

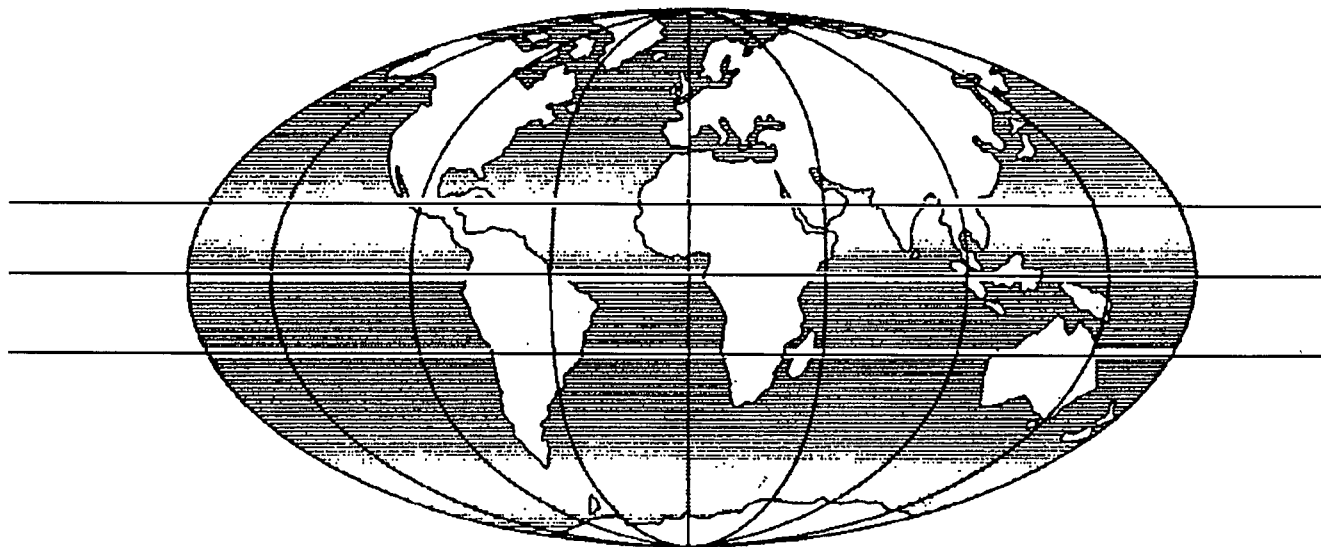


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# Reprint

**TITLE** **Priorities in improving road maintenance overseas: a check-list for project assessment**

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## **Priorities in improving road maintenance overseas: a check-list for project assessment**

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Surveys carried out principally by the World Bank suggest that, because of lack of maintenance in the past, significant proportions of the road networks in developing countries are in poor condition and require rehabilitation. The cost of carrying out this work runs into many billions of dollars. The economic benefits of road maintenance are considerable, but some technical assistance projects, funded by donors and carried out by consultants, have failed to effect permanent improvements in the performance of road maintenance departments. This may be because terms of reference for projects have failed to recognize the interdependence of the institutional, managerial and technical capabilities of the recipient organization and, in particular, the priority to be accorded to institutional capability. A check-list is proposed that can be used to review an organization's capability to identify any inadequacies in a systematic, quantifiable way so that technical assistance projects can be focussed on areas that are more likely to produce real long term benefits.

### **Background: the road maintenance crisis**

During the post-colonial period most developing countries made massive efforts to extend and improve their road networks. An efficient road transport system was seen as an essential precondition for general economic development and a high priority and large resources were assigned to road construction and improvement. By the mid 1980s some US\$10 billion per year were being spent in the road subsector in developing countries, mostly on new construction and improvements. The major international funding agencies gave enthusiastic support to such infrastructure development since economic returns were thought to be clearly predictable and to have a good chance of being realized. Moreover, road projects were relatively simple and cheap to administer if carried out by expatriate consultants and contractors.

2. No sooner were roads built and travelled on than they began, inevitably, to deteriorate. The resources and organization committed to the road construction effort were not matched by similar commitments towards road maintenance, and in recent years the scale of deterioration has become impossible to ignore. As one authority said, 'With road pavements built in the 1960s and 1970s reaching the end of their design lives, developing countries now face costs of some US\$40 billion to rebuild failed roads, plus a similar sum to prevent further failure. If these

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Written discussion closes 16 February 1990; for further details see p. ii.

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preventative measures are not taken within the next decade, the cost of road rebuilding, instead of repairs, could be up to US\$200 billion'.<sup>1</sup>

3. Until the start of this decade, road maintenance projects and programmes were seldom funded by international donors because it was claimed that support of recurrent expenditure did not contribute to real long term economic and social development. However, research carried out by the Transport and Road Research Laboratory in conjunction with the World Bank in the 1970s<sup>2</sup> quantified for the first time the relationship between road maintenance and vehicle operating costs. This in turn highlighted the dramatic effect that spending or failing to spend relatively small amounts of money on road maintenance could have on the economic return of a road construction project. At the same time donors were becoming increasingly alarmed about the poor condition of road networks and by the fact that the rate of deterioration was increasing. The benefits which should have ensued from the enormous investments in road construction of earlier years were being eroded by a failure to prevent widespread road deterioration.

### **Deteriorating road conditions**

4. Developing countries have a road network of approximately 1.8 million kilometres of engineered primary and secondary roads,<sup>3</sup> of which just over 1 million kilometres are paved. Their estimated replacement cost is US\$300 billion, excluding the cost of land, major earthworks and bridges. In addition there is a network of low-volume unpaved tertiary roads and tracks comprising 5-6 million kilometres with a total estimated replacement value of US\$75-100 billion.

5. Surveys, principally by the World Bank,<sup>3-5</sup> suggest that about 25% of all paved roads are in poor condition and require rehabilitation, and that only about 30% could be described as in good condition. The figures for unpaved primary and secondary roads are even worse: nearly 35% require rehabilitation and less than 30% are in good condition. No figures are available for minor unpaved roads and tracks. (As a comparison, the Standing Committee on Highway Maintenance reported in 1987 that in the UK 85% of trunk roads were in good condition, 3% required rehabilitation.)

6. The surveys estimated a US\$40-45 billion backlog in the expenditure on rehabilitation required to bring roads up to a good standard, with an additional US\$4-5 billion required annually to prevent further deterioration. With such backlogs it is not surprising that the situation is rapidly becoming more serious.

7. The scale and nature of the deterioration may be illustrated by taking two countries as examples. In Kenya, detailed measurements of road roughness carried out by the TRRL between 1978 and 1982 showed that there were 5-17% increases, depending on the type of pavement construction, on roads with initial roughness values of 2-4 m/km IRI. In Senegal, during the same period, paved roads deteriorated from a serviceability index of 3.6 to 3.0 on a scale of 5 (good) to 0 (bad), and unpaved roads deteriorated from 3.2 to 1.9. The road maintenance organizations in both these countries are of above average efficiency in the developing world, thus the rate of deterioration will be faster in many other countries.

### **Economic benefits of road maintenance**

8. The economic benefits of effective and timely road maintenance have been well documented in recent years. Benefits are obtained by

## ROAD MAINTENANCE IMPROVEMENT OVERSEAS

- (a) reducing the rate of road deterioration and therefore delaying investment in reconstruction
- (b) reducing vehicle operating costs
- (c) preventing the road becoming impassable.

9. Investment in road maintenance has generally led to rates of return in excess of 100% on donor-financed projects. Few maintenance projects have had rates of return as low as 50%. The return on new construction projects rarely exceeds this figure, and feeder road projects have even lower returns.<sup>3</sup>

10. In considering investment priorities within a sector, precedence should be given to those projects with the highest benefits. They should then be followed by successively lower-benefit projects until funds are exhausted or the benefits of additional projects are found to be below their opportunity cost. It can be argued, therefore, that projects within the road subsector should, in general, have the following order of priority

- (a) maintenance
- (b) upgrading
- (c) new construction.

### **Donor-funded road maintenance projects**

11. The World Bank called a meeting in Paris in February 1980 to exchange views on the difficulties faced by governments and funding agencies in the road maintenance field, and to seek consensus on ways to overcome them. An eight-point action plan was discussed,<sup>6</sup> and following the meeting several donors changed their lending policies to enable aid for road maintenance to be provided. This has resulted in a general shift of lending policies within the road subsector away from capital schemes and towards road maintenance.

12. This change of emphasis has confronted funding agencies and recipients with a new set of problems in project implementation, since road maintenance projects possess few of the characteristics which made road construction projects so simple to process through the appraisal, funding and supervision machinery.

13. New construction projects, whether by contract or by direct labour, can be measured relatively easily in terms of quantity and quality. There are recognized tests which can indicate whether construction work has been successful.

- (a) Was construction completed on time?
- (b) Was it to specification?
- (c) Did the cost exceed the estimate?

14. Road maintenance projects, on the other hand, are much more difficult to define and to assess. They often include management and institution building components as well as the more straightforward components relating to construction and procurement. The essential differences between construction and maintenance projects are summarized in Table 1.

15. The more complex, less easily controlled environment within which road maintenance projects are implemented has caused serious difficulties for agencies. Compared with construction projects it has been very difficult to obtain a similar degree of success within projects aimed at improving long term maintenance capability.<sup>3,6-8</sup> Problems of project implementation have been found in several

BROOKS, ROBINSON AND O'SULLIVAN

Table 1. Differences between construction and maintenance projects

	New construction, periodic maintenance, overlays and rehabilitation	Routine and recurrent maintenance
Duration	Tend to be short term	Long term
Technology transfer	Incidental	Crucial
Local capability	Relatively independent	Very dependent
Contractor's organization	Independent of local organization	Integrated with, and dependent on, local organization
Donor administration	Straightforward	Complex

areas and it is convenient to group them under the following headings.

- (a) Terms of reference. These have often proved inappropriate in addressing the fundamental problems of road maintenance performance.
- (b) Client attitudes. Frequently there has been a resistance to change in client organizations and top management has sometimes not given projects the support that was necessary for them to be successful.
- (c) Cultural issues. Western management practices have sometimes been difficult to integrate into a cultural situation that is fundamentally different. There have been problems of nepotism and corruption.
- (d) Staffing of project teams. Consultants' teams have sometimes proved badly motivated and of insufficient quality for the tasks required.
- (e) Economic and financial problems. Shortage of both foreign and local currency and the erratic timing of budget allocations have hampered operations.
- (f) Availability of counterpart staff. A lack of trained counterpart staff, and/or the client's unwillingness to commit them to the project has slowed progress and reduced technology transfer and institution building.
- (g) Staff training. It has been difficult to co-ordinate training with the needs of operational departments and there have been failures to provide suitable staff for training.
- (h) Equipment. The availability of mechanical equipment (whether through actual shortages or inadequate fleet management and workshop support) has often been a constraint in carrying out effective maintenance.
- (i) Computers. Projects have often relied on computers that have sometimes, in the event, been unavailable or there has been a lack of trained staff to operate them.
- (j) Data availability. Fundamental data about the road network and maintenance operations have often not existed.

16. A consistent problem has been the inability of the client organization to institutionalize improvements in road maintenance performance. In most cases, projects that had been operating fairly successfully while the consultant was in place have collapsed on departure of the technical assistance personnel at the end

## ROAD MAINTENANCE IMPROVEMENT OVERSEAS

of the contract period. The following quotations from consultants exemplify this<sup>7,8</sup>

On the departure of expatriate maintenance engineers, both civil and mechanical, as part of 'localisation' programmes, relatively young and inexperienced local engineers were quickly promoted to fill the vacant posts. In some cases the management problems which they would expect to have to deal with have been compounded by political or security problems, and by the added attractiveness of the private sector, or even overseas employment, which have left the road maintenance organisations severely short-staffed at senior management level.

... the programme of technical assistance for maintenance ... was not a success. The latest information ... indicates that economic conditions ... have deteriorated further following the departure of the consultant. None of the procedures developed and implemented during the study period are currently being used. The computer hardware acquired with loan funds is not in operation because (the client) does not have the personnel qualified to operate this equipment.

17. The lack of success in maintenance consultancy projects was highlighted by the World Bank

A great deal of emphasis has been placed in many Bank-assisted projects on the application of ... systems for planning, programming, budgeting, scheduling, control, and data collection, and it is difficult to avoid the conclusion that it has often been overdone. In some instances, the management information systems introduced by consultants have simply proved too complex to function or to be used beyond headquarters. In others, they were excessively dependent on computers that were unavailable or functioned poorly. More often, elaborate reports have continued to be produced at lower levels of the hierarchy, but there has been no effective system for checking them, and they have been little used, for lack of qualified headquarters personnel to handle them or for lack of interest. The effort seems to have been spread over too many systems, with too much detail, and with insufficient attention to the structural constraints on the ability of management to act.<sup>6</sup>

18. The aid donors met again in March 1985 in London to review progress since the Paris meeting. Whereas the theme for the Paris meeting had been the road maintenance problem, delegates now found themselves discussing the road maintenance crisis. That a problem had worsened into a crisis in a period of five years reflected not only the magnitude of the task confronting the donor community but the apparent inadequacy of traditional methods of project implementation to address it. Unlike most construction projects, maintenance projects cannot be insulated from conditions in the recipient country, in particular from conditions in the civil service of that country. It follows from this, and from the reviews quoted above, that maintenance assistance projects must relate closely to the institutional, managerial and technical level of development of the recipient country if permanent change is to be achieved through technical assistance methods.

19. Given goodwill and flexibility from all parties, even an ill-conceived project will show immediate short term benefits as the inefficiencies of almost all maintenance departments are so great. Few maintenance assistance projects last for more than two to three years and the apparent improvements achieved have disguised the lack of fundamental change.

20. The key to any improvement in this situation must be a recognition by lending agencies and recipient governments of the real situation that will confront the consultant. This in turn, requires the lending agency to analyse the institutional setting in far more depth than would be necessary for a construction or rehabili-

tation project. The result of such an analysis should indicate more precisely than before where external assistance is most likely to promote permanent change, and avoid the application of palliatives to problems which are symptomatic of institutional and managerial faults rather than the cause of inadequate performance.

### **Current conditions and project formulation**

21. The Authors have developed and tested a check-list to assist those responsible for the identification of maintenance projects in the road subsector in developing countries. It enables the capability of local maintenance organizations to be assessed and thereby ensures that selected projects address those areas where investment could result in sustained improvements. The check-list is included as Appendix 1 and was designed to assess an organization in terms of its institutional, managerial and technical capabilities. The interdependence of these aspects of a maintenance department can be better understood if the terms are described.

#### *Institutional capability*

22. In developed economies there invariably exists a legal framework which defines the responsibilities of government ministers and senior officials. This is not always the case in developing countries with the result that considerable reliance may be placed on a senior office-holder's personal interpretation of his powers and responsibilities. Routine procedures are often ill-defined or not defined at all, and a rational bureaucratic structure capable of analysing options, formulating plans and implementing work programmes is often not available.

23. Under such conditions leadership tends to be personal and arbitrary, and to depend upon the abilities and interests of senior office-holders. Implementation of leadership decisions cannot be relied on as the lower elements in the maintenance organization are not bound within a rational and disciplined framework linking them to the policy makers at the top. Indeed their interests and objectives may be at variance with the leadership. In extreme cases the bureaucracy is analogous to a constituency whose interests senior office-holders must satisfy as a precondition for implementing policy. In Max Weber's terms, the 'depersonalisation of administrative management' has not been achieved.<sup>9</sup>

24. Fundamental to the establishment of an efficient highway maintenance department is the existence of a legally constituted body with: clearly defined powers to undertake, or to contract out, maintenance; an administrative structure appropriate to its function; reliable access to a budget sufficient to fund both maintenance operations (or contracts) and its own salary and overhead costs; established procedures for the delegation of authority and the control of funds; an adequate number of staff of suitable calibre and the ability to provide training in techniques, procedures and management. To the extent that such a body exists and functions, a country may be said to possess institutional capability to carry out road maintenance.

#### *Managerial capability*

25. Where such an institutional framework exists management can concentrate on the efficient use of human and physical resources with a clear understanding of the role and powers of the institution and its goals. Management is required to: define activities; plan; allocate resources; motivate personnel; and control and monitor performance.

26. These are continuous interactive processes which provide information on



## ROAD MAINTENANCE IMPROVEMENT OVERSEAS

where improvements can be made and their likely effects. Subsumed within these general processes are the essential road maintenance operational tasks, to: establish and update inventories; prepare budgets; prepare work plans and schedules, contracts, tasks and job definitions; manage the equipment fleet; monitor costs; and to conduct a physical and financial audit.

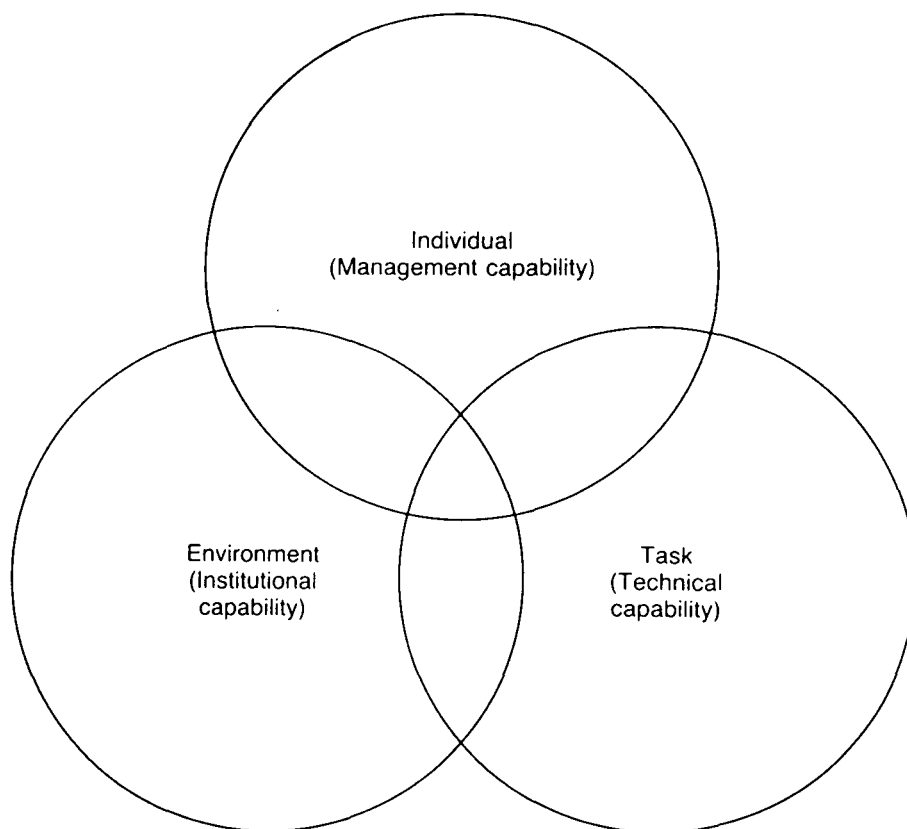
### *Technical capability*

27. Without technical resources, an institutional framework and management experience are of limited value. Sufficient numbers of competent staff are required by any organization. Lack of competence, at any level, will affect efficiency, but this is particularly important at the lower levels of responsibility, e.g. plant operators, technicians, mechanics and labourers.

28. Other requirements for efficient maintenance are: appropriate criteria for planning (these may take into account the main categories of benefit already referred to, and may incorporate a pavement deterioration model calibrated to local conditions); materials test facilities; effective quality control of all operations; implemented pavement inspection and monitoring systems; and access to research information on all aspects of road maintenance.

### **The check-list**

29. A check-list has been developed based on an assumption that interdependence between the institutional, managerial and technical capabilities of road maintenance organizations is critical to the outcome of maintenance projects. This concept is analogous to a scheme suggested by John Adair (Fig. 1)<sup>10</sup> to illustrate the interdependence of the individual, the task, and the environment within an



*Fig. 1. Adair model applied to a maintenance department*

organization. Adair sought to demonstrate that, for an organization to be effective, satisfactory performance in one area cannot be achieved without complementary capability in the others. Sufficient of each element must be in place in the road maintenance organization if improvements are to be sustainable. It may be that too much attention has been paid in the past to improvements in technical capability without first ensuring that institutional and managerial competence can support it. In many countries, straightforward relatively short term assistance to upgrade technical capability may be appropriate, but only if institutional and managerial performance is sufficient.

30. The questions included in Appendix 1 are designed to be answered in the following way:

- (a) Yes—good +1
- (b) No—bad -1
- (c) To some extent—indifferent 0

31. It was hoped that, by coding answers in this way, it would be possible to analyse the results from the check-list numerically to obtain a quantified assessment indicative of maintenance capability.

32. In order to test the check-list, several British consultants who had been involved in overseas road maintenance projects were invited to complete it based on the capability of the maintenance organization being assisted before the project was undertaken. The consultant also provided a copy of the terms of reference for the project in question.

33. Check-lists were completed for projects in ten countries with GNP/capita ranging from about US\$200 to in excess of US\$3000. If the +1 (good) scores in each category are added together and expressed as a percentage of the maximum possible score, major deficiencies are found in all of the maintenance organizations investigated. Fig. 2 shows that in no case did the aggregate score exceed 50%.

34. It is notoriously more difficult to effect institutional improvements than to

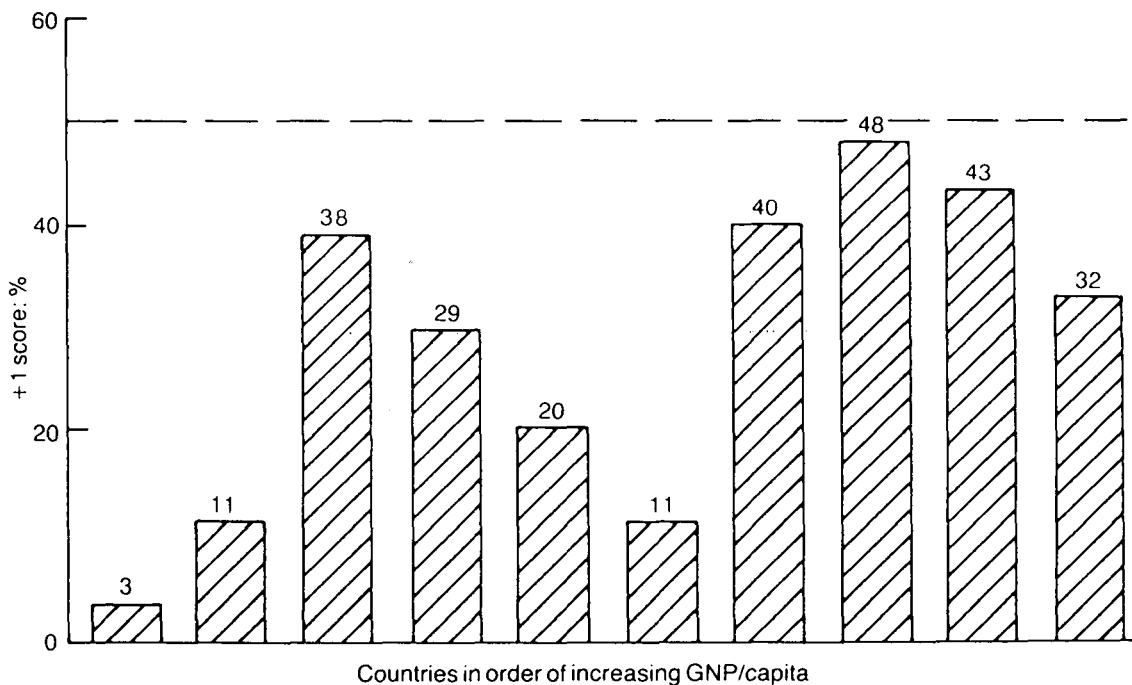


Fig. 2. Check-list results

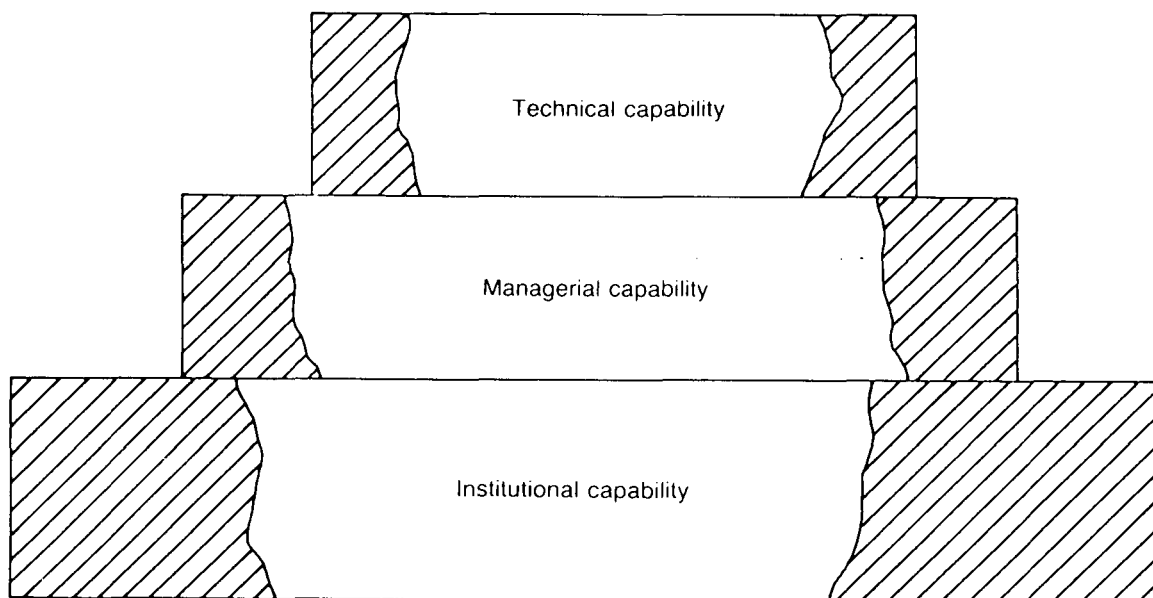
## ROAD MAINTENANCE IMPROVEMENT OVERSEAS

introduce specific management or technical advances. For example, the problem of relatively low pay for government employees and poor motivation (particularly acute in developing countries) has proved to be intractable, although it is clearly an important factor influencing the performance of maintenance departments. This leads to the perception that improvements at the institutional level are prerequisites to improvements in managerial and technical capability. There appears, therefore, to be a hierarchical relationship between these three categories (Fig. 3).

35. The results from the check-lists tend to support this hypothesis, since most of the countries reported on failed to achieve a high enough institutional score to provide the basis for investing in managerial and technical improvements. An exception was a province in China which achieved the highest institutional score, indicating that investment in managerial and technical improvements is likely to be worthwhile. By contrast, where the lowest institutional score was recorded, in Southern Sudan, it is evident that the introduction of managerial and technical improvements is unlikely to be successful without prior investment in institutional improvements. In both cases, consultants' experience supports these tentative conclusions.

36. All indications from the fieldwork reinforce the view that institutional capability is primary: that a certain level of institutional capability is required to support and sustain managerial capability, which in turn is a precondition for sustained improvements in technical competence.

37. Use of the check-list is inevitably subjective and, before more widespread application, it may need to be refined to minimize ambiguities. The answers obtained refer only to a particular time and, as such, they will be influenced by the effects of recent maintenance or technical assistance projects which may only be providing temporary improvements in the capability of the maintenance organization. However, it is believed that use of such a check-list can greatly assist aid agencies and maintenance departments to define more accurately those areas of the organization which are deficient and worthy of more detailed examination. This should ensure that aid to the maintenance sector is of the kind which has the highest chance of success.



*Fig. 3. Interdependence of institutional, managerial and technical capabilities*

### Conclusions

38. Evidence has been presented that road maintenance assistance projects have often failed to effect permanent improvements in road maintenance departments' performance. The evidence suggests that this is because the terms of reference for projects have failed to recognize the interdependence of the institutional, managerial and technical capabilities of the host organization, and in particular the resources required to achieve improvements in institutional capability.

39. Before maintenance assistance is contemplated, a thorough review of the recipient department's capabilities should be undertaken. A check-list is proposed which attempts to ensure that such a review is systematic, quantifiable, and capable of identifying areas of inadequacy. Development and refinement of the check-list will be possible as experience is gained in its use.

40. The Authors consider it likely that further investigation, using a wider sample than the ten projects tested in this Paper, would indicate that the most critical problems of road maintenance are related to the general level of development of a country. Thus, the problems of road maintenance are primarily institutional in countries with very low GNP/capita. In countries with higher GNPs, managerial and technical problems are more significant. The use of the check-list will assist in determining the appropriate mix of institutional, managerial and technical weaknesses that need to be addressed.

41. Looking beyond the design of individual projects to more general issues of policy, the perception and conclusions of this Paper may have radical implications for road maintenance lending. If it is correct that institutional, managerial and technical factors are interdependent and that institutional factors are primary, it follows that only a proportion of road maintenance projects being appraised by lending agencies will prove amenable to normal technical assistance interventions. Technical assistance, as at present carried out, is often effective in introducing new technical methods or management systems, but is less often effective in the notoriously difficult problems of institutional change. If institutional change is to be brought about, two criteria need to be met: (i) there must be full agreement at the operational level between lender and borrower as to the institutional changes required, and (ii) donors must be willing to continue providing support and technical assistance for a long period (3–10 years, rather than the more normal 1–3 years).

42. In practice this may mean treating donor assistance to institutions as a structural adjustment process in which lending for equipment purchases and operational support would be conditional on the achievement of agreed institutional improvements. Such improvements might include

- (a) the separation of road maintenance functions from other highway or public works
- (b) the establishment of a permanent training facility
- (c) the contracting out of certain road maintenance activities
- (d) arrangements to secure reliable funding, possibly by earmarking revenues
- (e) devolving authority to local offices, and providing local offices with resources
- (f) strengthening the structure of administrative control.

43. The prescription will vary with the case, but the borrower will always have the prime responsibility for making the required improvements. It will be the lending agencies' role to agree with the borrower the changes required, and to fund

and supervise the technical assistance needed to bring them about. The consultant's function would be first to make an initial diagnostic study to establish what needs to be and what can be done, and then participate in implementation. In carrying out the diagnostic study the check-list presented here provides a suitable framework.

44. Thus, in the difficult matter of institutional strengthening, borrower, lender and consultant all act as facilitators, each with a similar objective but with a different role.

45. The ideas put forward in this Paper have come a long way from conventional civil engineering. But it is always the case that the practice of civil engineering—what is built and how it is built—is profoundly conditioned by the social, political and legal environment of the time and the place. Brunel's Great Western Railway was conditioned by the attitudes and institutional environment of Victorian England, as the M25 is by those of England in the late 20th century. The Third World's road maintenance crisis is perhaps an extreme case of the dependence of engineering achievement on institutions and official attitudes. To ignore this puts its solution into question.

### **Acknowledgements**

46. The work described in this Paper forms part of the programme of the Transport and Road Research Laboratory and the Paper is published by permission of the Director. The views expressed in this Paper are not necessarily those of the Department of Transport or of the Overseas Development Administration.

47. Several of the consultants participating in the study of road maintenance projects asked not to be identified. To be equitable, therefore, none of them have been identified. The Authors nevertheless thank them for their participation and co-operation.

### **Appendix 1. TRRL road maintenance check-list**

1. *Institutional capability*
  - 1.1. Legal powers
    - 1.1.1. Is the responsibility for road maintenance legally defined?
    - 1.1.2. Are all roads the responsibility of the maintenance department?
    - 1.1.3. Are the legal powers understood?
    - 1.1.4. Are the powers adequate?
  - 1.2. Administration
    - 1.2.1. Is there an administrative structure capable of maintaining roads?
    - 1.2.2. Is there an unambiguous chain of command?
    - 1.2.3. Are responsibilities defined?
    - 1.2.4. Are staff aware of their responsibilities?
    - 1.2.5. Are decisions independent of the influence of nepotism, favouritism, graft or corruption?
  - 1.3. Human resources
    - 1.3.1. Are there sufficient personnel available?
    - 1.3.2. Are they adequately trained?
    - 1.3.3. Are they adequately motivated?
    - 1.3.4. Is there an internal training scheme?
    - 1.3.5. Are there operations manuals?
  - 1.4. Budget
    - 1.4.1. Is a budget awarded?
    - 1.4.2. Is it adequate?
    - 1.4.3. Can it be relied upon?
    - 1.4.4. Are operations independent of foreign exchange constraints?

## BROOKS, ROBINSON AND O'SULLIVAN

- 1.5. Financial control
  - 1.5.1. Does full financial control reside within the maintenance authority?
  - 1.5.2. Are accounts independently audited?
2. *Managerial capability*
  - 2.1. Inventory
    - 2.1.1. Does it exist?
    - 2.1.2. Is it up-to-date?
    - 2.1.3. Does it cover location and classification of all roads and structures?
  - 2.2. Planning and programming
    - 2.2.1. Is work programmed according to defined priorities?
    - 2.2.2. Are the costs and benefits of programmes assessed?
    - 2.2.3. Is programming done within a plan designed to preserve or enhance the network in the medium/long term?
  - 2.3. Budgeting
    - 2.3.1. Is there a regular and formal budgeting process?
    - 2.3.2. Is this related to actual costs and the ability to disburse?
  - 2.4. Cost control
    - 2.4.1. Is work done measured and costed?
    - 2.4.2. Are costs realistic in terms of overheads, equipment, materials and labour?
    - 2.4.3. Is cost information collected centrally and used for budgetary purposes?
    - 2.4.4. Is there a physical inspection and audit of work done?
    - 2.4.5. Is productivity measured?
  - 2.5. Plant and equipment
    - 2.5.1. Is there a fleet of plant and equipment of the size and composition required?
    - 2.5.2. Is the availability adequate?
    - 2.5.3. Is the utilization adequate?
    - 2.5.4. Are the workshops and stores adequate to support it?
    - 2.5.5. Is there an organization capable of managing the fleet cost-effectively?
    - 2.5.6. Is adequate financial provision made for replacement and repair?
  - 2.6. Supplies
    - 2.6.1. Are materials available as required?
    - 2.6.2. Does an adequate system exist for ordering and stockpiling road maintenance materials?
3. *Technical capability*
  - 3.1. Planning
    - 3.1.1. Are the criteria upon which road maintenance planning is based constantly under review?
    - 3.1.2. Do strong links exist between those responsible for road maintenance planning and those responsible for:
      - (i) design and construction?
      - (ii) traffic surveys and forecasting?
      - (iii) road safety?
  - 3.2. Materials
    - 3.2.1. Are the properties of materials used fully understood?
    - 3.2.2. Are there adequate testing facilities?
    - 3.2.3. Are materials of sufficient quality and quantity available?
    - 3.2.4. Are appropriate materials always used?
    - 3.2.5. Are testing methods appropriate and carried out at the appropriate frequency?
  - 3.3. Quality control
    - 3.3.1. Is quality control of products and materials adequate?
    - 3.3.2. Is quality control on site adequate?
  - 3.4. Condition measurement
    - 3.4.1. Are roads inspected systematically to determine maintenance requirements?
    - 3.4.2. Are physical measurements made of road condition to determine maintenance requirements?

## ROAD MAINTENANCE IMPROVEMENT OVERSEAS

- 3.4.3. Are condition measurements made using sophisticated or high speed instruments?
- 3.5. Field monitoring
  - 3.5.1. Is there any systematic monitoring of:
    - (i) quality of work?
    - (ii) work methods?
    - (iii) material quantities used?
    - (iv) hours spent on job?
  - 3.5.2. Do the results of any monitoring feed back into the future planning process?
- 3.6. Research and information
  - 3.6.1. Is there adequate access to current work on road maintenance from other road maintenance organizations or international research centres?
  - 3.6.2. Is research on road maintenance currently carried out within the organization?
  - 3.6.3. Are new techniques and practices introduced as a result of research results?

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