ISSUES IN ROAD MAINTENANCE

1. INTRODUCTION AND CONTEXT

   A. Introduction

1. **Almost everybody uses or is affected by the use of roads.** Road networks facilitate transport services and reduce the costs of travel and trade; individual roads enhance accessibility to markets and services. In most countries, roads are the major transport mode for both freight and passengers. Road networks have expanded in the Asia Pacific region, and freight and passenger transport will continue to grow, along with motorization.

2. **To achieve continuity of road transport benefits, road assets need to be maintained in good condition.** Virtually all Asian Development Bank (ADB) transport sector operations have used the project modality; hardly any have been dedicated to policy support. For road projects, sustainability refers to the continuation of transport services, and corresponding benefits, from the road facilities. The condition of a road will deteriorate over time through use—the wear and tear of expected and unanticipated traffic—or through neglect. Roads, including the bridges that complete them, are built in all types of topography and environments; their condition can also be affected by natural occurrences such as flooding and landslides. Road maintenance refers to the processes and resources that are combined to manage road conditions and the longevity of the road assets. It is part of the activities required to ensure an affordable and efficient road system. Road maintenance for the sustainability of road transport services is a generic activity common to all countries.

3. **This background paper provides an overview of road maintenance issues and activities,** based on a desk review of ADB materials mainly, This has been pursued through asking three questions for countries in which the ADB has road sector operations: First, what are the issues that arise, or keep arising, around road maintenance activities? Second, what actions are governments taking to enhance road maintenance? Third, what forms of support is ADB providing? The primary information source comprised readily available documentation relating to country, sector, and project-level operations and evaluations, for a selection of ADB developing member countries (DMCs); existing special studies and publications; web searches and documentation of other agencies; and discussions with staff of regional and other departments. A limitation of the approach is that maintenance operations and their improvement are not always separated from the broader capacity issues of the road sector as a whole, and each country has differing practices for road maintenance.

4. **The overview focuses on those road facilities that rely on government funding sources.** Road networks comprise different types of road—national, provincial, rural, and urban—according to their function and the agency responsible for them. For roads with restricted access, where tolls are levied and the funds are retained by the road operator, for the benefits of restricted access, or debt payments, or returns on investment, generally sufficient maintenance takes place to sustain the road investment. Roads with unrestricted access are public goods where one user’s use of the road does not deny its use to others; a network of such roads is necessary for inclusive growth. General access to road users and lack of a direct funding mechanism means that there are risks relating to sustainability inherent in the nature of such roads as public goods.

5. **By amount, 18.8% of ADB loan and grant-funded operations has been in the road transport sector,** ADB has long supported road network developments and related operations and capacities. However, concerns have been expressed about the sustainability of roads and road transport services. In one of its discussions in 2012, ADB’s Development Effectiveness Committee (DEC) expressed concern about the effectiveness, sustainability, and maintenance of road sector interventions, with some members suggesting that ADB should consider shifting financing from building new roads to
maintenance work in order to improve project sustainability.¹ In a separate discussion, where the sustainability of outputs and outcomes, especially in the road sector, was deemed less than likely, DEC members were of the view that, given the volume of ADB resources going into the road sector, ADB should strive to become the knowledge leader in the sector.²

6. **ADB’s sustainable transport initiative (STI) operational plan recognizes the continued importance of road maintenance as part of developing a transport system that is more sustainable—economically, socially, and environmentally.** “Asset Condition” is associated with all four dimensions of a sustainable transport system—accessible, safe, environment-friendly, and affordable—under the STI. ADB’s existing areas of transport operations—focusing mainly on roads—will remain relevant in most DMCs during the next decade, especially in areas relating to asset management and maintenance. ADB should continue to include road asset management in its road subsector policy dialogue and operational support, and assist DMCs to address accumulated road maintenance backlogs.³

B. **Context**

7. **Road networks in the DMCs vary considerably in length and standard.** Total road length ranges from more than 4,000,000 kilometers (km) for both the People’s Republic of China (PRC) and India to below 1,000 km for some small island countries where it is recorded.⁴ Indonesia, Pakistan, Philippines, Thailand, and Viet Nam all have road networks of greater than 150,000 km. Road density (length per square km) is highest in Sri Lanka (1.74) and India (1.25); however, for 15 countries, road density is less than 0.2 km per square km. In larger countries, low road densities imply higher transport costs and higher costs of arranging maintenance work. For 26 DMCs where consistent data are available, paved roads are 49.8% of the total road length. The proportion is more than 80% for some countries in Central Asia, where the legacy roads were built mostly to a common standard; it is high also in Malaysia and Pakistan. Motorways⁵ are a small proportion of total road length, where data are provided; in the PRC, where there has been a very large investment in expressways, motorways are just 1.85% of total road length. Motorways are commonly tolled; other classes of road are sometimes tolled to generate public revenues for the government or road sector agencies.

8. **There is variation in vehicle fleets also.** Of the countries with comparable data, the PRC accounts for around half of the 152,000,000 motor vehicles. India, Indonesia, Malaysia, and Thailand all have over 10,000,000 vehicles in use. The majority of motor vehicles, 107,000,000, are passenger cars; a quarter are vans and lorries. However, there is no convenient summary of the type or size of lorry by number of axles and wheels. There are a total of 304,000,000 motorcycles, over 100,000,000 in the PRC, 82,000,000 in India, and 61,000,000 in Indonesia; in several countries, the number of motorcycles exceeds that of motor vehicles, but where two-wheeled transport is not favored or practical, the opposite is the case.

9. **Road maintenance keeps a road network and transport services operating.** Increasing demand from road traffic will require continued construction and improvement of roads, in both urban and rural areas. Substantial economic benefits from road transport cannot be sustained without adequate maintenance, which helps keep a road network in good condition, operating indefinitely without major deterioration over time, and avoiding economic losses. Different road sections are at different stages in

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³ ADB. 2010. *Sustainable Transport Initiative: Operational Plan. Staff Working Paper.* Manila. “ADB will provide increased support for asset management and road maintenance. This will include financing programs to establish and implement improved systems for selecting, implementing, and financing road maintenance works, as well as financing investments in road rehabilitation and programs to reduce maintenance backlogs.” Pp.17/8.
⁴ International Road Federation. 2012. *World Road Statistics 2012: Data 2005 to 2010.* International Road Federation statistics are incomplete, and the latest years for different data and countries vary.
⁵ Motorways are defined, shortly, as roads that have no bordering properties, with separate carriageways for the two directions of traffic, which does not cross at the level with any road, railway, or footpath, and is reserved for specific categories of vehicles.
“a cycle of accumulating roughness, despite routine and periodic maintenance, until they are restored to their original smoothness by rehabilitation.” Proper maintenance needs tools to identify and plan maintenance tasks, a trained workforce with equipment to carry out the work, and the money to pay for it. Maintenance should be timely, preventing rather than curing significant road deterioration.

10. **The requirements for road maintenance differ from country to country and from place to place.** Decisions are needed on the level and form of maintenance activity. While for paved and unpaved trunk roads maintenance and its effectiveness may be oriented to the road pavement, for rural roads greater attention is required to off-carriageway works mostly related to the drainage system, halting damage to the road components outside the road surface. In addition, emergency maintenance may be required in response to damage from natural events, especially for bridges, river crossings, and other key road components in vulnerable or remote areas, where failure would sever transport services altogether for a time. As a result of inadequate maintenance, in most countries there is a large backlog of maintenance works still to be implemented.

11. **Improving road maintenance involves overcoming a reluctance to change the way things are carried out and financed at a systemic level, and therefore can be a slow process.** Different stakeholders must be able to realize both short- and long-term benefits from road maintenance activities. The main stakeholder groups in road maintenance include government agencies responsible for planning, executing, and financing these activities; contractors and others involved in carrying out the works; direct users of the roads; and beneficiaries affected by the supply of transport services. In addition, the finance ministry will play a significant role in sources of funding and their allocation. Some time ago it was concluded that “The overall picture in the study countries ... is changing with the increasing emphasis being given to traffic management, road safety, and road-user involvement.” Stakeholder groups can monitor capacity development programs and communicate with political actors and the general public, be involved in sector education programs, help mitigate negative effects and potential mismanagement, and help define needs and bring complaints.

12. **Lending for maintenance activities can yield high economic returns on expenditures with limited safeguard issues.** Reference to maintenance in ADB loan or grant project titles has been rare, and usually associated with rehabilitation, upgrading, or improvement also. Only nine projects, in six countries, approved between 1987 and 2008 referred explicitly to maintenance, or equivalent, in the title. For grants, five projects across six countries included reference to road maintenance in the title; four, from 2004–2009, were for labor or community-based maintenance activities. The nine loan-funded projects generally funded periodic, but also some routine, maintenance, including purchase of equipment and spare parts in one case. The expected economic internal rates of return (EIRRs) varied from 14% to well over 100%. In the three cases where project completion or post-evaluation reports were available, the minimum EIRR was 39%. It has been argued that, given the high returns available from maintenance expenditures, and to make best use of the resources available for maintenance, “more reasonable is a discount rate of 20%–30% per year.” This also argues for a separate budgetary item for maintenance that would be treated in a differential manner. Although referring to mitigation measures for environmental effects where necessary, only one of the nine loan projects was in Category A for safeguards at approval.

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7 Routine annual is generally distinguished from periodic maintenance every 5 or 7 years. However, there is no consistency in what maintenance includes. An alternative characterization of maintenance works is used in the PRC: routine maintenance, especially for lower class roads; medium maintenance (overlays and replacement of pavements); and major maintenance (work on sub-base and base also).
10 A specific case gave EIRRs of 46% for overlays, 42% for sealcoats, and 22% for rehabilitation subprojects.
11 ADB. 2003. *Footnote 6. P.5*. The discount rate relates to the allocation of government funds. The same source, p.4, also quotes a common figure that “Road maintenance is very good business for road users. ... for every additional $1 a developing country spends on road maintenance, road users save $3.”
II. ROAD SECTOR MAINTENANCE ISSUES AND STRUCTURES

A. Road Maintenance Issues

13. Operation and maintenance (O&M) policies and financing were found to be a significant factor in the likely sustainability of projects, including those in the transport sector. For ADB sovereign projects and programs with completion reports in 2001–2009, 35% were rated less likely or unlikely to be sustainable, even some rated effective or efficient.\(^{12}\) The main factors supporting a most likely rating were a positive assessment of pricing and financial viability, followed by O&M policies and financing. The main factors for an unsustainable rating were a negative assessment of the policy and regulatory environment, and O&M policies and financing. For the Transport and Information and Communications Technology (transport) sector also, insufficient funding for O&M was a main factor in a low sustainability rating, while good institutional capacity including technical expertise was associated with a high sustainability rating. Investment projects rated unlikely had a higher proportion of nonrevenue-generating activities. Further key issues related to an appropriate balance between investment for network expansion and the growing maintenance requirements for existing roads; high axle loads; and inadequate funding, particularly at subnational levels that had neither the human nor financial resources to cope. It was concluded that it was important to increase public awareness of the concept of maintenance and its benefits through user and community participation; financing of maintenance required a fiscal assessment at the sector and country level, including borrowing capacity; and sustainability involved attention to traffic management, especially truck design, and axle-load regulations and their enforcement.

14. A document analysis has been undertaken for 22 DMCs with road sector operations, to explore in more detail the main issues around maintenance in the road transport sector. The programming, approval, and evaluation documents relate to the period 2009–2012 (or the most recent relevant document). Additional documentation from other agencies and sources was also used in some cases. There are 174 observations relating to the 16 maintenance factors/issues identified (Table E.1).\(^{13}\) Eight of these issues each occurred in at least 11 countries, and comprise the top half of the issues raised. Four of the higher ranking issues related to the system for planning, identifying, and prioritizing maintenance activities, including inadequate maintenance, truck overloading, poor road design, and standards, and limitations of the road asset management system. Three issues ranked in the top half with respect to capacities within the road maintenance process; a lack of qualified staff by number or capacity; insufficient involvement of the private sector in road maintenance; and a lack of institutional capacity more generally, around the planning, execution, and financing of road maintenance. The lack of sufficient financing for road maintenance was the only issue common to all 22 countries. These eight higher ranking issues are elaborated on below.

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\(^{13}\) The documentation is repetitive. An issue has been recorded if it appeared once or more in the documentation. In most cases, the wording in the documents had a negative connotation, implying a factor of weakness in road maintenance arrangements.
### Table E.1, Summary Data Table on Maintenance Issues Identified in Selected DMCs

<table>
<thead>
<tr>
<th>Variables</th>
<th>N</th>
<th>%</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A. Maintenance Planning</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Inadequate maintenance</td>
<td>18</td>
<td>10</td>
<td>2</td>
</tr>
<tr>
<td>• Overloading</td>
<td>17</td>
<td>10</td>
<td>3</td>
</tr>
<tr>
<td>• Poor road design</td>
<td>12</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>• Road asset management system</td>
<td>11</td>
<td>6</td>
<td>8</td>
</tr>
<tr>
<td>• Untimely maintenance</td>
<td>7</td>
<td>4</td>
<td>10</td>
</tr>
<tr>
<td>• Limited construction materials</td>
<td>4</td>
<td>2</td>
<td>15</td>
</tr>
<tr>
<td><strong>B. Maintenance Capacities</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Limited capacity and number of qualified staff</td>
<td>17</td>
<td>10</td>
<td>3</td>
</tr>
<tr>
<td>• Lack of Institutional Capacity</td>
<td>15</td>
<td>9</td>
<td>5</td>
</tr>
<tr>
<td>• Need for strong private sector participation</td>
<td>15</td>
<td>9</td>
<td>5</td>
</tr>
<tr>
<td><strong>C. Financing</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Weak governance</td>
<td>8</td>
<td>5</td>
<td>9</td>
</tr>
<tr>
<td>• Transparency/risk of corruption</td>
<td>7</td>
<td>4</td>
<td>10</td>
</tr>
<tr>
<td>• Lack of quality contractor</td>
<td>6</td>
<td>3</td>
<td>12</td>
</tr>
<tr>
<td>• Lack of advanced technology</td>
<td>6</td>
<td>3</td>
<td>12</td>
</tr>
<tr>
<td><strong>D. Other Issues</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Natural disaster</td>
<td>5</td>
<td>3</td>
<td>14</td>
</tr>
<tr>
<td>• War/conflict</td>
<td>4</td>
<td>2</td>
<td>15</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>174</td>
<td>100</td>
<td></td>
</tr>
</tbody>
</table>

Total number of DMCs included in the study: 22

Sources: Review of ADB documents 2009–2012 (SAPE, CAPE, RRP reports, TA reports, and PCR) and documents from DMCs and other multilateral organizations.

15. **Inadequate road maintenance shortens the life of the roads and leads to high operating costs and a high incidence of accidents.** Maintenance resources in nearly all cases are less than the estimated requirements, both physical and financial; in one case only one-third of the requirements were being met. In another case, inadequate maintenance was associated with rapidly growing traffic, poor road maintenance standards, and design and construction deficiencies. In another case, inefficient implementation of road maintenance increased both the number of roads beyond maintainable condition and the backlog of deferred maintenance. The effects can be exacerbated by natural disasters; in one case, less than 5% was spent on routine maintenance, with most maintenance funds used to respond to emergency needs. Where road condition surveys took place, many roads were found to be in poor condition; in one case, only 40% of national roads were in good condition; in another, 60%; in a further case, 48% in poor condition and 32% in very poor condition. Some countries have been reducing the maintenance backlog as a priority, or focusing on rehabilitation. However, in general, because road construction is larger and more visible, and promotes economic and social development, it often takes precedence. This capital bias can be reinforced by other stakeholders also: “Politicians want to build new roads ... to engineers maintenance is not glamorous ... ‘rent seeking’ favors capital bias ... spending money to maintain ... an access road to a village seems unfair, when another village still has no all-weather access at all.”

14 Actual decision-making processes in some cases may be based on consensus or simple rules of thumb, with little incentive to update road databases and selection procedures. It is necessary to build a broader understanding of road maintenance objectives and benefits, and an ability to explain these issues when necessary.

16. **Overloading is a near universal problem in road operations in DMCs and a difficult one to address.** It stems in part from a mismatch between historic road designs and current traffic and vehicles, including the design and use of heavy vehicles. Those who contribute to overloading include truck owners and trucking companies, drivers, road users, and road beneficiaries, who all have a short-term interest in receiving and distributing goods at the lowest cost for current road and vehicle conditions. More specifically, roads can be undermined through heavy vehicles involved in haulage,
mining, or logging, for which the roads were not designed, or in road construction activities themselves. The weight of containers from ports varies with the regulation of origin countries, and may be problematic for local trucks and roads. Overloading is a function of the loads carried in relation to the number of axles, the number of wheels, and their placement on vehicles. The main problem is trucks with fewer axles, which also may be modified to carry more than the design weight. Several measures are being undertaken in various countries to address overloading and the consequences for road conditions. However, in practice no public institution may have the equipment, incentives, or power necessary to prevent excessive axle loading. Where freight rates are highly competitive, axle load problems could not be resolved without self-regulation by the trucking industry. To develop strategies to prevent overloading on roads, it is necessary to assess the current axle loads of road users. In the context of traffic growth, and regional cooperation around strategic international corridors, more attention needs to be paid to the evolution of the vehicle fleet and truck design, and the structure of the trucking industry.

17. The design standards of many roads were not for current traffic loads. Outdated design and construction standards do not correspond to international best practice, and may involve structural and physical weaknesses, that can be augmented by inadequate maintenance. In one case, outdated design standards and excess vehicle weights increased pavement damage, with 30% of bridges not meeting load-bearing requirements. In another, roads could not handle the rapidly growing freight and passenger traffic effectively, the road network was deteriorating, and many roads were seriously congested. In a further case, it was found that short-life design standards, and inconsistent supervision for maintenance, reduced the life of road assets, which subsequently required higher maintenance expenditure. In another case of rural roads, the technical standards were found to be low, with 71% dirt roads with no drainage, and impassable during the rainy season. In general, the effects of climate change could damage implemented infrastructure if designs are inadequate. In a region of severe winter weather, finding an appropriate technology solution for constructing the road pavement surface has repercussions on both the economic viability and sustainability of road facilities.

18. Budget requests for road maintenance generally must be justified through a prioritization process and delivery of outputs. The basic building blocks of a prioritization system are a road inventory, road condition surveys, cost data, and assessment of future economic benefits. The construction and use of road databases itself need budgetary resources; in one case, the road asset management unit did not have a dedicated budget and was significantly understaffed. In some countries, road condition surveys have been introduced only recently, and their frequency and coverage vary. In another case, it is still a struggle to collect system-wide data on a timely and periodic basis, and the road asset management system and its database remain incomplete. Updating the databases also can be uncertain; uncertainties in data collection may be reduced by contracting out the process, where feasible, for a number of years, thereby creating a budget commitment. The sophistication of the techniques applied for road asset management should be appropriate to the level of roads, and of available skills. In general, there is an issue of when and how to introduce new technologies into the process. In one recent case, assistance was provided for incorporating a geographic information system into the road database. However, although judged effective in establishing the enhanced database and its use in formulating updated periodic maintenance schedules, the technical assistance (TA) completion report concluded that the results were “less likely” to be sustainable, and the chosen technology solution was probably premature. There was limited understanding within the government of how to use the database, it was difficult to retain staff proficient in operating the system, and more attention should have been paid to how it was institutionalized.

19. Limited staff capacity impedes effective road maintenance activities irrespective of the level of funding. In most cases, the number of qualified staff is not enough, and there also can be staff

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17 TA-7297-MON: Road Database Development Using Geographic Information System. TCR. Gradual institutionalization of the database is being assisted through parallel TA.
turnover and changes in institutional structure. In one case, the experienced staff were more familiar with the procedures of a planned economy, and the younger staff tended to move on to the private sector. In part, skill shortages stem from weak human resources organization and planning, and inadequate training provision; there is a need for a continuing human resources program to recruit and train staff and replace incumbents who are promoted or move to other jobs. As the organization of maintenance changes, new skills are required, in particular, for outsourcing works including to the private sector or small-scale contractors, raising supervision demands. Weaknesses can be linked to more general failures; lack of proper training; weak career incentives; low morale; and lax supervision of works. Limitations can be more acute in subnational units, for managing local roads and traffic, and integrating local and national road networks; one consequence can be that available budgets remain underspent.

20. **Enhancing capacities for road maintenance is connected to institutional development for the road sector as a whole.** In one case, the limited institutional capacity at national, regional, and local agency levels reflected a lack of a legal and regulatory framework for managing the road network, weak enforcement of existing regulations, and poor financial management. In another case, incomplete national and regional transport policy and regulatory frameworks were associated with inadequate institutional capacity in road maintenance and management also. In a further case, a reform effort experimenting with performance-based contracts was not successful owing to a need to change both legislative provisions and procurement methods. Coordination among different agencies also causes weak sector performance. In one case, lack of clarity over the relative roles, responsibilities, and accountabilities of different road agencies undermined an assessment of institutional sustainability. A further case concluded that, despite assistance for both institutional and sector reform, the sector continued to lack sufficient capacity, including among provincial road agencies. With a different focus, in one case, although capacity had been improving, the main gap was assessed to be in project management, evaluation, and reporting, where focused training was recommended. A further issue relates to financial management. In one case, it was concluded that fragmented transport institutional structure was associated with weak governance, poor financial management, and poor project implementation. In a further case, it was concluded that a weak institutional base and governance problems caused weak internal controls and financial management. Overall, institutional capacity could fall rather than rise; in a final case, it was concluded that stated policies and strategies often fail to influence decisions; planning and priority-setting are neither objective nor transparent; budget controls and systems of financial management and reporting have become weakened; and technical standards have fallen.

21. **A key issue for execution of maintenance works is the introduction of competitive processes.** This includes moving from force account to outsourcing, to multiplication of companies, and to private sector contracting companies. These changes can help fill the skills gap in road maintenance activities, increase the efficiency with which resources are used, and transfer appropriate risks to those undertaking the work. However, both public sector and private sector capabilities vary considerably across countries, and in at least one case it was concluded that attitudes of government officials towards the private sector need to change. In another case, the few existing local design and construction companies had weak technical and financial capacity; procuring services from the market proved difficult. In several other countries, there is a lack of quality contractors and consultants, and domestic construction companies remain small, face significant human resource constraints, and produce well below government targets. This can make subcontracting difficult and unreliable. In several other cases also, there was a lack of private sector participation in contracted maintenance, and a corresponding lack of private sector capacity. In one small-country case, a specific project provided only limited opportunities for domestic contractors in small-scale civil works; private sector capacity diminished as investment in new equipment was discouraged. In another small-country case, a project experienced significant delays in civil works procurement due to lack of competitive bids and frequent
rebidding; the road agency intended to engage in performance-based term contracts for road maintenance to stimulate and develop the domestic contracting industry. 18

22. **For several countries, funds for road maintenance, especially for national roads, have increased.**19 Road maintenance is a continuous process, carried out at relatively small-scale and in different locations, and needs a regular and stable source of funding. In one recent case, more than half of ADB’s financing had supported road development, and road-related loan agreements included covenants to increase funding for road maintenance. However, maintenance funding has fallen, largely in response to fiscal constraints, and the government continues to emphasize capital investment. The program did not consider overall institutional arrangements for O&M and road asset management to sustain the road network, which is now recommended as the top priority for future operations, with its mainstreaming. In another case, although road maintenance funding had increased five or six times, it was sufficient for only one-third of the maintenance needs of the network. In further cases, respectively, the major problem affecting road maintenance funding was again the continuing high investment in new works; recurrent expenditures were only a very small fraction of capital expenditures spent for new roads per km; and regular infrastructure maintenance was underresourced and the government resorted to tolling highways to raise the needed revenues. Improvements in road maintenance financing can be found when the economy and government revenues are increasing; traffic growth increases demands for road sector expenditure but also provides a growing source of revenues. However, for none of the countries was it claimed that funding for road maintenance was adequate to maintain the existing road network in a serviceable condition. In one case, while the maintenance budget has been substantially increased in recent years, periodic maintenance still needs to be extended to more roads. In another case, “Although government funding tripled in the past few years, the [road maintenance trust fund] has remained unable to supply adequate funding for recurrent and periodic maintenance, and no arrangement exists as yet for the originally intended direct contribution to the fund from the government’s fuel levy. .. The intended extension of a road fund to the provinces has not taken place.”20

23. **Measures taken in different contexts to address insufficient road maintenance funding have generally included identification of specific revenue sources.** The earlier study on road funds and road maintenance argued that “without earmarking, there is only a small chance of DMCs consistently allocating sufficient revenues to meet road maintenance needs.” Further, despite the reduced fiscal flexibility, road maintenance should be funded through dedicated revenues, whether simply earmarked or from user charges.21 Road funds, or road maintenance funds, have been applied in several cases to enhance road maintenance funding. In general, where road maintenance funds have been established, road maintenance still remains underfunded. In one case, while the government did enact legislation for a road fund, the fund was never properly capitalized and its main revenue source was cancelled; a subsequent substantial increase in budget allocations was insufficient to meet maintenance needs. In another case, although there are plans to establish a road fund, priority is likely to be given to road construction, not maintenance. An alternative to a road maintenance fund mechanism is dedicated taxation charges allocated through the general budget. To be related to road use, such taxation is often based on vehicles and fuel at different stages of the supply process.22 Maintenance results depend on how the funds are spent. A large proportion of maintenance funds can themselves be

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18 Specific risks associated with road operation and maintenance have been identified as unpredictable and insufficient budgets, weak asset management capacity, and practices relating to the use of heavy equipment for nonpublic purposes. ADB. 2010. Guidance Note. Road Transport Sector Risk Assessment. Manila.

19 The documents reviewed do not seem to refer to expenditures over time in real terms, either allowing for changing costs of maintenance inputs or relative to maintenance contract prices.


21 ADB. 2003. Footnote 6. P.13. It also pointed out, p.14, that “funding road maintenance can be a shared responsibility between road users, who gain the mobility benefit, and property owners, who gain the access benefit” from frontage location. Dedicated road user charges should fund the mobility percentage of road maintenance expenditures.

22 In some circumstances, regardless of where a fuel tax is levied or raised, increases in fuel levies can have political ramifications (IED. 2010. Sector Assistance Program Evaluation for the Transport Sector in the Lao People’s Democratic Republic. Manila: ADB).
Of fundamental importance in road maintenance funding is a government commitment to the concept and benefits of road maintenance, and to its results. Operation of a general road fund presumes government understanding of the value of maintenance expenditures; it is essential that the finance ministry understand the value of maintenance. In one case, formation of an interministerial committee for road maintenance including the finance ministry was successful in mobilizing significant funding for routine maintenance of national roads. However, in another case, at an earlier stage, the finance ministry had allocated only an average of 16% of the road user payments to the road fund, and only 20% of the road fund for maintenance; greater commitment was required if these proportions were to be enhanced. In a further case, at an earlier stage, two problem areas for obtaining maintenance funds for the provincial level were the credibility of the provincial agencies’ assessment of financial needs, and the authorities’ appreciation of the impact on roads and the resulting economic and financial consequences of insufficient maintenance. Awareness and commitment can be enhanced where measures are in place to ensure accountability to road users, such as regular stakeholder consultations, and clear performance indicators for road maintenance agencies in the public domain.

### B. Dealing with Road Maintenance Issues

All governments have taken some action to improve road sector management, including repair and maintenance (Table E.2). Of 13 forms of action identified in the documentation for 22 countries, the most common in 12 countries was preparing a road maintenance plan in the broadest sense, including road sector strategies and programs including maintenance, plans and budgets for maintenance itself, and clarifying responsibilities for road maintenance. Ten countries took steps to prepare for greater private sector participation in road construction and maintenance, including piloting performance-based contracts, and maintenance outsourcing. Ten countries also addressed the issue of overloading, through introduction of resolutions, rules, and vehicle licensing; general control programs, through a government working group and action plan in one case; and the use of weighbridges and project level measures. A common action among nine countries was increasing the budget for road maintenance, at a specific rate of increase per annum, or a proportion of expected GDP for routine maintenance (0.3%). Sets of 10 countries had or were intending to establish a road fund, enhance capacity, and undertake institutional reforms.

#### Table E.2. Summary of Government Actions Relating to Road Maintenance

<table>
<thead>
<tr>
<th>Variables</th>
<th>N</th>
<th>%</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maintenance Planning</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Providing road maintenance plan</td>
<td>12</td>
<td>14</td>
<td>1</td>
</tr>
<tr>
<td>Regulating overloading</td>
<td>10</td>
<td>12</td>
<td>2</td>
</tr>
<tr>
<td>Inventory of road conditions</td>
<td>3</td>
<td>4</td>
<td>9</td>
</tr>
<tr>
<td>Establishing sustainable system for road maintenance</td>
<td>3</td>
<td>4</td>
<td>9</td>
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<tr>
<td>Quality control</td>
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<td>4</td>
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<tr>
<td>Using modern technology in road management</td>
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<td>2</td>
<td>12</td>
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<tr>
<td>Maintenance Capacities</td>
<td></td>
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<tr>
<td>Contracting and promoting private sector</td>
<td>10</td>
<td>12</td>
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<tr>
<td>Capacity development</td>
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<tr>
<td>Institutional reforms/development</td>
<td>8</td>
<td>10</td>
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<tr>
<td>Good governance/transparency</td>
<td>4</td>
<td>5</td>
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<td>Financing</td>
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<tr>
<td>Increasing road maintenance budget</td>
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<td>5</td>
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<tr>
<td>Established/establishing road fund</td>
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<td>12</td>
<td>2</td>
</tr>
<tr>
<td>Improving cost recovery schemes</td>
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<td>2</td>
<td>12</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>84</td>
<td>102</td>
<td></td>
</tr>
</tbody>
</table>

*Total does not add up to 100 due to rounding. Total number of DMCs included in the study: 22.*

Sources: Review of ADB documents 2009–2012 (SAPE, CAPE, RRP, TA reports, and PCR) and documents from DMCs and other multilateral organizations.
26. **Recommendations and lessons from evaluation reports are a means of focusing attention on specific issues such as road maintenance.** The Management Action Record System (MARS) shows a recommendation relating to maintenance in each of four road subsector evaluations involving five countries, and action plans for four of these countries. The action plans include coordination with development partners and continued policy dialogue. More specifically, different loan and grant operations were already addressing issues of funding through financing of periodic maintenance subprojects and pursuit of a dedicated fund; developing a performance-based road maintenance plan, including privatization processes in one case; and improving data collection processes on provincial and rural roads. However, for two of these cases involving regional road corridor development, the target date for completing the action plan was more than 4 years from the original recommendation, acknowledging that changes take time. A separate listing of lessons for road maintenance included the conclusion “for rural roads that projects need to have a well-defined sustainability framework in which arrangements for infrastructure maintenance; mechanism for removal of barriers to road usage; and capacity development for local civil, nongovernment and government organizations is strengthened to ensure sustainability and enhancement of project benefits.”

27. **For difficult issues, such as establishing road funds, a TA schedule may not be consistent with the political process.**

24 For 17 road sector TA activities approved since 2009, involving 10 countries, 6 were oriented primarily to improvements in maintenance management, and 4 more included road asset management as a main component. The other TA operations were for enhancing road safety and private sector participation, or for general institutional development of road agencies. Most of those with a focus on maintenance sought to improve the road asset management approach as a whole. In one case, assistance sought to determine those roads where a computerized system is applicable, and those where it is not; computerization may be less appropriate in some areas where road deterioration is due mainly to natural causes such as landslides, not traffic use. Two other cases focused on identification of road maintenance funds at the state level, and enhancing collection of road user charges; another included an overloading control scheme; and another included determination of urban road maintenance needs. In one situation, assistance was specifically focused on implementing a provincial road inventory with updated conditions, and preparing a prioritized expenditure plan, including annual maintenance work program and budget application. Generally, ADB could be more flexible in how and when it provides or administers TA, with possible use of cluster TAs, or twinning arrangements with other road sector agencies in the region.

**III. ILLUSTRATIVE COUNTRY CASES**

28. The following three cases illustrate that no country has yet fully resolved the issues around road maintenance; addressing issues of road maintenance systems, capacities, and financing is an ongoing process without any fixed solutions.

A. **People’s Republic of China**

29. **In recent years, actions taken at the central and local levels have impacted the prospects for improved road maintenance.** From 2005, a rural road maintenance policy provided maintenance subsidies for county, township, and village roads. Expansion of a primary network of tolled expressways and Class I highways, including corporatization of road operators, has generally ensured sufficient resources for maintaining this type of road. A fuel tax reform in 2009 has created a centralized source of revenues for road construction and maintenance. As the road system as a whole has expanded, ordinary road development has lagged behind. This has created a significant backlog in maintenance,
upgrades, and reconstruction. For ordinary trunk roads, 7.4% are unpaved, and 35% of rural roads are unpaved. Pavement conditions vary across the eastern, central, and western regions.

30. **At the end of December 2008, various funding mechanisms were replaced by revenues from an adjusted fuel tax, a tax on oil products at the point of production or import.** The fuel tax reform replaced several road maintenance revenue sources. These included a central vehicle purchase tax; a provincial road maintenance fee (RMF) (a variable monthly charge on vehicle owners, with 80% dedicated in principle for maintenance purposes; toll charges on some provincial government road facilities, to meet provincial maintenance and loan repayment needs; and domestic bank loans, guaranteed through the RMF and toll revenues. Typically, the RMF had funded over 50% of maintenance costs for all roads, while toll revenues funded an additional 40% at the national level and 20% at the provincial level. The change in charges on road users has had several short-term effects. First, fuel tax revenues are expected to grow at a lower rate than with the previous RMFs, and with the removal of tolls on class II roads also, there will be a provincial and local funding gap. Second, local governments will lose most of their capacity to deliver new projects through debt financing. Third, traffic diversion is already occurring, from tolled expressways to nontolled class II roads, including many trucks for which overloading fees are less than road tolls.

31. **The PRC's road sector funding gap is likely to grow within the context of the new financing arrangements, and the continued expansion of the road system.** Some policy issues are unresolved: (i) adequately addressing ordinary road maintenance needs alone would consume roughly two-thirds of all available central government road funding; additional road financing is needed; (ii) there is a need for a revenue source at the provincial and local levels; (iii) fuel tax rates are specified per liter; and by 2020 they may have lost 40% of their purchasing power. Some further policy recommendations have been made. These include the further consideration of the allocation method for distributing the fuel tax revenues now collected centrally; the identification of additional revenue sources; and the indexing of the fuel tax to inflation or construction and maintenance costs.

32. **Yunnan is a mountainous landlocked province, with limited arable land and poor transport conditions.** There is a high proportion of rural population (67%), of whom 5 million are below the poverty line. Yunnan’s road network is dense but of low quality. Many (81%) are gravel or earthen roads, and single-lane. Traffic levels are often well in excess of the volumes for which the roads were designed. In 2009, Yunnan’s first road network condition survey found that only 35% of the trunk highway network was in good condition, while 31% was in very poor condition requiring major rehabilitation. The main causes are insufficient funding and suboptimal use of funds. The prospect for road maintenance funding in the province is that it will not grow faster under the new arrangements than before. It was expected that maintenance funding from the central fuel tax allocation will increase by 10% per annum over the first 3 years of the project. However, in 2010, the gap between maintenance needs and funds available was about 30%, and there is a maintenance backlog. Presently, there is no planning or implementation of periodic maintenance, and a large proportion of the provincial maintenance budget (even supplemented by overloading fees) is spent on staff salaries and pensions. Open bidding procedures under the project were expected to result in capacity development of private companies. To limit the damage from overloaded trucks, project designs for the pavement and sub-base were to be based on pavement strength to carry forecast traffic volumes and axle loads, not simply the class of road, mobile weigh stations were to supplement the current fixed stations, and fines were to be increased. The Country Partnership Strategy 2011–2015 and the associated sector assessment identified the need for better road asset management and road safety and the importance of tackling the maintenance backlog of ordinary roads. ADB’s assistance includes the proposed Yunnan Sustainable Road Maintenance project.

25 ADB. 2012. _Financing Road Construction and Maintenance after the Fuel Tax Reform_. Manila. Tolls on class II provincial roads previously comprised 60% of tolled road length but generated only 12% of total toll revenues. P. 25. Expressways and Class I tolled highways that are self-financing are excluded from the processes based on the adjusted fuel tax.

26 ADB. 2010. _Report and Recommendation of the President for Yunnan Integrated Road Network Development Project_ (including linked documents). Manila.
33. **Rural road maintenance has long been underfunded.** The province has spent less per kilometer on rural road maintenance than on trunk roads by a factor of 25. Since 2007, rural road maintenance has been subsidized by the province; however, funding levels are still low in relation to the network size. Maintenance of some township and village roads, especially unpaved roads, is currently carried out on a voluntary basis. However, the system is unreliable, with low motivation; not timely; and labor availability not necessarily matching maintenance needs. Steps were taken to pilot a remunerated road maintenance scheme for low-volume unpaved roads, providing employment to ethnic minority women, and a small-scale TA associated with the project seeks to identify how this could be extended (see also chapter IV, A.).

**B. Mongolia**

34. **Mongolia is a large, sparsely populated, landlocked country, with a low population density and severe weather conditions during the winter.** This mining-based economy has been highly dependent on railways; the road network is very underdeveloped, with one of the very lowest road densities in the Asia and Pacific region. There are high transit costs and a low reliability of logistics chains, which constrain the country’s competitiveness. The majority of roads are only dirt tracks. Owing to the highly concentrated population, paved roads reach 60% of the people. For others, the lack of paved roads results in high transport costs and long travel times. Truck overloading appears to be severe and frequent by international standards. The National Development Strategy, 2008, aims to “construct paved roads in place of existing dirt tracks on 90% of the national road network by 2021, and strengthen the legal and regulatory framework for road maintenance.”

35. **The current maintenance system does not ensure long-term sustainability of the roads.** Although national roads receive routine maintenance, including winter maintenance, they have suffered from an absence of periodic maintenance. Fifty-six percent of the national surfaced roads are beyond their design life; and most gravel roads are no longer maintainable. Road maintenance expenditures increased in 2001–2011 but cover only 20% of estimated needs. To achieve the goal of paving the national network by 2021, periodic maintenance for paved roads would have to be 2,000 km per year; none has been performed during the past years. Road maintenance on the national roads is undertaken by 22 small mechanized maintenance units, 18 of which are state-owned. Prices do not provide a return on capital, so capital has to be replenished in the form of equipment. A viable local road-contracting industry is essential to ensure that the country has the capacity to maintain the existing and planned roads, as well as to support new construction. To encourage expansion of the contracting industry, contracts should be packaged appropriately, and a steady and expanding stream of work for local contractors created. In the Department of Roads (DOR), there is one management staff member per 75 km of roads, against 10–20 km internationally. The human resources of the road sector are limited to 500 engineers and 5,000 skilled workers; twice as many engineers and 40% more workers are needed. A national road sector capacity development road map was approved by the government in August 2011.

36. **Current sector financing channels are not sufficient for road maintenance.** Road maintenance expenditures, only $7,400,000 or less than 0.2% of GDP in 2009, are below other countries’ levels. It is

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30 The Western region investment program included establishing a road maintenance center to improve asset management and sustainability in each of three tranche subprojects; the procurement of equipment for the first tranche was estimated as $270,000, only 0.37% of the tranche project cost.
32 Initial implementation of the road map is being assisted through technical assistance: ADB. 2011. Proposed Technical Assistance to Mongolia for Road Sector Capacity Building (Financed by the JFPR).
estimated that, to maintain the whole network to good standards, $38,800,000 per year of expenditure is required for the national and local network. To clear the maintenance backlog, another $20,000,000 over 6 years is required. Moreover, the expansion of the network will double total maintenance needs over the next decade. A Road Fund was created in 2004 to provide funding for road sector expenditures, together with a Road Board to oversee its operations. The Road Board ceased operations in 2007. The Road Fund, now operated by the Department of Roads, has been the primary source of funding for road maintenance, albeit at a low level. The main sources of revenue for the fund are the fuel and vehicle licensing taxes. The rate for neither of these taxes has been increased since 1995, and revenues have shrunk considerably in real terms. There is a continued risk that the share of maintenance funding from the fund will fall, and road assets will be lost.

37. **Road maintenance in Mongolia, as in many countries, needs additional financial resources, further institutional development, and higher priority.** A number of policy proposals have been made for strengthening road maintenance operations in Mongolia that could be of interest more generally. First, road maintenance expenditures should be progressively increased from 0.2% of GDP to 0.5% of GDP in 2015. This would be sufficient to maintain the paved road network but not the local roads. Some funds could be reallocated from construction to maintenance. Second, reform the national Road Fund and the user charging system by dedicating the Road Fund revenues to maintenance, earmarking a larger proportion of fuel taxes to the road fund, and transforming the fuel tax into an ad valorem tax. Third, develop a periodic maintenance program—every 7–10 years for paved roads—and make it a new budgetary program with dedicated financing and performance targets. Fourth, improve the maintenance contracting system through a policy of commercializing road maintenance works through contracting companies, including reform of prices, incentives, and supervision mechanisms, and piloting new forms of contracting maintenance with the private sector. Fifth, sustain, develop, and institutionalize the road asset management system by ensuring funding for database maintenance, annual traffic counts, and road condition surveys, and a geographic information system (GIS)-enabled road database. Sixth, develop a joint overloading program by instituting agreements among the DOR, road inspectorate, and traffic police with authority to hold and fine vehicles; raising the level of fines for overloading; focusing on border and town entry points, where weigh scales cannot be avoided; and including road capital cost financing and maintenance requirements in mining concession agreements.

**C. Solomon Islands**

38. **The Solomon Islands comprise an archipelago with population concentrated on six main islands.** The road network, mostly on two islands, comprises 1,875 km, of which only some 104 km (6%) have a sealed surface. Surfaces for the rest are of gravel, coral, or earth. There are many bridges over watercourses, and fords. During the 1980s and 1990s, infrastructure deteriorated, exacerbated by a civil conflict in 1999–2003, when “many roads were closed, government services suspended, and export industries … brought to a halt,” and by natural disasters including a large earthquake and tsunami in 2007. ADB provided emergency support both postconflict and postdisaster, including substantial rehabilitation of infrastructure, the former reconnecting to markets, schools, and hospitals, the latter for rebuilding roads, wharves, jetties, and water supply. Roads not designed with earthquakes in mind were rebuilt to international standards for resilience to future disasters. The primary causes of road deterioration are high rainfall, poor drainage, lack of maintenance, and poor construction. Recognizing the years of neglect and deferred maintenance, several actions have been taken to help improve and maintain the road infrastructure. After recent projects, about 50% of roads still require rehabilitation.

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35 Much of the ADB program in the Solomon Islands is undertaken in partnership with other agencies including AUSAID, the EC, and the New Zealand government.
39. **The government’s primary strategy in the transport sector is to rehabilitate and maintain the existing road network.** The National Transport Plan (NTP), which articulates the government’s policies, strategies, and priorities for the transport system, was recently updated to include a prioritization methodology, subproject selection criteria, and a 3-year rolling work program of priority projects. Considerations in prioritizing projects include economic and social aspects, safeguards, and engineering standards. Priority roads will be rebuilt to design standards appropriate to traffic, topography, and climate adaptation requirements, including repair and replacement of bridges, reshaping and strengthening of pavements, and improvement of drainage, essential in the Solomon Islands context. The NTP is complemented by a National Transport Fund (NTF), established as a mechanism for pooling funding from external agencies and the government itself for rehabilitation and maintenance of transport infrastructure, including roads. This pooling of funds leads to greater use of government systems. Maintenance funding through the fund is significantly below the levels necessary to sustain current assets. Although there is a potential to relate road sector taxes, for example, for vehicle registration or fuel, to road sector expenditures, at present there is no dedicated revenue source for the NTF.

40. **Two principal issues relating to road maintenance are resource shortages, including both staff and funding, and lack of road condition survey data.** The latter are largely available only on an ad hoc basis for externally funded projects. The NTF is to be used for maintenance carried out through traditional equipment-based methods, labor-based, equipment-supported (LBES) methods, and/or community contracts, depending on the needs of each subproject. Recent projects have emphasized the need for regular maintenance, including of gravel roads every few years, and keeping the grass verges clear four times a year. High contractor mobilization costs between islands led to the realization that a contracting base in several islands is required; the Ministry of Infrastructure Development policy is to mainstream LBES methods in road maintenance to the maximum extent. At the same time, assistance has been provided for developing the capacity of national contractors and consultants, and of communities, in supervision and quality control for LBES maintenance. Lessons from recent projects are that in some cases poor data on unit rates of civil works has resulted in underestimating costs at the design stage, leading to cost overruns; and the importance of consulting stakeholders who are likely to be affected.

41. **A preliminary assessment of sustainability of the works undertaken under the emergency assistance operation noted some limitations of the maintenance system.** The rehabilitated roads were constructed with robust designs, ensuring that they are resilient to future natural disasters, and had ongoing road maintenance contracts. However, there were some shortcomings in maintenance of the project investments: the standard of maintenance works could be improved by upgrading contractor technical capacity and through stronger supervision of works; the annual road maintenance budget was faced with funding shortfalls, with road maintenance decreasing in 2010 and 2011 after several years of growth; and the road asset management unit did not have a dedicated budget and was significantly understaffed. However, overall, a team has been established, together with an asset inventory as well as some road condition data, with a GIS element through New Zealand volunteer assistance. Progress in the area of road maintenance capacities, national contractors, and communities suggests the Solomon Islands is a relatively good example of the development of a road maintenance approach within a constrained environment.

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37 The board of the NTF comprises the permanent secretaries of the government’s line and central agencies, and one development partner representative who represents the consolidated view of all development partners. ADB. 2010. Footnote 41, P. 5, footnote 12.

38 ADB. 2009. Proposed Asian Development Fund Grant and Administration of Grants. Second Road Improvement (Sector) Project. RRP.

IV. SOME RELATED FEATURES OF ROAD SECTOR OPERATIONS

A. Road Sector Employment

42. Maximi\ng direct em\ploy\m in road maintenance act\vities can be compli\cent by fund\ng shortfalls and a manage\nt burden. For more isolated areas, road sector employment can provide a significant increment to local incomes for both the persons employed and their communities. Labor-based (LB) methods of road maintenance prioritize the use of labor rather than equipment and are generally seen as creating job opportunities.\n
43. Labor-based methods can be applied at vari\ous levels of maintenance but can involve considerable management input. Application of LB methods requires identifying where they would be appropriate. In the Solomon Islands, substantial prior consultation with community groups and private businesses was necessary to create a transparent and competitive bidding process.\n
44. In each case it is necessary to clarify which is the principal objective—road development, community development, or private sector development. A review of LB road work methods found that ADB had assisted implementation of 13 projects with LB components in the previous 10 years. It included evidence from three cases in Cambodia, Solomon Islands, and Timor-Leste. The proportion of labor cost in total cost varied between the projects, and also from contract to contract. For two projects for spot and routine maintenance, labor contents ranged from 7% to 57%; in another project some compactor equipment was used to meet work quality requirements (LBES contracts), and the labor content was mostly below 40%. LB methods were found to be cheaper than traditional methods by 10%–50%; however, the work period can be longer, there can be more labor management problems, and late contract payments from the executing agency created discomfort for the contractor. Some recommendations were drawn for other applications of LB methods: (i) factors affecting the project choice of technology should be assessed fully in preparing investments projects; (ii) as part of that, some difficult works should be supported by limited heavy equipment; (iii) long-term capacity development in executing agencies and contractors is critical; and (iv) all contract documents, payment procedures, and monitoring and supervision methods should be simplified.

45. Sustainability of rural road maintenance carried out by women’s maintenance groups needed further consideration. Many rural roads in Yunnan province, PRC, are of low standard; voluntary labor contributions of nearby communities 2–3 days per year were not sufficient to prevent road

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40 "Road maintenance is a continuous process and its employment generation potential should not be underestimated. Under average conditions, one worker should be able to cover the routine maintenance works required on a 2 to 3 km (rural) road section." ILO. 2007. Rural Road Maintenance. Sustaining the Benefits of Improved Access. Pp 104 and 107.
44 An evaluation of assistance to rural roads also found that "Labor-intensive and environmentally friendly technologies may not be feasible for all rural roads." ADB. 2009. Footnote 26. Para.76.
deterioration. A pilot project in a poor ethnic minority area in Western Yunnan supported the establishment of women’s maintenance groups for community-based rural road maintenance works in two counties of Dehong prefecture.\textsuperscript{45} Grant funding was used to implement the pilot project, with counterpart funds from the prefecture and county communications bureaus, who also supervised the work.\textsuperscript{46} Twenty-one women’s maintenance groups, including 163 women, were trained in routine maintenance for maintaining 165 km of road. Ninety-two percent of the women were from households below the poverty line, while 55% were from ethnic minority groups. A large part of the work was for removal of landslides and for road surface and road shoulder repairs. Expenditure on tools, safety equipment, accident insurance, and transport of materials was 15% of the maintenance cost under this method, while 85% was spent on wages. An assessment of the results of the pilot project concluded that road conditions improved significantly, and access became more continuous.\textsuperscript{47} The road maintenance activities generated an average of 110 workdays in a year and provided a steady income. This in turn enhanced women’s status; annual salaries made up two-thirds of the household total in most cases. However, the sustainability of the approach was found to face two main obstacles. First, the county communication bureaus did not consider the expenditure levels per km sustainable, given their very low sources of funding. Second, owing to a lack of capacity at the local level, the required supervision resources were high. A subsequent small-scale TA sought to determine the minimum expenditure required for sustainable rural road maintenance, and how the management burden could be reduced.

\section*{B. Road Safety}

\textsuperscript{46} Road crashes or accidents are associated with all forms of road and road traffic. Accidents happen on rural roads, for example, where there is no lighting, and can be fatal; maintenance work itself, without appropriate traffic management, can be a problem; heavy truck traffic on roads with mixed uses can be an issue for both road maintenance and safety; road crashes also occur on expressways, highways, and urban roads. People are subject to road safety risks on a daily basis, as road and vehicle users, passengers, pedestrians, or simply in the vicinity of roads. In most DMCs, road accidents are rising. In Asia and the Pacific, every year there are 645,000 deaths and 30 million injuries, 60% of the global total.\textsuperscript{48} Between 50% and 75% of people who die in road accidents in Asia and the Pacific are vulnerable road users, such as pedestrians, cyclists, and motorcyclists. Economic losses from road crashes occur at the country and family level. For the DMCs, they are estimated at 2% of GDP. In the last 5 years, 22 million families have been affected by death or disability, 70% of such families suffer decreased income, and two-thirds have to arrange loans to cover the loss. The United Nations General Assembly has declared the period 2011–2020 the Decade of Action for Road Safety.

\textsuperscript{47} Maintenance, and the backlog of maintenance works, provides an opportunity to upgrade safety standards on roads. A successful road safety management system involves proactive prevention of crashes. A Shared Approach to Managing Road Safety has been adopted by the multilateral development banks. Many tools to improve road safety are available from the earlier experiences of different countries, such as road safety audits. However, up to now operationally within ADB, road safety has not been systematically considered throughout the project cycle, or as part of life cycle costs; only 1%–2% of project costs have been allocated in some project operations, with no sector-wide interventions.\textsuperscript{49} Road safety concerns could be combined with concerns about road maintenance through paying greater attention to the supply and design of vehicles, especially goods vehicles. Introducing new elements in truck design and manufacture, or import, for reducing road deterioration could be combined with those for enhanced road safety. Safe approaches to operation and

\textsuperscript{45} It was implemented in conjunction with the rural road component of the Yunnan Integrated Road Network Development Project, approved in 2010.


\textsuperscript{47} ADB. 2011. Empowering Women Through Rural Infrastructure. Manila.


maintenance of road infrastructure require coordination among government agencies and with all road stakeholders.

C. Climate Change Resilience

48. Road sector infrastructure is vulnerable to the effects of climate change and subject to risks from natural occurrences. The consequences of climate change can include a rise in sea levels; increased precipitation; an increase in the frequency and intensity of storms, floods, and droughts; and a reduction in natural flood control ecosystems. It was estimated that in 1980–2009, the Asia and Pacific region accounted for 38% of global economic losses from disasters. Climate change can have some particular effects with respect to road facilities: changes in and more extreme temperatures are likely to impact road pavements; stronger and more frequent storms may overcome the capacity of drainage and overflow systems, with faster velocity of water flows; increased salinity levels from sea level rises can reduce the structural strength of pavements and cause rusting of reinforced concrete structures.

49. The expenditure demands for road rehabilitation and road maintenance may increase through actions in response to climatic events, and in order to enhance climate change resilience. An approach and method have been proposed for climate-proofing investments in the road sector, focused primarily on new construction and improvement works. Adaptation options can include engineering considerations such as material specifications, cross section and standard dimensions, drainage and erosion effects, and protective engineering structures; and non-engineering options such as maintenance planning and early warning systems for natural events, alternative alignments, land use planning, and environmental management. Globally, it has been estimated that $15 billion–$30 billion a year would be required until 2050 for infrastructure, mostly for roads and urban infrastructure, of which 50% would be incurred in South and East Asia and the Pacific.

50. Inadequate or untimely maintenance increases the vulnerability of road infrastructure to climate change. In Pacific island countries, natural events occurring more frequently have caused significant damage to roads, bridges, and wharfs. In one case, weather change patterns plus years of neglect in maintenance had reduced their serviceable life prematurely. The impact of climate change on existing transport infrastructure that was maintained to current standards was generally considered to be moderate, with adaptation requiring minor to moderate investments. Given this link with maintenance activities, a reduction in future maintenance costs can be used as an approximate measure of the benefits for adaptation options. The cost of a chosen adaptation investment can be assessed against a saving in future O&M and rehabilitation costs. It has been estimated that, in general, $1 spent on disaster prevention can avoid later disaster recovery expenditures of at least $4. For existing infrastructure, improving O&M is also a form of climate change adaptation. Maintenance and contract scheduling should be adjusted to help avoid or mitigate climate change and natural disaster effects. An increase in maintenance contingency budgets would allow more intensive supervision and monitoring in the most vulnerable sections of road; and early warning systems for extreme events would prepare crews and contractors for high rainfall or mudslides. The number and scale of disasters triggered by extreme natural hazards or events have been increasing, especially for floods and storms. The consequences of continued lack of road maintenance may become more severe.

50. IED. 2012. ADB’s Response to Natural Disasters and Disaster Risks. Special Evaluation Study. Manila: ADB.
53. ADB. 2010. Footnote 41. Climate Change Adaptation Measures. Linked document. Para.3. Climate change adaptation costs were estimated at 15%–20% of total project costs for coastal roads, and 0%–10% for inland roads.
54. This is elaborated further in ADB. 2011. Footnote 59. Box 9. P.31. This approach can be adjusted for where current maintenance expenditures are inadequate, and O&M and rehabilitation cost savings are not the only benefits from adaptation investments.
V. CONCLUSION: GREATER FOCUS ON ROAD MAINTENANCE

51. With economic growth and increased incomes in the Asia and Pacific region, together with urbanization, road networks will continue to expand and traffic to grow. As the networks expand, the demand for maintenance also increases; extending the useful life of existing assets is a key component of sustainable road transport services on a sustainable road network. Road maintenance has been managed without all the required skills, and without the required financial resources. In almost all cases, road maintenance is underfunded; it is easier to address the problem of road maintenance where economies are expanding, revenues for government are being generated, and government debt levels are not too high.

52. DMC governments have taken many steps to improve road maintenance, some with assistance from ADB and other agencies. However, there has been no big breakthrough. Effecting change is a complex and slow process with legal, regulatory, institutional, technical, and financial facets. Also, more effort is required if works are to be modified to address issues of road safety and climate resilience. The previous evaluation of sustainability (footnote 14) included in its recommendations the promotion of project sustainability within DMCs and ADB. If ADB is to play a larger role in road maintenance, there may be a need for stronger advocacy for increased awareness and priority. The profile of road maintenance needs to be raised at the broadest level of planning and prioritizing within a sector perspective, including the role of maintenance and its benefits to road operators, users, and beneficiaries. At the same time, it is necessary to build a broader understanding of road maintenance objectives and benefits, and planning and prioritization processes, and an ability to explain these issues when necessary.

53. Road maintenance is a continuous activity, with relatively small-scale operations in diverse locations, that can generate significant returns and contribute to safer and more environmentally-friendly outcomes. ADB may well have to consider spending more of its funding on road maintenance rather than road construction investment. This may bring it into budget support territory. Consideration could be given to a diversification of lending modalities, to include support for policy and institutional changes, and achievement of results.

54. Based on this overview, the following steps could be considered if more focus and resources were to be placed on road maintenance activities:

(i) Road subsector maintenance stakeholders (agencies, contractors, transport operators, road users, and other beneficiaries) need to be involved in raising awareness of the benefits of road maintenance activities.

(ii) Maintenance is best addressed as a sector issue with solutions at the sector and national level. At the same time, within any project or program operation, maintenance should be planned at all stages of the operations cycle, and of the life cycle of road assets. Post-completion maintenance provisions could be built into project design including maintenance contracting beyond the investment period.

(iii) Appropriate financial sources for maintenance should be identified and linked to relevant stakeholders, including road users and selected beneficiary groups, together with adequate organization and staffing. “Second generation” road funds relying on the fee-for-services concept, based on dedicated revenue sources such as fuel and vehicle taxes, need to be looked into further and supported by ADB.

(iv) ADB modality options could be considered for road maintenance activities, beyond the predominance of investment projects: (a) Operations for removing the maintenance backlog could be funded through the sector loan modality, which provides flexibility in prioritizing subprojects of similar scale but in diverse locations. (b) To emphasize the need for effective and timely maintenance operations, and to focus on results rather than inputs, the recently piloted results-based financing for programs modality could be considered for...
supporting a program of road sector maintenance activities.\textsuperscript{56} (c) Program lending could be considered to address policy and institutional constraints to road maintenance planning and financing.

(v) Additional assistance for capacity and institutional development needs to consider the appropriate duration and phasing of the changes to be supported, including the options of cluster TAs or twinning arrangements with national road agencies in the region, allowing exchanges of staff, and providing an incentive for retaining qualified personnel.

(vi) Despite the difficulties of deriving appropriate methodologies for sectors implemented on a network basis, an impact evaluation of road maintenance activities could be undertaken to assess their effectiveness and efficiency, and their results from the point of view of all stakeholders.

\textsuperscript{56} ADB. 2012. \textit{Piloting a Results-Based Financing for Programs Modality, W-Paper}, Manila. Maintenance activities focus on the existing road facilities, and therefore may meet the pilot period exclusions criteria for this modality of no Category A safeguard classification and no high-value contracts.