Establishment of Road Research Capacity in Nepal/RDS Business Plan for First Five Years of Operation

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Final Version

Picture: from Asian Development Bank's Decentralized Rural Infrastructure and Livelihoods Project in Nepal

ReCAP
Research for Community Access Partnership

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Table of Contents

Appendices

Page

List of Abbreviations

ADB	:	Asian Development Bank
ANOVA	:	Analysis of variance
ARRB	:	Australian Road Research Board
AsCAP	:	Asia Community Access Partnership
CARD	:	Centre for Applied Research and Development
CSIR	:	Council for Scientific and Industrial Research
DDG	:	Deputity Director General
DFID	:	Department for International Development
DG	:	Director General
DoLIDAR	:	Department of Local Infrastructure Development and Agricultural Roads
DoR	:	Department of Roads
DoTM	:	Department of Transport Management
EDMS	:	Electronic Document Management System
EU	:	European Union
IECS	:	Institute of Engineering Consultancy Services
IFAD	:	International Fund for Agricultural Development
JICA	:	Japan International Cooperation Agency
MoST	:	Ministry of Science and Technology
MoF	:	Ministry of Finance
MoFALD	:	Ministry of Federal Affairs and Local Development
MoLTM	:	Ministry of Labour and Transport Management
MoPIT	:	Ministry of Physical Infrastructure and Transport
NAST	:	Nepal Academy of Science and Technology

NCCKMC	:	Nepal Climate Change Knowledge Management Centre
NEA	:	Nepal Engineers' Association
NMT	:	Non-Motorised Transport
NPC	:	National Planning Commission
R&D	:	Research and Development
RBN	:	Roads Board Nepal
RDI	:	Research, Development and Implementation
RDS	:	Research and Development Section
RDSP	:	Research and Development Strategic Plan
RDTC	:	Research and Development Technical Committee
ReCAP	:	Research for Community Access Partnership
SCAEF	:	Society of Consulting Architectural and Engineering Firms
SDE	:	Senior Divisional Engineer
SET	:	Science, Engineering and Technology
SHEQ	:	Safety, Health, Environment and Quality
TRL	:	Transport Research Laboratory
UK	:	United Kingdom
USAid	:	United States Agency for International Development

List of Tables

List of Figures

Abstract/

This document presents the Business Plan for the first five years of operation of the Research and Development Section (RDS) of the Department of Local Infrastructure Development and Agricultural Roads (DoLIDAR). The Business Plan is expected to evolve over time in line with the shifting views and expectations of DoLIDAR under the Ministry of Federal Affairs and Local Development (MoFALD), and the realities associated with the physical establishment of the RDS. The Business Plan addresses: (a) the vision, mission, goal and strategic objectives of the RDS; (b) governance issues, including the role and responsibilities of the Steering Committee, the institutional and physical location of the RDS, sources of funding, key performance indicators, and strategic relationships and linkages; (c) potential research areas, which future revision and prioritisation will be guided by a Research and Development Technical Committee (RDTC); (d) capacitation of the RDS in terms of human resources; 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 RDS.

1. Introduction

This document outlines the 5-Year Business Plan for the Research and Development Section (RDS) of the Department of Local Infrastructure Development and Agricultural Roads (DoLIDAR) under the Ministry of Federal Affairs and Local Development (MoFALD). The Business Plan will guide the establishment of the RDS and assist the RDS in fulfilling its mandate and achieving its strategic objectives as set by DoLIDAR 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 DoLIDAR to manage the execution of relevant, high quality research in infrastructure, including transport, and to implement the outputs of research and development activities.

The business plan has been structured as follows:

- **Chapter 2** presents the vision, mission and strategic objectives of the RDS;
- **Chapter 3** deals with Governance issues, including the role of the Steering Committee, the location of the RDS within the institutional structure of DoLIDAR, the physical location of the RDS, 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 Research and Development Technical Committee (RDTC) is presented, as well as the process for developing a Research and Development Strategic Plan. This chapter also outlines the importance of establishing working groups and technical committees to support and add value to the activities of the RDS, and the importance of realising demonstration projects;
- **Chapter 5** deals with critical operational issues that could impact on the performance of the RDS, including both human resource and supporting infrastructure to sustain its operations in line with its mandate. It addresses issues such as recruitment of staff; the skills development plan, and supporting infrastructure;
- **Chapter 6** deals with knowledge management, inclusive of information transfer and the importance of an information centre and of holding training courses, seminars and workshops for the uptake and embedment of knowledge;
- **Chapter 7** presents a tentative cost structure for the RDS, 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 RDS.

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 is to promote safe and sustainable rural access in Africa and Asia through research and knowledge sharing between participating countries and the wider community.

The Business Plan presented in this document is expected to evolve over time in line with the shifting views and expectations of both DoLIDAR and the Steering Committee, and the realities associated with the physical establishment of the RDS. The Business Plan should therefore be updated on a regular basis.

2. Vision, Mission and Strategic Objectives of the RDS

2.1 Vision

For the Research and Development Section to be a national entity providing scientific, engineering and technological leadership to the Nepalese government, Provinces, Municipalities and the private sector for attaining a network of good quality and safe provincial and rural roads, offering a high level of satisfaction to its users

2.2 Mission

Through research, development, implementation and dissemination of research outcomes, to enhance provincial and rural connectivity, and connectivity to the strategic road network, and to ensure the transportation of people, goods and services in a safe, economic and sustainable manner, contributing to economic, social and cultural development

2.3 Rationale

2.3.1 Scope of the RDS

Aligned with its mandate, and for all functional areas for which it has legislative responsibility (e.g. roads and transport; housing, buildings and town development), the objectives of DoLIDAR are as follows:

- to support the Ministry in policy and strategy formulation (inclusive of strategic planning);
- to provide national leadership, coordination and liaison (inclusive of foreign aid coordination);
- to provide monitoring, evaluation and oversight across all Provinces (inclusive of centralised asset management);
- to support human resource development, inclusive of the enhancement of technical and project administrative capabilities in Provinces;
- to assure quality in construction by means of reference testing at DoLIDAR's National Reference Laboratory;
- to prepare national norms, standards and manuals related to provincial and rural infrastructure, and facilitate training and orientation within provinces and municipalities to ensure uniformity in approach;
- to support the development of appropriate technology and solutions for provincial and rural infrastructure development, and their dissemination through courses, workshops and seminars;
- to stablish and manage an information centre as a knowledge resource accessible to all stakeholders.

Within the above context, and within the mandate of DoLIDAR, the Research and Development Section (RDS) of DoLIDAR will provide national leadership of research and development by managing the development of appropriate technologies and solutions for provincial and rural infrastructure in line with the mandate of DoLIDAR, and by managing the implementation and dissemination of these, as well as their embedment in guidelines, manuals, norms, standards, etc.

The intent, however, is for the RDS to start small, with the view to expand the Section in future after it has been fully established, after its staff have been fully versed in research and development (R&D) management (i.e. knowledge creation/adaptation) and knowledge management, and after the RDS has achieved several early successes that will demonstrate the value of the RDS. During the initial stages of the establishment of the RDS, some dedicated effort will be required to organise and capacitate RDS staff, and to align operations to achieve the above, potentially through capacity building and mentorship support provided by the ReCAP programme of DFID.

In view of this, it is recommended that the scope of the RDS be confined at first to structured R&D support for the planning, engineering and social dimensions of *road and transport provision*, with the view to expand the scope to include other infrastructure fields (e.g. housing, buildings, town planning) in the near future after the RDS has been fully established. However, it should be noted that the RDS could manage R&D projects in fields other than *roads*

and transport in the foundation years, but in a less structured and coordinated manner than they would do for *roads and transport* R&D.

2.3.2 Rationale

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

There is a strong link between the socio-economic development and livelihoods of local and rural communities, and the provision of efficient and effective access. The provision of basic road infrastructure enhances livelihood and income generation activities in local and rural areas. Provincial and rural roads play a meaningful role in increasing work opportunities, improving income, fostering consumption and reducing poverty. Improved access and mobility equates to, among others, reduced travel time and cost, better use of resources leading to higher incomes, the development of small businesses in local and rural areas as well as growth in tertiary activities and public sector employment.

An effective Provincial and rural road network is thus of key importance since it is a catalyst for sustained economic growth and social development. Through research, development, implementation of research outcomes and capacity building, the RDS will support the Government of Nepal in achieving the Millennium Development Goals and Sustainable Development Goals set by the United Nations, and support Nepal in also achieving its national goals (e.g. reducing traffic fatalities by half by 2020).

2.4 Value Proposition

The establishment of the RDS is a high priority for DoLIDAR to enhance the delivery and implementation of fit-for-purpose planning, engineering and technological solutions and to stimulate innovation supporting the socio-economic development of Nepal. Once established and fully operational, the RDS will add value to DoLIDAR through the provision of:

- a proficiently managed and coordinated portfolio of R&D projects, executed in accordance with the engineering and technological priorities endorsed by DoLIDAR[1];
  - access to a multidisciplinary skills and expertise base in infrastructure planning and engineering to support the execution of R&D projects. This skills and expertise base would include competences in, for instance, planning, design, procurement, construction, maintenance and infrastructure asset management;
  - access to a multidisciplinary skills base and expertise in traffic management and safety, as well as transport operations (inclusive of passenger transport);
  - coordination for the establishment and monitoring of demonstration projects to pilot new innovations, procedures and practices;
  - managerial and coordination support for the development/updating of guidelines, norms and standards for provincial and rural infrastructure, traffic management and safety, and transport operations;
  - access to several technology and software platforms that will provide technical support to DoLIDAR and its stakeholders;

[1] Based on guidance and direction provided by the Research and Development Technical Committee (cf. Section 4.1) and endorsement by the Steering Committee (cf. Section 3.1)

- knowledge management services to coordinate efficient and effective uptake and embedment of the outcomes of all R&D activities and to provide access to and diffusion of information to all stakeholders:
  - coordinate the transfer of technology through training courses, workshops and seminars;
  - support to the information resource centre to become a repository for, among others, text books, local and international conference proceedings and journals, research reports, technical guidelines, norms and standards, all of which should be easily accessible to all stakeholders;
- overall technological leadership for developing solutions and products that will address infrastructure and transport related problems that impact on the national priorities of Nepal, including public service delivery, socio-economic development, creation of employment opportunities through, for instance, the implementation of labour intensive approaches, and traffic safety, thus leading to socio-economic impact and public good.

2.5 Goal and Strategic Objectives

The goal of the RDS is to serve the provincial and rural road and transport needs of Nepal 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, cost-effective R&D based solutions that:

- address the current and future provincial and rural infrastructure and transport needs of the country;
- support sustainable development (e.g. climate resilience) and asset preservation; and
- enhance socio-economic impact.

It will provide innovative engineering solutions for the planning, design, procurement, construction, maintenance and management of provincial and municipal infrastructure, as well as transport operations and traffic safety, based on applied research supporting socio-economic development.

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

2.5.1 Establishment of the RDS

- Establishing (year 1), strengthening (years 2 and 3) and broadening (year 4 and beyond) the RDS in line with the research priorities of the country and in support of the service delivery priorities of DoLIDAR and its stakeholders;
- Developing a research agenda for the RDS, guided by the Research and Development Technical Committee (RDTC) and endorsed by the Steering Committee;
- Establishing linkages/access to research infrastructure to support the research agenda;
- Establish strategic relationships with appropriate (local) service providers.

2.5.2 Management of Relevant Knowledge Generation and Transfer

- Coordinating long-term, demand-driven research activities to maximise benefits for the country;
- Developing innovative and cost-effective solutions for local problems;
- Adapting appropriate technology and solutions sourced from elsewhere to satisfy local conditions;
- Conducting forensic investigations to understand causes and mechanisms of premature failures and other problems identified (e.g. traffic accidents), and to support activities to prevent their recurrence;
- Drafting and/or updating of guidelines, norms and standards;
- Supporting the establishment of an information resource centre to host, among others, books, local and international conference proceedings and journals, research reports, technical guidelines, norms and standards, inclusive of an electronic repository for reports, etc.;

- Managing technology transfer through press releases and publications (on DoLIDAR's website, for instance), training, workshops, seminars and conferences in order to advance knowledge within the sectors served by DoLIDAR;
- Assessing the contribution and impact of the activities and outcomes of the RDS on socio-economic growth, cost reductions, employment creation, poverty reduction and social development through improvements made in the planning, design, procurement, construction, maintenance and management of provincial and rural infrastructure, and in transport operations and traffic management.

2.5.3 Human Capital Development

- Attracting and nurturing local capacity to undertake relevant research (e.g. universities and private sector);
- Developing and implementing capacity building programmes to develop research management skills and establish a research culture;
- Cooperating with universities, also securing opportunities for DoLIDAR staff undertaking post-graduate studies while participating in the research programme of the RDS.

2.5.4 General

- Establishing sustainable (i.e. long-term) local sources for funding of R&D activities;
- Involve development partners in the Research and Development Technical Committee (RDTC) and Steering Committee meetings to identify opportunities for collaboration.

3. Governance

3.1 Strategic Oversight

A Steering Committee will provide overarching strategic oversight of the RDS. The role and responsibilities of the Steering Committee will include the following:

- To steer the establishment and operations of the RDS and assess the adoption of 'good governance' principles;
- To endorse the priority research, development and implementation projects recommended by the RDTC and identify and/or endorse allocation of funding to projects;
- To support the appointment of project champions and teams;
- To provide overarching project guidance 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 RDS. It is recommended that the Director General (DG) of DoLIDAR (cf. Section 3.2) be appointed as the Chairperson of the Steering Committee.

It is recommended that the membership of the Steering Committee will comprise senior representatives of organisations that would include:

- DG of the Department of Local Infrastructure Development and Agricultural Roads (DoLIDAR) – Chairperson
- Joint Secretary of the National Planning Commission (NPC)
- DDG of the Department of Roads (DoR) under the Ministry of Physical Infrastructure and Transport (MoPIT)
- DDG of the Department of Transport Management (DoTM) under MoPIT
- Executive Director of Road Board Nepal (RBN)
- Under Secretary of the Ministry of Federal Affairs and Local Development (MoFALD)
- Under Secretary of the Ministry of Finance (MoF)
- Under Secretary of the Ministry of Science and Technology (MoST)
- President of the Nepal Engineers' Association (NEA)
- President of the Society of Consulting Architectural and Engineering Firms (SCAEF)
- President of the Federation of Contractors' Associations of Nepal (FCAN)

Representatives of development partners, which could include the Asian Development Bank (ADB), the World Bank, the German Development Bank (KfW), USAid, the EU, JICA and DFID, should be invited on a needs basis to witness the proceedings of the meetings as observer members. Their attendance is recommended in order to identify potential synergies between projects and programmes, as well as potential for (co-)funding of RDS activities/projects.

The Head of the RDS, in his/her capacity as the Chairperson of the Research and Development Technical Committee (RDTC), should also be a member of the Steering Committee.

3.2 Institutional Structure

3.2.1 Institutional Location and Reporting Structure

Institutionally, it is proposed that the RDS be located as a new Section in the proposed new organogram of DoLIDAR (see Figure 1). The RDS would operate as an entity that would support all Divisions of DoLIDAR on an equitable basis, although its focus will initially be limited to provincial and rural roads and transport across the disciplines of planning, design, procurement, construction, maintenance, operations, infrastructure management, and monitoring and evaluation, with the additional focus to provide technical leadership to Provinces in particular.

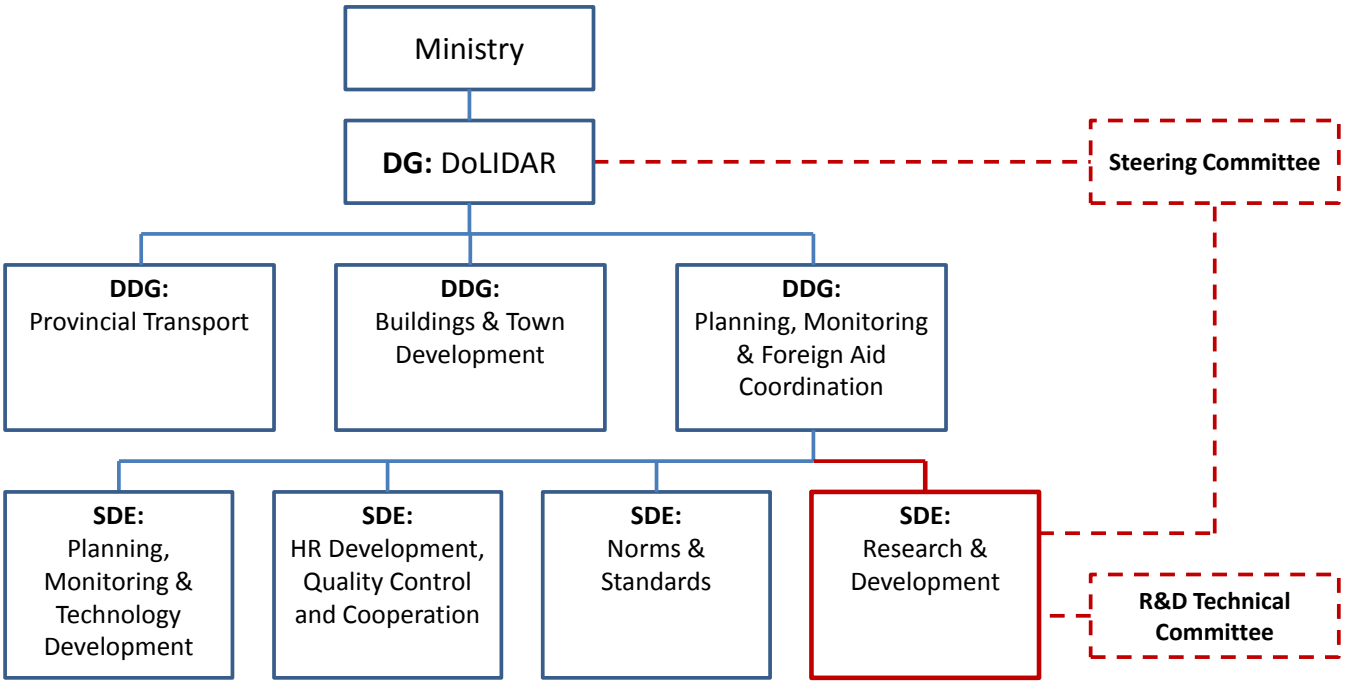

Figure 1: Proposed institutional location of the RDS within the structures of DoLIDAR

3.2.2 Physical Location

The RDS will be physically located at the Head Office of DoLIDAR in Kathmandu, the seat of the Central Government of Nepal, and in close proximity of potential R&D suppliers (e.g. universities).

3.2.3 RDS Organogram

The physical structure of the RDS will evolve over time. Initially, and independent of the institutional location of the RDS, a structure such as the one shown in Figure 2 is proposed. The RDS will be supported by two groups, namely *R&D Management* and *Knowledge Management*.

The RDS will be headed by a Senior Divisional Engineer (SDE), and the two sub-sections managed by (senior) Engineers.

The various responsibilities associated with R&D Management are presented in Chapter 4, and those for Knowledge Management in Chapter 6, whilst the responsibilities of the Senior Divisional Engineer and Engineers are outlined in Chapter 5.

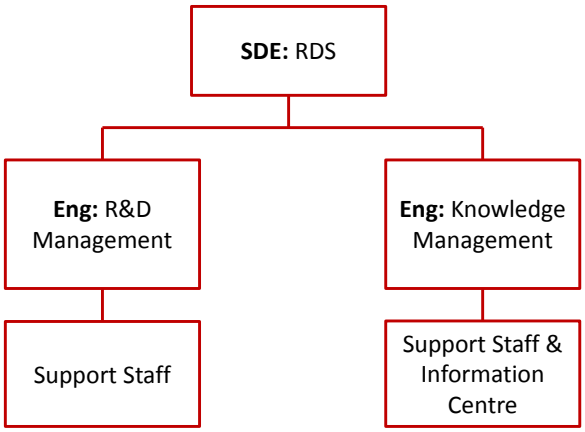

Figure 2: Proposed structure of the RDS

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

3.3 Sources of Funding

The RDS will require long-term guaranteed funding for at least five years, but preferably ten years after its establishment, i.e. its overheads and operational costs should be fully funded by DoLIDAR. The initial focus of the RDS will be on establishing the Section and setting up the science, engineering and technology (SET) base for the effective management of R&D, including the capacitation of its staff and yielding early returns in terms of research outputs benefitting the sector. From the outset, the RDS should have a strong technology focus and its functions should therefore not be diverted to sourcing and securing funding apart from prioritisation of funding for the execution of priority research project in line with the Research and Development Strategic Plan.

Hence, DoLIDAR would have to carry the costs for the operations of the RDS. Sources of funding will have to be identified and mobilised. These could include:

- Funding by DoLIDAR to cover the costs of RDS staff, facilities and equipment;
- Government of Nepal (GoN) funding for R&D projects;
- RBN funding for R&D;
- Attracting funding from Development Partners; and
- Recover costs from other institutions, both public and private, for whom training or specialist assistance is provided.

The returns that DoLIDAR will yield from supporting the RDS financially are multi-facetted and include: more cost-effective and more sustainable infrastructure; improved access; more efficient deployment of limited resources; strengthening the SET skills base of Nepal and of DoLIDAR in particularly; early solution for problems on site; and easy access to technical information through the Information Centre.

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 RDS into objective and measurable values. Since the RDS 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 RDS is on track to satisfy the short-term institutional objectives, and those required for gauging whether the RDS 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 RDS, and their progress in achieving those, are listed in Table 1. Since the RDS Business Plan is a ‘living’ document, the actions required for achieving the key performance indicators need to be updated on a regular basis.

Table 1: Critical Success Factors, Key Performance Indicators and Target Dates for the establishment of the RDS

Critical Success Factors	Key Performance Indicators	Target date	Achieved/ Outstanding
Establishing Good Governance Principles for the RDS	Institutional location of the RDS finalised	Sep-17	☑
	Physical location of the RDS finalised	Sep-17	☑
	Steering Committee established	Nov-17	☒
	RDS Business Plan accepted by DoLIDAR	Nov-17	☒
	RDS Business Plan accepted by Steering Committee	Dec-17	☒
	Linkages with key stakeholders in Nepal established	Apr-18	☒
	Linkages with international R&D centres established	Sep-18	☒
Establishing an RDS Research Agenda	RDTC established	Sep-17	☑
	Research needs identified	Sep-17	☑
	Research needs prioritised	Nov-17	☒
	Road Research Strategic Plan drafted by RDS	Feb-18	☒
	Road Research Strategic Plan accepted by RDTC	Mar-18	☒
	Research proposal format accepted by RDTC	Mar-18	☒
	Detailed research proposals drafted	Apr-18	☒
Operational Requirements for Establishing the RDS	Human resource requirements for RDS identified	Sep-17	☑
	Key results areas for RDS staff identified and agreed	Mar-18	☒
	Staffing plan for RDS accepted	Mar-18	☒
	Training and capacity building plan accepted	Mar-18	☒
Operationalisation of the RDS	RDS offices (including IT, etc.) allocated/established	Apr-18	☒
	RDS staff allocated/recruited	Apr-18	☒
	Linkages with Information Centre established	Apr-18	☒
	Supporting RDS databases established	May-18	☒
	RDS engineers capacitated	Jun-18	☒
	Supporting documentation for RDS available	Jun-18	☒

The critical success factors and key performance indicators to gauge whether the RDS 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 RDS; and
- Ensuring good governance.

The actions to achieve the KPIs should be assessed annually.

Table 2: Critical Success Factors, Key Performance Indicators and Targets for the operations and management of the RDS

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 RDTC meetings held	2	2	2	2	2
	Compliance with RDTC directives	100%	100%	100%	100%	100%
	No. of research projects initiated in Year	6	7	8	9	10
	No. of active research projects in Year	6	10	13	15	16
	No. of research projects in active development (not started in Year)	7	8	9	10	11
	No. of projects initiated with RDS funding	3	3	4	5	6
	No. of projects initiated with Development Partner contribution	3	4	4	4	4
	No. of projects involving local R&D suppliers	4	4	5	5	6
	No. of projects successfully completed	3	5	7	9	11
	% 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	75%	80%	80%	85%	90%
Ensuring effective transfer of technology to practice	No. of research reports produced	10	12	14	17	20
	No. of projects briefs / newsletters produced	5	6	7	8	10
	No. of conference papers presented	2	2	4	4	5
	No. of journal articles published	0	1	2	3	4
	No. of workshops held	4	5	6	7	8
	No. of seminars / forums held	2	2	3	3	4
	No. of new or updated guidelines / manuals published	0	1	2	3	4
	No. of new or updated norms / standards published	0	1	2	2	3
	No. of demonstration projects successfully implemented	1				2
Strengthening the skills base of the RDS	No. of engineers appointed in the RDS	4	4	4	5	5
	No. of RDS engineers inducted in good research practices	4	-	-	1	-
	No. of RDS engineers inducted in R&D management	4	-	-	1	-
	No. of RDS engineers inducted in Knowledge Management	4	-	-	1	-
	No. of information specialists	1	1	1	2	2
	No. of training coordinators	0	0	1	1	1
	Average % time spent on administration/management	60%	60%	55%	50%	50%
	Average % time spent on quality assurance	10%	10%	15%	20%	20%
	Average % time spent on capacity building (RDS staff)	20%	15%	10%	10%	5%
	Average % time spent on capacity building (external - e.g. workshops)	10%	15%	20%	20%	25%
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%
	Adherence to health, safety and environment standards	100%	100%	100%	100%	100%
	R&D collaboration - No. of MoUs signed	2	4	4	6	6

3.5 Strategic Relationships and Linkages

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

3.5.1 Within Nepal:

The RDS should have strong linkages with organisations that can carry out research within Nepal. These could include:

- Tribhuvan University, Institute of Engineering
  - Centre for Applied Research and Development (CARD)
  - Institute of Engineering Consultancy Services (IECS)
  - Centre of Excellence in Road Safety (in the process of being established)
- Kathmandu University, Department of Civil and Geomatics Engineering
  - Environmental Modelling Laboratory
- Engineering colleges at:
  - the Far-Western University
  - the Mid-Western University
  - the Pokhara University
  - the Purbanchal University
- Nepal Academy of Science and Technology (NAST)
  - Nepal Climate Change Knowledge Management Center (NCCKMC)
- Nepal Engineers' Association (NEA)

Signing of memoranda of understanding/agreement with the above entities will facilitate the procurement of their services for the execution of R&D activities. Such memoranda may already be in place (e.g. with the Institute of Engineering of the Tribhuvan University) but may need to be revisited to realign them with DoLIDAR's new emphasis on R&D. Others, such as with the NEA, will still have to developed and implemented.

Some of the research activities may be supported by post-graduate students, which will contribute to the development of these students in a work environment, but they should be led by senior academic staff of the university. Arrangements to involve DoLIDAR staff registered for post-graduate studies in RDS-led projects should also be negotiated.

In the case of the NEA, the Executive functions of the Association will act as the R&D Contractor, with appropriate members of the Association operating as project staff managed by the Executive function of the NEA.

The RDS should also establish linkages with other players in the field of provincial and rural infrastructure, such as other government entities (e.g. Research and Development Unit of the Department of Roads).

3.5.2 International Linkages and Alliances:

The RDS should have 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 Asia. Memorandums of Understanding could be signed between the RDS 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 Bangladesh and Myanmar. It is important for the RDS to establish

formal linkages and networks between those emerging road research centres as well as universities that have been in existence for a number of years. Those formal linkages and networks could facilitate the sharing of best practices; avoid duplication of research, and facilitate multi-national collaboration on projects in order to:

- provide scientific input into regional and national government policy on rural transport and road engineering;
- support the creation and preservation of an efficient and safe road network in the region;
- stimulate new innovations in road construction in the region.

4. Research, Development and Implementation Plan

4.1 Role and Responsibilities of the RDTC

A Research and Development Technical Committee (RDTC) should be constituted to provide technical guidance and direction to the RDS and to advise the Steering Committee on the nature and scope of research, development and implementation activities to be or being undertaken in the road infrastructure engineering domain.

Its membership could comprise technical experts of the following organisations:

- DoLIDAR
- Department of Roads (DoR)
- Nepal Academy of Science and Technology (NAST), e.g. Nepal Climate Change Knowledge Management Center (NCCKMC)
- Universities
- Nepal Engineers' Association (NEA)
- Society of Consulting Architectural and Engineering Firms (SCAEF)
- Federation of Contractors' Associations of Nepal (FCAN)
- Development Partners (as observers)

The Head of the RDS, when appointed, would be the Chairperson of the RDTC.

The role and responsibilities of the RDTC 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 RDTC should enhance the development of road and transport research policy, encourage multidisciplinary research, stimulate innovation in road construction technologies, and support the promotion of best practices in Nepal. The RDTC decision-making process on research, development and implementation should reflect the national strategic plan of the road sector.

The RDTC should convene at least two times a year, but preferably more frequently during the establishment phase of the RDS.

4.2 Research and Development Strategic Plan

4.2.1 Process

In association with the RDTC, the RDS should prepare an annual Research and Development Strategic Plan (RDSP) to direct its R&D operations and plan its deliverables. This Plan needs to be endorsed by the Steering Committee before it is implemented.

Progress against the RDSP will be reported at the meetings of the RDTC, and the Plan needs to be updated after each meeting to incorporate recommendations made by the RDTC. Any significant changes made to the Plan will have to be presented to the Steering Committee for final approval.

The following **process** is recommended for the identification, prioritisation and execution of a portfolio of research projects associated with *Roads and Transport*[2]:

1. Prepare a database of all current and past research undertaken on roads and transport in Nepal (once-off, but to be updated continually) [responsibility: RDS R&D Management];
2. Identify new R&D needs internally, and externally through interaction with key stakeholders [responsibility: RDS R&D Management];
3. Relate the needs identified to any current and previous R&D undertaken [responsibility: RDS R&D Management];
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: RDS R&D Management and RDS Knowledge Management];
5. Organise a RDTC meeting to table the identified themes with the main needs in a structured manner [responsibility: RDS R&D Management];
6. Identify additional research themes (also focussing on the positioning of DoLIDAR and their stakeholders to address future challenges), discuss the merits of each, and follow a structured process/ procedure for prioritising the R&D themes and needs [responsibility: RDTC 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 RDTC 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 the top five selected) – this process would require a significant number of RDTC responses (> 20) to be statistically significant;
    c. Allow each member of RDTC 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 RDTC 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 Research and Development Strategic Plan (RDSP; to be updated annually) [responsibility: RDS R&D Management];
8. Submit the RDSP to the RDTC for evaluation and (provisional) acceptance [responsibility: RDS R&D Management and RDTC];

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

9. If 'provisional', incorporate recommendations of the RDTC, resubmit to members of RDTC for their final approval, and on approval by RDTC members submit the RDSP, inclusive of a proposed implementation plan, to the Steering Committee for endorsement [responsibility: RDS R&D Management];
10. Evaluate and (provisionally) endorse the RDSP and prioritise themes/projects, and identify (potential) sources of funding [responsibility: Steering Committee];
11. If 'provisional', incorporate recommendations of Steering Committee, resubmit to members of the Steering Committee for their final approval, and on approval by Steering Committee members finalise the implementation plan, inclusive of sources of funding and procurement plan;
12. Procure R&D suppliers to implement the prioritised projects of the RDSP in line with the Steering Committee's endorsement [responsibility: DoLIDAR Procurement and RDS R&D Management];
13. Manage prioritised projects outsourced to R&D providers so as to ensure that they are delivered on brief, on budget, on time, and to the required level of quality [responsibility: RDS R&D Management];
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: RDS R&D Management and RDS Knowledge Management];
15. Monitor the uptake and embedment of the project's outputs [responsibility: RDS Knowledge Management];
16. Conduct impact assessment by monitoring a pre-defined set of indicators over time so as to see 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 DoLIDAR.

4.2.2 Preliminary research needs identified

Based on preliminary feedback received from sector stakeholders, the following R&D needs were identified (clustered by subject area but listed in no particular order):

Asset management:

- Inventory of all roads (including design of the inventory); functional classification; proposals for road ownership and managerial responsibility

Road design and materials:

- Appropriate selection and use of dust suppressants (project has been initiated)
- Appropriate surfacings for roads on steep hills
- Manual to assist provincial/municipal engineers to select surface types based on existing road characteristics, available budget, maintenance capacity and availability of materials, equipment and skilled / unskilled labour
- Collect and analyse data from existing trials and experiences, focusing on life cycle costs and suitability. This should be complemented by surfacing trials to be carried out in different ecological zones, looking at promising alternatives

Construction and maintenance:

- Maintenance of provincial and rural roads:
  - Best-practice guidelines
  - capacity building
- Guidelines, norms and standards for design, construction and maintenance of gravel roads

- Develop and implement work norms and technical standards for equipment use on non-engineered unpaved roads
- Quality control/assurance (e.g. laboratory testing proficiency scheme – linked to the establishment of a National Reference Laboratory)

Structures:

- Develop and endorse appropriate norms and standards for Local Road Network (LRN) bridges
  - Modular bridges (project has been initiated)
  - Suspension bridges

Traffic management and traffic safety:

- Black spot identification / improvement
  - Detailed analyses of accident data to determine types and causes of accidents on provincial and rural roads with the aim to developing targeted solutions for the most common types of accidents and black spots
  - Review of geometric design standards to incorporate recommendations
  - Target: reduce road fatalities by half by 2020
- Vehicle overloading management and enforcement
- Assessment of factors governing the selection of non-motorised transport (NMT) and provision of recommendations for improvements to the status quo to encourage greater use of NMT

Environment:

- Climate adaptation of provincial and rural road networks (i.e. climate-resilient solutions, including erosion control; slope stability; drainage structures):
  - Standards, manuals and guidelines on resilient road infrastructure
  - Policies and strategies for mainstreaming climate resilience in the operations of DoLIDAR
  - Capacity building through training courses, workshops and seminars
- Policies and regulations for addressing uncontrolled material mining (aggregate and river sand), also contributing to undermining/scouring of (bridge) structures, embankments and side slopes

In addition to the above, the following needs linked to the establishment of the RDS were identified:

- Development of an output database of past and current research projects undertaken in Nepal, inclusive of relevant university outputs (Masters and PhD dissertations, research reports), as well as DoLIDAR and donor funded research outputs;
- Development of protocols for the establishment, monitoring and management of demonstration projects.

Once prioritised by the RDTC, research priorities and associated proposals would be classified in three groups:

- 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 RDS 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.

The Research and Development Strategic Plan should include the objectives, deliverables and an outline of the timescale and estimated resource requirements for all projects categorised in any of the above three classes.

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 Nepal 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; to resolve and endorse implementable outcomes of R&D; and to coordinate the activities of the RDS and the Centre of Excellence in Road Safety to maximise synergy and minimise duplication of efforts.

These committees and working groups could be overarching; project-specific; constituted as sub-committees of the RDTC; or formed in response of a resolution made at an industry forum (cf. Section 6.5.4).

The following technical committees and working groups could be established to support the R&D activities of the RDS and the achievement of the envisaged end-products:

Overarching committees / working groups:

- A Coordinating Committee to harmonise/synergise the activities of the RDS and and the Centre of Excellence in Road Safety (when established)

Working groups / technical committees (**examples**; should be aligned with the prioritised research needs):

- Technical committee on asset management
- Technical committee on norms and standards for LRN bridges
- Working group on vehicle overloading management and enforcement
- Working group for the establishment of a laboratory proficiency testing scheme

4.4 Demonstration Projects

Several demonstration projects (e.g. road experiments, trialling of innovative materials and construction procedures) have been or will be carried out in Nepal. 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 RDS. 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.

Protocols need to be developed by the RDS for the establishment and periodic monitoring of the demonstration projects, and for performance data management and reporting. These should be established in Year 1 by the RDS.

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

5. Operations

5.1 Human Resources

5.1.1 Short to Medium Term Staffing Requirements

The staff complement of the RDS should be aligned with the scope of the RDS, which is the provision of leadership in R&D management and knowledge management.

It is anticipated that the RDS would initially be staffed by at least four engineers (inclusive of the Senior Divisional Engineer) and one information specialist, with the potential to grow to at least six engineers, two information specialist and a training coordinator in a few years' time.

The RDS staff would initially comprise two (senior) Engineers, one (junior) Engineer, one Information Specialist and support staff. Indicative staff positions and their responsibilities are shown in Table 3 below:

Table 3: Initial human resources requirements for R&D and Knowledge Management (Year 1)

Rank/Position	Indicative requirements/responsibilities	No. of positions required (Year 1)
Senior Divisional Engineer: RDS	**Key tasks:** • Strategic direction and business planning • Budgeting and financial monitoring and control • Contract management • Identification and securement of sourcing of funding for R&D programme and knowledge dissemination • Stakeholder management (inclusive of RDTC and Steering Committee management) • Quarterly and annual performance reporting • Operational Policy • Human resource management **Profile:** • University degree in civil engineering • At least 15 years of professional experience in a related professional capacity, management and strategy • Professional experience in Nepal • Good knowledge of roads and transport, in particular related to provincial and rural infrastructure • Proficient in Nepalese and English	1
(Senior) Engineer: R&D Management	**Key tasks:** • Technology foresight studies • Sector analyses • Needs determination • R&D strategy development and submission to RDTC • R&D theme and focus definition and submission to RDTC • Project proposal development and approval • R&D progress monitoring • Output evaluation and monitoring • Uptake evaluation and monitoring in association with *Knowledge Management*	1

Rank/Position	Indicative requirements/responsibilities	No. of positions required (Year 1)
	• Performance indicator development and performance trends analysis **Profile:** • Bachelor degree, but ideally a Masters degree • At least 10 years of professional experience in a related professional capacity and research activity • Professional experience in Nepal • Good knowledge of roads and transport, in particular related to provincial and rural infrastructure • Some knowledge of technology management and R&D management • Proficient in Nepalese and English	
(Senior) Engineer: Knowledge Management	**Key tasks:** • Assess information requirements of its stakeholders • Collection, compilation and processing of data, information and knowledge needs within the DoLIDAR structure • Facilitate access of DoLIDAR staff and stakeholders to (electronic) information sources and services, in cooperation with DoLIDAR's Library • Review of Terms of Reference of R&D projects and R&D proposals received (in conjunction with *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) • Cooperation and facilitation within networks for road and transport information and knowledge exchange within Nepal and on the regional and international level (scope to be broadened when the RDS is fully established) • Organisation of classroom and hands-on training courses, workshops • Organisation of the publishing of newsletters and projects briefs to keep DoLIDAR staff and external stakeholders informed on RDS activities and outputs • Management of data archiving **Profile:** • Bachelor degree, but ideally a Masters degree, in civil engineering, economics, or related field • At least 10 years of professional experience in knowledge management / organisational development projects • Professional experience in Nepal • Good knowledge of roads and transport, in particular related to provincial and rural infrastructure	1

Rank/Position	Indicative requirements/responsibilities	No. of positions required (Year 1)
	• High proficiency in using ICT and good understanding of ICT networks, hardware and applications; experience with GIS is an asset • Proficient in Nepalese and English	
(Junior) Engineer	**Key tasks:** • Assistance to (senior) Engineer: R&D Management in tasks provided above • Scheduling and running of workshops and other training interventions • Data processing for both (senior) Engineers in knowledge management and R&D management **Profile:** • University degree in civil engineering or related field • At least 5 years of professional experience in Nepal • Some knowledge of roads and transport, in particular related to provincial and rural infrastructure • Good data processing skills and statistical analysis • Proficient in Nepalese and English	1
Information Specialist	Must 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 staff required (excluding support staff):	**5**

It would be expected that Knowledge Management function of the RDS would have to employ at least one additional (junior) Engineer within the next five years to support the (senior) Engineer in the fulfilment of his/her obligations in line of the number of additional R&D projects to be managed and the management of R&D outputs to ensure their uptake and embedment in DoLIDAR.

Also, in support of the training mandate under the responsibility of Knowledge Management, it would be advised to appoint a Training Coordinator, focussing on the coordination of training courses, workshops, technical committee meetings, wider industry forums and any other means of knowledge diffusing in DoLIDAR and among its stakeholders.

Initially one Information Specialist would be required to support the establishment and operation of competences in knowledge management. As the RDS grows and/or the demand for knowledge management increases, consideration should be given to employing an Assistant Information Specialist.

Other support staff would be appointed and allocated to the RDS on a needs basis.

5.1.2 Recruitment Plan

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

1. Agree on staff composition of the RDS;
2. Determine the key results areas for each position;
3. Agree on a schedule for recruitment;
4. Identify and approach suitably qualified DoLIDAR staff who could be assigned to the RDS;
5. Advertise vacant positions and interview short-listed applicants;
6. Appoint suitably qualified persons for the RDS;
7. Implement an Induction Programme for RDS engineers to familiarise them with the research environment. It is important that they change their fundamental thinking from that of, for instance, *why the status quo should be followed* to *how we can do it differently to improve on the status quo*.

5.1.3 Skills Development Plan

Recruitment, growth of human capital and retention of skills are crucial for the purposes of sustaining a strong SET base to enable the RDS to fulfil its mandate. Professional growth of RDS staff, knowledge generation through a culture of learning and sharing, and the creation of opportunities for engineers/planners employed by the RDS are fundamental to sustain a strong SET base.

As a knowledge-centred entity, the RDS 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. For instance, staff of the RDS should be encouraged to attend relevant international conferences to keep abreast of latest developments that would benefit Nepal. This learning should be channelled back in the form of: (a) dissemination to local practitioners, and/or (b) formulation of R&D projects to explore their adaptability and implementation in Nepal.

Traditional, formal learning opportunities (organisation and involvement in workshops, technical committees, lectures, conferences) - while very important - will not be enough to sustain a workforce in a knowledge-based age. The RDS 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 will facilitate learning while encouraging collegial interaction and improving access to information. Collaboration beyond the walls of the RDS, in line with the mandate of the RDS, has to 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 RDS's reputation for innovation.

The RDS 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 staff** to familiarise them with the research environment, which should include training on the standards that R&D suppliers 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 research 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;
  - How to establish and monitor demonstration projects;

  - Data collection, data management and statistical analysis of research data;
  - General road engineering topics from the perspective of R&D (e.g. infrastructure planning; design of roads; materials design; asset management; traffic safety; etc.).

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

5.2 RDS Infrastructure

5.2.1 RDS Facilities

The RDS will be established in Kathmandu, on the premises of Head Office of DoLIDAR. No new facilities will be required for the offices of the RDS in the short to medium term since the RDS will be allocated offices within the existing premises of DoLIDAR.

The RDS will not manage nor be held accountable for facilities (e.g. testing laboratories) employed by appointed R&D Suppliers to produce R&D outputs. Such responsibilities should reside with the R&D Suppliers contracted to execute the RDS projects. Hence, the R&D Supplier will have to ascertain whether the facilities employed by them are adequately equipped to provide quality, reliable and fully trustworthy results. In this endeavour, the R&D Supplier may insist on executing correlation testing at other testing facilities to ascertain the above, subject to prior approval by RDS/DoLIDAR.

In terms of laboratory and field testing facilities, the R&D Suppliers could select among a wide array of facilities available to provide such services, including:

- laboratory facilities of DoLIDAR;
- Central Laboratory of DoR;
- testing facilities available at universities;
- private laboratories.

In-house research conducted by DoLIDAR staff should ideally make use of the DoLIDAR facilities, unless such projects are linked to post-graduate studies undertaken by DoLIDAR staff, in which case either DoLIDAR or university facilities could be used.

5.2.2 Supporting RDS Infrastructure

Each staff member will require the necessary computer resources, mostly desk-top machines, but laptops are preferred for those staff spending extended periods out of the office.

Good back-up facilities will be essential and a management programme to ensure that backups are routinely made by all staff at fixed intervals should be implemented. Ideally, secure off-site storage of selected backup media should also be arranged.

On-line access to information and other resources supporting the activities of the RDS are also essential. This is addressed in the next Chapter dealing with Knowledge Management.

5.3 SHEQ Management

Safety, Health, Environment and Quality (SHEQ) is a collective responsibility and is guided by the policies and procedures of DoLIDAR, which the RDS and its R&D Suppliers all have to comply with.

6. Knowledge Management

6.1 General

Knowledge management refers to any initiative that focuses on knowledge as a primary resource of the organisation, and attempts to make it more productive by increasing access to it, developing it, capturing it in databases, or applying it to enhance processes, products, and services[3]. 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 techniques[4].

The above is in line with the definition of knowledge management adopted by ReCAP for the purpose of its Knowledge Management and Communications Strategy: "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"[5].

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 RDS research (Section 6.5);
- Records management activities (Section 6.6).

6.2 Information Centre

6.2.1 Introduction

Library/information services associated with knowledge management of R&D 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 an accessible storage platform that also participates in the activities of its user community
- A fully digitised platform for innovation, integrated into the knowledge management activities of the RDS and focussed on pro-active support.

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

[4] 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.

[5] 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 the user requirements of DoLIDAR, 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 appropriate for DoLIDAR. It is therefore this option that is outlined 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 outputs created for the RDS. 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 RDS and DoLIDAR 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 RDS staff and its R&D suppliers, DoLIDAR 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 externally by R&D suppliers – so that appropriate items could be made available to all interested stakeholders simultaneously and quickly. At the same time the design should make provision for ethical conduct and adherence to copyright law.

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 DoLIDAR staff;
- Library network services for borrowing from and supplying material to peer institutions (e.g. university libraries);
- Records and document management services to ensure accessibility to information but also for the dissemination of quality products to internal and external stakeholders;
- Various physical spaces for DoLIDAR staff and information centre staff, such as a reading area with work stations; smaller meeting areas; office space for the information centre staff, and storage facilities.

Access to the Intranet/Internet 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.

6.3 Virtual Collaboration Platforms

Research is increasingly done collaboratively, and is often interdisciplinary of nature. It is foreseen that several of the RDS research projects will be achieved through a combination of delivery mechanisms involving R&D suppliers such as academic institutions, consultants and other national and international research units. While the final research outputs of these collaborative research projects will be captured in the Research Outputs Database (cf. Section 6.6), access to web based collaboration platforms may be required to allow file sharing between the RDS and R&D suppliers, as well as for collaborative report writing between members of the R&D project teams during the execution of projects.

6.4 Web-Based Knowledge Portals

Both internal and external web portals are required. An intraweb will serve as a portal for DoLIDAR staff to find organisational information, and in particular to learn about developments and outputs related to the activities of the RDS. It will afford staff quick and efficient access to the information.

The external website will provide a snapshot of the organisation to the outside world, and in particular will contribute to the knowledge dissemination efforts of the RDS. A sustainable, easily accessible knowledge portal providing a clear description of the RDS's purpose, services and outputs will assist it in building a strong reputation in the road and transport sector. It will make R&D outputs accessible to external stakeholders through the institutional repository and thereby support research uptake. As such, it is an important communication tool for the RDS.

6.5 Information and Technology Transfer

6.5.1 Publication Strategy

To establish the RDS as a reputable research entity and to promote knowledge dissemination and uptake, the R&D suppliers should be encouraged and supported to publish their research in high standing, peer-reviewed journals and/or to present their research at conferences. Publishing further provides the opportunity to influence policy and practice through academic channels. The RDS should however ensure a balance between academic publication and information intended for decision makers. The RDS'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 and 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 release of the final documents so that stakeholders can contribute to the content before finalisation of the documents.

Such events are essential to ensure dissemination of the research findings, to increase awareness of the RDS 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 DoLIDAR 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 DoLIDAR 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

DoLIDAR. 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 RDS staff on sabbaticals at international universities or research centres to master skills in R&D management and knowledge management.

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

6.5.4 Roads Forum

It is recommended that a Roads Forum be established, possibly in cooperation with DoR. The Roads Forum would serve as a medium for the exchange of information and technologies, promoting best practice, and to facilitate the discussion of issues of strategic importance to the roads sector. Its specific goals could include:

- To provide a perspective of overarching strategic issues as it affects (rural) road engineering and transport;
- Promote best practices;
- Establish task groups with specific national objectives;
- Disseminate new technologies and research findings;
- Provision of a forum for acceptance of technological changes;
- Provision of a forum for interaction between theory and practice and for identification of technology development needs.

The Roads Forum would make provision for representation and participation from the broader roads sector, particularly municipal, provincial and national Government authorities, tertiary institutions, consulting engineers, contractors and road construction material suppliers, among others.

6.6 Records Management Activities

The RDS 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 RDS falls within the structures of DoLIDAR, it should comply with the DoLIDAR records management procedures. The RDS's R&D and knowledge management activities may however result in additional records management requirements not currently addressed by DoLIDAR.

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, laboratory reports, technical manuals and guidelines as well as information published externally by RDS staff and its R&D suppliers, 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 on contracts; project management plans; relevant protocols and standards; ethics approvals (where required); and project finances and records should be stored in project files. Research data sets created as part of the research activities conducted by R&D suppliers should ideally form part of the Research Outputs Database of the RDS. It is important for on-going and future research (as well as for the verification of research results, if required) 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, indirect costs, depreciation and R&D project costs is presented below for the first year of operation.

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):

- Senior Divisional Engineer: USD 5,900/year
- (senior) Engineer: USD 4,600/year
- Information Specialist: USD 4,000/year
- (junior) Engineer: USD 3,600/year
- Support staff: USD 2,900/year

Based on the above, the total Human resource cost for Year 1, including two administrative staff, is **USD 29,000**.

Project-Attributable Costs, Indirect Costs and Depreciation

Rough estimates of direct R&D project costs, indirect costs, depreciation and R&D project costs are shown below.

Direct R&D project costs reflect the amount payable to local R&D providers for contract research. They have been calculated on the basis of four projects to be initiated in Year 1, with an average input of *500 man-days per project per year*, HR rates of USD 850 per month for private consultants and USD 600 per month for academic staff of universities (average of the two rates has been used for budget purposes, i.e. *USD 700 per month*). Project disbursable costs have been assumed to be *30 per cent* of the total HR cost.

It should be noted that no provision has been made for R&D projects to be undertaken by international consultants. It is assumed that such projects will be funded by Development Partners.

Indirect costs are include cost items such as: 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); etc. These costs are difficult to quantify at present and, therefore, estimated at *100 per cent* of the total human resource costs indicated above for the first year, and *50 per cent* of human resource costs in subsequent years.

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.

The amount for ***depreciation*** would cover computers and furniture, depreciated over a period of two years.

DIRECT & INDIRECT COSTS (USD) - YEAR 1	155 000
Direct R&D project costs	66 000
Indirect costs	29 000
Information Centre	50 000
Depreciation (computers/furniture)	10 000

Based on the above, , the cost structure (taking into account the above assumptions, limitations and exclusions), indicates that a minimum of **USD 184,000** should be budgeted for the operations of the RDS in its first year of operation, based on assumed USD 29,000 of Human Resource costs and USD 155,000 of Direct and Indirect Costs.

7.2 Five-year cost structure of the RDS

In Table 2, Section 3.4, it is noted that the staff complement of the RDS (excluding administrative staff) will increase from 5 staff members in Year 1 to 8 staff members (i.e. from 4 to 5 engineers, and from 1 to 3 support staff in Knowledge Management 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)	**29 000**	**29 000**	**32 000**	**39 000**	**39 000**
DIRECT & INDIRECT COSTS (USD)	**155 000**	**174 000**	**213 000**	**261 000**	**282 000**
Direct R&D project costs	66 000	109 000	153 000	197 000	218 000
Indirect costs	29 000	15 000	16 000	20 000	20 000
Information Centre	50 000	40 000	40 000	40 000	40 000
Depreciation	10 000	10 000	4 000	4 000	4 000
Required Investment (USD)	**184 000**	**203 000**	**245 000**	**300 000**	**321 000**

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

- The staff complement will expand as per the targets set in Table 2;
- Project-attributable costs increase assuming that more projects will be undertaken as per the targets in Table 2;
- Indirect costs are accounted for as 100 per in Year 1, and 50% in subsequent years of total RDS Human Resource cost;
- Information Centre costs include subscription fees for on-line access to major scientific publication houses. However, these costs could be reduced if agreements can be reached with, for instance, the Tribhuvan University to (proportionally) share in the costs of subscription fees.

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

MEMORANDUM OF UNDERSTANDING (MOU)

BETWEEN

Department of Local Infrastructure Development and Agricultural Roads

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

(hereinafter referred to as "DoLIDAR")

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 provincial and rural infrastructure, including transport operations ("the FIELD")

WHEREAS:

- DoLIDAR has been enacted to conduct or cause to conduct research and studies related to provincial and rural government infrastructure, 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 provincial and rural infrastructure planning and investment decisions;
  - Collaborative field and laboratory research initiatives in provincial and rural infrastructure design, materials, construction, maintenance, management and impact assessment;
  - Development of standards, specifications, technical manuals and guidelines for infrastructure materials, design, construction, maintenance, management and impact assessment;
  - Knowledge exchange: Exchange of publications and other relevant scientific and technical documentation on topics related to provincial and rural infrastructure, 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 DoLIDAR 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 Nepal (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 DoLIDAR, mean the Director General of DoLIDAR 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 Kathmandu, Nepal (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 DoLIDAR:

……

xxx

xxx

On behalf of <Organisation>:

……

xxx

xxx

In the presence of:

1. ……

   xxx

   xxx

2. ……

   xxx

   xxx

In the presence of:

1. ……

   xxx

   xxx

2. ……

   xxx

   xxx

Appendix B/Good Research Practice Guide

Good Research Practice Guide

B.1 Introduction

The purpose of this section is to provide an overview of good research practices to guide and support DoLIDAR in ascertaining that the expected standards of R&D will be met by R&D Suppliers. This will ensure that DoLIDAR' R&D Suppliers achieve the highest quality and ethical standards in research, driven by integrity, honesty and professionalism of their staff. The guidelines are intended for researchers and research support staff of any third parties that may be contracted by DoLIDAR, but is equally applicable for DoLIDAR staff conducting in-house research.

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, back up the researcher's hard-drive onto a CD or other medium. 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 involved or who could be affected by it. Experiments on humans must follow the international guidelines, and surveys involving people must adhere to the same guidelines or those prevailing in Nepal.

The researcher must ensure that people involved are fully aware of all the risks and dangers in advance of that involvement. 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, DoLIDAR research must be made available to the community at large. This can be achieved through open access to the research outputs of DoLIDAR. 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 the efficient and proper use 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 RDS 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 have therefore a responsibility to develop and maintain the skills they need in their research while assisting others with their personal development.

It is expected that DoLIDAR managers and R&D Suppliers recognise and deliver on their responsibilities for mentoring and staff development and ensure that junior engineers/researchers – 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.

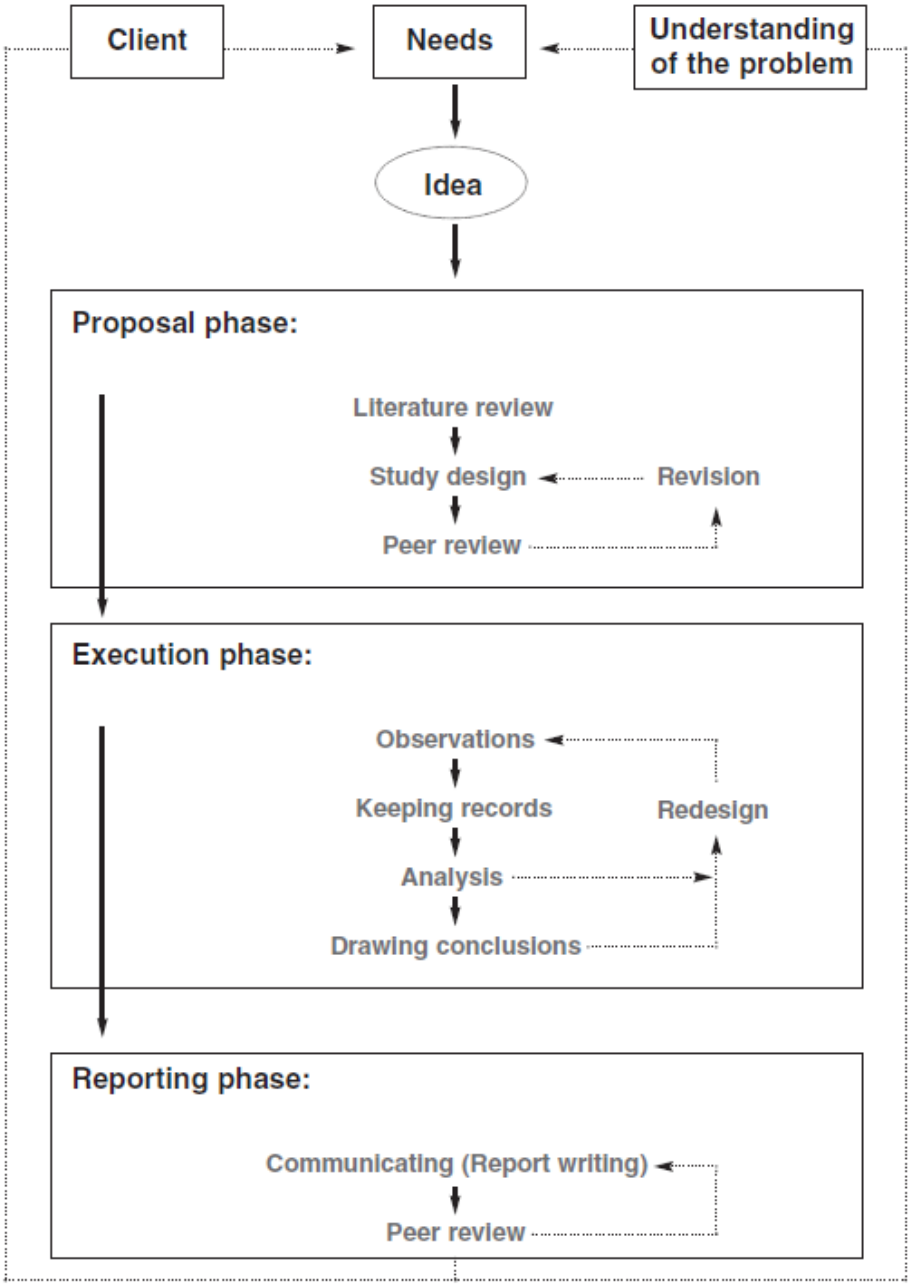

Figure B.1: Research Process[6]

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. A research proposal's main function 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

[6] 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 get at the essence of the problem, by asking whether it is essential that the answer to the question be known to be able 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 careful 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.