



COMPENDIUM OF BEST PRACTICES IN ROAD ASSET MANAGEMENT

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Contents

Introduction	1
What is Road Asset Management?	3
RAMS in the CAREC Region.....	6
Best Practices.....	8
1. Limit the Amount of Data Collected	9
2. Make the Database Easy to Use	11
3. Start with Simple RAMS Software	13
4. Institutionalize RAMS from the start	15
5. Publish Annual Performance Statistics.....	17
6. Integrate RAMS into Business Processes	19
7. Separate Management and Implementation	21
8. Ensure High-Level Support to RAMS	23
9. Continue Development Support to RAMS	25
10. Develop the works implementation capacity	27
Country Status Reports	30
Afghanistan	32
Azerbaijan	33
Georgia	34
Kazakhstan	36
Kyrgyz Republic	37
Mongolia	38
Pakistan	39
People's Republic of China.....	40
Tajikistan.....	41
Turkmenistan	42
Uzbekistan	43
Figures	
Figure 1 Road asset management and RAMS	5
Figure 2 Pavement Quality Index in Yunnan Province, PRC (2011)	18
Figure 3 Budget levels and allocations in Myanmar	24

Abbreviations

ADB	Asian Development Bank
AZZA	State-owned maintenance company (Mongolia)
CAREC	Central Asia Regional Economic Cooperation
COR	Committee of Roads (Kazakhstan)
CPMS	China Pavement Management System
DEP	Maintenance implementation unit (Kyrgyz Republic)
dTIMS	Deighton's Total Infrastructure Management System
DOR	Department of Roads (Mongolia)
GIS	Global Information System
GPS	Global Positioning System
GUSAD	maintenance unit (Tajikistan)
HDM4	Highway Design and Management
IRI	International Roughness Index
JICA	Japan International Cooperation Agency
MID	Ministry of Investment and Development (Kazakhstan)
MOC	Ministry of Construction (Turkmenistan)
MOT	Ministry of Transport (China, Tajikistan)
MOTC	Ministry of Transport and Communications (Kyrgyz Republic)
MPW	Ministry of Public Works (Afghanistan)
NHA	National Highway Authority (Pakistan)
PLUAD	area-based maintenance unit (Kyrgyz Republic)
RAM	Road Asset Management
RAMD	Road Asset Management Department (Pakistan)
RAMS	Road Asset Management System
RDMU	Road Data Management Unit (Azerbaijan)
RMA	Road Maintenance Account
RMD	Road Management Department (Kyrgyz Republic)
RMU	Road Maintenance Unit (Afghanistan)
RONET	Road Network Evaluation Tool
RRF	Republican Road Fund (Uzbekistan)
RTD	Roads and Transport Department (Mongolia)
SCR	State Committee for Roads (Uzbekistan)
TTFS 2020	Transport and Trade Facilitation Strategy 2020
UAD	corridor-based maintenance unit (Kyrgyz Republic)
USAID	United States Agency for International Development

Introduction

1. The Central Asia Regional Economic Cooperation (CAREC) Program is a partnership of 11 countries¹ and 6 multilateral development partners². The aim of CAREC has been to promote development through cooperation, leading to accelerated economic growth and poverty reduction. The CAREC Program focuses on regional cooperation in the priority areas of transport, trade facilitation, trade policy and energy.

2. The CAREC Transport and Trade Facilitation Strategy 2020 (TTFS 2020) was endorsed at the 12th Ministerial Conference in October 2013. This document builds on projects and initiatives undertaken since 1997 to enhance transport and trade, aiming to (i) establish competitive transport corridors; (ii) facilitate the movement of goods and people through CAREC corridors and across borders; and (iii) provide sustainable, safe, and user-friendly transport and trade networks.

3. TTFS 2020 attaches importance to providing adequate management and maintenance of CAREC road corridors to ensure that they deliver the intended level of road service quality.

4. At the 14th Meeting of the CAREC Transport Sector Coordinating Committee in April 2015 (Ulaanbaatar, Mongolia), CAREC member countries reconfirmed the benefits of sharing good practices that already exist within CAREC countries, and endorsed the idea of producing a compendium of best practices in road asset management.³

¹ The CAREC countries are Afghanistan, Azerbaijan, Georgia, Kazakhstan, the Kyrgyz Republic, Mongolia, Pakistan, the People's Republic of China (PRC - represented geographically by Xinjiang Uygur Autonomous Region and Inner Mongolia Autonomous Region), Tajikistan, Turkmenistan and Uzbekistan

² The six multilateral development partners supporting the CAREC Program are the Asian Development Bank (ADB), the European Bank for Reconstruction and Development (EBRD), the International Monetary Fund, the Islamic Development Bank, the United Nations Development Programme (UNDP), and the World Bank.

³ A Summary of Proceedings of the 14th Transport Sector Coordinating Committee Meeting is available at: <http://www.carecprogram.org/uploads/events/2015/010-TSCC-Meeting-Mongolia/Summary-Proceedings-14th-CAREC-TSCC.pdf>

5. This report is a first attempt at collating such good practices across CAREC member countries, and is intended to be updated from time to time. It has been produced through a review of openly available information from each CAREC member country.
6. The report is mainly intended for the benefit of road agencies responsible for the management and maintenance of CAREC roads.
7. For practicality, the report applies a narrow definition of road asset management, as opposed to covering a wider ecosphere of interventions that are required for road management in general.

What is Road Asset Management?

*Road asset management looks at optimizing the **level** and the **allocation** of road maintenance funding in relation to medium- and long-term results on road conditions and road user costs.*

8. The objective of road asset management is generally to optimize the economic benefits by minimizing the sum of maintenance costs and road user costs – road asset management looks not only at the maintenance costs for the road entities, but also at the road transport costs for road users, encompassing all the costs related to road transport (total road transport costs). Road asset management can help determine the optimal funding levels that help minimize these total road transport costs, and can demonstrate how available funding can best be allocated to specific roads or road sections, and to specific types of maintenance and repair. In doing so, it does not look at short-term impacts on the road network, but rather at medium- or long-term impacts (generally a timeframe of at least 20 years is used).

9. This introduces a significant change from traditional maintenance implementation that is aimed at repairing as much existing damage as possible within an available yearly budget. Road asset management, on the other hand, aims to achieve a specified service level or road condition at the lowest cost. In doing so, it takes a long-term perspective, considering the future impacts of current budget allocations. Such a change in approach often sees a shift from repairing roads in poor condition, to preserving roads in good or fair condition, avoiding them from deteriorating and requiring costly repairs in the future. In the short-term, this results in poor condition roads being given less attention, but in the long run it frees up funding to address the maintenance backlog.

10. Road asset management is based on an analysis of road data related to inventory, condition, traffic, unit costs and road deterioration models. The data is entered into a Road Asset Management System (RAMS) that allows the data to be analyzed and optimal budget levels and allocations to be determined. However, road asset management is more than just the RAMS, and includes the integration of the RAMS into the wider context of structures and procedures within which it operates, complementing the economic optimization criteria of the RAMS with other policy objectives (e.g. connectivity, accessibility).

11. A RAMS is considered to include any system that is used to collect, store and process road and bridge inventory, condition, traffic and related data, for road planning and programming purposes. A RAMS generally involves a computerized road asset management system, involving data collection, data management (database) and data analysis.

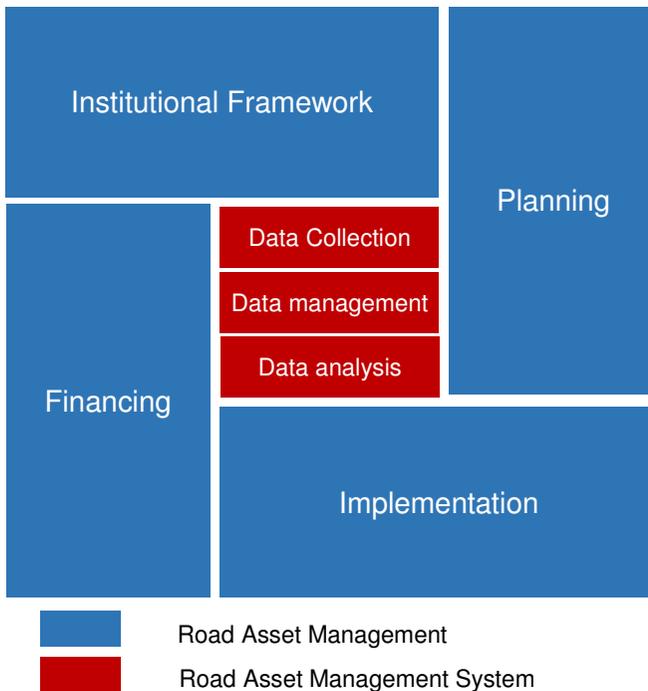
- **Data collection** - This involves carrying out surveys and collecting data on the road network. This includes data that continuously changes and needs to be updated regularly (e.g. road condition, traffic) and data that hardly ever changes (e.g. road alignment, topography, surface type).
- **Data management** - This generally involves a database that brings all the collected data together and makes it readily available for planning and monitoring purposes. This may include simple textual or numerical data (e.g. road name, road length) as well as GPS related data (alignment, road condition) or multimedia files.
- **Data analysis** - This involves the analysis of the collected data to determine the optimal approach in terms of required funding and allocation of that funding to different roads and to different types of interventions. This often looks only at pavements, but may also include bridges, other structures, road furniture and road service stations.

12. However, the RAMS cannot be seen separately from the context it operates in, and the term road asset management will therefore have a wider focus, including the integration of the RAMS into the institutional framework, into road network planning and programming systems, into road sector financing and budget allocation procedures, and into the implementation of road maintenance. Road asset management looks at the development of appropriate business processes that allow the RAMS to be used effectively to execute the business needs of the entity responsible for the road network.

- **Institutional framework** - The institutional structure has a significant influence on the role that a RAMS may play in the decision-making process. It is therefore important to look at the role and position of the RAMS within the existing institutional framework.

- **Financing** - The impact of a RAMS is dependent on the degree to which it can influence funding levels, and align these with the actual funding needs. It is therefore important to look at how funding levels are influenced by the RAMS.
- **Planning** - A RAMS is only effective to the degree in which it can influence plans for the road sector and influence the budget allocations to different roads and intervention types. It is therefore important to look at the linkage of the RAMS to the existing planning systems.
- **Implementation** - During implementation, budget allocations are used to carry out planned road interventions. The effectiveness and efficiency of the implementation and thus the degree in which the RAMS targets will be met, depends on the capacities of government and private sector contractors and consultants, and the contracting approaches that are used.

Figure 1 Road asset management and RAMS



RAMS in the CAREC Region

Six of the eleven CAREC countries are currently piloting aspects of a RAMS, four additional CAREC countries already have a strengthened RAMS in place, and one CAREC country has successfully mainstreamed RAMS in its road operations.

13. A review of the experiences with road asset management in the 11 CAREC countries was carried out by means of a desktop review of country and project documents and interviews with a limited number of government staff, development partners and consultants. This review has focused on the trunk road network managed at national level⁴. A summary of the results is presented below and in the table on the following page. More detailed information for each country is provided in the country status reports at the end of this document.

14. Six CAREC countries are in the initial phases of developing a RAMS. They are piloting data collection, database development and data analysis, but this is not happening regularly or only for a portion of the trunk road network.

15. Four CAREC countries can be considered to have a RAMS in place. They are regularly collecting data in a format suitable for the RAMS, they have proper data management and data quality control procedures in place, and they regularly carry out analysis of the data. However, the RAMS is still very much a stand-alone tool that is not yet integrated into decision-making procedures, and is mainly used for monitoring purposes.

16. One CAREC country has mainstreamed and integrated the RAMS and is carrying out road asset management. Data collection, management and analysis is fully institutionalized and carried out regularly, data analysis forms an input for maintenance planning and influences funding levels and maintenance budgets, and implementation is outsourced in line with maintenance plans. However, it must be noted that this significant achievement is the result of 20 years of support to RAMS development.

⁴ In the People's Republic of China (PRC) the trunk road network is managed at provincial level.

General road data	AFG	AZE	GEO	KAZ	KGZ	MON	PAK	PRC	TAJ	TKM	UZB
Total roads (km)	38,700	59,002	21,800	96,718	34,810	49,200	260,131	4,356,218	26,767	58,592	183,724
Trunk road network (km)	17,900	19,002	6,824	23,485	18,810	11,200	12,131	494,700	14,067	13,644	42,530
Rural/urban road network (km)	20,800	40,000	15,000	73,233	16,000	38,000	248,000	3,861,518	12,700	44,948	141,194
Country size (km ²)	652,230	86,100	69,700	2,699,700	191,801	1,553,556	881,912	9,326,410	141,510	469,930	425,400
Road density (km/100km ²)	5.9	68.5	31.3	3.6	18.1	3.2	29.5	46.7	18.9	12.5	43.2
RAMS	AFG	AZE	GEO	KAZ	KGZ	MON	PAK	PRC	TAJ	TKM	UZB
Data collection (frequency)	Starting	Annual	Annual	Starting	Starting	Annual	Annual	Annual	Starting	None	Starting
Data collection (extent)	Pilot	Network	Network	Pilot	Pilot	Network	Network	Network	Pilot	None	Pilot
Database	No	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No	Yes
RAMS	No	Yes	Yes	No	No	Yes	Yes	Some provinces	No	No	No
Strategy analysis	No	Yes	Yes	No	No	Yes	Yes	Some provinces	No	No	No
Road Asset Management	AFG	AZE	GEO	KAZ	KGZ	MON	PAK	PRC	TAJ	TKM	UZB
RAMS unit	No	Yes	Yes	No	No	Yes	Yes	Yes	No	No	Yes
Dedicated maintenance funding	No	Yes	No	No	No	Yes	Yes	Yes	No	No	Yes
Influencing financing	No	No	No	No	No	No	Yes	No	No	No	No
Influencing planning	No	No	Partially	No	No	No	Yes	No	No	No	No
Maintenance implementation	In-house + Bidding	In-house	Bidding	In-house + Bidding	In-house + Bidding	In-house	Bidding	In-house + Bidding	In-house	In-house	In-house + Bidding

Best Practices

The following are considered best practices in introducing and developing road asset management:

- 1. Limit the amount of data collected*
- 2. Make the database easy to use*
- 3. Start with simple RAMS software*
- 4. Institutionalize RAMS from the start*
- 5. Publish annual performance statistics*
- 6. Integrate RAMS into business processes*
- 7. Separate management and implementation*
- 8. Ensure high-level support to RAMS*
- 9. Continue development support to RAMS*
- 10. Develop the works implementation capacity*

17. The review of the current status of road asset management in the 11 CAREC member countries has resulted in the identification of a number of common issues that the CAREC countries face. These are not necessarily specific to the CAREC region, although the CAREC countries do have some common characteristics, especially since many of the countries formerly belonged to the Soviet Union.

18. The review has identified how certain CAREC member countries have overcome these issues, providing lessons learned for other member countries. This has been complemented by successful experiences from other countries outside the CAREC region and lessons from other studies looking at road asset management.

19. The result is the identification of a set of 10 best practices that are considered crucial to the successful introduction of a road asset management system (RAMS), and its integration into the institutional framework, into road network planning and programming systems, into road sector financing and budget allocation procedures, and into the implementation of road maintenance works. These 10 best practices are introduced in detail in the following sections.

1. Limit the Amount of Data Collected

To limit the time and money spent on data collection, this should focus on minimum data requirements, collected at suitable levels of accuracy, using reliable methods of collection, applying appropriate data formats, and ensuring proper quality control procedures.

20. Road asset management is dependent on data. However, since the collection of data costs time and money, the data collection should be limited to what is actually needed. Collection of data that is not required or is not suitable for use in the RAMS, can make data collection overly costly, putting the sustainability of the RAMS at risk.

21. Many CAREC countries spend time and money collecting data that is not required, that is too detailed, that is unreliable, or that is in a format that is not useable. When designing the data collection, the following requirements should be met:

22. **Collect only what is required** – A RAMS requires a limited amount of data for the entire network. This should not be confused with the data needs for project preparation, where more detailed data is required, but only for the few roads where interventions are planned. The types of data to be collected for the RAMS should be kept to a minimum, especially for data that is collected on an annual basis. Additional types of data can be gradually added as the RAMS evolves, other data needs are identified, and new data collection methods are introduced.

*In **Mongolia**, annual surveys collected a lot of data that was not being used in the RAMS or for other planning purposes. The annual data collection has since been amended to focus on a more limited set of data types that are required for the RAMS, reducing the number of data types to be collected from 18 to 2.*

23. **Use an appropriate level of accuracy** – Although the collection of very accurate data seems like a good idea, this generally increases the cost, while not necessarily improving the outcomes of the RAMS. Especially during the introduction of a RAMS, less expensive data collection methods may be preferable, even where these reduce the accuracy of the data.

24. **Ensure that data is reliable** – Although a lower level of accuracy is acceptable, the data should be reliable. Only if data is reliable, can the level of accuracy be kept within acceptable margins. Unreliable data leads to unreliable results, with errors in the data itself compounding the level of inaccuracy.

In the People's Republic of China, the introduction of automated survey vehicles greatly reduced the cost of data collection, while at the same time improving the reliability of the data.

25. **Ensure data has the correct format** – Data must have the correct format to be entered into the RAMS, or should be easily transformed into that format. For instance, qualitative condition measurements of good or bad are not always easily translated into quantitative measurements related to affected surface area.

26. **Introduce proper quality control procedures** – Before collected data is entered into the database, it should be checked for inconsistencies and processed to fit the parameters of the database. This is generally done in a separate database where data is entered and checked before being transferred to the main database.

In Azerbaijan, standards for data quality control and processing were introduced to avoid data errors from being transferred to the database.

2. Make the Database Easy to Use

The database needs to be properly structured, using appropriate software and local language interfaces to make it easily accessible by different levels, in order that it may be used not only for the RAMS, but also for monitoring of road sector performance.

27. Apart from providing a system to manage the data for the RAMS, the road database also performs other functions such as providing data on specific roads and providing statistics on the road network as a whole. It contains a wealth of information for planning interventions and monitoring the performance of the road network.

28. To allow the database to provide these functions, it must be made easily accessible. This requires the database to be remotely accessible so that the data can be accessed (and checked) from different offices. This is preferable to having several copies of the database, where different copies may contain different data.

29. It also means that the database should be easy to use. This requires an easy web-based interface to search for data, but also a function to export data to commonly used software formats such as Excel or Access, allowing users to further process and analyze the data. Parallel systems may exist for the general public (with a more limited set of data) and for use by authorized government staff (with a more complete set of data).

30. Although not strictly necessary initially, in the long run the system may be further developed to also allow for remote entry of certain data types by local offices. Systems should also allow access to the maps, photographs and video data included in the database. The database should furthermore have a local language interface to allow users to easily access the data they require.

In Kyrgyz Republic, Excel was used as the basis for the initial road database. This included the complete road inventory, as well as road condition data for part of the network. A Russian language interface was developed to facilitate use by the Road Management Department.

31. Apart from making the database easy to access, the data needs to be well structured. This especially relates to the way that roads are divided up into sections, and data is linked to these sections. This requires road sections that are small enough to accurately pinpoint problem areas, but not too small that the database becomes unwieldy due to the large amounts of data. The location of the road sections should also be made easily identifiable, both using maps and by naming sections according to chainage and/or place names.

*In Yunnan Province in **China**, data is linked to road sections of one kilometre in length, with the chainage of each section recorded in the database. This facilitates analysis, both by means of a RAMS and using simple spreadsheet software.*

32. A second element of structuring the road sections, is the proper use of road codes. Road codes are a series of numbers and letters that uniquely identify each road, and in some cases even the road section or location. Letters are generally used to identify the type or administrative level of the road, followed by sequential numbering for the different roads of that type. In some cases, additional numbers or letters are included to identify the province, state or oblast where the specific road section is located. Such a unique identifier is required for all databases, and further assists in identifying the road and its location, avoiding confusion that may exist when road names are used.

*In **Kazakhstan**, road codes exist for the main road network of international roads (M), strategic republican roads (A) and other republican roads (P). However, in existing policies and plans, the road codes are generally omitted and only road names are used, with different documents using different names. This can lead to confusion in some cases, where it is not fully clear which road section is being referred to.*

3. Start with Simple RAMS Software

The introduction of a RAMS should start simple, with inexpensive software that is easy to use, allowing this to evolve over time as the specific needs of the road management entity become clear and a more detailed RAMS can be developed that responds to these needs.

33. Road Asset Management Systems vary from simple spreadsheets to complicated software requiring many types of data. In introducing a RAMS, it is important to start simple and gradually evolve to a more comprehensive system that fits the needs of the country and its road network. Several CAREC countries have introduced a RAMS that uses technologies that are costly and difficult to use, undermining the sustainability of the RAMS.

34. During the introduction phase of road asset management, the country will likely be unfamiliar with RAMS and will not be clear on the potential options in terms of data requirements and support to road management. During this stage, a simple off-the-shelf software should be used with the objective of becoming familiar with the possibilities of a RAMS, in order that it may subsequently be adjusted and upgraded to the specific requirements of a country. Too many countries have started with complicated software, only to have the system fail due to the high data and skill requirements.

*In **Belarus**, the government started using Highway Design and Management (HDM4) software as the basis for their RAMS. After several years of implementation, they decided to develop a specialized system that better responded to their specific needs.*

*In **Kyrgyz Republic**, use was made of Microsoft Excel as the basis for the first RAMS. This contained the database and was able to automatically prepare several standardized reports for management purposes. Although simple, it was easily understandable and was made available with a Russian language interface. In the coming years, this will likely be upgraded to other software as the government clarifies what it needs.*

35. Many of the types of road asset management software are only available in a limited number of languages. This makes it difficult to use in many of the CAREC countries. To facilitate the use of the software, a local language interface should be provided, or an additional front-end module added in the local language. At the very least, a detailed manual should be provided, which explains the software options in both languages.

*In **Mongolia**, use was made of Deighton's Total Infrastructure Management System (dTIMS). To facilitate the use of the software, a Mongolian language front-end module was added.*

4. Institutionalize RAMS from the start

The RAMS should be institutionalized from the very beginning, identifying clear institutional responsibilities and resources for its operation, and involving the RAMS unit in the introduction and development of the RAMS.

36. In many countries, the RAMS has been developed with consultant support under the umbrella of a donor-funded road project. The consultant is generally responsible for initial data collection and the development of the database and data analysis software, as well as the institutionalization of the RAMS and the training of staff.

37. However, often the focus is on the data collection and system development, with institutionalization and training only happening at the end. This generally gives a less than desirable result as institutional structures are not properly designed and tested, and staff have little opportunity to practice their skills. When the project and the consultant support come to an end, there is a high risk that the system will not work as designed.

38. To avoid this problem, institutionalization needs to be given a higher priority and started right from the beginning of the RAMS development. No actions should be undertaken until there are clear counterparts that will become responsible for the data collection, data management and data analysis. These should have a well-defined structure and should have sufficient qualified staff assigned to take over the RAMS. These RAMS units should also have an operational budget assigned to allow them to collect, manage and analyze the required data.

*In **Kazakhstan**, instrumental examinations are expressly mentioned in the budget subprogram 100 of the Committee of Roads. This allows a specific budget to be allocated each year for the collection of data.*

*In **Pakistan**, a Road Asset Management Directorate has been created under the National Highways Authority. This is responsible for all data collection, data management and data analysis.*

39. Only once such a RAMS unit is in place, should the consultant proceed with defining the data collection requirements and modalities, the data management options and the data analysis procedures. This should take place with full involvement of the staff of the RAMS unit, allowing them to receive on-the-job training and to practice their skills. This will also ensure that the RAMS is better adapted to existing data collection procedures and fits better into existing business processes.

*In **Azerbaijan**, a Road Data Management Unit has been created under the national road operator Azeryolservis, which has been responsible for data collection and management since 2013.*

40. To avoid delays in the creation of a RAMS unit, the institutionalization should be set in motion during project preparation. Before the project starts, the RAMS unit should be in place, allowing the consultant to immediately start working with the staff of the RAMS unit. At the moment of writing this compendium of best practices, RAMS units were only created in half the CAREC countries. In a number of these countries, the RAMS units had only just been created, or only existed in some provinces.

*In **Tajikistan**, continued support to the development of a RAMS is being provided by ADB and the World Bank. A RAMS unit has not yet been created, but the Economic Analysis and Forecasting Department of the Ministry of Transport has been identified as a possible candidate for housing a RAMS unit.*

5. Publish Annual Performance Statistics

Even where a RAMS is not yet used for decision-making, the publication of statistical yearbooks and performance reports allows the performance of the road sector to be monitored, and provides an incentive for the regular collection of data in support of a RAMS.

41. A RAMS revolves around the analysis of data. However, for this to be possible, the data first needs to be collected and managed. The data collection and management processes need to function well before the RAMS can be successfully introduced.

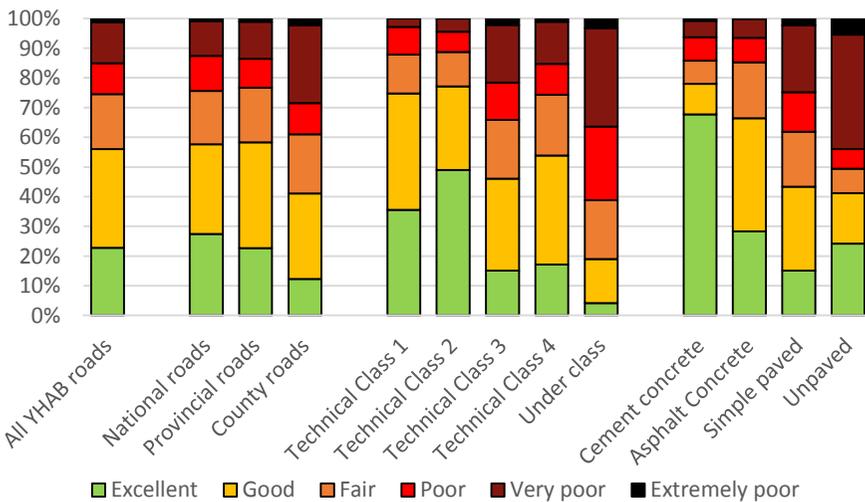
42. To motivate the annual collection and management of data, even where a RAMS may not yet be fully operational, some countries have started publishing annual performance statistics. These are published in statistical yearbooks or in annual reports. Apart from providing information about the performance of the road sector over time, this ensures that the collected data is used. Where such results are made available publicly, they can also introduce greater transparency.

43. The regular collection and publication of such data, institutionalizes the concept of data collection and data management, as well as data analysis as a road management tool. From there it is a small step to introduce a fully-fledged RAMS.

*In **Georgia**, the Road Data Management Unit (RDMU) of the Roads Department is responsible for data collection and for managing the road database. Each year the Roads Department prepares an Annual Report with support from the RDMU. Increasingly, the road data is being used for HDM4 analyses in support of planning.*

In the **PRC**, the National Highway Performance Assessment Standards require the different provinces and counties to annually collect data on the road networks under their responsibility. Many provinces only use this data for the publication of the Statistical Yearbooks for the road sector in their province, and as input for the national statistical office. However, the regular data collection and management means that data is readily available for entry into a RAMS as was evident in recent ADB and World Bank projects aimed at strengthening road management.

Figure 2 Pavement Quality Index in Yunnan Province, PRC (2011)



Source: ADB TA7962

6. Integrate RAMS into Business Processes

The RAMS is ultimately intended as a planning tool rather than a monitoring tool and needs to be integrated into decision-making processes in order to be effective.

44. A RAMS can be a very powerful tool to determine the optimal use of available maintenance funding, as well as for determining optimal budget levels for the maintenance of the existing road network. A RAMS can indicate what types of interventions give the best value for money, as well as showing which roads should be prioritized in order to get the maximum economic benefit out of the available maintenance budget. In addition, a RAMS can help determine the budget levels required to improve the road network to a certain minimum condition and keep it there, and indicate what the future effects of different budget levels will be on road network conditions. This makes it a powerful tool for decision-making and negotiations on the amount of funding to be allocated to road maintenance.

*In **Pakistan**, road network data is collected on an annual basis, entered into the RAMS and used to prepare annual maintenance plans. The use of the RAMS in the planning and budget allocation process has seen a shift towards periodic maintenance, which now receives approximately 60% of maintenance funding. The results have been convincing, with average network roughness reducing from IRI 8.0 in 2000 to IRI 5.6 in 2014. The RAMS is also used to estimate budget needs, which are used in negotiations about the amount of funding to be allocated to the Road Maintenance Account each year.*

45. Most CAREC countries have not yet integrated the RAMS into decision-making processes for planning and budgeting, and often the RAMS serves only as a monitoring tool. This is an underutilization of the RAMS, which can be a very effective tool in planning and budgeting for road maintenance, repairs and rehabilitation.

*The available maintenance budget in **Azerbaijan** is estimated to be sufficient to cover existing needs, but a RAMS analysis has shown that allocations can be further optimized to preempt a gradual deterioration of the network.*

46. Incorporating the RAMS into decision-making processes requires that the RAMS is properly designed and adapted to fit within existing planning and budgeting procedures. One important aspect in this sense is to ensure that the timing of data collection, management and analysis fits the country's planning cycle.

47. A more difficult issue is to ensure that the output of the RAMS actually feeds into existing planning procedures. Many of the CAREC countries have inherited old Soviet systems of spring and autumn visual surveys of the road network, with maintenance plans prepared by local-level maintenance units based on perceived needs. A RAMS does not easily fit into this system, where equipment-based survey methods are generally used, data is compiled at central level, and budget is allocated based on the optimization of economic benefits. This will require a transition from bottom-up planning procedures based on visual inspections to more top-down decision-making procedures based on data analysis. The draft plans prepared with the RAMS may still be amended based on comments received from local maintenance units or local authorities, as long as this does not divert too much from the economically optimal allocation of maintenance funds.

*In **Kazakhstan**, maintenance is carried out by Kazakhavtodor, which also carries out visual surveys and prepares annual maintenance plans through its local offices. A RAMS is currently being developed that will make use of road condition survey vehicles for collecting data. Kazakhstan recently introduced results-based budgeting, linking budgets to the targets to be achieved. This approach fits in well with the RAMS, that can help determine appropriate targets based on the available budget, and can also monitor achievement of these targets.*

7. Separate Management and Implementation

A RAMS is a road management tool that can assist the road manager in planning maintenance and repair investments and in monitoring performance of maintenance implementation in the road network. It is not intended to support the day-to-day implementation of maintenance works by the implementing entity. Responsibility for the operation of the RAMS should therefore be assigned to the road manager, separating this function from maintenance implementation.

48. The RAMS is a management tool that helps determine the best allocation of maintenance funding to different types of maintenance and repair, and to different roads or road sections in the network. It focuses on the planning and budgeting phase, comparing possible budget allocations to different types of maintenance and different sections of roads, and selecting the option that leads to the lowest long-term maintenance costs and road user costs. This is different from the implementation phase, where the budget allocations have been decided and the maintenance types and road sections have been selected. In the implementation phase a more detailed assessment of the specific maintenance needs is prepared for the selected roads, and the works are carried out.

49. Proper road management requires separation of these responsibilities, with the road manager responsible for planning and budgeting, as well as monitoring of performance, while the implementing entity (contractor) is responsible for achieving the planned results. Where the same entity is both responsible for planning and monitoring the results as well as achieving these results, a conflict of interest arises as it becomes responsible for assessing its own performance.

*In **Afghanistan**, a Road Authority has recently been created to manage the road network. With support from USAID, a Road Fund is also being developed to ensure proper funding for road maintenance. Development partners have also been supporting the development of private sector contractors, including the introduction of performance-based contracting.*

50. In most of the CAREC countries, the entity responsible for road management is also responsible for implementation by in-house units. These in-house implementation units are also strongly involved in preparing the maintenance plans and monitoring road network performance. A minority of CAREC countries has moved beyond this and has introduced a separation of responsibilities in management and implementation functions. However, in most of these countries the separation is not very clear, causing confusion regarding the placement of the RAMS.

*In **Uzbekistan**, Uzavtoyul used to be responsible for both management and implementation. With the transformation of Uzavtoyul into the State Committee for Roads (SCR), a certain degree of separation between management and implementation has been introduced. SCR is responsible for strategic planning and programming, while the former Uzavtoyul implementation units have been set up as unitary enterprises that will be contracted through SCR's Directorate for Construction and Reconstruction of Public Roads.*

*In **Georgia**, the Roads Department is responsible for the management of the trunk road network. The former force account units were privatized in 1999 and all works implementation is currently contracted out to the private sector. This includes routine summer and winter maintenance, which is packaged based on 34 zones and contracted out under one- or two-year contracts. Construction supervision is also contracted out, although maintenance supervision continues to be carried out by the Roads Department.*

8. Ensure High-Level Support to RAMS

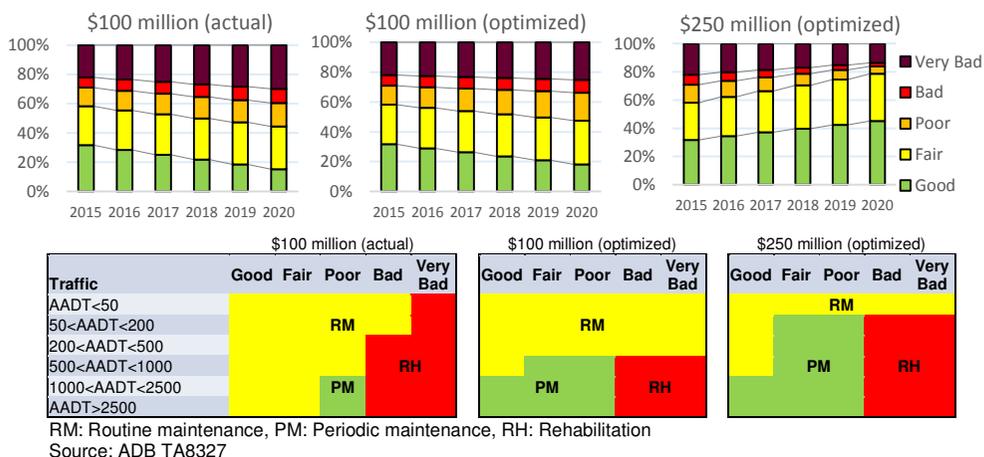
To ensure that the RAMS is properly integrated into the existing framework and procedures, high-level support is needed and should be mobilized from the very beginning of the RAMS introduction.

51. Although the development of a RAMS is relatively straightforward and can be done largely with project and consultant support, its integration into the institutional framework and decision-making procedures requires support from high-level officials. Without such high-level support, the RAMS will continue to be a stand-alone tool, with little impact on road management.

52. To achieve such support, it is important to convince high-level officials of the benefits of a RAMS as a decision-making tool, explaining how it can help determine suitable maintenance budget allocations and optimize the impact of available budgets on road conditions and road user costs. A strategy analysis can be a powerful tool in this process, showing how future road conditions are likely to evolve under different budget scenarios, and demonstrating how available budgets are best allocated to different types of roads and to different types of maintenance, comparing this to current practice.

*The results of the strategy analysis from **Myanmar** (see following page), show how an optimized allocation of available road maintenance funding leads to a slower deterioration of the road network conditions, and how an increase in maintenance funding is needed to achieve a gradual improvement of road conditions. Similarly, the RAMS results show a shift in focus in the allocation of the available budget from rehabilitation of roads in poor condition to periodic maintenance of roads with high traffic volumes in good or fair condition. Additional budget allocations are used to expand the periodic maintenance and rehabilitation to lower volume roads.*

Figure 3 Budget levels and allocations in Myanmar



In the PRC, the Ministry of Transport is strongly promoting the use of RAMS for maintenance planning. However, the high degree of decentralization and the large number of entities responsible for the trunk road network, make implementation difficult, despite this high-level support.

53. Such high-level support is not strictly necessary at the very beginning, but it should be mobilized as soon as possible to ensure that the RAMS is integrated into existing procedures. The high-level support does not necessarily have to come from the road sector, and may come from a finance ministry or planning ministry.

In Kazakhstan, the Ministry of Finance has introduced results-based budgeting. This requires annual targets to be set for key performance indicators in each sector. This approach is very much in line with a RAMS and will support the introduction of a RAMS in the road sector.

9. Continue Development Support to RAMS

The introduction and development of a RAMS and its successful integration into decision-making procedures takes at least 5-10 years. Technical support needs to be provided throughout this period.

54. RAMS introduction in the CAREC countries has been strongly supported by development partners. This is generally done on a project basis, with project consultants providing technical assistance and project funding used to procure survey equipment as well as hardware and software for the database and data analysis modules.

55. CAREC countries and development partners are learning how RAMS introduction can be better supported. One common challenge is that the timeframe for a single project is often too short to allow for the full development and integration of a RAMS, which generally takes 5-10 years, and often more. Projects have tended not to look beyond the end of the project period, and during project design little attention has been given to follow-up support after the end of the project. Achieving RAMS piloting, strengthening and mainstreaming in one single project has been found to be overly ambitious.

*In **Pakistan**, the introduction of the RAMS for national highways and motorways started already in the 1990s. It has sustained its efforts over the past 20 years to get to the current stage, and now some of the provinces are embarking on this process.*

56. Instead, to ensure a coordinated and continuous support to RAMS development, stepwise support through a series of consecutive projects is required. The consecutive steps should be designed beforehand, clarifying what each project will aim to achieve and how they will build on the accomplishments of the previous project. This would require at least three consecutive projects to deal with the following steps:

1. **Piloting of the RAMS and awareness raising of its potential** (including the creation of a RAMS unit and the mobilization of high-level support)
 2. **Strengthening of the RAMS and capacity development** (including expansion of data collection, the strengthening of systems and the further training of staff of the RAMS unit)
 3. **Mainstreaming of the RAMS and integration into decision-making** (including its use in planning and budgeting, and the development of the works implementation capacity)
-

*In **Uzbekistan**, the ADB has been supporting the introduction and strengthening of a RAMS for the international and national road networks through two consecutive projects. The World Bank is providing further support by expanding the data collection, the database and the RAMS to the regional road network.*

57. The coordination of the different projects and their consecutive stepwise support should be led by the government, and strongly supported by development partners and project (preparation) consultants.

*In **Georgia**, the World Bank has been supporting the introduction of road asset management for more than 10 years through a series of several different projects. Where the focus was initially on international roads, this was subsequently expanded to include secondary roads and even local roads, with a detailed road inventory carried out in support of the RAMS. The functions of the RAMS are also continuously being improved and expanded in each subsequent project, with improvements in data collection equipment, updates to database and RAMS software, and additions of new functions such as a bridge management system and a road safety management system. This stepwise approach appears to be leading to the successful adoption of the RAMS by government.*

10. Develop the works implementation capacity

The use of a RAMS tends to result in a shift in the types of maintenance and repair being carried out, with greater attention being given to preventive periodic maintenance of roads in good or fair condition. This requires the development of suitable technologies and capacities in the contracting industry, including the availability of suitable equipment to ensure quality and efficiency.

58. Many of the CAREC countries are currently focusing on routine maintenance complemented by rehabilitation of roads in very poor condition. A lack of funding for rehabilitation means that routine maintenance is carried out even on roads that are in poor condition. This is resulting in excessive expenditure on patching, where application of periodic maintenance is likely to be more efficient. Periodic maintenance is also likely to be more effective in such roads, improving the overall state of the pavement and reducing roughness. A RAMS analysis can clearly show the impact, both in terms of medium- to long-term maintenance costs, but especially in terms of road conditions and road user costs.

59. A RAMS analysis generally recommends a greater application of periodic maintenance, especially for roads in fair condition. This goes at the cost of roads in poor and very poor condition, especially where these carry little traffic. The idea is that timely periodic maintenance of roads in fair condition will reduce the need for investment in routine patching, and will avoid the need for costly rehabilitation in the future.

*In **Mongolia**, a recent RAMS analysis identified the urgent need for periodic maintenance of main national roads linking to PRC and the Russian Federation, as well as a large portion of the rest of the national road network, in order to avoid the need for costly rehabilitation in the near future. However, in the past the focus has been on carrying out routine maintenance and rehabilitation, and little experience exists with implementing periodic maintenance. Further support is therefore needed to develop adequate skills and*

capacities for implementing this ambitious periodic maintenance program.

60. The application of high quality surface treatments, chip seals, overlays, etc., can greatly extend the life of a road. However, to achieve the desired quality and benefits of periodic maintenance, this requires suitable equipment and contractors that are experienced in applying the periodic maintenance treatments. Existing equipment and skills in many CAREC countries are focused on routine patching and larger rehabilitation works, and little experience exists with periodic maintenance.

*In **Pakistan**, the National Highway Authority is responsible for the management of the trunk road network. It has a Road Asset Management Directorate for planning and budgeting maintenance works and monitoring performance. Implementation of maintenance works is contracted out to private sector contractors on a competitive basis. In 2014-2015, periodic maintenance made up 59% of total maintenance expenditure for roads managed by NHA. Several years of carrying out periodic maintenance has resulted in a large number of contractors who have suitable experience and appropriate equipment.*

61. Where suitable implementation capacity does not yet exist, this can be developed through training and support to contractors. Especially in a context based on competition, contractors are generally quick to develop the desired capacities in order to have an advantage over their competitors. In the case of in-house units, it generally takes more time to introduce such changes as there is no commercial incentive for change and improvement.

62. Traditional contracting arrangements based on volume-based payments do not provide proper incentives for implementing maintenance in a timely manner (when volumes are still small). The introduction of alternative arrangements such as performance-based contracting, often on a multiannual basis, can lead to better results at a lower cost. Such contracts also link up well with a RAMS, with both focusing on performance. The RAMS data can also be used to monitor contractor performance.

Country Status Reports

Six of the eleven CAREC countries are currently piloting aspects of a RAMS, four CAREC countries have a strengthened RAMS in place, and one CAREC country has successfully mainstreamed and integrated the RAMS.

63. The following pages provide an overview of the status of the different CAREC countries regarding road asset management. The countries can be roughly divided into three groups.

64. The first group includes countries where the RAMS has been introduced and is being piloted with support from development partners. This can be seen as the first stage of RAMS development. Some road data collection has been carried out, a database has been developed, and some data analysis has been done, although this is in some cases only for project purposes. However, the systems are only pilot versions, often implemented by project consultants, and are not yet sustainable. Six CAREC countries can be considered to be in this group.

65. The second group of countries has managed to strengthen the existing RAMS, and can be considered to be in the second stage of RAMS development. Data collection takes place for most of the trunk road network and is repeated in consecutive years, the database has been further developed, and data analysis takes place for the entire trunk road network, going beyond the project scope. Generally, the responsibility for the RAMS has been institutionalized to a certain degree, with a RAMS unit in place. However, the results of the RAMS are not yet influencing annual maintenance planning and budgeting. Four CAREC countries can be considered to be in this group.

66. The last group includes countries where road asset management has been mainstreamed, and can be considered to be the final stage of RAMS development. Road data collection, management and analysis are carried out on a regular basis, and have been institutionalized. The RAMS results are used in the preparation of annual and multiannual maintenance plans, and in the preparation and negotiation of budget requests. A strong and competitive implementation capacity has developed to carry out the different maintenance types in line with the plans. Currently only one CAREC

country can be considered to be in this group, although other countries are likely to join in the near future.

Afghanistan

Country size:	652,230 km ²	Trunk road network:	17,900 km
Road network:	38,700 km	Road density:	5.9 km/100km ²

67. Afghanistan has a low road density. The Ministry of Public Works (MPW) is responsible for regional and national highways as well as provincial roads. It has provincial offices and carries out most work through in-house units.

68. Data collection has been carried out in the past with support from USAID and JICA, although this was focused on project investments rather than full network surveys. The ADB has been supporting the update of the Transport Sector Master Plan, including a nationwide road inventory.

69. A Road Maintenance Unit (RMU) was created under MPW with project funding, and HDM4 was used for data analysis. However, this was very much oriented at project investments, and the RAMS was not institutionalized, with the RMU being dissolved at the end of the project. More recently, with support from USAID and ADB, a Road Authority was created, which is now responsible for the management of the trunk road network. This would be a suitable candidate to house a RAMS unit.

70. Road sector financing is very dependent on donor funds, with government only providing a small portion of the estimated maintenance funding needs. USAID and ADB are supporting the creation of a Road Fund with sustainable financing based on user charges.

71. Although most works are being carried out through force account by MPW in-house units, several projects have involved contractors in maintenance, especially through performance-based contracts. Security issues are a concern, hampering data collection, implementation and supervision.

Azerbaijan

Country size:	86,100 km ²	Trunk road network:	19,002 km
Road network:	59,002 km	Road density:	68.5 km/100km ²

72. Azerbaijan has the highest road density of the CAREC countries. The trunk road network is managed by Azeryolservis, a semi-autonomous state-owned company responsible for construction, rehabilitation and maintenance. Almost all maintenance works are carried out by in-house district maintenance units under Azeryolservis. Some performance-based contracts have been piloted with private contractors.

73. With support from the World Bank, a full inventory of the state roads was carried out in 2012. Identification of the roads belonging to Azeryolservis was a challenge. Data collection included GPS, geometric and roughness data as well as video logging. Specific survey equipment was procured for this purpose. Azeryolservis continued data collection in subsequent years.

74. A Road Network Databank was developed in 2012, after a previous version never became fully operational. Standards for quality control and data processing, including external auditing, were developed to improve reliability of the data. The database allows for direct transfer of data to HDM4.

75. A Road Data Management Unit (RDMU) was created in Azeryolservis that is responsible for data collection, management and analysis. Staff were trained and involved in the data collection under the World Bank projects. Use is made of HDM4 for analysis, and the RDMU staff prepare annual reports on HDM4 results and network status.

76. Maintenance is funded from the Road Fund that was restored in 2007 and is funded from several earmarked road user charges. Maintenance planning is still done based on needs identified by the district maintenance units under Azeryolservis. The HDM4 analysis has shown that the amount of maintenance funding is in line with needs, but that the allocation needs to be improved, giving higher priority to periodic maintenance and to roads in good-fair condition.

Georgia

Country size:	69,700 km ²	Trunk road network:	6,824 km
Road network:	21,800 km	Road density:	31.3 km/100km ²

77. International roads and secondary interstate roads are managed by the Roads Department (RD) under the Ministry of Regional Development and Infrastructure (MRDI), while local roads are managed by municipal authorities. International roads tend to be in good condition, but 40% of secondary roads and 70% of local roads are in poor condition. All works are contracted out to the private sector that mainly consists of former force account units that were privatized in 1999. Design-build and performance-based contracts have been successfully piloted and are currently being replicated in other parts of the network.

78. The World Bank has been supporting the development of a RAMS through various successive projects since 2004. This initially focused on the international roads and was subsequently expanded to also include secondary roads and even local roads. A full inventory of the entire road network was carried out as a basis for the database. Road condition data is currently collected annually for most of the trunk road network, including traffic and roughness data. The data is entered into a road database that is linked to a GIS mapping system. The database is managed by the Road Data Management Unit (RDMU) under RD, which was created in 2007. The data collection and database are continuously being improved and expanded.

79. RDMU uses the database to prepare RD's annual report. More recently, RDMU is using HDM4 to prepare and annually update 5-year rolling programs for the trunk road sector. The latest World Bank project includes financial disbursements linked to the annual analysis of the road data and the preparation of these rolling programs.

80. A Road Fund existed previously, but was abolished in 2004. Road sector funding currently comes from the general government budget, with a significant portion coming from development partners. Funding continues to be aimed mainly at construction. Although the allocations for rehabilitation and periodic maintenance have increased significantly over the past 10 years (mainly development partner funding), routine maintenance continues to be severely underfunded.

Kazakhstan

Country size:	2,699,700 km ²	Trunk road network:	23,485 km
Road network:	96,718 km	Road density:	3.6 km/100km ²

81. Owing to its large geographical size, Kazakhstan has a very low road density. The trunk road network falls under the responsibility of the Committee of Roads (COR) under the Ministry of Investment and Development (MID). There is also a road manager, Kazavtozhol, which is responsible for day-to-day management of the trunk road network. Routine summer and winter maintenance is carried out by the state enterprise Kazakhavtodor, while routine, mid-term and capital repairs are contracted out. Performance-based maintenance contracts will likely be piloted in 2017.

82. Data collection is currently carried out by Kazakhavtodor, which carries out spring and autumn surveys. This is based on visual surveys and is focused on surface defects. The format and reliability of the data are not yet compatible for use in a RAMS. The World Bank is currently supporting the development of a RAMS, including the procurement and retrofitting of survey equipment. A network inventory is currently ongoing. It is likely that the oblast level road laboratories under COR will become responsible for data collection, since many of these laboratories already have survey vehicles. A limited amount of road condition data is planned to be collected in 2016. A road database is being developed that will be remotely accessible.

83. Discussions are ongoing with regards to responsibilities for data management and data analysis. Possible candidates include COR, Kazavtozhol and the research institute KazdorNII. A National Road Asset Management Centre was established, with participation of these stakeholders.

84. Road maintenance funding comes from the Republican Budget, but is insufficient and has decreased in recent years. The Government aims to introduce more tolls to fund maintenance of its main road network. The Ministry of Finance recently introduced results-based planning and budgeting, where budget allocations are linked to clearly defined targets to be achieved. The ADB supported the COR to identify suitable indicators and targets for the road sector, some of which will use the analyzed data from the RAMS.

Kyrgyz Republic

Country size:	191,801 km ²	Trunk road network:	18,810 km
Road network:	34,810 km	Road density:	18.1 km/100km ²

85. The trunk road network in the Kyrgyz Republic is managed by the Road Management Department (RMD) under the Ministry of Transport and Communications (MOTC). There are 5 regional road units (PLUADs), 3 corridor-based road units (UADs) and a State Directorate that are responsible for most of the maintenance implementation through a total of 57 depots (DEPs) and two state-owned contractors. Performance-based maintenance contracts are currently being piloted by ADB.

86. Although road condition data has been collected in the past, this is not yet done regularly. With recent support from the World Bank, data was collected in a portion of the international road network.

87. An inexpensive Excel database was developed with the full inventory data of the trunk road network. The database also contains all the collected road condition data and can produce standard reports (tables and graphs) for RMD. It has a Russian language interface to facilitate its use by RMD staff. The World Bank's Road Network Evaluation Tool (RONET) was introduced for analysis of the collected condition data. The ADB and the World Bank are currently supporting the further development of the RAMS.

88. Maintenance funding comes mainly from the Republican Budget. A Road Fund was enacted in 1998, but revenues go directly to the Republican Budget, from which annual allocations are made to MOTC. Maintenance allocations are very low, forming only one-third of estimated minimum allocations needed to avoid deterioration of the network. The government aims to increase allocations to at least 80% of minimum needs by 2017.

89. Budget allocations are based on needs identified by the road units, and are mainly used for capital repair and routine repair and maintenance, with little attention given to periodic repair.

Mongolia

Country size:	1,553,556 km ²	Trunk road network:	11,200 km
Road network:	49,200 km	Road density:	3.2 km/100km ²

90. Mongolia has the lowest road density of all the CAREC countries. The trunk road network is managed by the Roads and Transport Department (RTD) under the Ministry of Roads, Transportation Construction and Urban Development responsible for policy setting and procurement, and the Department of Roads (DOR), a road agency responsible for maintenance implementation. Maintenance works are allocated to the 19 state-owned companies (AZZAs) under DOR and 4 private companies.

91. ADB has been supporting DOR in the collection of data, providing survey equipment that was mounted on DOR vehicles. Survey equipment procured under previous projects had fallen into disrepair. The project helped reduce the amount of data being collected, focusing on data required for planning rather than for design purposes, reducing data needs from 18 to 2 items (roughness and surface condition).

92. Responsibility for data collection was allocated to the Road Research Institute created under DOR in 2012. For data analysis, use was made of both HDM4 and dTIMS in the past, although neither had complete data or was being used for maintenance planning. To avoid confusion, a decision was recently made to continue only with the easier-to-use dTIMS. A front-end management module in the Mongolian language was added to facilitate use by DOR. Periodic maintenance plans were prepared using dTIMS. The implementation of the periodic maintenance plans is still awaited.

93. Road maintenance is primarily financed by the Road Fund that is operated by DOR. Road Fund revenue is very limited, covering 20% of estimated needs. The lack of additional State Budget allocations means that maintenance investments are being capped rather than being supported by the existence of the Road Fund. Maintenance planning is based on the needs identified by the AZZAs.

Pakistan

Country size:	881,912 km ²	Trunk road network:	12,131 km
Road network:	260,131 km	Road density:	29.5 km/100km ²

94. The trunk road network in Pakistan is managed by the National Highway Authority (NHA). All maintenance works are contracted out to private contractors through competitive tendering.

95. NHA annually collects road network data through a combination of instrumental surveys and visual inspections. NHA has developed a remotely accessible road database that is linked to a pavement management system, a bridge management system, a GIS system and a contract management system.

96. In the early 1990s a maintenance management system was introduced, which has over time evolved into a RAMS. A Road Asset Management Directorate (RAMD) was created under NHA in the year 2000. RAMD makes use of HDM4 software to carry out strategy analyses and network programming. The strategy analyses are used in negotiations regarding the budget levels for the trunk road network, while the network programming forms the basis for annual maintenance plans.

97. Maintenance is funded from a Road Maintenance Account (RMA) that was created by ministerial notification. Despite having a more fragile status than a Road Fund, it has been very successful in fulfilling its objectives. The RMA is financed from road user charges, national budget allocations and loans. The RMA is managed by RAMD, and its use is limited to maintenance and rehabilitation. RMA budgets largely meet estimated needs, although recently provinces have been requesting roads to be reclassified as national roads, increasing the size and funding needs of the network being managed by NHA. Most of the RMA budget is allocated to periodic maintenance.

98. Certain provincial governments are initiating the use of RAMS for use on the provincial road network. Such efforts are being supported by different development partners. NHA's strong expertise will play an important role in building the capacity of provincial road authorities in this regard.

People's Republic of China

Country size:	9,326,410 km ²	Trunk road network:	494,700 km
Road network:	4,356,218 km	Road density:	46.7 km/100km ²

99. The PRC is the largest of the CAREC countries and has by far the largest road network, and the second highest road density. The Ministry of Transport (MOT) has decentralized responsibility for the trunk road network to the 27 provincial departments of transport and the transport bureaus in the 4 major cities. In some provinces, responsibility has been further decentralized to prefecture (city) level. Expressways are often managed by public or private companies. Almost all maintenance is carried out by in-house units. Performance-based contracts with contractors have been piloted in several provinces.

100. In 2007, the Highway Performance Assessment Standards introduced a set of road condition indicators, against which local authorities are required to report on an annual basis. These standards have introduced the need to regularly collect data on the road network, especially regarding pavement defects and roughness. Most provinces have purchased automatic survey vehicles, reducing costs and increasing reliability of data collection. Performance data is published in statistical yearbooks for each province and at national level.

101. Many provinces have created specialized units responsible for data collection and management, often as subsidiaries under the highway bureaus. PRC has developed its own RAMS software, the China Pavement Management System (CPMS). Despite the Ministry of Transport promoting the use of CPMS and support provided by donors, the large number of entities involved in the road sector has limited its uptake. In most of the provinces, CPMS is only used for road monitoring and for preparing annual reports, and has yet to be incorporated into budget allocation procedures.

102. Maintenance is mainly funded from a national fuel tax that was introduced in 2009. Fuel tax allocations to road maintenance fall short of estimated needs, especially since a large portion of the fuel tax revenue is used for network development.

Tajikistan

Country size:	141,510 km ²	Trunk road network:	14,067 km
Road network:	26,767 km	Road density:	18.9 km/100km ²

103. The Ministry of Transport (MOT) is responsible for the trunk road network in Tajikistan. Road maintenance is mainly carried out by the 62 maintenance units (GUSADs) under MOT. However, MOT is developing a strategy for outsourcing maintenance works, including the piloting of performance-based contracts.

104. The GUSADs collect yearly inventory, traffic and visual condition data, although this data is not assembled in a central database, and is not used for monitoring or planning purposes. The World Bank is currently providing support for the procurement of survey equipment.

105. A Highway Information System database was developed in the past and is currently being upgraded with support from ADB. The World Bank is providing further support to allow the database to be used by the GUSADs. ADB and World Bank are supporting the development of a complete RAMS system, which will likely be housed in the Economic Analysis and Forecasting Department of MOT.

106. Maintenance funding comes from the State Budget and to a limited degree from public-private partnerships. A Road Fund existed, but was abolished in 2000. Although road maintenance funding has been increasing in recent years, it only covers half the estimated maintenance needs. The allocation of existing road user charges to road maintenance could cover most of the needs.

107. Planning is carried out by the Economic Analysis and Forecasting Department, although this focuses on capital works. The State Program on Transport and Development 2010-2025 includes specific budget targets for rehabilitation and maintenance of the international and national road networks. Annual maintenance plans are prepared by the GUSADs based on perceived needs.

Turkmenistan

Country size:	469,930 km ²	Trunk road network:	13,644 km
Road network:	58,592 km	Road density:	12.5 km/100km ²

108. The trunk road network in Turkmenistan is managed by the Turkmenavtoyollary State Concern under the Ministry of Construction (MOC). Maintenance works are carried out by in-house road units under Turkmenavtoyollary.

109. Turkmenistan does not currently receive road sector support from development partners. It is understood that RAMS development has not yet commenced, either for data collection or for data management and analysis.

110. In this light, it is recommended to start with a simple road data collection exercise and database, using this for a one-time data analysis exercise to develop a maintenance strategy. This may then form the basis for future project support from development partners. Where sufficient interest from government exists, such a project may also include continued support to RAMS development.

Uzbekistan

Country size:	425,400 km ²	Trunk road network:	42,530 km
Road network:	183,724 km	Road density:	43.2 km/100km ²

111. Until recently, the management of the trunk road network was shared by the Republican Road Fund (RRF) and the joint stock company Uzavtoyul. In February 2017, Uzavtoyul was transformed into the State Committee for Roads (SCR) and given responsibility for strategic planning and for the development of policies and programs. Uzavtoyul's implementation units were transformed into unitary enterprises under SCR, which will be contracted through SCR's Directorate for Construction and Reconstruction of Public Roads.

112. ADB has been supporting RRF and the Uzavtoyul in data collection in international and national roads, developing a program for annual surveys and training staff. Bridge condition surveys were simplified, and an attempt was made to also simplify the spring and autumn surveys. The provision of road survey equipment was hindered by lengthy government procurement approval procedures. The World Bank is currently expanding the data collection to the regional roads that make up the rest of the trunk road network.

113. The existing road database was recently upgraded to link up with HDM4 for data analysis. The new database also corresponds better to the outputs of the spring and autumn surveys, and allows export to an Excel spreadsheet for easy use. RRF and Uzavtoyul staff were initially trained in the use of HDM4, but the lack of a Russian language interface made it difficult to use. The Russian language database was therefore expanded to include simple works programming tools, while still allowing exporting to HDM4 for strategy analyses. Although SCR is now responsible for preparing investment plans, these have to be approved by RRF. As such, both SCR and RRF will benefit from the use of a RAMS. A RAMS unit was created under RRF in the past, but it is unclear what will happen to this in the new structure.

114. RRF funding is estimated to be sufficient to cover maintenance and rehabilitation of the trunk roads, but part of this funding is currently used for development. The percentage allocated to maintenance has

actually been decreasing, with especially periodic maintenance receiving limited attention.

Compendium of Best Practices in Road Asset Management

This document presents the 10 best practices for the introduction and development of road asset management. This is based on a desktop review of the experiences in the 11 member countries of the Central Asia Regional Economic Cooperation (CAREC), which are in different stages of development of road asset management. The best practices presented in this document have been identified based on the common problems faced by the different CAREC member countries, and the solutions applied by CAREC and non-CAREC countries that have been most successful in the development of road asset management.

Apart from the best practices in the introduction and development of road asset management, this document provides an introduction of the general concept of road asset management, and presents an overview of the status of road asset management in each of the CAREC countries.