demonstrate their potential benefits before they are implemented on a wider scale and incorporated into norms and standards.

These demonstrations projects, if properly branded, will also enable the RDU to increase its visibility, credibility and stature with time.

6.6 Records Management Activities

The RDU will have a responsibility to efficiently manage, store and retain data, documents and other forms of information (records) for specific periods of time and thus ensuring compliance with applicable legislation; corporate governance; long-term access to its own records; and proper project and contractual management. This will require a sustainable records management system for both records relevant to its research and consulting services as well as to its support services.

As the RDU falls within the structures of the DRRD, it should comply with the DRRD records management procedures. The RDU's research activities may however result in additional records management requirements not currently addressed by the DRRD.

A Research Outputs Database could be used to record research project outputs and related material such as project proposals, progress reports, research reports, learning briefs, safety documents, laboratory reports, technical manuals and guidelines as well as information published externally by RDU staff, e.g. conferences papers and posters, journal articles, books, chapters in books and training material. In addition to file servers, which are useful for day to day research or laboratory activity, an Electronic Document Management System (EDMS) could be considered for research document and content management, collaborative writing, version and access control. Other project specific records such as risk assessments; contracts and proof of delivery of contracts; project management plans; relevant protocols and standards; research ethics approvals; equipment calibration reports and operating procedures; laboratory workbooks; project finances and records should be stored in project files. Research data sets created as part of the research activity form part of the research outputs of the RDU and, as such, it is important for on-going research as well as verification of research results that these data sets be preserved along with the context giving documentation, research reports and results.

7. Indicative Budget

7.1 Cost structure for Year 1

A coarse estimate of the human resource costs, project-attributable costs, indirect costs and depreciation is presented below for the first year of operation. These estimates are based on the resources required to realise the objectives of the Rural Road Research Strategic Plan (cf. Chapters 4 and 5), assuming that all necessary resources to undertake the identified research projects are available, and at least four projects are to be initiated in Year 1 and all start at the same time, which may be unlikely.

Human Resource Costs

The human resource costs shown below were calculated on the basis of the human resources provided in Chapter 5. For budget purposes, the salary levels were set as follows (rounded figures):

- Candidate Researcher: USD 1,500/year
- Researcher: USD 1,600/year
- Senior Researcher: USD 1,800/year
- Principal Researcher: USD 2,300/year
- Assistant Director: USD 2,600/year
- Deputy Director: USD 2,800/year
- Director: USD 3,100/year

Based on the above, the total Human resource cost for Year 1, but excluding administrative staff, is **USD 17,300**.

Project-Attributable Costs, Indirect Costs and Depreciation

Very rough estimates of the project-attributable costs, indirect costs and depreciation are shown below. Project-attributable costs are those costs incurred directly on projects during their execution in order to achieve the projects' objectives. The estimated project-attributable cost has been taken as **90 per cent** of the sum of the total project costs of five projects (Priority Projects 2 to 6) likely to be initiated in Year 1 (cf. Chapter 4), but assuming that all projects will be executed by the RDU researchers.

Indirect costs are those costs that are **not** directly related to specific projects. They could include cost items such as: salaries of administrative staff; stationary; travelling costs and subsistence allowances associated with the attendance of meetings, workshops and seminars; training and conference costs; formal studies; equipment rental; software licences; communication (telephone/internet); electricity, water consumption, etc. These costs are difficult to quantify at present and, therefore, estimated at **150 per cent** of the total human resource costs indicated above.

The cost for establishing an Information Centre is also difficult to quantify at this stage. The cost shown below should be seen as establishment costs to obtain the required library systems to manage both external and internal publications, and to cover initial subscriptions.

An allocation has been made for the physical establishment of the laboratory (i.e. capital costs, inclusive of building costs, plumbing, electrical installations, etc). The amount for depreciation would cover computers and furniture, depreciated over a period of two years, including depreciation of laboratory equipment (purchasing cost estimated at USD 230,000) over a longer time period. Equipment for the laboratory is not expected to be purchased in Year 1.

DIRECT & INDIRECT COSTS (USD) - YEAR 1		246 000
Project-attributable costs		75 000
Indirect costs		26 000
Information Centre		50 000
Laboratory establishment		90 000
Depreciation (computers/furniture)		5 000

Based on the above, and assuming that all R&D will be executed by RDU staff with no involvement of Development Partners, the cost structure (based on its assumptions, limitations and exclusions) indicates that a minimum of **USD 265,000** should be budgeted for the operations of the RDU in its first year of operation, based on assumed USD 17,300 of Human Resource costs and USD 246,000 of Direct and Indirect Costs.

7.2 Five-year cost structure of the RDU

In Table 2, Section 3.4, it is noted that the staff complement of the RDU (excluding administrative staff) will increase from eight staff members in Year 1 to 20 staff members (i.e. from 4 to 10 researchers, and from 1 to 7 laboratory/field staff by Year 5). This is reflected in the indicative five-year budget, or rather the cost structure, shown below:

COST COMPONENTS	Year 1	Year 2	Year 3	Year 4	Year 5
HUMAN RESOURCE COSTS (USD)	17 300	18 800	25 700	33 800	38 000
DIRECT & INDIRECT COSTS (USD)	246 000	336 000	270 000	261 000	277 000
Project-attributable costs	75 000	83 000	91 000	100 000	110 000
Indirect costs	26 000	28 000	39 000	51 000	57 000
Information Centre	50 000	60 000	60 000	60 000	60 000
Laboratory establishment	90 000	150 000	30 000	-	-
Depreciation	5 000	15 000	50 000	50 000	50 000
Required Investment (USD)	263 300	354 800	295 700	294 800	315 000

The cost structure is based on the following assumptions (**Note:** no provision for inflation has been made):

- The staff complement will expand as per the targets set in Table 2, while also allowing for staff progression on the Research Career Ladder;
- Project-attributable costs increase by 10 per cent per annum, assuming that more projects will be undertaken;
- Indirect costs are accounted for as 150 per cent of total Human Resource cost;
- Depreciation significantly increases in year 3 (on the back of laboratory equipment purchases already to be initiated in Year 2 for delivery in Year 3), after the laboratory facility has been established, while also accepting that more sophisticated equipment can be depreciated over longer periods of time. It should be noted that “Laboratory establishment” and “Depreciation” do not accommodate for Development Partner involvement. These estimates could be reduced significantly if Development Partners such as KfW, JICA and others would become involved in the funding of facilities and associated equipment.

Appendix A/ Draft Memorandum of Understanding for national and international partnerships

MEMORANDUM OF UNDERSTANDING (MOU)

BETWEEN

The Department of Rural Road Development

....., herein represented by, in his/her capacity as, and he/she being duly authorised thereto

(hereinafter referred to as “DRRD”)

and

< **Organisation** >

....., herein represented by, in his/her capacity as, and he/she being duly authorised thereto

(hereinafter referred to as < **Organisation** >)

RELATING TO

Potential collaboration in Research, Development and Implementation between the parties in the field of rural roads and transport (“the FIELD”)

WHEREAS:

- DRRD has been enacted to conduct or cause to conduct research and studies related to rural roads and transport, and to facilitate the application of useful results emanating from these research activities and studies;
- <Organisation> has been enacted to ...;
- The Parties recognise the synergy between them and both parties acknowledge comprehensive co-operation will take time to develop;
- This MOU, therefore, serves as an initial document in which both parties agree to explore the opportunities to increase the potential for collaboration;
- The Parties possess proprietary information, technical knowledge, experience, specimens and data of a secret and confidential nature relating to the FIELD, all of which are regarded by them as valuable assets of a highly confidential nature (INFORMATION); and
- The Parties wish to explore possible areas of Collaboration between them and wish to negotiate in good faith and to conclude in due course specific contractual agreement(s) relating to such areas including but not limited to (bullets below serve as an example):
 - Collaborative research on rural road infrastructure planning and investment decisions;
 - Collaborative field and laboratory research initiatives in rural road design, materials, construction, maintenance, management and impact assessment, and in transport operations, traffic management and safety;
 - Development of standards, specifications, technical manuals and guidelines for rural road materials, design, construction, maintenance, management and impact assessment;
 - Knowledge exchange: Exchange of publications and other relevant scientific and technical documentation on topics related to rural road and transport, and exchange of information concerning scientific and technical events organised by one of the parties;
 - Capacity building and skills development: Organisation of courses and seminars and temporary exchanges of staff, in order to promote synergies and complementarity of know-how and experience between the two parties and more effective capacity building of staff regarding relevant research and development methods and activities, and
 - Visit of personnel from DRRD to <Organisation>, and vice versa.

NOW THEREFORE THE PARTIES HERETO AGREE AS FOLLOWS:

1. The Preamble hereto shall form an integral part of this Agreement.
2. **CONFIDENTIALITY/SECRECY**
 - 2.1 The Parties shall:
 - (a) treat as strictly confidential and secret any and all INFORMATION given or made known to them arising from this association;
 - (b) keep all such INFORMATION obtained secret towards third parties and only use it in co-operation with each other for the purpose expressly agreed upon by the Parties and to disclose same to their employees only on the basis of the need to know;
 - (c) if required, cause all of their employees who are directly or indirectly given access to the said proprietary and secret INFORMATION to execute Secrecy Undertakings in a form acceptable to the Parties in order to protect the Parties against the unauthorised disclosure of such INFORMATION to any third party and to fully co-operate in the enforcement of such Secrecy Undertakings.
 - 2.2 The above undertakings shall not apply to
 - (a) INFORMATION, which at the time of disclosure is published or otherwise generally available to the public.
 - (b) INFORMATION which after disclosure by the disclosing party is published or becomes generally available to the public, otherwise than through any act or omission on the part of the disclosing party.
 - (c) INFORMATION which the Parties can show was in their possession at the time of disclosure and which was not acquired directly or indirectly from each other.
 - (d) INFORMATION rightfully acquired from others who did not obtain it under pledge of secrecy to either of the Parties.
 - (e) INFORMATION which a party is obliged to disclose in terms of an Order of Court, subpoena or other legal process.
 - 2.3 This MOU shall not confer rights to any invention, discovery, improvement or know-how currently existing or emerging from the execution (of this Agreement) or of any further joint Project on either Party and such ownership of rights shall form the subject matter of separate agreement(s) between the Parties. (For the avoidance of doubt, it is specifically recorded that the rights to any Intellectual Property created prior to the effective date hereof, shall vest exclusively with the Party who created and/or invented it.)
 - 2.4 The provisions of this Clause 2 shall survive any termination/cancellation of this Agreement, for whatever reason, for a period of **3 (three) years** following such termination/cancellation.
3. **SCOPE OF THIS MOU**
 - 3.1 This MOU sets out the basis on which the Parties shall negotiate in good faith in order to identify a project or projects such as, but not necessarily limited to, those associated with the areas of Collaboration described in the Preamble to this Agreement, with the aim of concluding a formal contractual agreement(s) relating to such identified areas of possible collaboration.

- 3.2 Each Party shall furthermore, where appropriate, provide a documented breakdown and valuation to the other Party of its intended financial or other contribution to the proposed collaboration, on a project-to-project basis.
- 3.3 Nothing contained in this MOU shall be construed as binding the Parties to any form of exclusivity in THE FIELD and both Parties shall be entitled to conduct business independent of each other where market requirements so dictate, unless otherwise agreed upon in writing in a formal agreement(s) as envisaged in Clause 4.1 below.

4. **PROPOSED FORMAL AGREEMENTS**

- 4.1 As envisaged by Clause 3.1 above, it is the intention of the parties to enter into a formal written agreement(s) on a project by project basis, which agreement(s) will incorporate the terms of this MOU as well as such other terms as the parties may subsequently consider desirable or necessary.
- 4.2 The Parties record by their signature hereto that this document is intended to promote a relationship in good faith, for the benefit of both the parties.
- 4.3 At the effective date hereof, the possible areas of collaboration as appear in the Preamble to this Agreement, have been identified.
- 4.4 Both parties will nominate a senior person to manage joint initiatives and if necessary a steering committee on a project-by-project basis.

5. **AGENCY AND PARTNERSHIP**

- 5.1 No party shall present itself as the representative or agent of the other party for any business, legal or any other reason, nor shall it have the power of authority to commit the other party, unless it receives the other party's prior written consent.
- 5.2 Nothing in this MOU shall be interpreted as establishing a partnership or joint venture between the Parties and both parties shall act as independent contractors and organisations

6. **COMMENCEMENT AND DURATION**

- 6.1 This MOU shall operate as from the date of signature thereof ("the effective date") and shall remain binding for a period of 3 (three) years, unless terminated prior thereto by mutual written consent between the parties.
- 6.2 This MOU may after expiry be renewed by the parties, in accordance with Clause 6.3 below.
- 6.3 No alteration, variation, addition or agreed cancellation of this MOU shall be of any force or effect unless reduced to writing as an addendum to this MOU and signed by the Parties or their duly authorised signatories.

7. **FINANCIAL ARRANGEMENTS**

- 7.1 Each Party shall be responsible for its own costs incurred in the execution of its duties in terms of this MOU, until such time as a written agreement has been reached on the contribution of each Party to a specific project(s) to be executed in collaboration.
- 7.2 Save insofar as breach of Clause 2 hereof is concerned and without in any way affecting the validity of this agreement, it is hereby recorded that neither party shall be liable as against each other merely as a result of premature cancellation of this MOU, unless otherwise agreed in a subsequent formal agreement(s), as envisaged in Clause 4 above.

8. **GOVERNING LAWS AND DISPUTE RESOLUTION**

- 8.1 This MOU shall be governed by and interpreted in accordance with the laws of Myanmar (Note: should ideally be a third country if the MOU is signed between organisations situated in two different countries).
- 8.2 In the event of any dispute arising from this Agreement, the Parties shall make every effort to settle such dispute amicably.
- 8.3 If the dispute is not capable of being settled between the Parties amicably, such dispute shall be elevated to the Senior Management of the Parties or their duly designated representatives for mediation purposes. (For purposes of this clause, "Senior Management" shall, in the case of DRRD, mean the Director General of DRRD and in the case of <Organisation>, the xxx of <Organisation>).
- 8.4 Should the dispute still remain unresolved, the dispute will be adjudicated by a competent court in Nay Pyi Taw, Myanmar (see note in Section 8.1 above).

9. **GENERAL**

- 9.1 This document contains the entire MOU between the Parties and neither Party shall be bound by any undertaking, representation or warranty not recorded herein or added hereto as provided herein.
- 9.2 No failure or delay on the part of either Party in exercising any right, power or privilege hereunder shall operate as a waiver thereof, nor shall any single or partial exercise of any right, power or privilege preclude any other or further exercise thereof, or the exercise of any other right, power or privilege. The rights and remedies herein expressly provided are cumulative and not exclusive of any rights or remedies which the Parties would otherwise have.
- 9.3 No indulgence, leniency or extension of time which either Party ("the grantor") may grant or show to the other shall in any way prejudice the grantor or preclude the grantor from exercising any of its rights in the future.
- 9.4 Both Parties shall pay their own costs relating to the preparation and settlement of this MOU.
- 9.5 This MOU shall be for the personal benefit of each of the Parties and may not be assigned in whole or in part by either Party without the prior consent of the other Party, except that a Party's interest shall be assignable without the consent of the others in pursuance of any merger, consolidation or reorganisation or voluntary sale or transfer of all or substantially all the assigning Party's assets where the merged, consolidated or reorganised corporation or entity resulting there from or the transferee of such sale or transfer has the authority and power effectively to perform that Party's obligations to the other under this MOU.
- 9.6 This MoU may be terminated by either Party by giving 3 (three) months written notice of such cancellation to the other, subject to clause 2.4 above.

In the witness whereof, the parties hereto have caused this MoU to be signed in their respective names at

_____ on this ____ day of _____ 20xx.

On behalf of DRRD:

On behalf of <Organisation>:

.....
xxx
xxx

.....
xxx
xxx

In the presence of:

In the presence of:

1.
xxx
xxx

1.
xxx
xxx

2.
xxx
xxx

2.
xxx
xxx

Appendix B/ Good Research Practice Guide

Good Research Practice Guide

B.1 Introduction

The purpose of this document is to provide guidance in conducting research in order to maintain the expected standards that the RDU is expected to meet as a research entity. This will ensure that the RDU achieves the highest quality and ethical standards in research, driven by integrity, honesty and professionalism of its staff. The guidelines are intended for researchers and research support staff of the RDU as well as any third parties that may be contracted by the RDU.

Much of what is presented in this appendix is based on existing good research practice from established research institutions, and has been adopted and modified where necessary from the following references:

- Good Research Guide, Council for Scientific and Industrial Research (CSIR, South Africa)
- Good Research Practice – What is it? Swedish Research Council
- Good Research Practice: Principles and Guidelines - MRC ethics series:
- Shamoo A and Resnik D. 2009. Responsible Conduct of Research, 2nd ed. (New York: Oxford University Press).

B.2 Main Principles of Good Research Practice

What is good research? Good research is objective, verifiable, directed study and analysis, carefully conducted and recorded, and effectively communicated.

The following are the main principles of good research:

B.2.1 Honesty and Transparency

Researchers must strive for honesty in all their work. This applies to the whole spectrum of research, from experimental design, data collection and analysis, to reporting and publishing the results. It also applies to what it is that a researcher does not choose to say. A researcher should not be restricted to citing research or data that corroborates the hypothesis s/he wishes to pursue. Long-term viability of the organisation and the researcher's reputation should not be sacrificed for the short-term expediency of satisfying a client's desire for a particular outcome, if the research does not support that conclusion.

The contributions of others should always be acknowledged. This includes ideas, findings and data that are not the researcher's. This can be done routinely by referencing sources in the text. Data contributions and financial support can be highlighted in a section on acknowledgements. Failure to acknowledge the contributions of others is regarded as unprofessional conduct.

B.2.2 Keeping Records

The various data and samples that are collected in the course of a research project are referred to as source or primary data. It is necessary to keep clear, accurate, reliable and traceable records of the research methods used and of the results obtained, including interim results. This is necessary to demonstrate proper research practice and also to ensure that all the relevant information can be assembled to analyse an experiment, or repeat it. Sometimes the study needs to be repeated by someone else, or by the lead researcher years after the event. In some cases questions are subsequently asked about either the conduct of the research or the results obtained. Secondly, it can be for legal reasons, to show that the researcher was the first to have a particular idea, or to prove that s/he performed the professional tasks with due diligence. Proper records and retention of source data can also assist to respond to allegations of research misconduct and to clear one's name.

Both paper and electronic records need to be kept in a safe place and in such a way that they can easily be located and interpreted later. The electronic data must be held on a secure server and/or be password protected. Additionally, the researcher's hard-drive should be backed up regularly onto a CD or other medium. A hard copy of data must be kept in a locked filing cabinet or similar. It is important that the procedures adopted are followed. Data must be stored in an appropriate format, normally for a period of at least 10 years from the date of any publication which is based upon it.

B.2.3 Respect to all those Involved in the Research and the environment

A researcher has a duty to respect and maintain the dignity, rights, safety and wellbeing of all stakeholders involved or whom could be affected by the research being conducted. Experiments on humans must follow the international guidelines, and surveys involving people must adhere to the same guidelines or those prevailing in Myanmar.

The researcher must ensure that people involved are fully aware of all the risks and dangers prior to their involvement. The confidentiality of those involved must be protected unless consent has been attained to reveal their identity or any other confidential information. The appropriate informed consent must be obtained properly, explicitly and transparently.

Research that has a reasonable possibility of causing significant environmental damage or undesirable social consequences must be subject to an impact assessment. As a consequence, this will mean that a management plan, including response measures and a rehabilitation plan, must be in place before the research proceeds.

B.2.4 Openness and Accountability

As a government funded institution, the DRRD research must be made available to the community at large. This can be achieved through open access to the research outputs of the DRRD. While the widest dissemination of results should be supported as much as possible, confidentiality agreements that have been put in place with third parties such as sponsors should prevail.

Good practice requires that research results are checked before being made public. Researchers should always be prepared to question the outcome of their research. Establishing internal peer review mechanisms should ensure that this is adhered to.

Researchers have a responsibility to ensure efficient and proper usage of resources provided from public funds. Efforts should be made to maximise effectiveness and avoid waste, including reviewing project progress.

B.2.5 Supporting training and skills development

The RDU Managers will be expected to provide the direction and resources for training, and R&D Suppliers on the other hand will be expected to train and provide opportunities for development to support their teams in conducting their work to the highest standards. R&D Suppliers therefore have a responsibility to develop and maintain the skills they need in their research while assisting others with their personal development.

It is expected that the RDU managers recognise and deliver on their responsibilities for mentoring and development of staff and to ensure that young researchers/engineers, and support, technical and administrative staff are supported in understanding and adopting good practice at an early stage and throughout their career.

B.3 Steps in the Research Process

The model presented below is generic in nature. It is based upon a practical and step-by-step approach to scientific research process. The above presented principles are applied within the process to achieve high quality research standards.

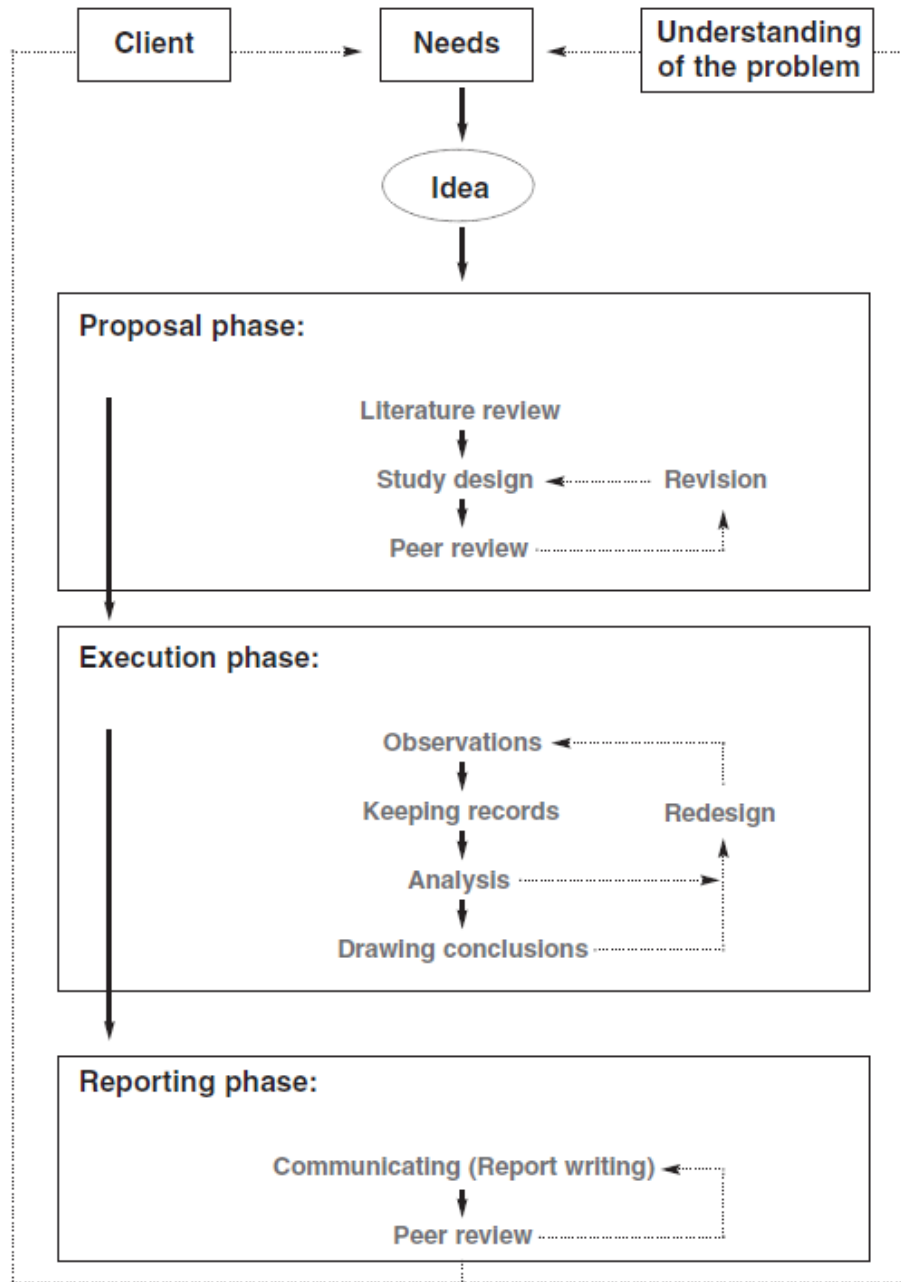


Figure B.1: Research Process⁷

B.3.1 Proposal Phase

Based on Figure B.1, the first step is to put everything together in the overall plan, called a research proposal, outlining the research problem and how to plan to investigate it. The main function of a research proposal is to detail the operational plan for obtaining answers to the research questions. It must provide information on **what** is being proposed to be done, **how** it will be done and **why** the selected proposed strategy.

B.3.1.1 The initial Idea

Formulating a research problem is the first step in the research process. A research problem identifies and indicates what is to be researched. The idea/s should clearly be expressed and as brief as possible. The more

⁷ Council for Scientific and Industrial Research (CSIR). *Good Research Guide: Second Edition*. Edited by RJ Scholes, Pretoria, 2003.

specific and clearer the idea is the better, as this influences everything else that follows in the research process. If the list of key questions is very long it may be that something too large is being tackled or that the core issue is not being identified. Complex ideas should be split into their components and their complex interrelations can be expressed better in a diagram.

The main function of formulating a research problem is to decide what needs to be found out. The objective is to understand the essence of the problem, by asking whether it is essential that the answer to the question be known in order to solve the problem. If the answer is yes, then it is a key question.

All the questions must be phrased as key questions. Some problems lend themselves to a very formal key question, known as a hypothesis, which leads to testable predictions.

It is often that several alternate hypotheses may explain the observed phenomenon. Sometimes it is useful to test the null hypothesis. In this case it is assumed that an action has no effect.

B.3.1.2 Designing a Study

The general principle is that the outcome of a research design should include a description, justification and explanation on how the answers to the research questions will be found. It shows the decision made for setting out the specific details of the research. A faulty research design is more likely to lead to misleading findings. Thus the information to be collected must be able to answer the question posed, with as little doubt as possible.

A decision needs to be made on how the data will be collected. In order to achieve this, it is essential to understand the research goals. Research can be undertaken with a view to achieving beneficial and useful applications, but it can also have the important and more fundamental aim of increasing the knowledge base. The principles of good research as presented in Section B.2 apply in both cases.

Various methods of data collection for qualitative and quantitative studies are available. The classic scientific approach to a problem is to conduct a careful experiment in which all factors except one or a few are held constant, and those are increased or decreased by a known amount. This kind of experimental design aims to minimise uncontrolled variation.

When a problem has many variables it is impractical to vary each of them one by one. The situation becomes more difficult when the factors interact, since then they must be varied in all possible permutations. The recommendation is to use a 'natural experiment', in other words, rely on the variation that already exists in the sample population to understand the relationships between the variables. Analysis can be by multivariate linear or non-linear modelling, if a researcher already has a good idea of the relationships in the data, or a variety of indirect pattern-seeking methods if the researcher does not.

Statistical expertise should be sought to help in the design of the experiment to ensure a properly designed study.

B.3.1.3 Literature Review

Reviewing the literature takes time and effort, but make it part of the project. Checking what is already known about the topic of interest is time well spent. More formal approaches to finding information include scientific databases, such as Science Citation Index, Physics Abstracts, etc. It is usually quicker and cheaper to modify someone else's approach than to develop one from first principles. (Don't re-invent the wheel!!) The pilot phase, sometimes called 'scoping' the project, should consume 10% to 20% of the total project time and funding.

Research peers are often the best people to guide a researcher to useful sources of information, especially semi-formal literature and unpublished studies that a researcher will not find any other way. The researcher should discuss rough ideas informally among its peers before spending a lot of effort on writing proposals. Consult the Information Specialist(s) – they are trained to help researchers to find information needed.

Computer searches are quick and powerful. It is most effective for researchers to do the search themselves, because only they know all the permutations of the key phrases. Most databases include abstracts; when a promising one is identified, download the full paper, or order it through the library.

The Internet allows one to connect with a much wider circle of peers, and allows one to get information that is not yet published. A query placed on an appropriate bulletin board can yield information very efficiently and rapidly. Browsing the World Wide Web in a systematic and directed way can be useful, but can also seduce a researcher into many interesting but unproductive side-alleys. Be wary of information offered on the Internet, since it does not have to pass through any formal peer review process.

Filing information sources in an organised way, along with all the information needed to reference them is good practice; it will save time. This includes: author/s (name and initials), date of publication, full title, title and editor/s name/s if it appears in a book, journal name and volume if in a periodical, page numbers, publisher and publisher's location (city). The researcher should make brief notes to remind him/her about the contents of the reference. There are several good software programmes that can handle reference lists efficiently. For informal sources, record the person's name, the date of the communication and some way of communicating with them: an address, telephone/fax number or email address. Ask their permission to be quoted before doing so.

B.3.1.4 Proposal Writing

All projects must be documented clearly, systematically, including clear outcomes and end points, plans for statistical analysis, any ethical and regulatory approvals. In writing the proposal, the following information about the study should be provided:

- 1 **Project rationale**
 - 1.1 Background and problem statement
 - 1.2 Link to stakeholder needs
 - 1.3 Research questions and rationale for doing project
Provide a rationale for doing the project (why?) as well as the consequent research questions that have to be answered.
 - 1.4 Envisaged impact
Discuss:
 - the envisaged eventual impact of the project as well as the pathways that would lead to that impact;
 - a description of the envisaged uptake of the deliverables, including technology transfer mechanisms, target markets and/or users, potential partners and /or customers, and
 - a review of the characteristics of the end deliverable to address the uptake, embedment and envisaged impact.
 - 1.5 Project objectives
- 2 **Project description and planning**
 - 2.1 Research Approach and methodology
Provide a description of the methodology to be followed, experimental design (where applicable), the data acquisition process, data sources, data processing procedures, and scope and limitations of the study.
 - 2.2 Tasks
Indicate completion date of tasks, deliverable and budget
 - 2.3 Basic Gantt chart
Supply a basic Gantt chart indicating tasks, overlap, task completion times etc. for progress monitoring purposes

- 3 **Final deliverable**
 - 3.1 Deliverable description (e.g. report, guideline, manual, standard, policy)
 - 3.2 Strategic Human Capital development
 - 3.3 Publications
- 4 **Implementation of final deliverable(s), these may include the following:**
 - 4.1 Patents
 - 4.2 Technology demonstrators
 - 4.3 Software packages
 - 4.4 Commercialization issues
 - 4.5 General technology transfer
- 5 **Partners and customers**

Provide a brief list of partners and potential customers.
- 6 **Team**
- 7 **Project Costs**

B.3.1.5 Peer Review

The proposal just like the final report should be peer reviewed. Peer review is a system of self-regulation. It means that the work is exposed to people who are knowledgeable in that field for critical assessment. If they find it lacking, the work is unlikely to be funded or accepted until the faults are corrected.

Peer review is the main quality control system in research. It is intended to keep the research on track. It helps to identify obvious flaws that may be missed. While ample time should be provided for peer review, it makes no sense to spend half the project resources on the review process. The level of review should be scaled to the size of the project and to the consequences of getting it wrong. As a guide, spend a total of 10% of the resources of a small project (a small project is less than one month of work for one person) and less than 5% of large project resources on all stages of the review process. Split the effort half-half between the proposal and reporting phases.

Review by peers outside the organisation may sometimes conflict with the need for commercial or national secrecy. There are cases where ideas are stolen. In these cases the researcher should look for an acceptable alternative, rather than doing no review at all:

- Use peers within the organisation, preferably one not intimately involved in the project, and perhaps even from another discipline.
- Contract external reviewers, and make confidentiality a condition of the contract.
- Use trusted, recently retired colleagues, who have little to gain from knowing what the researcher is working on.

B.3.2 Execution Phase of the Research Study

This is the phase in which the data will be collected from which inferences and conclusions will be drawn. As part of the research design, a decision will have been made on the procedure to be adopted to collect the data. Every attempt should be made to avoid bias in the selection of a sample and to attain maximum precision. Data collection should be precise, accurate and unbiased. In scientific research, **precision** is a measure of how close repeated measurements of the same thing are to one another, while **accuracy** is how close their mean is to the true mean of the population and **bias** is a systematic difference between the observed mean and the true mean. Precision is desirable in science, but accuracy is essential.

B.3.2.1 Observations

Observations are supposed to be made objectively, but bias often creeps in because of observer subjectivity. Subconsciously, observers sometimes measure certain treatments differently from others, perhaps because of expected results to conform to some preconceived pattern. To combat this effect, researchers use 'blind' trials where possible, in which neither the researcher nor the subject are aware in advance which treatment has been applied to which sample. Sometimes there are non-random environmental effects or time-dependent analytical effects. For this reason it is good practice to randomise experiments and analysis runs (i.e. don't analyse all the replicates of one treatment in one batch - mix them up with other treatments).

Observations should include a control sample. The purpose of controls is to detect effects not related to the factors under investigation. A control typically has an unchanged value of the experimental variables a researcher is changing in the treatment. For example, in chemical stabilisation analysis, a 'blank' (untreated) is a sample that contains none of the substance for which a researcher is testing. Blanks must be exposed to exactly the same analysis as the rest of the treated samples. To avoid unconscious bias, controls are sometimes hidden, so that a researcher does not know which they are at the time of analysis. In medical science placebos play a similar role. In some cases, bias can be removed after the experiment by subtracting the value of the control from all the sample values. Scientific trials should always have some form of control, the best that is possible under the circumstances.

The proper use and maintenance of equipment and systems is an important element of the research process. Calibration is the process whereby bias is removed. It involves adjusting the method or instrument until the measured value agrees with a reference standard. All instruments require calibration, and new methods need to be calibrated against existing accepted methods. Calibrations need to be ongoing, to check for drift, at a frequency that depends on the stability of the instrument. Always document the calibrations made: the time, the date, the reference standard used, the measurement before calibration and the measurement after calibration, servicing, faults, breakdowns and misuse. For applications where accuracy is critical, the calibration process must be traceable right back to a standard kept in a national or international place of reference. Appropriate procedures should be in place and responsibilities assigned to ensure training and support for use, regular servicing and calibration of equipment by trained staff.

Standards are reference materials with known properties. For instance, a researcher may use a standard set of weights to calibrate a balance or a synthetic beam/cylinder to calibrate stiffness measurement. Treat these with care to avoid damage or contamination. Standard specimens are usually expensive. It is good practice to make a secondary standard for everyday use, which has been calibrated against the 'primary standard'.

B.3.2.2 Data: Processing

The way data is analysed largely depends upon the type of information (descriptive, quantitative, qualitative or attitudinal) and the way the findings will be communicated. In the event that quantitative analysis is to be used, it is also necessary to decide upon the type of analysis required, such as frequency distributions, cross-tabulations or other statistical procedures, for example regression analysis, factor analysis and analysis of variance. The variables to be subjected to statistical procedures should also be identified.

It is worth mentioning that scientific observations contain some error and reducing the error so that true differences can be distinguished from natural variation or 'noise' is a fundamental technique in scientific research. An integral part of the study is to carefully carry out an error analysis, or at least a discussion of possible sources of error and other factors that could affect the validity of the results should be presented. However, the researcher must ensure that such assessments are realistic.

This means that a researcher should always clearly state how confident s/he is about the conclusions drawn. Several measurements are usually made during data collection. Researchers should report the mean value of measurements and show the variation (by giving the standard deviation, standard error or the range) and the number of observations the findings are based on. Good practice requires that when a graph is presented, the variation around the sample mean must be illustrated by drawing a bar equal to the standard deviation, standard error, or confidence interval, and clearly stating which one of these is used in the caption.

An observed difference between two sets of results is said to be 'significant' when there is a very low probability that the difference is purely due to chance. The basis of almost all statistical significance tests is a comparison of the observed difference between treatments to the variation within treatments. When reporting the results of such a test, it is good practice to say what sort of test was performed, the number of samples in each treatment, and the probability that the difference is purely due to chance. The results of an ANOVA test can be reported. Statements such as 'nearly significant' or 'a non-significant trend' should be avoided as they are scientifically meaningless. Always refer to good practice in statistical analysis or seek the services of an expert in the field.

B.3.2.3 Data: Retention and Preservation

- **Principles:**

The principles, standards and technical processes for data management, retention and preservation should be formalised. In addition, the processes should be supported by appropriate data standards addressing issues of confidentiality and information security, monitoring and quality assurance, data recovery and data management reviews where suitable.

There should be clarity on the ownership and custodianship of research data, samples and related material used or created in the course of the research.

There are two main reasons for keeping clear, reliable and traceable records:

1. To ensure that all the relevant information can be assembled to analyse an experiment, or repeat it. Sometimes the study needs to be repeated by someone else, or by the researcher years after the event.
2. For legal reasons, to show that the researcher was the first to have a particular idea, or to prove that s/he performed professional tasks with 'due diligence'.

- **Requirements:**

- It is good practice to keep tidy, up-to-date notes and record of raw data in a single, easily located place. All research data must be recorded and retained securely (for example, in electronic or hard copy laboratory notebooks) in a form that is original, legible and attributable. No erasures are allowed; mistakes and corrections are crossed out neatly and signed where a researcher records information in a bound notebook, which should be written in waterproof ink and on numbered pages.
- Specimens and soil samples as well as cores should be retained within the research laboratory. Any transfer or disposal should be documented.
- Field data sheets, such as visual assessment sheets, questionnaires, digital/video and audiotapes, etc. should be retained in their original form. A standard data sheet should be developed for routine observations. Such data sheets should include a date and the observer's name. For outdoor work, it is recommended that the data sheets be printed on coloured paper to avoid glare. Write in pencil or waterproof ink. File the data immediately, preferably with a photocopy or electronic copy somewhere else.
- Where research data relating to a project are held in different formats (for example, completed questionnaires, visual assessment, images and scans), these must be cross-referenced and recorded in the main record.
- The main record should be updated as soon as possible after data are collected; where the dates of collection and recording are different, this should be recorded.
- The main record should be approved by a supervisor as evidence that records are complete and accurate. Queries should be discussed as soon as possible and any changes resulting should be signed-off by the relevant parties.
- Information relating to participant consent should be held securely and subject to the same retention.

B.3.2.4 Drawing Conclusions

Scientific research only draws conclusions that are supported by data with a high level of confidence. A common and tempting mistake is to extrapolate the findings far beyond the field in which they have been found to hold good. If speculations are made, make it clear when doing so. If a researcher draws on data and findings from other scientifically tested research, it must be referenced so that it can be traced. Be wary of 'personal communications', 'unpublished data' and websites, all of which are data sources which have not been tested.

The conclusions drawn must follow logically from the evidence offered. The logic must be clear not only to the researcher, but also to whoever is reading the report. Where the data permit another interpretation, the researcher should mention it.

One of the fundamental characteristics of good researchers is that they are open about what they know and what they don't know. If a researcher has done whatever s/he can in the circumstances to reduce uncertainty, being unsure is not a disgrace. A poorly tested theory cannot imply that something is a fact.

The most important thing is that conclusions should match study objectives, point for point. Conclusions must be qualified with conditions and uncertainties, and researchers should not try to hide them completely among 'ifs', 'buts' and 'on the other hands'. Researchers should not hedge their conclusions so thoroughly that they are by definition true (e.g. 'It is concluded with high confidence that x may be true...').

The conclusions drawn and the outcome should be subjected to quality assurance and, where appropriate, peer review. They must be confirmed by the research team.

B.3.3 Reporting Phase

B.3.3.1 Duty to Publish

The research conducted will contribute effectively to the transmission of new knowledge to the wider society when the results are made public. The publication is often essential in that others are able to build on the researcher's ideas or can develop practical applications. Publication will also enable the scientific community to scrutinize and discuss the results achieved.

Researchers have therefore a duty to communicate their results in a permanent form and not to withhold their findings from society and other scientists. This duty is to the sponsors of the work, to society, to scientific peers and above all, to the researcher and the organisation s/he works for. Successful researchers publish widely and often.

B.3.3.2 Approval of Publication by Client

Where clients require confidentiality, negotiate with the client regarding the bits that may be revealed, and write the communication in such a way that trade secrets are protected. The client should be allowed to review the paper before it reaches the public domain. Ensure that the contract is clear about what may be published, and when.

B.3.3.3 Define audience

Researchers should be responsible for communicating in a way that can be understood. The first step is to define with whom they will be communicating, and to understand their expectations, language level and prior knowledge.

If researchers are communicating to a mixed audience, they will often have to do it in more than one way - for instance, a colourful, illustrated summary brochure for the public, accompanied by a data-packed report for the experts. Choose the media carefully - should it be a presentation, a written report, a video, a poster, or some combination?

B.3.3.4 Length of Report

Good communication is not aided by excessive length or detail. For busy decision-makers, two sides of a single page is an effective length. Reports longer than 20 pages are unlikely to be widely read. Longer reports should be segmented into digestible chunks. Put the supporting detail into appendices, and provide summaries for the overall report and for each section. Break up solid text with graphics, tables and boxes.

B.3.3.5 Content and Structure of Report

Writing the report is the last step of the research process. The report should be written in an academic style and be divided into different chapters and/or sections based upon the main themes of the study. A written scientific report typically has the following structure:

- Title page - descriptive title, authors, addresses, key words, report numbers, date, version number
- Abstract or Executive summary
- Introduction - why the work was done, and statement of objectives
- Methods - enough detail to repeat the work to verify it
- Results - make extensive use of tables and graphics
- Discussion - make sure any uncertainties are mentioned
- Conclusion - should address each of the objectives
- Acknowledgements - of financial, technical and other support, contribution or input should be clearly acknowledged
- References - only those used in the document, and in consistent and complete form
- Appendices - data too extensive for the main text, or topics which are not central to the main argument

The above is a suggested structure and can be altered to suit a particular report (for instance, by combining results and discussion), but the researcher should aim to keep a logical flow. Large volumes of raw data should be put into appendices.

B.3.3.6 References

They fulfil two purposes. First they substantiate statements that are made, and secondly they acknowledge work by others. The amount of referencing needed depends on the type of document, ranging from exhaustive in technical review articles, to almost none in popular articles.

In writing for a scientific audience, each key point not based on presented data should be supported by at least one, and usually not more than three references. It is recommended to use the earliest appropriate reference that supports the point made, and add a more recent one if there have been significant recent developments. A good recent review is often an appropriate second reference. Use any of the accepted styles for referencing, but this must be consistent within a document.

Every reference must be complete: author/s, date, article title, book or periodical title, book editors if it is a chapter, volume number if a periodical, page range, city of publication, publisher. Personal communications should be treated as footnotes or bracketed in the text, and must include a way of tracing the informant.

It is common practice not to include articles in preparation or submitted for review in the reference list; they should be treated as untested personal communications. All references in the reference list must appear in the text, and vice versa.

General references that are not in the text should be in a Reading List or Bibliography.

Websites, unless they contain the online version of scientific communications that have passed through a rigorous peer-review process, are not equivalent to scientific publications. There is no way of assessing their quality, and they may not be there when checking on them again. Web references should be treated like personal communications. Provide the URL (<http://webaddress/...>) and the date on which it was accessed.

B.3.3.7 Presentation of tables and Graphs

Provide table numbers and self-explanatory heading (above the table), and make sure that every table is referred to in the text. All table columns must be identified with a heading, and given units where appropriate. Tables for publication should not have any vertical lines. Where cells contain no data, indicate this using '-' or 'ND', not a zero.

Numerical values should be rounded to the significant digit. Using the decimal point or comma should be consistent throughout.

Data in graphs, text and tables should not be repeated unnecessary - the most appropriate format for the type of data and the points that have to made should be used. Figure captions (below the figure) should be sufficiently self-explanatory that the figures can be browsed without reading the text. Simple, clear, consistent fonts should be used.

Each figure should be referenced in the text. Use bar charts for data that fall into classes, and line graphs or scatter plots for continuous data. Graph axes must be labelled and given units.

Dependent variable should go on the y-axis.

Graphs should be kept uncluttered - 3-D effects for 2-D data should not be used. Grid lines, or more than three variables per graph, should be avoided. Ensure that there is a legend for symbols and lines, on the graph or in the caption.

B.3.3.8 Knowledge Management

Knowledge can be made more available to colleagues and stakeholders by informal and formal actions. Informal actions include discussing with colleagues, and giving and attending seminars inside and outside the organisation. Formal actions include identifying all the available knowledge before project commencement; identifying persons who can be consulted during project execution; and reviewing and recording the essential learning after completing the project, including not only technical knowledge, but team interactions, political and market insights etc., that typically do not feature in project reports. Formal knowledge management systems that exist in the organisation should be used. Examples include reference and publications databases, client and contact lists and idea registers.

Publication on the Internet is becoming more common as it an excellent way of making texts available and of presenting results with minimum delay. However, to safeguard quality and also to avoid the problems associated with publication of preliminary results, the best recommendation is that an article should not be posted on the Internet until it has also been accepted by a scholarly journal.

Appendix C/ RDU Establishment Support

Concept Note for a Long-Term Technical Assistance Programme

General

This Concept Note outlines the objectives and scope of services for a *Long-Term Technical Assistance Programme* aimed at instituting research capacity in Myanmar for the physical establishment of a Research and Development Unit (RDU) located with the structures of the DRRD. This Concept Note should be read in conjunction with the 5-year Business Plan of the RDU. The Concept Note is aligned with the needs of the DRRD.

Objectives

The objectives are to:

- Establish RDU research capacity;
- Fast-track the physical establishment of the RDU in Nay Pyi Taw, inclusive of the Information Centre and RDU-associated laboratory infrastructure;
- Implement a capacity building and skills development programme targeting researchers as well as laboratory staff;
- Provide long-term support to ensure that the RDU lives up to its mandate and achieves its Key Performance Indicators;
- Provide long-term technical guidance and mentorship to the RDU with the execution of their research agenda to support the achievement of appropriate and implementable research outcomes;
- Establish technical working groups and committees, as well as strategic relationships and linkages, both nationally and internationally.

Scope of Services

The organisation appointed to provide Long-Term Technical Assistance to the RDU will be required to support the RDU in their attainment of the following:

Capacitation of the RDU from a staffing perspective:

- Finalisation of job descriptions/profiles for the required positions in the RDU in association with the DRRD;
- Provision of assistance to the DRRD/RDU with the recruitment of staff:
 - Advertisement of the positions;
 - Assessment of candidates applying for positions;
 - Placement of appointed staff on the Research and Technical Career Ladders.

Induction and training of RDU staff:

- Development and implementation of a Capacity Building and Skills Development Plan, which, inter alia, addresses career ladders, performance management, mentorship, staff retention, professional registration, training programmes, secondments, etc;
- Implementation of the “Good Research Guide” (i.e. through induction training) to inform RDU researchers about the standards that they would be expected to meet when conducting research;

- Assistance with the development and implementation of a staff induction programme;
- Assistance with the drafting of tailor-made skills development plans for individual staff members, identifying broad areas of training that would be required in the short to medium term, potential secondments to other (international) research centres and post-graduate training programmes;
- Development of course material for short-term training on aspects such as:
 - How to conduct field investigations and perform technical audits and forensic investigations;
 - Laboratory management and quality systems;
 - Data collection, data management and statistical analysis of research data;
 - Pavement engineering, which could include topics such as:
 - Structural design and analysis of road pavements;
 - Essential materials for road construction;
 - Maintenance and rehabilitation;
 - Pavement performance monitoring;
 - Asset management;
 - Introduction to transportation engineering and traffic safety.
 - Presentation of courses to RDU staff and to other invited participants from within and outside the structures of the DRRD;
 - Assistance with training of laboratory staff, in partnership with the DRRD and the DOR.

Assistance with the physical establishment of the RDU and materials testing/reference laboratories, including:

- Assist with allocation of offices for the RDU, inclusive of the information Centre, and equipment of the offices with the necessary furniture and fittings;
- Critical assessment of ICT support infrastructure (e.g. telephones, computers, IT networks, internet connectivity with sufficient bandwidth, database systems, data backup systems), and drafting of recommendations;
- Assistance with implementation of fit-for-purpose ICT support infrastructure;
- Identification of other capital items the RDU will require to support its operations and secure their availability;
- Alignment of the laboratory (and field) equipment required by the RDU in the short, medium and long term and as described in the RDU Business Plan with those available from the Mobile Plant and District/Regional Laboratories;
- In conjunction with the DRRD and Development Partners, provision of assistance with the procurement of essential equipment required by the RDU in the short to medium term to support its research and quality control/assurance activities, among others;
- Establishment of a reference testing and research laboratory for the DRRD.

Operational systems, standards and manuals:

- Provision of assistance to the DRRD/RDU with the development of laboratory standards and manuals, insofar as they pertain to the operations of the RDU, to enable the laboratories to operate in line with ISO 17025 standards, with a view of attaining accreditation in the future;

- Provision of assistance to the DRRD/RDU with the drafting of a quality manual and procedures to enable the RDU to operate in line with the requirements of ISO 9000, with a view of attaining certification in the future;
- Identification of standards, guidelines and other documentation that will support the operation of the RDU;
- Assessment of the current status of and/or provision of assistance with the development of standard data collection forms, standard reporting forms and formats, and analytical tools that support the research, development and implementation activities of the RDU;
- Establishment of laboratory operating systems, including sample tracking systems among others.

RDU Information Centre – Provision of guidance and support for:

- Library technical services, such as purchasing, acquiring and managing documents and publications for the research staff;
- Library network services for borrowing from and supplying material to peer institutions nationally and internationally;
- Intermediary services to conduct literature searches and preliminary scoping work on behalf of researchers;
- Records and document management services to ensure accessibility for staff, but also for the dissemination of RDU outputs to the wider research and stakeholder networks;
- Establishment of various physical spaces for knowledge workers and information service staff, such as: a reading area with work stations, small meeting areas, office space for information centre staff and storage facilities;
- Provision of electronic systems and data storage facilities allowing for the effective management of digital objects. In this case ‘management’ includes the indexing and organisation of material for easy access; the reliable long-term storage of the objects so that they remain retrievable; and the preservation of the digital objects to ensure that the items remain accessible and reliable.

Governance, partnerships and networking:

- Supporting the operations of the Rural Road Research Technical Committee (RRRTC) and provision of assistance for the identification and prioritisation of research needs and the updating of the Rural Road Research Strategic Plan (RRRSP);
- Supporting the operations of the Steering Committee and provision of assistance with the updating of the RDU Business Plan;
- Assistance with the sourcing of external funding for the execution of research and development projects;
- Assistance with the establishment of technical committees and working groups in line with the research agenda/priorities of the RDU;
- Provision of advice and identification of mechanisms and modalities for networking, cooperation and/or collaboration with outside organisations, such as those listed in Section 3.5 of the RDU Business Plan;
- Assistance with the establishment of formal linkages with R&D centres and other relevant organisations (e.g. academic institutions and knowledge centres).

Technical assistance with the execution of the RDU research programme

- Assisting the RDU in prioritising research projects, taking cognisance of feedback received from the RRRTC and Steering Committee;
- Assisting the RDU with the identification/sourcing, allocation and levelling of financial, human and technical resources;
- Provision of technical, managerial and mentorship support for planning and execution of research projects, such as those outlined in the Rural Road Research Strategic Plan;
- Provision of assistance with organising and running working group and technical committee meetings that are specially established to support the research projects;
- Peer review of research outputs and assistance with technology transfer to industry.