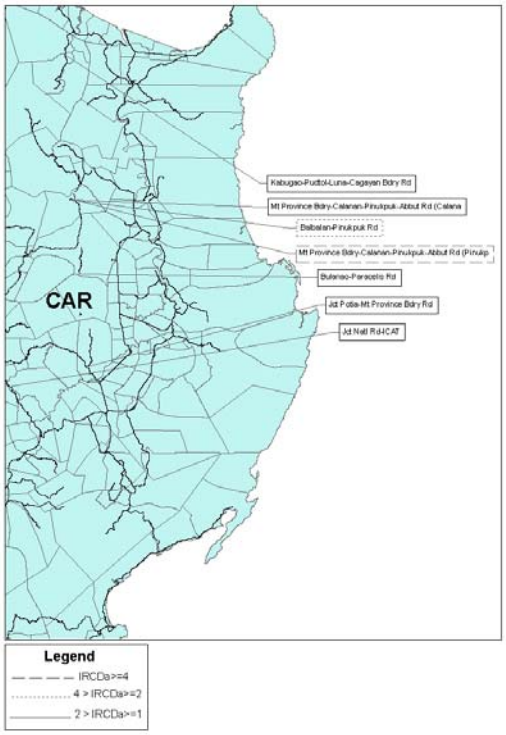
JAPAN INTERNATIONAL COOPERATION AGENCY

THE DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS

THE STUDY ON RISK MANAGEMENT FOR SEDIMENT-RELATED DISASTER ON SELECTED NATIONAL HIGHWAYS IN THE REPUBLIC OF THE PHILIPPINES

FINAL REPORT

GUIDE I
RISK MANAGEMENT PLANNING



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PREFACE

Over the last three decades, the Philippines has undertaken the rapid development of the road network, the total length of which reaches more than 200,000 km, including 30,000 km of national highways. Along with the development of the road network, road slope disasters have caused wide public concern. These road slope disasters frequently destroy or block the roads, particularly during the rainy season, due to such natural conditions as steep topography, fragile geology, heavy rainfall and frequent earthquakes.

The Department of Public Works and Highways (DPWH) of the Republic of the Philippines is undertaking to improve road maintenance with their own resources and expertise, as well as the assistance from international funding institutions. The Pavement Management System (PMS) and the Bridge Management System (BMS) have been established as applications of the Road and Bridge Information Application (RBIA), and the systematic maintenance of pavements and bridges started in 2004 through the issuance of various Department Orders.

However, a management system for Road Closure Disasters (RCDs) had not yet been established in RBIA. To address this situation, the DPWH decided to formulate a systematic procedure for road slope management with assistance from JICA. The Study entitled "The Study on Risk Management for Sediment-related Disaster on Selected National Highways in The Republic of The Philippines" was undertaken from March 2006 to June 2007.

The main results of the study were the establishment of a systematic procedure for collecting information on road slopes along national highways, and development of a database system named RSMS (Road Slope Management System).

The procedures for collecting information on road slopes and planning systematic management policies have been compiled in the technical manual entitled "Guide to Mitigation and Management of Road Slope Disaster." This guide is composed of three volumes as follows

1) Guide I contains instructions and procedures for making a reasonable management plan;

2) Guide II provides a systematic inventory survey for collecting data and formulating a database on road slopes; and

3) Guide III explains and demonstrates design methods to prevent road slope disasters.

In this Guide I: Risk Management Planning, management planning for road slope disasters is explained, utilizing the results of the Inventory Survey on selected national highways. Chapter 1 describes the situation of road slope disasters along national highways. Chapter 2 summarizes

the general method of the inventory survey in connection with RSMS. Chapter 3 discusses technical methods for utilizing the inventory survey results. Chapter 4 proposes how to formulate and plan projects on slope disaster prevention.

Contents and Users of Guide

Guide No.	Title of Volume	Contents	Main Users in DPWH
I	Risk Management Planning	1. Formulation and utilization of road slope management database 2. Target setting and programme formulation for risk management 3. Project formulation of disaster prevention	Central Office (Information & Communication Technology Service, Planning Service, Bureau of Maintenance) Regional Office District Engineering Office
II	Inventory Survey and Risk Assessment	4. Procedure of inventory survey - Assessment of Potential Road Closure Disaster (FRCDp) - Assessment of disaster magnitude and other disaster situation - Alternative Countermeasure planning and cost estimates - Indicative Feasibility Assessment (IFA)	Central Office (Planning Service, Bureau of Maintenance) Regional Office (Planning and Design Division, Maintenance Division) District Engineering Office (Planning and Design Section, Maintenance Section)
III	Road Slope Protection	5. Countermeasure design method 6. Countermeasure design example 7. Temporary treatments for road slope disasters and quality control for restoration work	

The study had been carried out in close cooperation with the counterpart team of DPWH, and, in the process of the study technical transfer had been smoothly conducted. This Guide will be helpful in the implementation of the nationwide Inventory Survey, and contribute to the reduction of road slope disasters.

DEFINITION OF TERMS FOR RISK MANAGEMENT OF ROAD SLOPE DISASTERS (RSD)

Terms		Definitions
Disaster	:	A road slope failure, which could stop traffic flow and be dangerous to road users and inhabitants along the road.
Disturbance	:	Deformation of the slope and/or road structures or slope collapse which has not reached the road.
Visible Disturbance	:	Signs of potential disaster such as collapse, open cracks, depression, upheaval, or muddy spring water on the road or slope.
Road Closure Disaster [RCD]	:	A disaster which causes closure of the whole or partial width of the road Deformations and collapses that do not close the road are not necessarily regarded as a RCD but just as a 'Disturbance'.
Loss	:	Monetary amount of damage caused by a disaster, specifically defined as the sum of the reopening cost, human lives lost, and detour cost.
Risk	:	The total damage characterized by the potential frequency and magnitude of the disaster. Annual total loss is an expression of the risk. The risk is distinguished from the hazard, which could be defined, in the case of this Study, as the overt danger to the road and road users.
Frequency of Road Closure Disasters per Year [FRCD]	:	The number or RCD occurrences per year for a slope
Intensity of Road Closure Disasters of a Road Section [IRCD]	:	Average RCD occurrences per unit length per year for a road section, *i.e.* the total FRCD's for the road section divided by its length

GUIDE TO MITIGATION AND MANAGEMENT OF ROAD SLOPE DISASTER

GUIDE I RISK MANAGEMENT PLANNING

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CHAPTER 1

INTRODUCTION

1.1 Risk of Road Closure Disasters (RCD) in the Philippines

In the Philippines the total length of national highways with the potential for road closure disaster is 1,774 km out of 29,005 km, as shown in Table 1.1. In 2004 and 2005, RCDs occurred 2,969 and 2,447 times respectively, averaging 2,708 as also shown in Table 1.1.

Table 1.1 Annual Average Road Closure Disasters (based on 2004 & 2005 data)

Region	Total Road Length	Road Length with RCD Risk	Annual nos. of RCDs	Actual Intensity of RCD	Average Annual Losses
Unit	km	km	nos. of RCD per year	nos. of RCDs per (year*km)	million pesos per year
Acronym	TRL	RLwRCD	ANRCD	IRCDa	AL
Expression				ANRCD/ RLwRCD	
CAR	1,844	238	981	4.13	1,171
NCR	1,014	5	1	0.20	0
I	1,609	82	41	0.50	25
II	1,753	208	193	0.93	210
III	1,989	260	235	0.90	367
IV-A	2,404	116	62	0.53	47
IV-B	2,172	157	326	2.08	197
V	2,196	30	95	3.19	77
VI	2,880	93	134	1.45	69
VII	1,960	114	153	1.34	66
VIII	2,332	88	86	0.97	63
IX	1,140	103	36	0.35	17
X	1,604	90	57	0.63	39
XI	1,446	102	84	0.82	78
XII	1,304	30	88	2.92	86
XIII	1,357	59	138	2.33	115
Grand Total	**29,005**	**1,774**	**2,708**		**2,627**
Average				**1.45**	
				Round figure to two decimal	

RCD: Road Closure Disaster

Losses induced by RCDs are estimated at PHP 2,627 million annually, as shown in Table 1.1 and Figure 1.1. This includes reopening costs, value of human lives lost, and detour cost. It does not include damages to electricity, communication, and other infrastructures installed along the road, the impact on economic activities supported by the road, and psychological impacts.

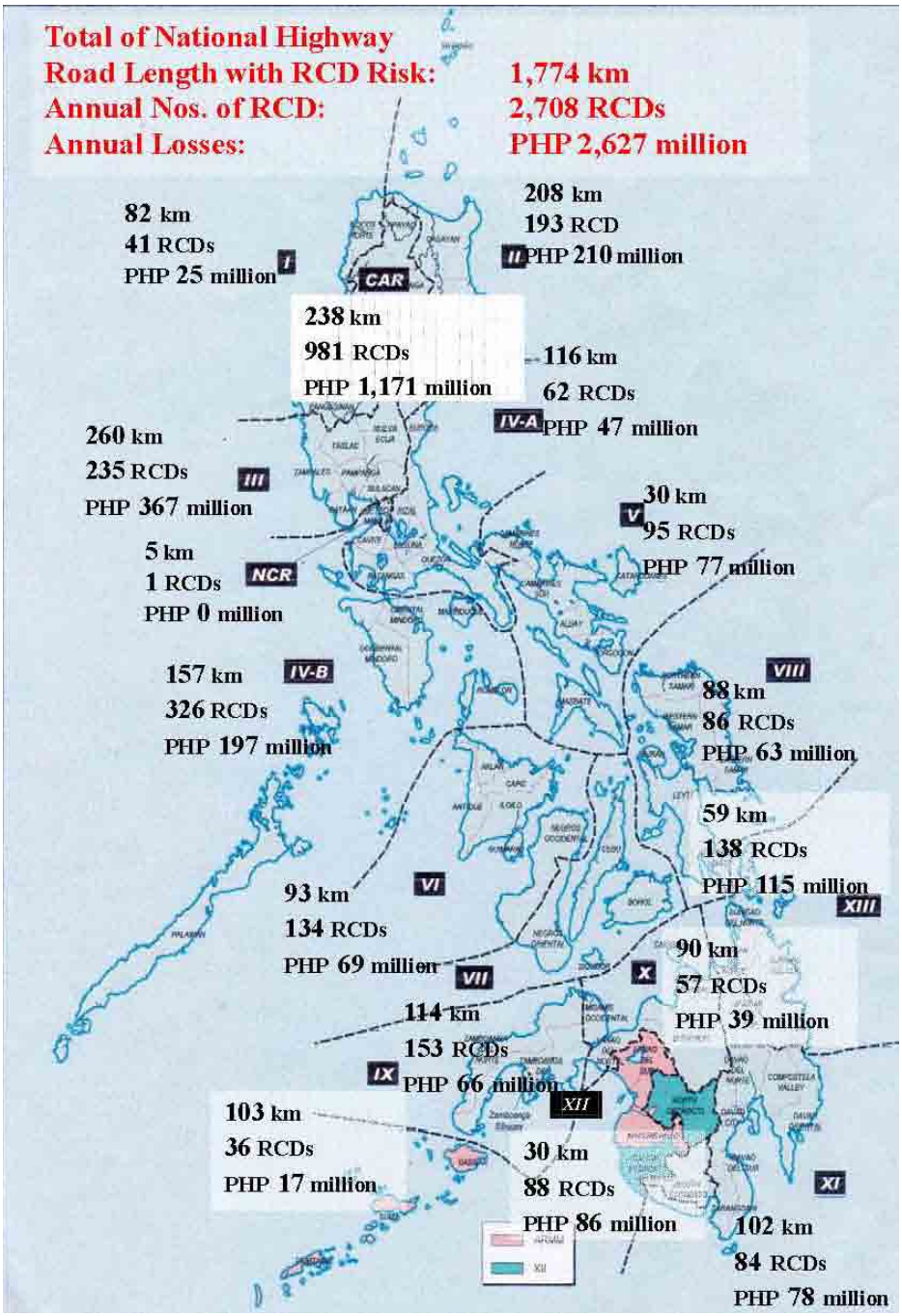


Figure 1.1 Average Annual Numbers of RCDs and Losses (based on 2004 and 2005 data)

1.2 Purpose and Necessity of Practical Risk Management

The situation of road disasters in the Philippines can be improved by systematic and reasonable management by the DPWH, the government agency tasked with the mission of preserving traffic function and safety of the national highways.

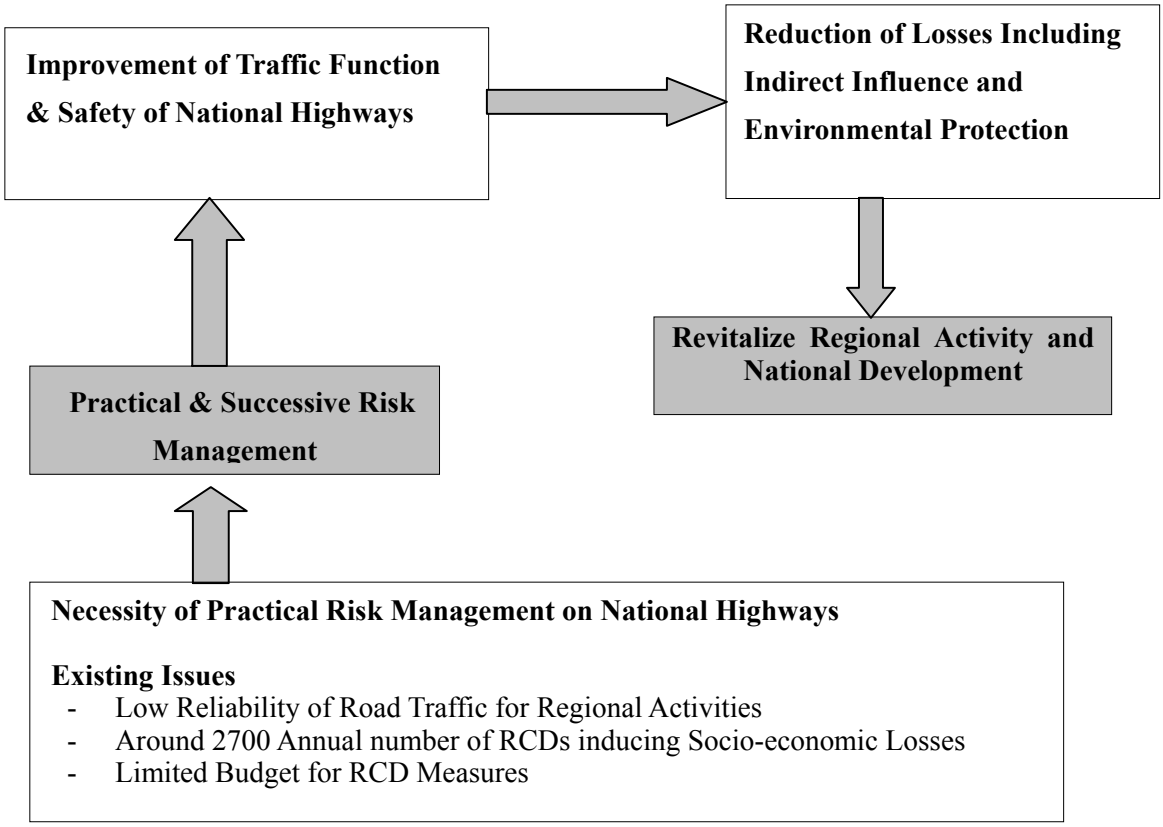


Figure 1.2 Purposes and Necessity of Practical Risk Management

Practical and successive risk management of RCDs will improve the traffic function and safety of national highways, as shown in the Figure 1.2. This will contribute to the reduction of accountable losses (reopening cost, human lives lost, and detour cost) and of indirect costs such as stagnation of social activities and the psychological impact induced by RCDs.

Practical and successive risk management of RCDs is a key activity of DPWH that can contribute to the revitalization of regional socio-economical activities and national development.

1.3 Contents of Guide I

(1) Contents of Each Chapter

Guide I sets out the methodology for risk management utilizing indicators obtained from inventory surveys. The Guide is composed of the following five chapters:

Chapter 1;	Introduction
Chapter 2;	Formulation and Update of RSMS database
Chapter 3;	Basic Procedure of Risk Management Planning
Chapter 4;	Target setting and program formulation
Chapter 5;	Project formulation for the Road Slope Disaster Management

Chapter 2 describes the Inventory survey and RSMS database as the methods of providing the basic data for Risk Management Planning.

In Chapter 3, the basic procedure for risk management planning is described

In Chapter 4, the procedure for setting targets for of risk levels for national highways is given, utilizing risk level indicators such as Potential Frequency of RCDs (FRCDp) and Potential Annual Loss (ALp), data collected by the Inventory Survey, reference to risk and quality levels of foreign countries, and risk and quality levels of pavements and bridges in the Philippines. The procedure for priority-ranking of road sections for risk management is also described.

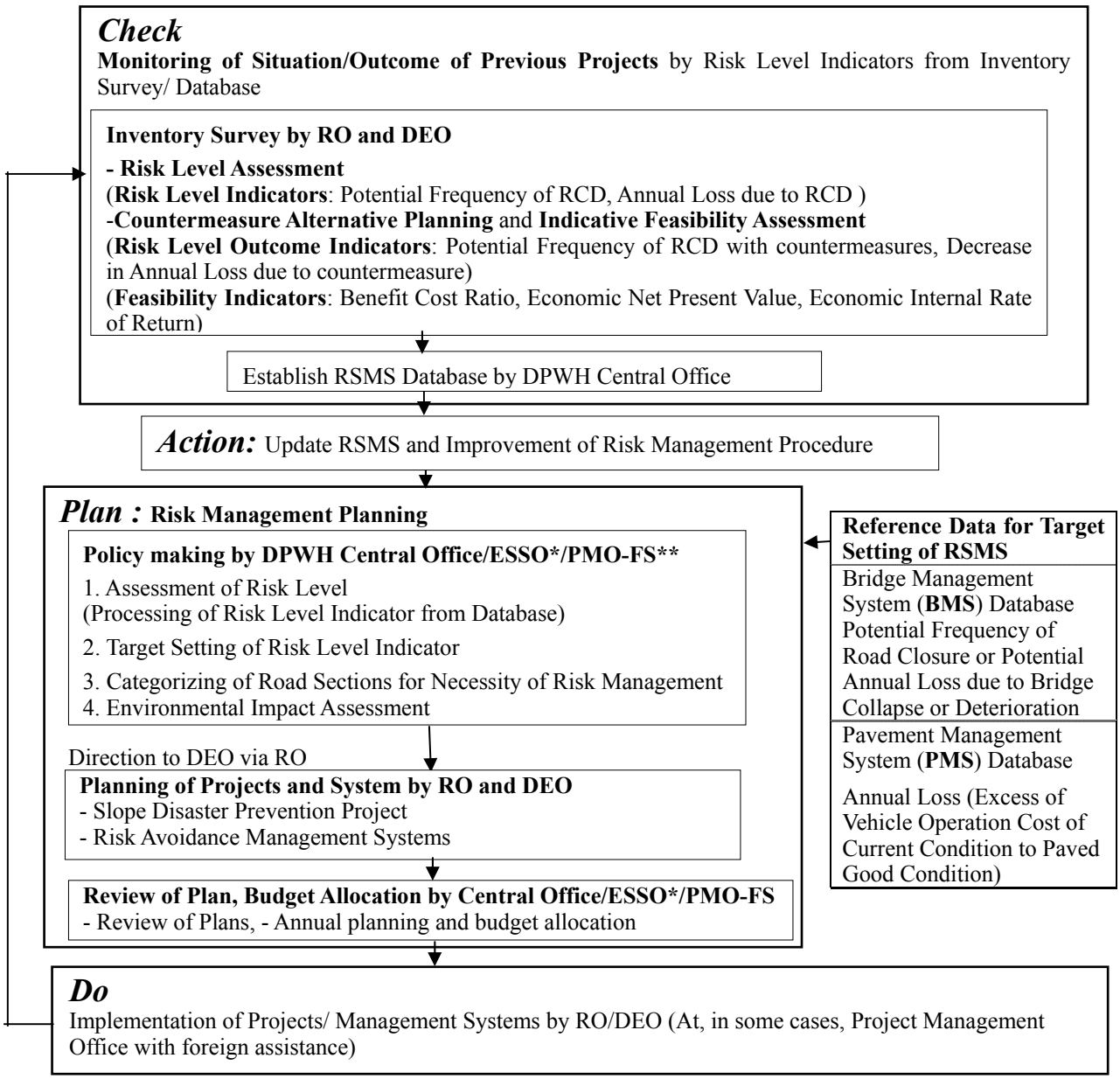
In Chapter 5, the procedure for project-planning of disaster prevention works is given, including budget planning, and presenting actual planning examples. The implementation system and roles of concerned DPWH units are laid out.

(2) Non-inclusion of Risk Avoidance Management Procedure in this Guide

The concept of "Risk Management" includes preventive work, risk avoidance management, and routine maintenance. However, this guide is limited to the planning method for preventive work on RCDs to be used by DPWH planners. The procedure for risk avoidance management for rain induced disasters (early warning and traffic regulation system) is not included in this guide. That should be undertaken according to DPWH's Calamities and Disaster Preparedness Control Plan (CDPCD) and Standard Operation Procedures (SOPs) based on Department Order No. 36 of 1988. The RSMS database and risk management policy (target level and priority ranking of road sections) should be used for the formulation of new and revision of existing risk avoidance management plans and operating procedures for specific road sections.

1.4 Cycle of Road Slope Management Utilizing Road Slope Management System (RSMS) Database

Risk management for road disasters on national highways will be conducted following the PDCA cycle (Plan, Do, Check, Action), utilizing the RSMS database as shown in Figure 1.3.



* ESSO: Environment & Social Safeguard Office
** PMO-FS: Project Management Office - Feasibility Studies

Figure 1.3 PDCA Cycle of Road Slope Management utilizing the RSMS Database

The outline of the PDCA cycle for risk management is described below:

(1) Plan of Risk Management

DPWH Central Office formulates risk management policy and budget allocation plan utilizing the RSMS database of Inventory Survey such as risk level indicators and required cost for target risk level. For planning, reference data for target setting, such as international comparison of risk level of RCD and quality level and risk level for pavements and bridges in the Philippines from PMS/BMS database, are collected.

Regional and District Engineering Offices formulate the following plans according to the risk management policy:

- Slope disaster prevention project; and
- Risk avoidance management systems

(2) Do the Plan

Along with the plan, projects and systems for RCD should be implemented annually by Regional and District Engineering Offices supported by the units concerned in the Central Office.

(3) Check the Outcome of Implementation

Inventory surveys are conducted after the primary program (multi-year implementation of slope disaster prevention projects) and RSMS database are updated. The database can provide updated risk level indicators, based on the outcomes of previous projects, and data for the next stage of risk management planning.

(4) Action for Update/ Improvement of RSMS Procedure

The RSMS database system should be updated and risk management procedure should be improved. The scores and coefficients used in inventory sheets should be improved by statistical analysis.

1.5 Cycle Term of Road Slope Management

As described in Section 1.5 the Cycle of Road Slope Risk Management Utilizing RSMS Database, the inventory survey results can be used to evaluate and monitor the risk levels for each slope disaster prevention project.

Therefore, inventory surveys should be conducted nationwide periodically (after medium term project implementation, 5 years). In case a road improvement project is ongoing in the specified road section during the periodical inventory survey, the DEO should conduct the survey only after

the project has been completed.

1.6 Adjustment with Bridge Management System (BMS) and Pavement Management System (PMS)

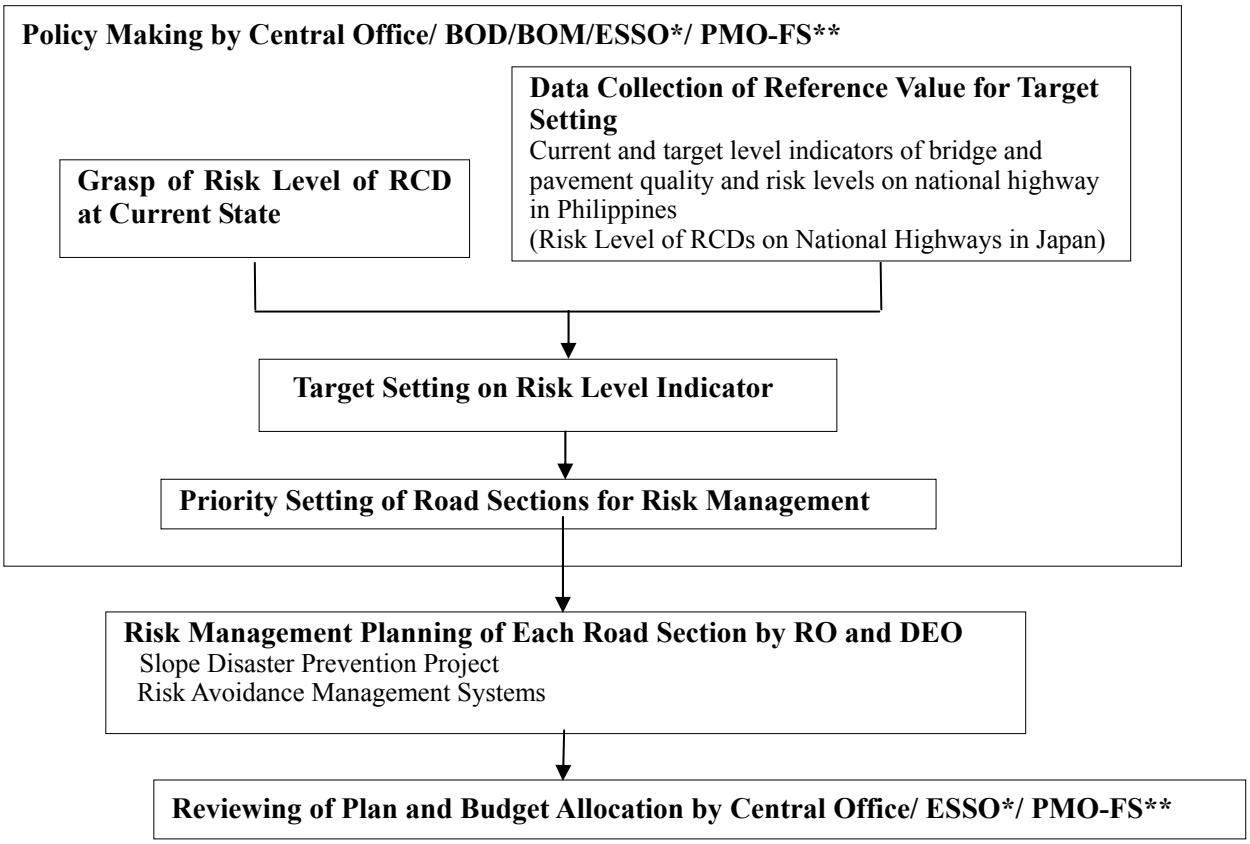
RSMS is designed for road slope management only, as BMS and PMS were also designed for their own objectives - bridges and pavements, respectively. When each road slope management plan is prepared, it is essential to consider the corresponding management plans for bridges and pavements as illustrated in Figure 1.3.

The target levels for implementation of projects, i.e., road slopes, bridges and pavements, should be equitably distributed. Prioritization of the projects in the three management plans (bridge, pavement and road slope) should be evaluated considering their economic impacts. The RSMS database can provide indicators of risk levels and economical feasibility that can be compared with BMS and PMS.

1.7 Work Flow of Risk Management Planning

The work flow of risk management planning is shown in Figure 1.4.

Risk Management Planning uses feasibility indicators obtained from the Inventory Surveys (IS)/ RSMS database and processed values. The detailed procedures for risk management planning of RCD are described in Chapters 2 and 3.



* ESSO: Environment & Social Safeguard Office
** PMO-FS: Project Management Office of Feasibility Study

Figure 1.4 Work Flow of Target Setting and Program Formulation

CHAPTER 2

FORMULATION AND UPDATE OF RSMS DATABASE

2.1 RSMS Database

2.1.1 Purposes of RSMS Database

The purposes of the RSMS database system are as follows:

- To be a repository of road slope inventory and road slope disaster information;
- To provide indicators for the planning of Road Slope Risk Management; and
- To serve as a statistical source to refine frequency scores and coefficients of countermeasure effectiveness for Potential Frequency of Road Closure Disaster (FRCDp) and Indicative Feasibility Assessment (IFA) in the Inventory Survey Sheets.

2.1.2 Flow Diagram of RSMS Formulation and Utilization using MS Excel

The data collection and utilization procedure is illustrated in Figure 2.1 and summarized below:

- Data on road slope inventory survey and disaster records are entered and stored in MS Excel format;
- Excel data can be imported into the RSMS database system server installed at the DPWH Central Office; and
- RSMS can provide data for risk management planning using its query function in MS Excel format

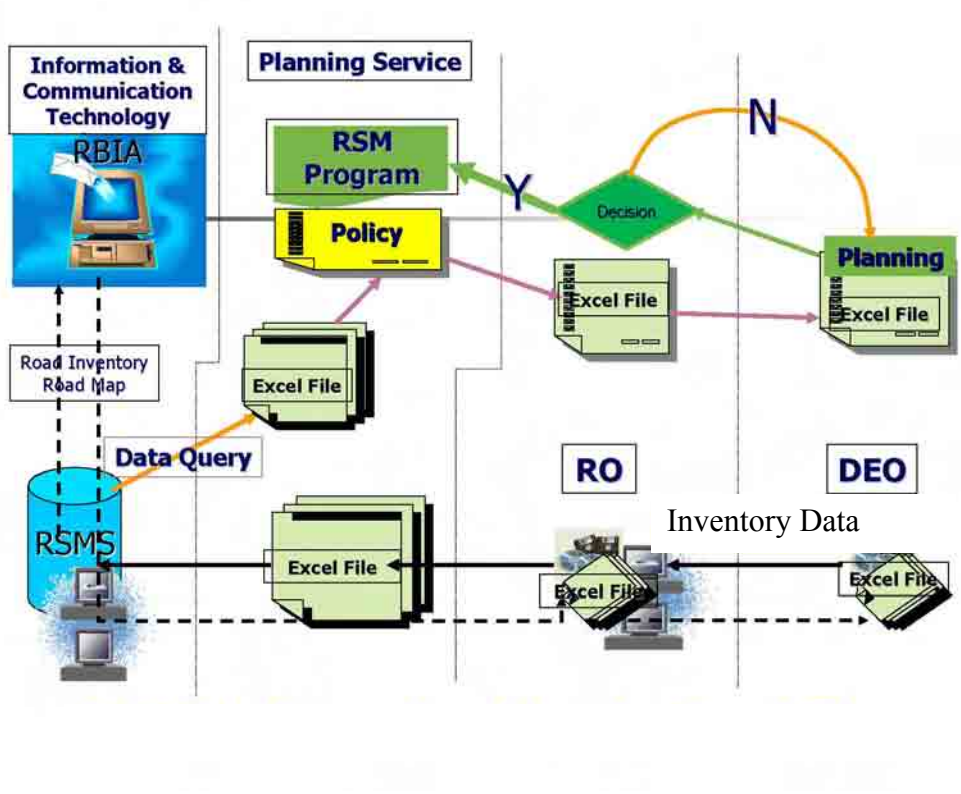


Figure 2.1 Flow Diagram of RSMS Formulation and Utilization using MS Excel

Step 1

The slope inventory survey and disaster inspection and recording are carried out by the District Engineering Office (DEO). Templates for the inventory survey are used for recording the acquired information at the survey sites. The text information is input and image files (digital photos and scanned sketches) are pasted into the Excel sheets at the DEO.

The Excel files are sent to the Central Office (CO) after being checked by the Regional Office (RO).

Step 2

At the CO, the Excel files are stored in specified folder(s) in the disk attached to the database server PC. The operator checks the contents of the Excel sheets. If a problem is found, this is reported to the staff concerned in the RO or DEO for resolution. The Excel files with problems are returned for appropriate correction.

Step 3

At the CO, the staff in charge of highway countermeasure planning can analyze the data

accumulated in the database. The functions in the database application, such as parameterized querying, make the decision-making process effective and fast. For example, if users would like to know the locations of slopes where the need for countermeasures has been identified, a query can be performed easily with the database application. The answers in the list format are entered as Excel files and can be sent to each RO with directions on the methodology for risk management planning. The RO distributes the Excel files to each DEO under its jurisdiction.

Step 4

The DEO formulates a management plan indicating the priority slopes from the list sent by the CO. The resulting plan is sent to the CO after the review and approval by the RO.

2.1.3 Formulation of the Database

The database should be updated by the Central Office each time data are submitted. The database can import text data from the inventory data sheet of Excel.

The information provided in Excel files is imported into the database after validation. Image files (digital photos, scanned sketches, etc.) are not imported into the database, but linked with the database as Excel files.

The detailed procedure is shown in Appendix 4 - Road Slope Management System (RSMS) Database Operations Manual.

2.1.4 Map Display Function of RSMS

Basic map functions of GIS quality are available in the RSMS. The flow of the basic operation is described below.

(1) A map of the whole country is displayed on the PC monitor. On the map, specific areas are enclosed in rectangles. When the cursor is placed inside a rectangle, the color of the rectangle changes, which means the area is active and selectable.

(2) The user selects one of the areas by clicking the mouse. The area can also be selected using a menu.

(3) A zoomed map of the selected area is displayed. The locations of the national highways

are displayed on the map. The locations of the surveyed points are displayed in circles. When the cursor is placed on one of the circles, the color of the circle changes, which means the point is active and selectable.

(4) If the user selects one of the survey points, the corresponding survey Excel sheet appears on the monitor.

(5) The user can select other points in other areas without closing the Excel sheets.

The detailed procedure is shown in Appendix 5 - Road Slope Management System (RSMS) Map Display Operations Manual.

2.2 Update of Scores and Coefficients for Potential Frequency of RCD (FRCDp)

The road slope inventory survey can provide FRCDp as a risk level indicator as shown in Figure 2.3. FRCDp is calculated using the following formula.

$FRCDp = FRCDpoc \times CCE$

$FRCDpoc = \sum FS$

$CCE = \sum FRCDa / \sum FRCDbc$

$FRCDa = Na/Ya$

$FRCDbc = Nbc/Ybc$

Where:

FRCDp:	Potential frequency of RCDs of a slope [no. of RCDs per year]
FRCDpoc:	Potential FRCD without countermeasure of a slope [no. of RCDs per year]
CCE:	Coefficient of countermeasure effectiveness for FRCDp of a countermeasure-type [coefficient]
FS:	Frequency score for FRCDp (FS is assigned to each factor category of each factor item for FRCDp as shown in Figure 2.2 [no. of RCDs per year]
FRCDa:	Actual frequency of RCDs of a slope [no. of RCDs per year]

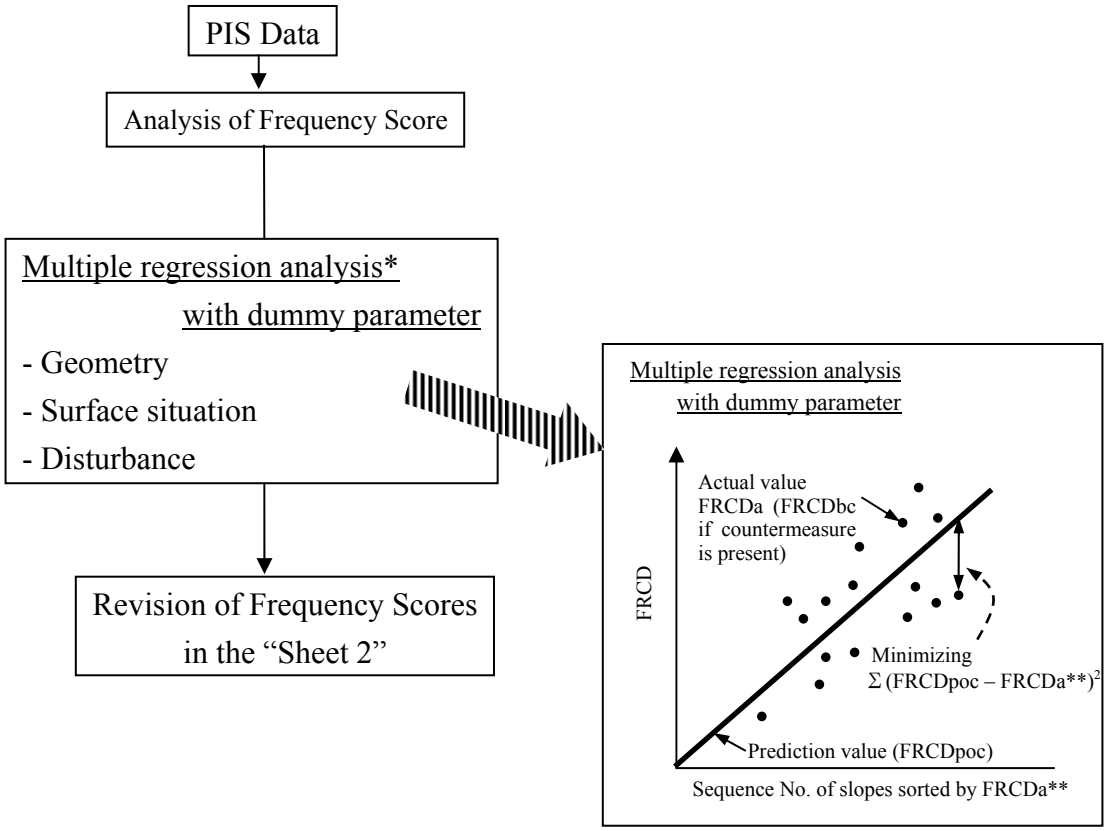
FRCDbc: Actual frequency of RCDs of a slope before countermeasures are installed [no. of RCDs per year]

Na: Actual number of RCDs of a slope in 'Ya' year [no. of RCDs]

Ya: Period of available disaster record of a slope [years]

Nbc: Actual number of RCDs of a slope in 'Nbc' years before countermeasure is installed [no. of RCDs]

Ybc: Period of available disaster records of a slope before countermeasures are installed [years]

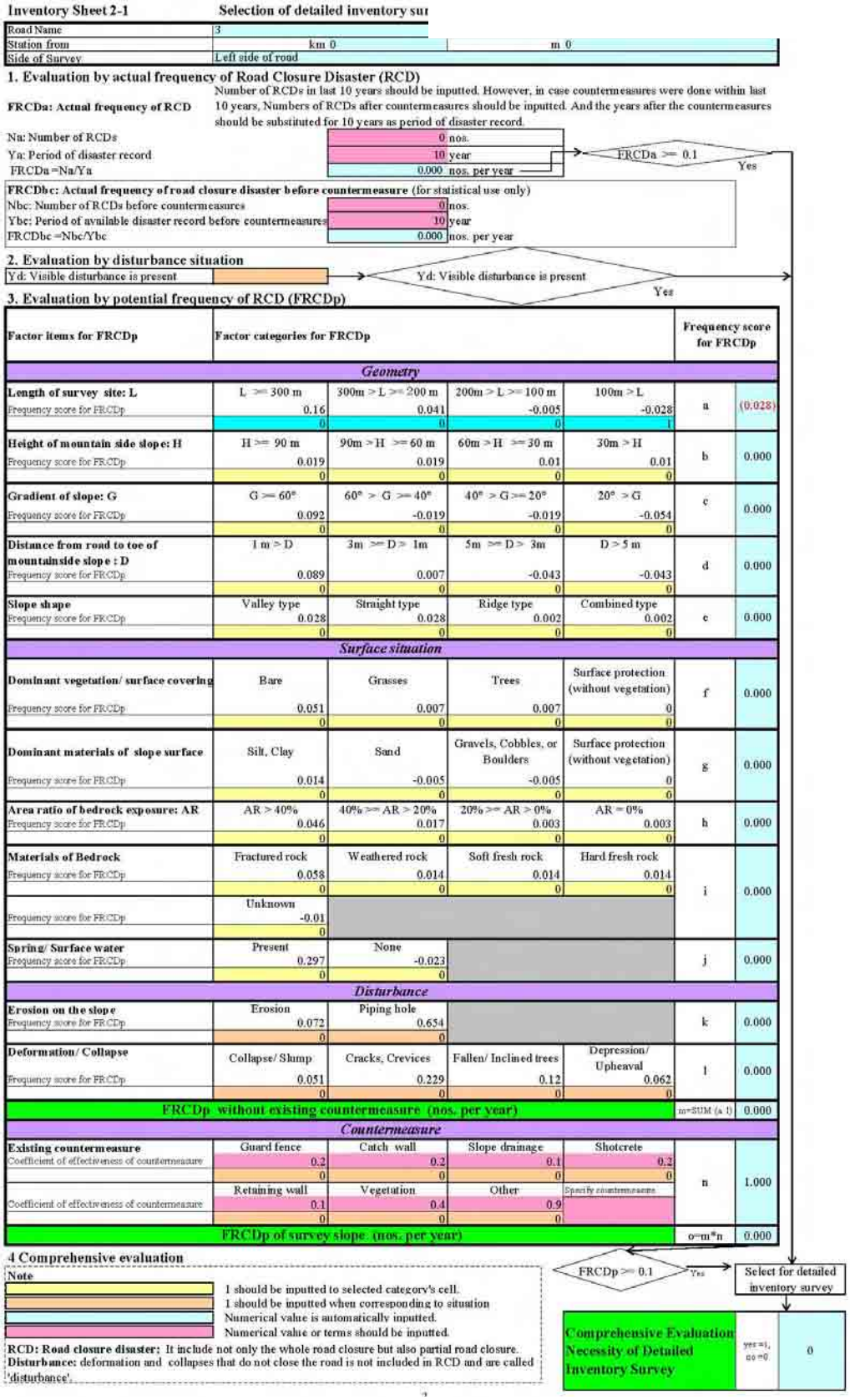


*Multiple regression analysis with dummy parameter is the method of minimizing the residual sum of squares between actual values (FRCDa) and predicted values (FRCDpoc) using the correlations of FRCDa and slope disaster frequency factors.

** FRCDa, in case of countermeasure is installed, FRCDbc should be adopted instead of FRCDa

Figure 2.2 Illustration of Analysis Method of FRCDpoc (Prediction Value)

A frequency Score is assigned to each corresponding factor category of each factor item such as slope gradient, height, etc. and CCE are set by the pilot inventory survey of 251 km length (it is part of the preliminary inventory survey sections subject to FRCDp evaluation). When the nationwide inventory survey is completed, the scores and coefficients should be analyzed for accuracy improvements in FRCDp prediction. The detailed procedure for the analysis is shown in Appendix-6.



Inventory Sheet 2-1	Selection of detailed inventory sur			
Road Name	3			
Station from	km 0		m 0	
Side of Survey	Left side of road			

1. Evaluation by actual frequency of Road Closure Disaster (RCD)

FRCDa: Actual frequency of RCD — Number of RCDs in last 10 years should be inputted. However, in case countermeasures were done within last 10 years, Numbers of RCDs after countermeasures should be inputted. And the years after the countermeasures should be substituted for 10 years as period of disaster record.

Na: Number of RCDs	0	nos.
Ya: Period of disaster record	10	year
FRCDa =Na/Ya	0.000	nos. per year

FRCDa >= 0.1 → Yes

FRCDbc: Actual frequency of road closure disaster before countermeasure (for statistical use only)

Nbc: Number of RCDs before countermeasures	0	nos.
Ybc: Period of available disaster record before countermeasures	10	year
FRCDbc =Nbc/Ybc	0.000	nos. per year

2. Evaluation by disturbance situation

Yd: Visible disturbance is present → Yd: Visible disturbance is present → Yes

3. Evaluation by potential frequency of RCD (FRCDp)

Factor items for FRCDp	Factor categories for FRCDp				Frequency score for FRCDp	
Geometry						
Length of survey site: L	L >= 300 m	300m > L >= 200 m	200m > L >= 100 m	100m > L	a	(0.028)
Frequency score for FRCDp	0.16	0.041	-0.005	-0.028		
	0	0	0	1		
Height of mountain side slope: H	H >= 90 m	90m > H >= 60 m	60m > H >= 30 m	30m > H	b	0.000
Frequency score for FRCDp	0.019	0.019	0.01	0.01		
	0	0	0	0		
Gradient of slope: G	G >= 60°	60° > G >= 40°	40° > G >= 20°	20° > G	c	0.000
Frequency score for FRCDp	0.092	-0.019	-0.019	-0.054		
	0	0	0	0		
Distance from road to toe of mountainside slope : D	1 m > D	3m >= D > 1m	5m >= D > 3m	D > 5 m	d	0.000
Frequency score for FRCDp	0.089	0.007	-0.043	-0.043		
	0	0	0	0		
Slope shape	Valley type	Straight type	Ridge type	Combined type	e	0.000
Frequency score for FRCDp	0.028	0.028	0.002	0.002		
	0	0	0	0		
Surface situation						
Dominant vegetation/ surface covering	Bare	Grasses	Trees	Surface protection (without vegetation)	f	0.000
Frequency score for FRCDp	0.051	0.007	0.007	0		
	0	0	0	0		
Dominant materials of slope surface	Silt, Clay	Sand	Gravels, Cobbles, or Boulders	Surface protection (without vegetation)	g	0.000
Frequency score for FRCDp	0.014	-0.005	-0.005	0		
	0	0	0	0		
Area ratio of bedrock exposure: AR	AR > 40%	40% >= AR > 20%	20% >= AR > 0%	AR = 0%	h	0.000
Frequency score for FRCDp	0.046	0.017	0.003	0.003		
	0	0	0	0		
Materials of Bedrock	Fractured rock	Weathered rock	Soft fresh rock	Hard fresh rock	i	0.000
Frequency score for FRCDp	0.058	0.014	0.014	0.014		
	0	0	0	0		
Frequency score for FRCDp	Unknown					
	-0.01					
	0					
Spring/ Surface water	Present	None			j	0.000
Frequency score for FRCDp	0.297	-0.023				
	0	0				
Disturbance						
Erosion on the slope	Erosion	Piping hole			k	0.000
Frequency score for FRCDp	0.072	0.654				
	0	0				
Deformation/ Collapse	Collapse/ Slump	Cracks, Crevices	Fallen/ Inclined trees	Depression/ Upheaval	l	0.000
Frequency score for FRCDp	0.051	0.229	0.12	0.062		
	0	0	0	0		
FRCDp without existing countermeasure (nos. per year)					m=SUM (a-l)	0.000
Countermeasure						
Existing countermeasure	Guard fence	Catch wall	Slope drainage	Shotcrete	n	1.000
Coefficient of effectiveness of countermeasure	0.2	0.2	0.1	0.2		
	0	0	0	0		
	Retaining wall	Vegetation	Other	Specify countermeasure		
Coefficient of effectiveness of countermeasure	0.1	0.4	0.9			
	0	0	0			
FRCDp of survey slope (nos. per year)					o=m*n	0.000

4 Comprehensive evaluation

FRCDp >= 0.1 → Yes → Select for detailed inventory survey

Comprehensive Evaluation Necessity of Detailed Inventory Survey	yes=1, no=0	0

Note

- 1 should be inputted to selected category's cell.
- 1 should be inputted when corresponding to situation
- Numerical value is automatically inputted.
- Numerical value or terms should be inputted.

RCD: Road closure disaster: It include not only the whole road closure but also partial road closure.
Disturbance: deformation and collapses that do not close the road is not included in RCD and are called 'disturbance'.

Figure 2.3 FRCD Evaluation Spreadsheet (Inventory Form 2)

2.3 Reporting of Disasters and Updating of Chart/Equations for Indicative Feasibility Assessment

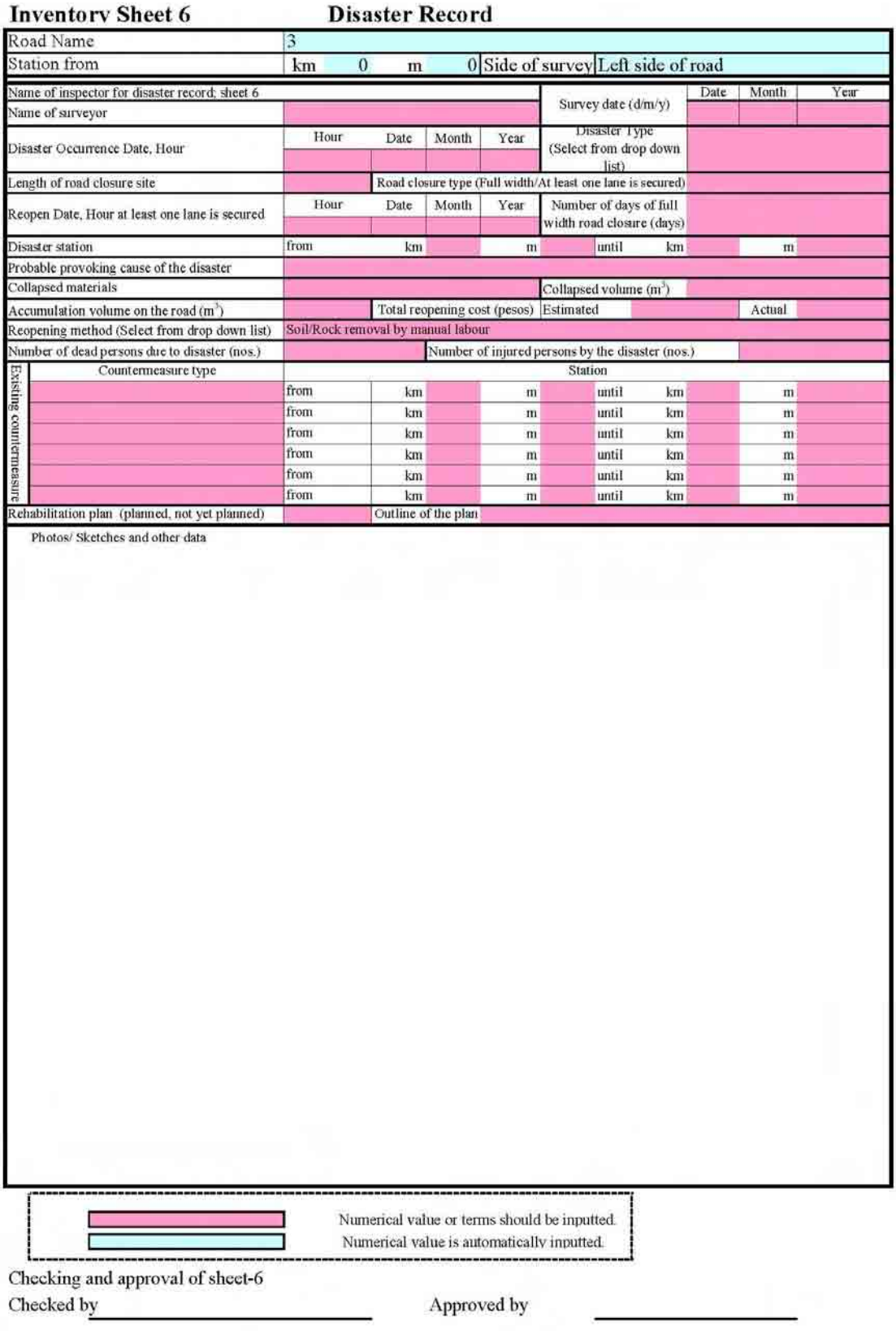
Statistical analysis of road closure disaster records can provide charts or equations for Indicative Feasibility Assessment (Inventory Form 5). To improve the accuracy of the feasibility assessment, the District Engineering Office (DEO) shall conduct inspections and reporting of road closure disasters as soon as possible after a disaster occurred. The inspection and reporting form is prepared as Inventory Form 6 and shown in Figure 2.4.

The DEO shall submit the disaster record (Inventory Form 6) to the Planning Service of DPWH Central Office via the Regional Office (RO) at the same time submitting the inventory survey as Inventory Form 6.

Coefficients and ratios to be updated are shown in Table 2.1

Table 2.1 Update of Coefficients and Ratios for Indicative Feasibility Assessment

Chart/Coefficients/Ratios	Unit	Updated Portion of Guide in Inventory Survey
Chart for Estimating Collapsible Volume	-	p3-30, Figure 3.30
Chart for Estimating Ratio of Accumulated Volume to Collapsible Volume	-	p3-31, Figure 3.31
Reopening Cost per Accumulation Volume at Closure Site (excluding fixed cost)	pesos per m^3	p3-32 to p3-38, equation 3.4 to 3.11 Figure 3.17 to 3.18
Reopening Cost per Accumulation Volume at Closure Site (excluding fixed cost)	pesos per m	
Fixed Cost for Reopening per RCD	pesos per RCD	
Average Number of Human Deaths per RCD	persons per RCD	p3-39 Table 3.8
Frequency Distribution of Road Closure Days per RCD	days	Figure 3.20
Chart for Estimating the Number of Road Closure Days by Length of Road Closure Alignment for Landslide	days	Figure 3.21



Inventory Sheet 6 **Disaster Record**

Road Name	3									
Station from	km 0 m 0	Side of survey	Left side of road							
Name of inspector for disaster record; sheet 6				Survey date (d/m/y)			Date	Month	Year	
Name of surveyor										
Disaster Occurrence Date, Hour	Hour	Date	Month	Year	Disaster Type (Select from drop down list)					
Length of road closure site		Road closure type (Full width/At least one lane is secured)								
Reopen Date, Hour at least one lane is secured	Hour	Date	Month	Year	Number of days of full width road closure (days)					
Disaster station	from	km		m		until	km		m	
Probable provoking cause of the disaster										
Collapsed materials					Collapsed volume (m^3)					
Accumulation volume on the road (m^3)		Total reopening cost (pesos)			Estimated			Actual		
Reopening method (Select from drop down list)	Soil/Rock removal by manual labour									
Number of dead persons due to disaster (nos.)		Number of injured persons by the disaster (nos.)								
Existing countermeasure: Countermeasure type	Station									
	from	km		m		until	km		m	
	from	km		m		until	km		m	
	from	km		m		until	km		m	
	from	km		m		until	km		m	
	from	km		m		until	km		m	
	from	km		m		until	km		m	
Rehabilitation plan (planned, not yet planned)		Outline of the plan								

Photos/ Sketches and other data

Numerical value or terms should be inputted.
Numerical value is automatically inputted.

Checking and approval of sheet-6

Checked by _____ Approved by _____

Figure 2.4 Disaster Record (Inventory Form 6)

CHAPTER 3

BASIC PROCEDURE OF RISK MANAGEMENT PLANNING

3.1 Basic Procedure for Risk Management Planning

The basic policies for risk management planning for RCD are set out below:

Basic Procedure of Risk Management Planning for RCD

1. Target Road Sections:

Target Road Sections are those with potential RCDs.

Road Sections for which rehabilitation projects are already ongoing or planned in Medium-Term Investment Programs should also be included.

2. Overall Indicators for Risk Management Planning:
Present Potential Intensity of Annual Loss (IALp) and
Target Intensity of Annual Loss (IALt) [pesos per (year * km)]:

Indicators for risk management planning are IALp and IALt, the target outcome value of implementing the slope disaster prevention project.

3. Target Intensity of Annual Loss (IALt) Values for Arterial Roads and Secondary National Roads:

Target IAL Values are set for 1) National Arterial Roads and 2) National Secondary Roads considering their functional importance.

4. Priority Category for Risk Management:

Priority is classified by the value of difference between IALp and IALt which shows the benefit to be gained by implementing the disaster prevention projects

5. Working Unit of Risk Management Planning

The general plan will be formulated by the Central Office of DPWH, and a detailed plan for each Road Section will be made by the Regional Office and District Engineering Office concerned.

3.2 Target Road Sections for Road Slope Management

Target Road Sections that have the potential for slope disasters have been identified.

There are 434 selected Road Sections totaling 1,773 km in length (current figure as of FEB 2007, subject for verification).

Appendix-1contains an inventory list and map of the target road sections.

In the list, shadowed road sections have already been selected for inclusion in the Medium-Term Investment Program. In these Road Sections, there are ongoing rehabilitation projects that are also included in the planning for new slope disaster prevention projects up to completion. Rehabilitation involves a comprehensive disaster prevention work, and it is therefore expected that the occurrence of RCDs will be reduced significantly.

3.3 Overall Indicators for Risk Management Planning

Overall indicators for risk management planning are Present Intensity of Annual Loss (IALp) and the associated target (IALt) [pesos per year per km] as defined below.

Present Potential Intensity of Annual Loss (IALp) [pesos per (year * km)]

Present annual economic loss induced by RCDs per km for a section is estimated from the data obtained from the Inventory Survey.

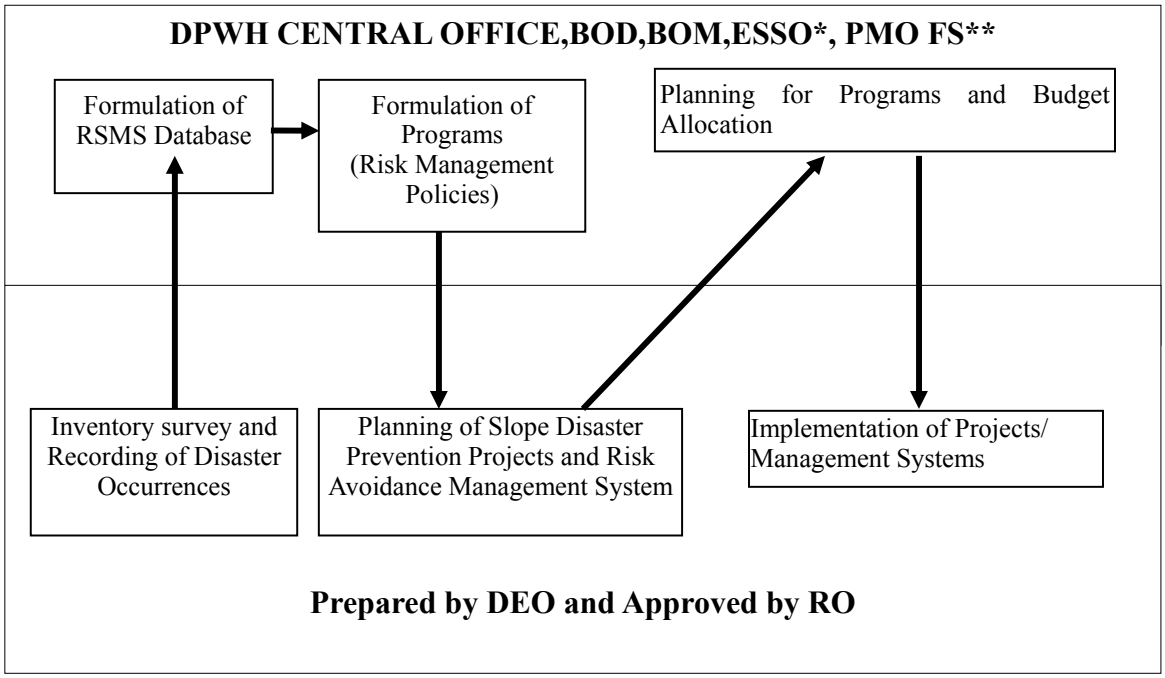
Target Intensity of Annual Loss (IALt) [pesos per (year * km)]

Target annual economic loss per km of a section expected after the implementation of disaster prevention projects is set by policy makers, considering the average risk level indicators of national highways nationwide, international comparison of risk levels, economic loss induced by road surface condition, bridge collapse, and budget condition in the Philippines, etc.

The detailed procedure is described in Chapter 4.

3.4 Implementation System for Risk Management Planning

Risk management planning is done by the Central Office in close cooperation with Regional Offices and District Engineering Offices, as shown in Figure 3.1.



ESSO: Environment & Social Safeguard Office
PMO FS: Project Management Office-Feasibility Studies

Figure 3.1 Implementation System for Road Slope Risk Management

The Central Office prepares the general policy on risk management utilizing the RSMS database and information on existing rehabilitation projects.

The Central Office also compiles and reviews detailed plans for each road section submitted by the Regional and District Engineering Offices and allocates the budget for priority projects and management systems.

Regional and District Engineering Offices conduct inventory surveys and plan slope disaster prevention projects and risk avoidance management systems for specific road sections according to the general policy formulated by the Central Office.

CHAPTER 4
TARGET-SETTING AND PROGRAM FORMULATION

4.1 Target-Setting Viewpoints and Work Flow

4.1.1 Viewpoint of Target-Setting

Target-setting in risk management planning is important in order to create a reasonable and practical plan. The target risk levels shall be set from various viewpoints and using various types of information as mentioned below.

Viewpoints for Target-setting

(1) Strategy for the Road Network of National Highways
(2) Balance with PMS and BMS
(3) Indicative cost to achieve the target value.

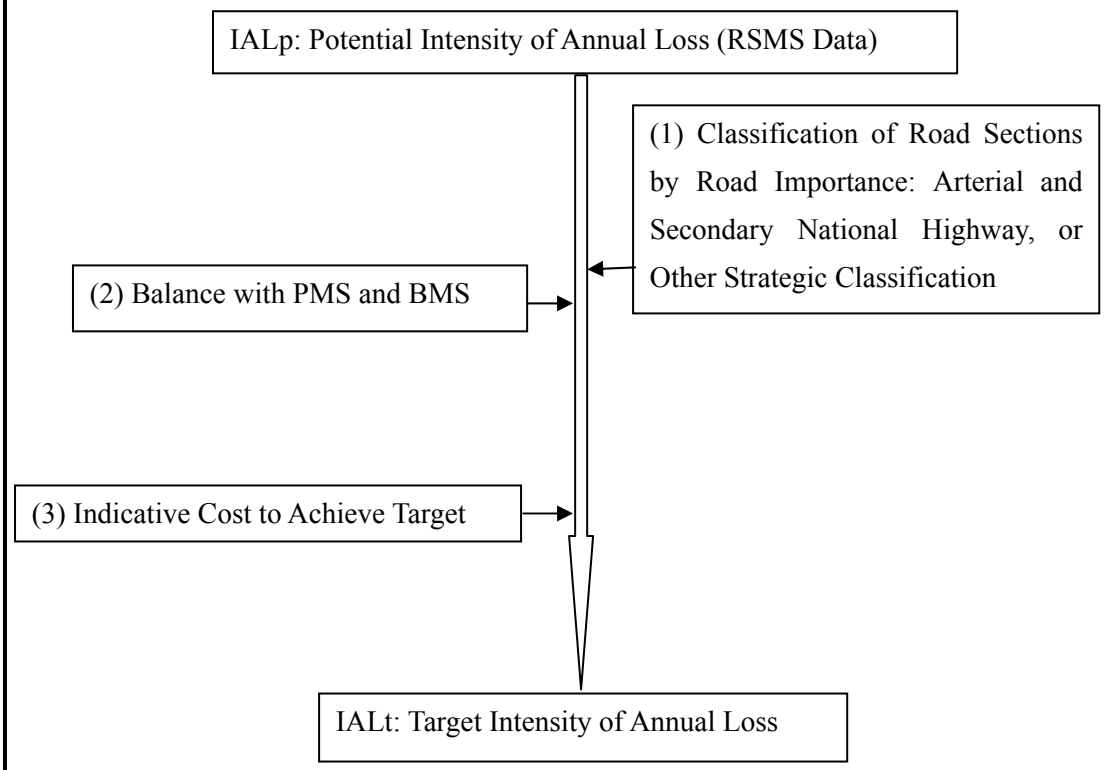


Figure 4.1 Viewpoints for Target Setting

(1) Classification of Road Sections by Road Importance:

The national highways in the Philippines are classified into Arterial and Secondary roads. Because Arterial and Secondary roads differ in their strategic importance and in the consequences of their loss on the traffic network, the target value for the risk level indicator will differ for each classification.

Arterial and Secondary roads will be classified by considering the following purpose of risk management, if necessary.

The purpose of risk management is to revitalize regional activity and national development by reducing losses, including indirect influence and environmental protection, which is the major strategy in providing a network of national highways

Slope disaster prevention measures obtain direct benefits that can be calculated, as well as benefits that cannot be calculated, such as improved traffic reliability. Reliable traffic conditions are expected to attract industrial investors and tourists.

(2) Balance with PMS and BMS

The Pavement Management System (PMS), Bridge Management System (BMS), and Road Slope Management System (RSMS) should have balanced target levels. It is not reasonable to have well-maintained bridges and pavements if frequent RCDs will cause large economic losses. The opposite is also the same. Therefore, a balance between the PMS, BMS, and RSMS with respect to risk and loss levels must be considered when setting the target for risk management planning.

(3) Indicative Cost of Achieving the Target Values

To set realistic targets, the indicative costs of achieving the target value shall be checked using risk level outcome indicators and countermeasure costs from the inventory survey.

4.1.2 Work Flow of Program Formulation

The work flow for program Formulation for risk management on road slopes by the DPWH Central Office is as follows.

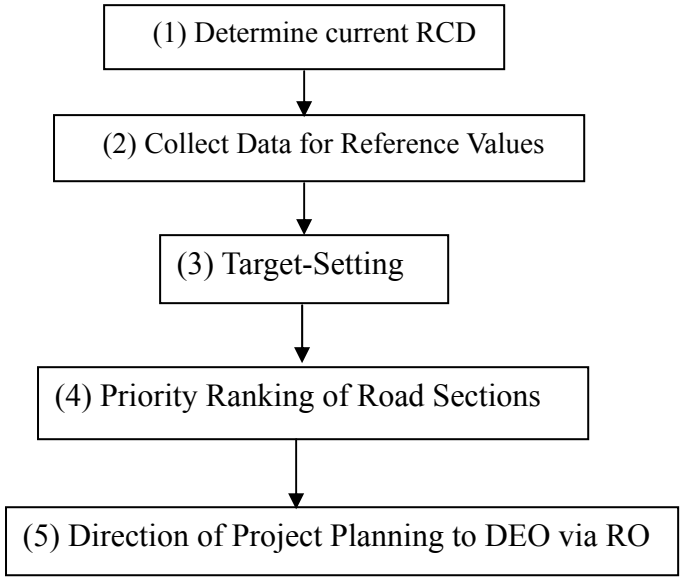


Figure 4.2 General Flow of Program Formulation

(1) Determine current RCD

The current risk level can be determined by estimating IALp, which can be obtained by processing FRCDp of the RSMS database. (Refer to 4.3.1)

(2) Data collection for Reference Values

Major reference data are the PMS and BMS databases. Risk level information is required to be collected and processed for both systems to set reasonable and practical targets of RSMS. (Refer to 4.3.2)

(3) Target-Setting

IALt (Target intensity of annual loss induced by road closure disaster) is the indicator to be used for determining the reduction of risk level. The target value is set considering the current risk level being used for road slopes, pavements and bridges and considering the results of the studies mentioned above (1) and (2). (Refer 4.3.3)

(4) Priority Ranking of Road Sections

A priority ranking is prepared to judge the priority for implementation based on divergences between the values of IALp and IALt. (Refer to 4.4)

(5) Direction of Project Planning to DEO via RO

The program and policy for planning the risk reduction projects is informed and directed project planning to DEO via RO. (Refer to 4.5) Along with the policy, ROs and DEOs formulate risk reduction projects with a management system for risk avoidance.

4.2 Indicators for Target-Setting and Program Formulation

Some indicators such as IAL and IATE are created to represent potential and target risk levels for road closure disasters that are applied to make general policy for the disaster reduction program. Estimated feasibility indicators in DIS such as BCR, ENPV and EIRR are applied to formulate projects for risk reduction. The following indicators are applied for planning risk reduction program as shown in Table 4.1. The relationships between indicators are shown in Figure 4.3.

(1) Potential Risk Level Indicators

(a) Risk Level Indicators from RSMS

FRCDp (Potential Frequency of Road Closure Disaster), Alp (Potential Annual Loss) and FRCDpwc (Potential Frequency of RCD) of the slope are evaluated on Sheet 5 in the inventory survey. These are basic indicators to represent the risk level of each slope on national highways.

(b) Risk Level Indicators processed from RSMS

Planning the risk reduction program is conducted for each 1 km section of national highways. Indicators to represent the risk levels of 1 km sections of national highways which are IRCDp (Potential Intensity of RCD), ULp (Potential Unit Loss per RCD of a section), IATEp (Potential Intensity of Annual Encountering RCD of a section), IALp (Potential Intensity of Annual Loss of a section) are processed using the indicators mentioned above.

The detailed procedure for processing is described in section 4.3.1.

(2) Target Risk level Indicators

Target Risk Indicators for sections are IRCDt (Target Intensity of RCD of a section), IATEt (Target Intensity of Annual Traffic Encountering RCD of a section) and IALt (Target Intensity of Annual Loss of a section).

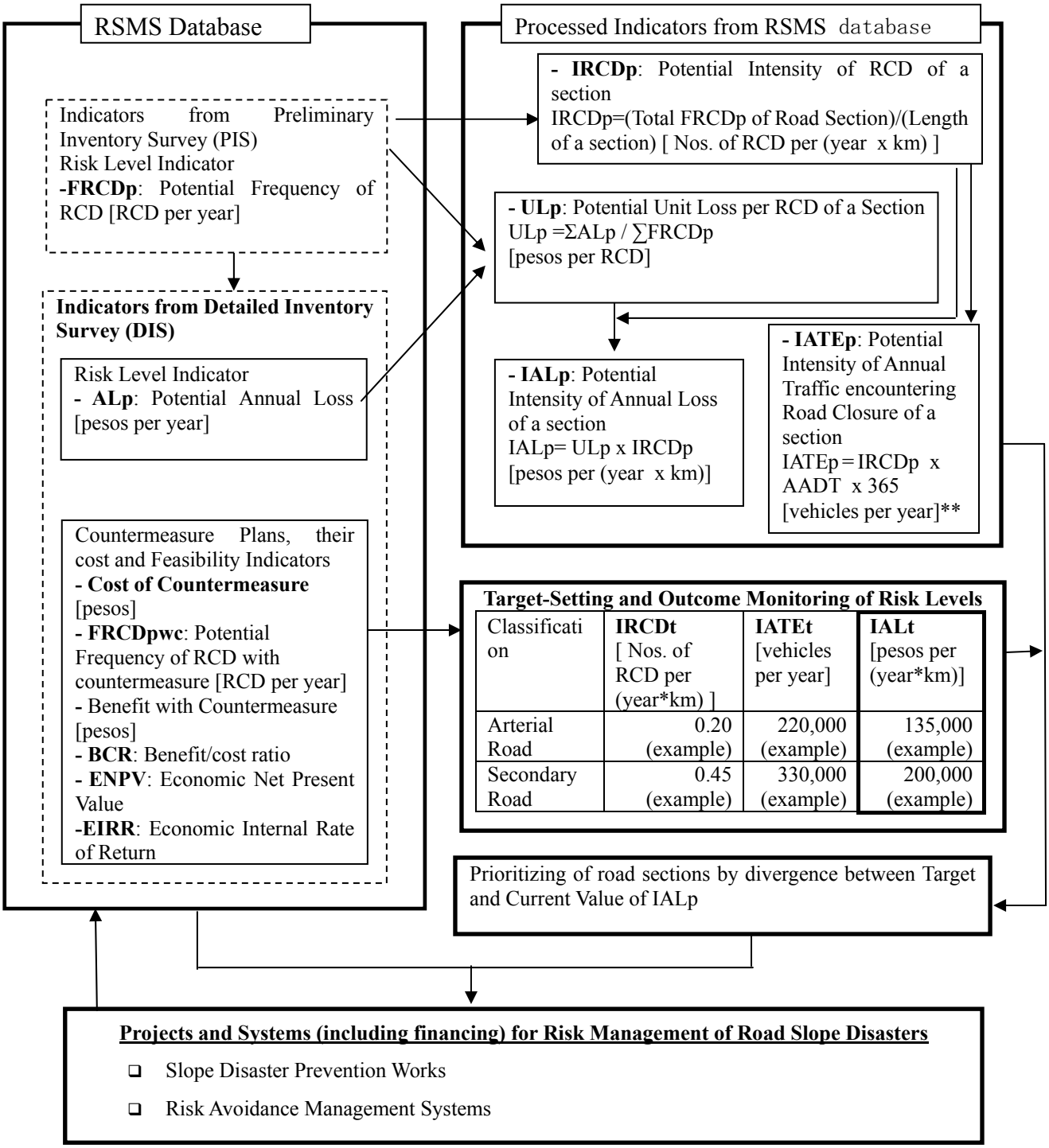
These indicators are set in the disaster reduction program for which the planning method is mainly described in section 4.3.3.

(3) Feasibility Indicators

Feasibility indicators are estimated on sheet 5 of the inventory survey. These indicators are used to assess the feasibility of risk reduction projects for every section.

Table 4.1 Explanation of Indicators Output from the RSMS Database

Abbreviation	Full Spring	Unit	Object	Explanation
(1) Potential Risk Level Indicators				
(a) Risk Level Indicators from RSMS database (Inventory Survey)				
FRCDp	Potential Frequency of RCD	RCD per year	slope	The number of estimated occurrences of RCD per year in future. Estimated by inventory sheet 2
ALp	Potential Annual Loss	pesos per year	slope	ALp is estimated by inventory sheet 5
FRCDpwc	Potential Frequency of RCD with countermeasures	RCD per year	slope	FRCDp is estimated by inventory sheet 5 FRCDpwc = RRR * FRCDp where RRR: risk reduction ratio
(b) Risk Level Indicators processed from RSMS database (Inventory Survey)				
IRCDp	Potential Intensity of RCD of a section	Nos. of RCD per (year*km)	section	IRCDp=(Total FRCDp of Road Section)/(Length of Road Section)
ULp	Potential Unit Loss per RCD of a section	pesos per RCD	section	Average Loss per RCD in a road section
IATEp	Potential Intensity of Annual Traffic encountering RCD of a section	Vehicles per year	section	IATEp = IRCDp* AADT *365
IALp	Potential Intensity of Annual Loss of a section	Pesos per (year*km)	section	IALp = ULp * IRCDp
(2) Target Risk Level Indicators				
IRCDt	Target Intensity of RCD of a section	Nos. of RCD per (year*km)	section	Target of IRCDp
IATEt	Target Intensity of Annual Traffic encountering RCD of a section	Vehicles per year	section	Target of IATEp
IALt	Target Intensity of Annual Loss	Pesos per (year*km)	section	Target of IALt
(3) Feasibility Indicators from RSMS database (Inventory Survey)				
BCR	Benefit/cost Ratio	ratio	slope	Indicative Indicators of the countermeasure's benefit and cost streams. These are estimated assuming a 20 year project life:
ENPV	Economic Net Present Value	pesos	slope	
EIRR	Economic Internal Rate of Return	%	slope	



** Traffic data to be obtained from the Road and Bridge Information Application (RBIA)

Figure 4.3 Risk Management Planning and Outcome Monitoring using Indicators obtained from RSMS Database

4.3 Target-Setting of Risk Management

The purpose of risk management is to improve traffic reliability, the foundation of social and economic activities and regional development, attracting industrial investors and tourists. Target-setting for risk management should consider the basic strategy for building up the national highway network.

(1) Risk Level Indicators for target-setting are as follows:

(a) IRCDp: Potential Intensity of RCD of a section [nos. of RCD per (year*km)]

(b) IATEp: Potential Intensity of Annual Traffic Encountering Road Closure of a section [vehicles per year]

(c) IALp: Potential Intensity of Annual Loss of a section [pesos per (year*km)]

(2) Reference Values for target-setting are as follows:

(a) Reference Values for Bridge Management;

(a)-1 (B) IRCDp: Potential Intensity of Road Closure due to Collapse or Deterioration of Bridges [nos. of RCD per (year*km)]

(a)-2 (B) IATEp: Potential Intensity of Annual Encountering Road Closure due to Collapse or Deterioration of Bridges [vehicles per year]

(a)-3 (B) IALp: Potential Intensity of Annual Loss due to Collapse or Deterioration of Bridges [pesos per (year*km)]

(b) Reference Value on Pavement Management;

(P) IALp: Potential Intensity of Annual Loss generated by poor pavement (Excess of vehicle operation cost comparing with ‘paved good condition’

(3) Cost and Benefit of RSMS/BMS/PMS

c-1 Cost and Benefit of RSMS

c-2 Cost and Benefit of BMS

c-3 Cost and benefit of PMS

(4) Consideration of Importance of Road Sections

4.3.1 Determining the Current Risk Level

The following indicators are calculated to grasp the current risk level.

(1) IRCDp: Potential Intensity of Road Closure Disaster of a section

(2) IATEp: Potential Intensity of Annual Traffic encountering Road Closure of a section

(3) IALp： Potential Intensity of Annual Loss of a section

(1) Potential Intensity of Road Closure Disaster of a Section (IRCDp)

Potential Intensity of Road Closure Disasters of a section is calculated by the following formula.

IRCDp = Σ FRCDp/LS Equation 4.1

Where:

IRCDp Potential Intensity of RCD of section [Nos. of RCD per (year* km)]

∑FRCDp Total FRCDp of section [RCD per year]

LS Length of section [km]

(2) Potential Intensity of Annual Traffic Encountering Road Closure (IATEp)

IATEp = IRCDp * AADT*365 Equation 4.2

Where:

IATEp Potential Intensity of Annual Traffic encountering Road Closure of a section [vehicles per year]

(Annual traffic encountering RCDs weighted by the dimensionless value of IRCDp)

AADT Annual Average Daily Traffic [vehicles per day]

(3) Potential Intensity of Annual Loss (IALp)

Potential Annual Loss of a slope (ALp) is estimated for high risk slopes for which the Detailed

Inventory Survey (DIS) is conducted. Therefore, to obtain the Potential Intensity of Annual Loss of a section (IALp), Potential Unit Loss per RCD of a road section (ULp) is calculated from data of slopes where DIS is conducted. IALp can be obtained by multiplying ULp and IRCDp.

ULp = ΣALpDIS / ΣFRCDpDIS Equation 4.3

Where:

ULp Potential Unit Loss per RCD of a section [pesos per RCD]

ΣALpDIS Total Potential Annual Loss of Slopes with DIS of a section [pesos per year]

ΣFRCDpDIS Total FRCDp of Slopes with DIS of a section [Nos. of RCD per year]

IALp = ULp * IRCDp Equation 4.4

Where

IALp Potential Intensity of Annual Loss of a section [pesos per (year* km)]

ULp Potential Unit Loss per RCD of a section [pesos per RCD]

IRCDp Potential Intensity of RCD of a section [Nos. of RCD per (year* km)]

Examples of the calculation of the risk levels are shown in Table 4.2.

Table 4.2 Example of Current Risk Level

Road Name	Indicators		Length of a section	Total FRCDp of a section	Total FRCDp with DIS of a section	Total potential annual loss with DIS of a section	Potential unit loss per RCD of a section	**Potential Intensity of RCD of a section**	Annual Average Daily Traffic	**Potential intensity of annual traffic encountering road closure of a section**	**Potential intensity of annual loss of a section**
Kennon Rd	Abbreviation		LS	∑FRCDp	∑FRCDpDIS	∑ALpDIS	ULp	**IRCDp**	AADT	**IATEp**	**IALp**
	Equation						∑ALpDIS / ∑FRCDpDIS	**∑FRCDp / LS**		**IRCDp * AADT*365**	**ULp * IRCDp**
	Unit		[km]	[Nos. of RCD per year]	[Nos. of RCD per year]	[pesos per year]	[pesos per RCD]	**[Nos. of RCD per (year* km)]**	Vehicles per day	**[vehicles per year]**	**[pesos per (year* km)]**
Road Section ID	Sections	km station									
		240.880--242	1.12	1.333	0.446	773,603	1,734,536	**1.190**	4,944	**2,147,749**	**2,064,407**
		242-243	1	1.658	1.139	3,111,064	2,731,399	**1.658**	4,944	**2,991,960**	**4,528,660**
		243-244	1	0.213	0.103	218,000	2,116,505	**0.213**	4,944	**384,371**	**450,816**
		244-245	1	0.982	0.872	2,390,000	2,740,826	**0.982**	4,944	**1,772,078**	**2,691,491**
		245-246	1	1.122	0.467	1,450,000	3,104,925	**1.122**	4,944	**2,024,716**	**3,483,726**
		246-247	1	0.914	0.668	1,646,000	2,464,072	**0.914**	4,944	**1,649,368**	**2,252,162**
		247-248	1	0.987	0.776	1,490,000	1,920,103	**0.987**	4,944	**1,781,101**	**1,895,142**
S00407LZ		248-249	1	0.598	0.598	1,360,000	2,274,247	**0.598**	4,944	**1,079,127**	**1,360,000**
		249-250.004	1.004	0.998	0.897	1,330,000	1,482,720	**0.994**	4,944	**1,793,776**	**1,473,859**
		Grand Total	9.124	8.805	5.966	13,768,667					
		Road Section Average		-			2,307,856	**0.965**	4,944	**1,793,776**	**2,227,167**

Note: Road Section is defined using the Road Inventory stored in the RBIA. Road Section has a Road Section ID.

A section is defined by this Guide basically as a 1 km road between km stations. A road between the start/end of the Road Section and the nearest km station is included in the adjacent section.

Risk levels should be calculated for both the sections and the Road Section Average

Slopes that extend over the boundary between adjacent sections are included in the starting point side section.

4.3.2 Data Collection of Reference Values for Target-Setting

The following data on road maintenance are to be used as reference value to decide the target value for RCD.

(1) Current and target risk levels for bridges

(2) Current and target risk levels for pavements

(1) Current and Target Level for Bridges

The current and target levels for bridges and pavements on national highways should be processed or determined from the PMS and BMS databases using the form shown in Table 4.3.

Table 4.3 Current and Target Levels for Bridges and Pavements on Highways in Philippines

Management Objects and Evaluation Index		Unit	Current Level		Target Level	
			National Arterial Road	National Secondary Road	National Arterial Road	National Secondary Road
Bridge	Potential Intensity of Road Closure due to collapse or deterioration of bridge	[Nos. of road closure per (year*km)]				
	Potential Intensity of Annual Traffic encountering road closure due to collapse or deterioration of bridge	[vehicles per year]				
	Potential Intensity of Annual Loss (Impassable due to collapse or deterioration of bridge)	pesos per (year* km)				
Pavement	Potential Intensity of Annual Loss (Excess Vehicle Operation Cost to surface type 'paved' condition 'good')	pesos per (year*km)				

(2) Other Reference Information

Risk levels used in other countries are also useful for target-setting. For example the risk level of RCD on national highways in Japan is shown in the Table 4.4.

Reference: The Risk level of RCD on Ordinary National Highways in Philippines and Japan

Table 4.4 Risk Level of RCD in Philippines and Japan

Indicators	Unit	National Highways in Philippines (2004-2005)		National Highway in Japan (physical year 2005)			
		Road Sections with RCD Risk		(managed by central government)		(managed by local governments)	
		Arterial	Secondary	Whole	Designated traffic management section	Whole	Designated traffic management section
Total Road Section Length	km	1,069	705	21,733	1,363	32,004	6,461
IRCDa Actual Intensity of RCD in Road Section (in 2005 fiscal year)	[Nos. of RCD per (year * km)]	**1.546** 18 times as large as it of Japan	**1.496** 13 times as large as it of Japan	**0.014**	**0.085**	**0.033**	**0.114**
AADT: Annual Average Daily Traffic	[vehicles per day]	3,000	2,000		19,500		9,100
IATEa: Actual Intensity of Annual Traffic encountering Road Closure (in 2005 fiscal year)	[vehicles per year]	1,693,000 3 times as large as it of Japan	1,327,000 4 times as large as it of Japan	99,600	605,000	110,000	379,000
IALa: Actual Intensity of Annual Loss	[pesos per (year*km)]	1,580,000	1,327,000	It is not made public.			

Source:
Philippines
Questionnaire Survey by JICA Study 2006 for 2004-2005

Japan
1. Ministry of Land Infrastructure and Transport Japan 2006, Statistical Year Book of Road Traffic Management .(Dourokoutu Kai
2.Fiscal year 2005 road census in Japan

Note: Designated Traffic Management Sections are Set in Japan to avoid human loss risk on RCD-prone sections

4.3.3 Target Values for Arterial and Secondary National Highways

To decide the target levels for arterial and secondary roads, it is useful to make a table of indicator values as shown in Table 4.5.

For example, the tentative target values shown in Table 4.6 are set considering the results of the pilot inventory survey.

Table 4.5 Risk Level Indicters (Tentative Values)

IRCDp: Potential Intensity of RCD of a section	Potential RCD Sections of National Arterial Roads		Potential RCD Sections of National Secondary Roads	
	IATEp: Potential Intensity of Annual Traffic encountering Road Closure of a section	IALp: Potential Intensity of Annual Loss of a section	IATEp: Potential Intensity of Annual Traffic encountering Road Closure of a section	IALp: Potential Intensity of Annual Loss
[Nos. of RCD per (year*km)]	[vehicles per year]	[pesos per (year*km)]	[vehicles per year]	[pesos per (year*km)]
0.001	1,095	670	730	450
0.002	2,190	1,340	1,460	900
0.010	10,950	6,700	7,300	4,500
0.020	21,900	13,400	14,600	9,000
0.100	109,500	67,000	73,000	45,000
0.200	219,500	134,000	146,000	90,000
1.000	1,095,000	670,000	730,000	450,000
2.000	2,190,000	1,340,000	1,460,000	900,000
10.000	10,950,000	6,700,000	7,300,000	4,500,000
20.000	21,900,000	13,400,000	14,600,000	9,000,000

Table 4.6 Tentative Value Setting and Expression of Risk Level Indicators

	Unit	Potential RCD Sections of National Arterial Road	Potential RCD Sections of National Secondary Road
AADT: Annual Average Daily Traffic	[vehicles per day]	3,000	2,000
ULp: Potential Unit Loss per RCD of a section	[pesos per RCD]	6,700,000	4,500,000
IRCDp: Potential Intensity of RCD	[nos. of RCD per (year*km)]	parameter	parameter
IATEp = IRCDp * AADT*365 Potential Intensity of Annual Traffic encountering to Road Closure of a section	[vehicles per (year*km)]	1,095,000*IRCDp	730,000*IRCDp
IALp = ULp * IRCDp Potential Intensity of Annual Loss	[pesos per (year*km)]	670,000*IRCDp	450,000*IRCDp

Note: These tentative values should be calculated and set again after the nationwide inventory survey is conducted.

4.3.4 Realistic Target Setting

To set realistic targets, a table of the cost-effectiveness feasibility indicators of the countermeasures against RCD, as extracted from the inventory survey data, is to be prepared as shown in Table 4.7.

Table 4.7 Cost-effectiveness of Countermeasures (Tentative Values)

Risk Level and Feasibility Indicators	Unit	Potential RCD Sections of National Arterial Road			
		Current State (with no counter measure)	Countermeasure to high risk slopes (FRCDa or FRCDp >= 0.1 or visible disturbance is recognized)		
			Alternative III Low Effectiveness countermeasure (Risk reduction is under 30%)	Alternative II: Moderate Effectiveness countermeasure (Risk reduction is 30-70%)	Alternative I : High Effectiveness countermeasure (Risk reduction is over 70%)
Cost of countermeasure with 20 years maintenance	[pesos]	0	5,414,800,000	10,476,000,000	15,479,000,000
Decrease in annual loss	[pesos per year]	0	797,872,000	1,127,834,000	1,501,315,000
BCR: Benefit/Cost Ratio at 15% discount rate for 20 years		-	1.06	0.78	0.70
Economic net present value at 15% discount rate		-	-365,786,000	-2,953,440,000	-5,288,497,000
Economic Internal Rate of Return		-	14%	9%	7%
IRCDp: Potential Intensity of RCD of a section	[Nos. of RCD per (year*km)]	1.546	1.237	0.773	0.247
IATEp: Potential Intensity of Annual Traffic encountering Road Closure of a section	[vehicles per year]	1,692,000	1,354,000	846,000	270,000
IALp: Potential Intensity of Annual Loss of a section	[pesos per (year*km)]	1,580,000	828,000	517,000	165,000

Note: A similar table should be made for national secondary roads.

4.4 Prioritization of Road Sections for Risk Management

The benefit gained from the implementation of a risk management plan is the difference between the present-state potential value of Intensity of Annual Loss and the target value:

Benefit = IALp - IALt

Sections with a large difference between the present-state potential value and the target value of risk level indicators are high-priority (bottleneck) sections for risk management.

In prioritizing road sections, the most comprehensive index is the benefit in a monetary value. When the present-state value is larger than the target level, the sections are judged to need risk management. The level of difference is classified into five categories as shown in Table 4.8: the bigger the difference of the category, the higher the priority of the section for inclusion in Medium Term Risk Management Program. The category should be set so that the number of sections (length of sections) included in each category will be even.

Table 4.8 Prioritizing by Divergence between Target and Present Value of IALp (Tentative Value)

Target for National Secondary Highway : IALt = 200,000 [pesos per (year*km)]		
Priority Ranking (Necessity of Risk Management)	IALp Divergence Current value – Target value	IALp Range
1	Over 400,000	Over 600,000
2	200,000 - 400,000	400,000 - 600,000
3	100,000 - 200,000	300,000 - 400,000
4	50,000 - 100,000	250,000 - 300,000
5	0 - 50,000	200,000 - 250,000
6 (Below target level)	Below 0	Below 200,000

An example of the classification of risk management level is shown in Table 4.9.

Table 4.9 Example of the Prioritization of Risk Management Level

Target Intensity of Annual Loss [pesos per (year* km) is 200,000

Road	Indicators		Length of a section	Total FRCDp of a section	Potential Intensity of RCD of a section	Potential Intensity of Annual Traffic encountering Road Closure	Potential Intensity of Annual Loss	Priority Rank (Necessity of Risk Management) shown in Table 4.7
Kennon Rd	Acronym		LS	∑FRCDp	IRCDp	IATEp	IALp	
	Unit		[km]	[Nos. of RCD per year]	[RCD per (year* km)]	[vehicles per year]	[pesos per (year* km)]	
		km station						
Road Section ID	sections	240.880-242	1.120	1.333	0.446	2,147,749	2,064,407	1
		242-243	1.000	1.658	1.139	2,991,960	4,528,660	1
		243-244	1.000	0.213	0.103	384,371	450,816	2
		244-245	1.000	0.982	0.872	1,772,078	2,691,491	1
		245-246	1.000	1.122	1.467	2,024,716	3,483,726	1
		246-247	1.000	0.914	0.668	1,646,368	2,252,162	1
		247-248	1.000	0.987	0.766	1,781,101	1,895,142	1
		248-249	1.000	0.598	0.598	1,079,127	1,360,000	1
S00407LZ		249-250.004	1.004	0.998	0.897	1,073,766	1,473,859	1
		Total	7.224	8.805	5.966			
		Section Average	-	-	-	1,793,376	2,227,167	1

4.5 Direction to Local Offices to Plan the Projects and Management Systems

The DPWH Central Office sends to the DEOs, through the Regional Offices, the list of sections prioritized in order of 'Necessity of Risk Management,' with the direction that the planning of disaster prevention projects and risk avoidance management systems depends on the risk levels (priority ranking of the necessity of risk management).

The detailed procedure to be followed by the DEOs in project planning is described in Chapter 5.

CHAPTER 5

PROJECT FORMULATION FOR ROAD SLOPE MANAGEMENT

5.1 Responsible Offices in DPWH for Road Slope Risk Management

Several DPWH offices manage road slopes as shown in Figure 5.1. The role of each office/organization is shown in Table 5.1.

The Planning Service in the DPWH Central Office is the main unit responsible for maintaining the RSMS database and for planning risk management. The Bureau of Maintenance (BOM) coordinates the planning and implementation of the risk avoidance management system, which is the current practice.

The Planning and Maintenance Units of the ROs and DEOs are in-charge for the conduct of inventory surveys and risk management planning. In addition, Maintenance Units will coordinate the planning and implementation of the risk avoidance management systems and routine maintenance rehabilitation works as currently practiced.

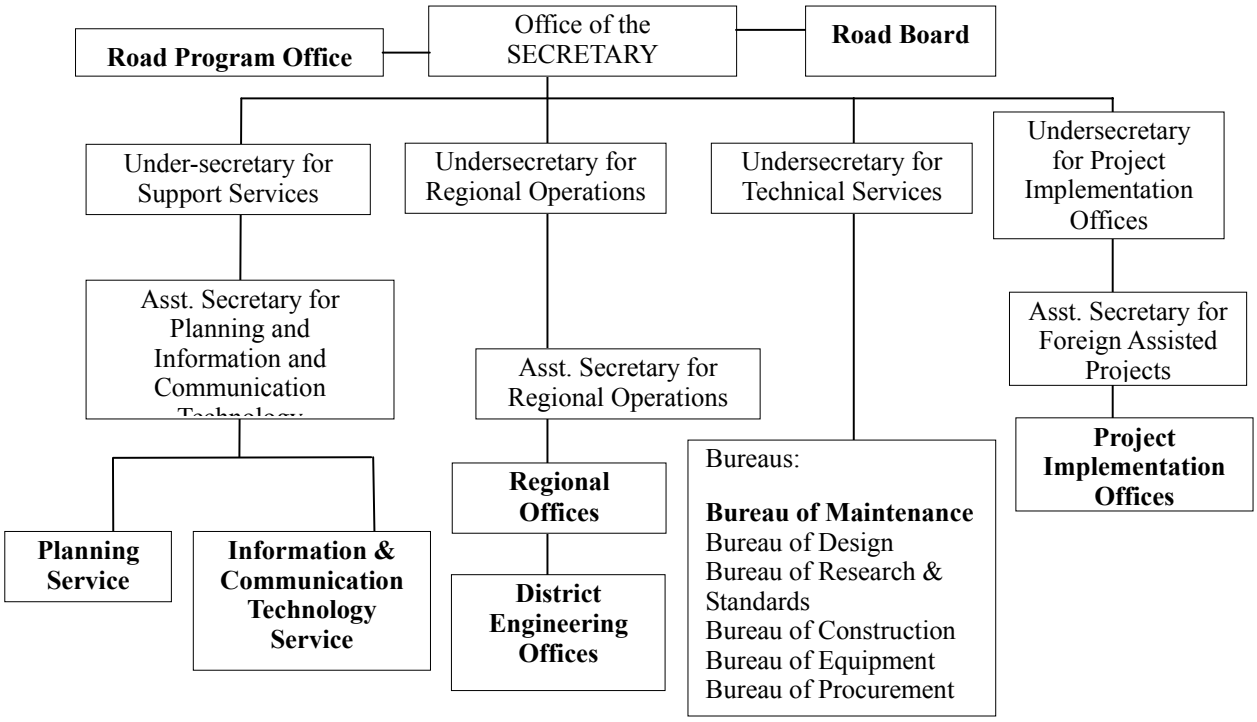


Figure 5.1 DPWH Offices Responsible for Road Slope Risk Management (as proposed under the rationalization plan of the Department)

Table 5.1 Roles of the Different Offices involved in Road Slope Risk Management

Office	RSMS Database	Disaster Prevention Works	Risk Avoidance Management Systems
Road Board	Final decision on financial coordination		
Road Program Office	Coordination among other road programs		
Planning Service	Formulation of Database	Policy making and program formulation for slope disaster prevention	
Information & Communication Technology service		-Data preparation for program formulation -Administration and updating of RSMS	
Bureau of Maintenance		Program formulation and implementation direction & support for routine maintenance	Program formulation implementation direction & support
Bureau of Design		Review of countermeasure plan and design	
Other Bureaus	Related technical services		
Regional Offices	Approve Inventory survey and disaster recording	Approve slope disaster prevention projects and routine maintenance system	Approve risk avoidance management system
District Engineering Offices	Preparation of inventory survey and disaster records	-Planning of slope disaster prevention projects and routine maintenance system -Implementation of disaster prevention project	-Planning of risk avoidance management system - Crisis management and rehabilitation works
Project Management Offices		Assistance on project/system implementation by request	

5.2 Outline of Risk Management Planning by Regional and District Engineering Offices

Regional Offices (RO) and District Engineering Offices (DEO) plan 'Slope Disaster Prevention Projects' and 'Risk Avoidance Management Systems' according to the list of slope inventory and road sections of risk management priority ranking.

The ROs check and consolidate all the planning materials from the DEOs and submit them to the Central Office of the DPWH.

The contents of the planning materials are shown in Table 5.2. The detailed planning procedure for each 'Slope Disaster Prevention Project' is explained in Section 5.3.

The planning for ' Risk Avoidance Management Systems' involves the revision/enhancement of existing systems and is conducted by the BOM, the Maintenance Division of ROs, and the Maintenance Section of DEOs. The revisions/enhancements should reflect the risk levels, which are clarified by the inventory survey.

The details of this procedure are outside the scope of this Guide.

Table 5.2 Project and Management System Planning

Planning Item	Contents
Slope Disaster Prevention Projects	- Selection of appropriate countermeasures - Specification and planning of annual budget for the countermeasures
Risk Avoidance Management System	- Announcing a route risk chart to the public - Avoidance of loss of human lives by an alert system and traffic regulation - Report system when disaster occurs - Restoration system when disaster occurs - Community-based risk management against natural hazards - Budget planning

5.3 Planning of Slope Disaster Prevention Projects

Planning of slope disaster prevention project is conducted considering data provided by the CO and information on rehabilitation projects provided in the Medium-Term Investment Program.

Data provided by the CO

a) Target sections
b) Target IALt for each section
c) Priority ranking for each slope
d) Reference information on PMS and BMS

Data to be collected from concerned project management offices

f) Rehabilitation/improvement plan for road slopes

The disaster prevention plan should include the following content.

(1) Selection of countermeasure alternatives and Multi-year implementation plan
(2) Budget planning

The planning of slope disaster prevention projects should include road sections subject to improvement/rehabilitation projects that are planned and being implemented in the Medium-Term Investment Program (2006-2010). The list of projects in the Medium-Term Investment program is shown in Appendix-1-3 for reference.

Draft plans (the slope inventory list prepared by DEO) of slope disaster prevention projects shall be informed to the concerned PMOs implementing or planning projects in the Medium-Term Investment Program to coordinate and revise each project planned by PMO and DEO.

Based on the Procedural Manual for DENR Administrative Order 2003-30 and Memorandum Circular 005 Series of 2006, roads rehabilitation/improvement with more than 50% increase in capacity (in terms of length/width) is covered by the Philippine Environmental Impact Statement (EIS) System. Hence, such projects are required to secure an Environmental Compliance Certificate (ECC) prior to project implementation.

5.3.1 Selection of Countermeasure Alternatives and Multi-Year Implementation Plan

- The DEO selects a reasonable countermeasure alternative based on the feasibility indicators shown in the slope inventory. When the IALp of a road section does not reach the target level after implementation of the countermeasure, the countermeasure should be revised and subjected to evaluation to identify an alternative with a bigger risk reduction ratio.
- In the event that the execution/implementation of countermeasure(s) will take two (2) or more years, then budget scheduling shall be evenly distributed through each year. Road sections with high FRCDp will be given priority for implementation; however this can be affected by other requirements.

The main items for slope disaster prevention planning are described in Table 5.4 and consist of the following:

- Selected Countermeasure Plan
- Budget
- Proposed implementation year
- FRCDpwc: FRCDp with selected countermeasure

The data for these items are entered into Table 5.3 which is the part of 'Countermeasure Progress Management' in the 'Slope Inventory: Integration Table of Risk Management for Road Slope Disasters (Appendix -2)'. The 'Slope Inventory' is exported in an Excel spreadsheet file by the RSMS database system at the Central Office and distributed to the DEO via the RO. 'Slope Inventory' is subdivided into three portions: 'Result of PIS', 'Result of DIS', and 'Countermeasure Progress Management'.

The DEO also calculates the Intensity of Annual Loss of Road Section with countermeasures (IALpwc) as shown in Table 5.4.

Table 5.3 Countermeasure Progress Management Portion in Slope Inventory

Survey ID	Countermeasure progress management				
	Selected countermeasure plan	Budget (pesos)	Proposed implementation year	Situation of countermeasure implementation; Planned, ongoing, completed	FRCDpwc: FRCDp with selected countermeasure plan (nos. of RCD per year)

Table 5.4 Input Items of Countermeasure Progress Management

Item	Drop down menu	Description
Selected Countermeasure Plan	Countermeasure alternative I / Countermeasure alternative II / Countermeasure alternative III /	DEO selects referring to the results of the feasibility indicators shown in the slope inventory. When section IALp with selected countermeasures does not reach the target level on one (1) km, the countermeasure selection should be revised for an alternative with a larger risk reduction.
Budget [pesos]	-	Only the construction cost is summed up. The maintenance costs after construction are not included. The amount estimated in the inventory survey may be revised.
Proposed implementation year	-	In the event that execution/implementation of countermeasure(s) will take two (2) or more years, then the budget should be evenly distributed over each year. High FRCDp will be prioritized for implementation, though this can be changed by other requirements.
Situation of counter measure implementation	planned / ongoing / completed /	Fill out according to the situation of existing and planning project. **Blank:** there is no plan **Planned:** when DIS did this planning **Ongoing:** when Central Office approved the plan and allocated the budget **Completed:** when countermeasures were completed
FRCDpwc: FRCDp with selected countermeasure plan [Nos. of RCD per year]	-	FRCDpwc of each countermeasure alternative is shown in the Slope Inventory. FRCDpwc of selected countermeasure alternative is entered.

An example of risk level indicators with countermeasures is shown in the 5.5 which is generated by planning disaster prevention project.

Table 5.5 Example of Risk Level Indicators with Countermeasures

Road Name	Indicators		Length of a section	Total FRCDp of a section with counter measure	Potential Unit Loss per RCD of a section	**Potential Intensity of RCD with countermeasure of a section**	Annual Average Daily Traffic	**IATEp with countermeasure of a section**	**IALp with countermeasure of a section**
Kennon Rd	Acronym		LS	∑FRCDpwc	ULp	**IRCDpwc**	AADT	**IATEpwc**	**IALpwc**
	Equation					∑FRCDpwc / LS		IRCDpwc * AADT*365	ULp * IRCDpwc
	Unit		[km]	[Nos. of RCD per year]	[pesos per RCD]	**[RCD per (year* km)]**	Vehicles per day	**[vehicles per year]**	**[pesos per (year* km)]**
Road Section S00407LZ	sections	km station							
		240.880-242	1.120	1.333	1,734,536	**1.190**	4,944	**193,297**	**185,797**
		242-243	1.000	1.658	2,731,399	**1.658**	4,944	**119,678**	**181,146**
		243-244	1.000	0.213	2,116,505	**0.213**	4,944	**153,749**	**180,146**
		244-246	1.000	0.982	2,740,826	**0.982**	4,944	**124,045**	**188,404**
		245-247	1.000	1.122	3,104,925	**0.122**	4,944	**101,236**	**174,186**
		246-248	1.000	0.914	2,464,072	**0.914**	4,944	**131,949**	**180,173**
		247-249	1.000	0.987	1,920,103	**0.987**	4,944	**178,110**	**189,514**
		248-250	1.000	0.598	2,274,247	**0.598**	4,944	**151,078**	**190,400**
		249-250.004	1.004	0.998	1,482,720	**0.994**	4,944	**233,191**	**191,602**
		Grand Total	9.124	8.805		**-**	**-**		
		Road Average	Section	-	2,307,856	**0.965**	4,944	**154,191**	**197,703**
								Target Level	**200,000**

Note: When summing up the FRCDpwc of a slope, slopes that extend over adjacent sections are included in the starting point side section.
If each IALpwc of one (1) km section exceeds the target level, countermeasure alternative selection should be changed to achieve a high Risk Reduction Ratio (RRR).

5.3.2 Budget Planning

The DEO estimates the annual cost of the following items of the multi-year plan:

(1) Construction Cost

(2) Maintenance Cost for Countermeasure Works

(3) Potential Re-opening Cost

(1) Construction Cost

The construction cost does not include the maintenance cost.

(2) Maintenance Cost for Countermeasure Works

The maintenance cost of countermeasure works begins after the construction. Maintenance works include vegetation of the road slope and cleaning of drainage.

(3) Potential Annual Reopening Cost

The Potential Annual Reopening Cost for the first year will be estimated using the value of annual average Potential Reopening Cost prior to the implementation of the countermeasure work. It is expected to decrease by the second year because of the effectiveness of the countermeasure. The expression for Annual Reopening Cost is:

$$ARCpwc(n+1) = ARCpwc(n) * IRCDpwc(n+1)/IRCDpwc(n) \quad \text{Equation 5-1}$$

Where:

ARCpwc(n+1) Annual reopening Cost with countermeasure of year n+1 [pesos]

ARCpwc(n) Annual reopening Cost with countermeasure of year n [pesos]

IRCDpwc(n+1) Intensity of RCD with counter measure of year n+1 [RCD per (year* km)]

Table 5.6 Format of Budget Planning

DEO				
Road Name				
Road Section ID				
year	Construction Cost	Maintenance cost of Countermeasure works	Potential Reopening Cost	Total
2009				
2010				
2011				
2012				
Sub Total				
Road Name				
Road Section ID				
year	Construction Cost	Maintenance cost of Countermeasure works	Potential Reopening Cost	Total
2009				
2010				
2011				
2012				
Sub Total				
Road Name				
Road Section ID				
year	Construction Cost	Maintenance cost of Countermeasure works	Potential Reopening Cost	Total
2009				
2010				
2011				
2012				
Sub Total				
Road Name				
Road Section ID				
year	Construction Cost	Maintenance cost of Countermeasure works	Potential Reopening Cost	Total
2009				
2010				
2011				
2012				
Sub Total				
Road Name				
Road Section ID				
year	Construction Cost	Maintenance cost of Countermeasure works	Potential Reopening Cost	Total
2009				
2010				
2011				
2012				
Sub Total				
Ground Total				