RESPONSIBLE PAVEMENT MANAGEMENT
FROM TECHNICAL TO POLITICAL RESPONSIBILITIES

Peter Schut and Geert Fuchs,
DHV Environment and Infrastructure,
Amersfoort, The Netherlands
peter.schut@dhv.nl

Philip Joubert
Stewart Scott International Transportation Division,
Sandton, Republic of South Africa
PhilipJ@ssi.co.za

ABSTRACT

When considering the highway maintenance process it is vital to achieve good communication between policy makers, those concerned with pavement management and the general public. A Pavement Management System (PMS) occupies a fundamental role in this field by providing concise, objective information and thus eases the assessment of alternative maintenance strategies. A PMS is a valuable and multi-functional aid to effective pavement management. As a management and policy tool a PMS is an extremely useful instrument in the translation of political decisions and policy statements into a viable maintenance plan within the budgetary constraints. A PMS as a technical tool aids the choice at project level by determining the most effective methodology for this maintenance plan.

In the early stages of the PMS all available highway data was stored within the software database. This proved to be an inefficient use of the resource and lead to excessive storage and data management requirements. Data collection has now been redefined so that only data deemed necessary is stored i.e. the road condition survey, relevant quantities, traffic models and trigger values. From this raw data the most cost effective solutions with their prices are generated.

For the financing of the remedial works a dedicated road fund is one possible solution. Great care must be taken in defining the scope of the works financed by the road fund.

The Integrated Management of the Public Space methodology (IMPS) is going to be important in determining scheme priorities. Within this IMPS it is possible to compare technical values with other values that are not easily quantifiable, e.g. amenity value, perception and environmental priorities.

In South Africa the national PMS guideline document (TRH22, draft 1994) is in urgent need of updating to reflect the development in the field of pavement management and IT. Of particular interest are the performance management system requirements in the Municipal Systems Act. Financial ratios, which, amongst others, include operating expenditure, will be used to compare the efficiency of municipalities countrywide.

PMS is an operational tool for municipalities for almost 20 years and in the Netherlands almost 75% of all the municipalities are using it! It is a success story in the Netherlands. The clue to the success is the clarification of the role of the PMS in the decisionmaking process and ***to keep it as simple as possible!***

KEY WORDS

PAVEMENT MANAGEMENT / PLANNING AND BUDGETS / MAINTENANCE STRATEGIES / ROLES AND RESPONSIBILITIES / COMMUNICATION / PMS

1. INTRODUCTION

By controlling budgets policy makers have a tremendous influence on the processes of pavement management and maintenance. Within these financial constraints the pavement managers have to prioritise the necessary maintenance tasks and formulate the most cost effective program of maintenance works.

The PMS has proved itself to be an indispensable aid in the communication between those responsible for developing and implementing the highway maintenance policy. The PMS is able to show either the resultant condition of the pavements based on strategic decisions and available budgets or the budget required to attain a desired condition of the road network. Thus it can be seen that the PMS has a central position in the management of pavement maintenance, as a technical tool, a management tool and a policy tool.

The experience in the Netherlands is that since the introduction of PMS's in the early 80's, 75% of all of the local authorities (municipalities and provinces) are utilising a pavement management system. DHV is responsible for the implementation of a PMS in approximately one third of these authorities. In South Africa, a similar trend exists where all National, Provincial and large local authorities use PMS's for the provision of decision making information.

2. THE MAINTENANCE PROCESS

The experience generally is that it is very important that all the staff know their responsibilities in the organisation. This guarantees that the process of the PMS is performed correctly (see figure 1).

A pavement management system has in this process two main functions. Primarily the PMS delivers information about the pavements at network level for the policy makers, i.e. it acts as a communication tool. Secondly, it ensures that the money at project level is efficiency spent, the technical tool.

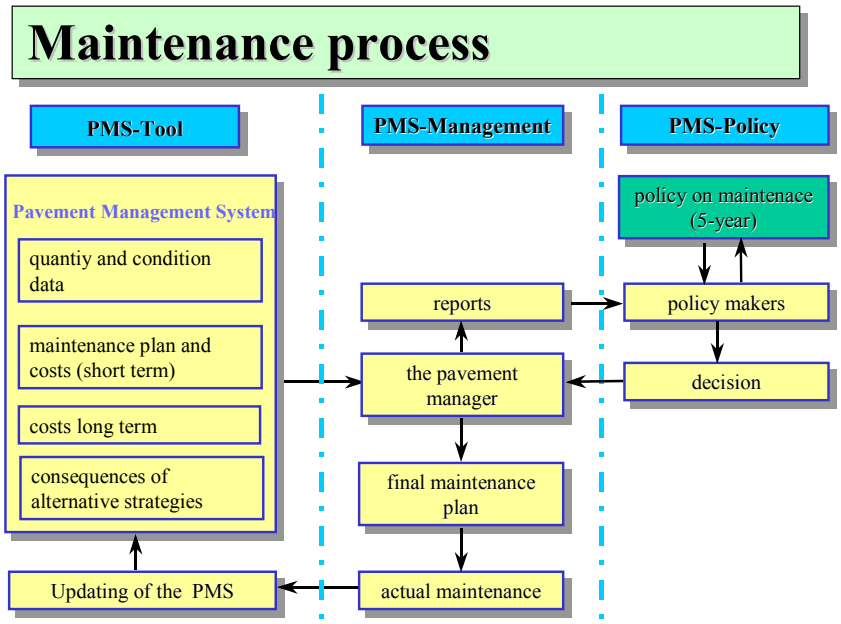

FIGURE 1 The Maintenance process

2.1 Information at network level

The information at network level is of great interest for the decision makers and budget directors because it helps to justify the short and long term decisions that have been made by the policy makers. These decisions include:

- the technical, economical and financial aspects related to the principal options of maintenance and rehabilitation
- the strategic order for prioritisation, scheduling and location of maintenance and rehabilitation projects
- the budget reservation and evaluation.

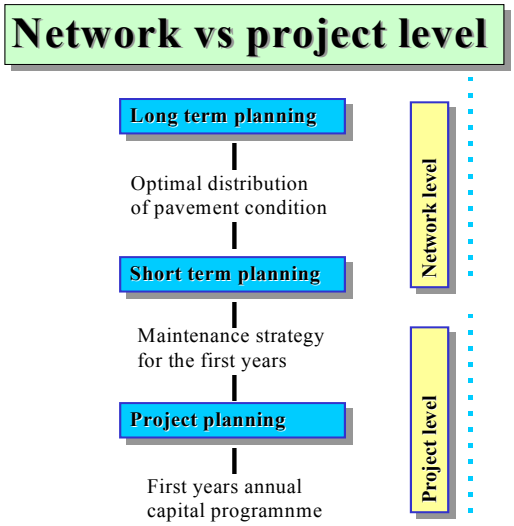

FIGURE 2 Project and network level

With the PMS the information (at network level) on the short and long term effects of several maintenance strategies can be compared. The policy makers are therefore informed and their responsibilities are pointed out. With this information a good choice of the various options can be made and the decision for a certain maintenance strategy is then made by the responsible politicians. The maintenance strategy is of course coupled to the specific budget.

The decision on a strategy in both the Netherlands and South Africa is not only a technical. The development at this moment is that social aspects influence the maintenance strategy.

This is a logical development, although the technical evaluation still forms the base for decisions. When the policy makers choose one of the strategies it is the duty of the pavement manager to inform them of the long term effects. In most of the cases the policy makers are elected for a period of 4 years. Since a PMS evaluates strategy with a longer impact than 4 years, some of these strategies can create a conflict of interest. For these situations an objective PMS is of utmost importance for the pavement manager.

2.2 Information at project level

The project level is of greater interest for the technical staff and pavement managers. This level determines the most efficient maintenance in terms of costs over a given period of time. On the project level the maintenance plan is prioritised and detailed into separate projects. With this information the pavement manager can evaluate the treatments, priorities and implementations.

The information on the short term (0 - 5 years) is more exact and detailed than the information for the long term (more than 5 years). Although prediction models are improving it is very difficult to accurately predict the maintenance actions and the costs for a period of more than 5 years, based on the information of the road condition survey Therefore it is only realistic to predict for the short term. The maintenance costs for the period longer than 5 years should determined in another way.

In most of the cases the available budget for the maintenance of the pavements is insufficient. The PMS is in this case a technical tool to prioritise the maintenance activities.

3. THE PMS TOOL

As shown, the PMS is a vital part of the maintenance management process in all aspects. It is not only a way of communication with the policy makers, but it is also a tool to determine the priority and type of maintenance required. Therefore with the system it is possible to know what and when action have to be done. The system described in this paper was developed by DHV, based on the Dutch CROW system for PMS.

3.1 The process

The process of a pavement management system contains several annual activities:

- updating of the PMS, inventory data (quantity)
- condition survey of the pavements (quality)
- maintenance plan and costs for the short term (0 - 5 years)
- budget for the long term (more than 5 years)
- consequences of alternative strategies.

3.2 Updating of the PMS

A PMS can only be useful when the stored data is up to date. The data must be correct and recent. In the early years (since 1985) extensive and very detailed data corresponding to the pavements were collected. Later it was realised that a problem was created with all

this information in the database: the problem of updating! The data is only of use when it is current! Now in the Netherlands only the basic and rough data is collected and updated:

- road number and name
- road section
- cross section - *carriageway, footpath, . .*
- length
- square meters
- existing pavement type - *asphalt, block pavements, concrete*
- the age - *since last major maintenance or construction*
- road category - *the traffic type and volume.*

Any changes to this information must be current and sufficient for the rest of the process. The priority list of the selected maintenance sections with the type and costs of treatments can be compiled with information on the current condition of the pavements.

3.3 Condition survey of the pavements

With a road condition survey two inspectors survey the pavement condition on the various kinds of pavements, including asphalt, blocks and concrete. To ensure an objective assessment the inspectors use a defect catalogue (assessment manual) in which the defects and the condition ratings have been described. The defects include for example:

- texture - *ravelling*
- evenness - *depressions, rutting*
- cracking - *alligator cracking*.

The objectiveness of the survey is very important. In fact in the whole process this road condition survey is the most critical part. If the results of the survey is not objective, the results of the planning and budgeting will not be objective. When surveying with only one inspector it is more difficult to get an objective result. To get a more objective result, it is better to survey with two inspectors. They can be in discussion with each other about the defects.

A typical result is described in the figure 3.

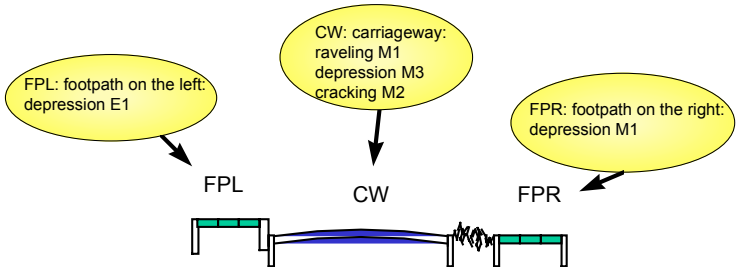

FIGURE 3 The results of a survey (project)

For every section the surveyors must assess all of the defects in severity and extent. In the example the evenness for the footpath on the left is 'failed' (E) and the extent is 'localised' (1). This combination is translated to a number 5 on a 5-scale, in which 5 is failed and 1 is excellent.

When the road condition survey is finished, the pavement manager will know the condition level of the pavements of his total city, categorised by asphalt and elements (blocks). See example in Figure 4.

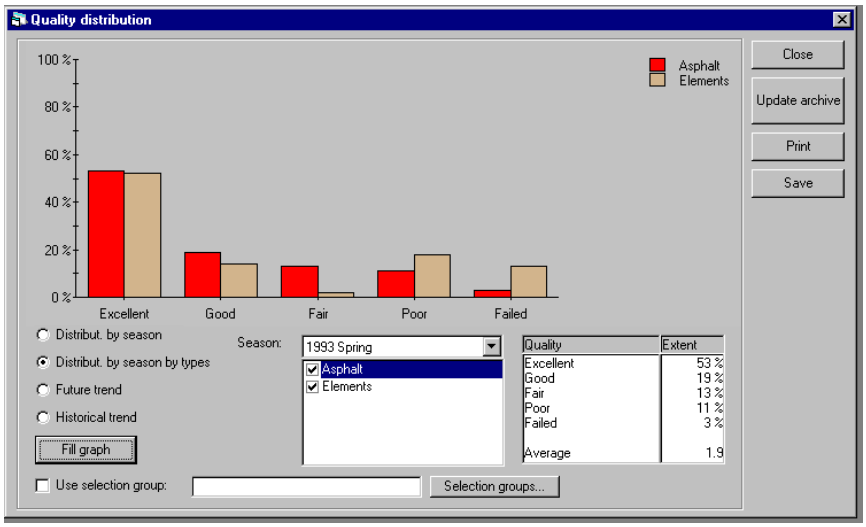

FIGURE 4 The results of a survey (network)

The pavement manager now knows the condition level, and combined with the quantities, behaviour models and warning levels, he can develop his maintenance plan.

3.4 Maintenance plan and costs the short term (0 - 5 years)

The maintenance plan establishes the most effective way of assessing treatment and the costs. This includes the timing of the treatment, in other words the priorities. The input parameters for the process in which the priority is defined are:

- the condition
- the age
- the road category and the construction
- behaviour models and warning levels.

Differentiation is made between the short term (0 - 5 years) and the long term. The results of the road condition survey and all the data from the PMS about the pavements does not allow accurate prediction of treatment type for a period longer than 5 years. There are many influences affecting the road over that long period, making long-term predictions very inaccurate.

For the short (0 - 1 year) and the middle term (2 - 5 year) we are able to predict the kind of treatment. For every section which has to be maintained in the next 5 year period we evaluate several treatments and select the most effective. This is done by looking at the period of 25 years after the first treatment.

A PMS helps the pavement manager to define the priorities and select the most effective treatment. A PMS is not able to interpret effects of the environment in which the pavement is located. A treatment check by means of a site visit or panel inspection is necessary. First of all the treatments for the short term must be checked. Next the pavement manager has to look for any other technical plans (activities) which could have their effect on the pavements. And last but not least, there is the influence of the public. And last but not least, in the Netherlands and South Africa there is the influence of the public. In many cities the residents can influence the process of maintenance, in terms of the priorities and in the type of treatments. We must take care that this development is kept in balance with the technical aspects of the PMS process. Only when the pavement managers finally checks the list and corrects it, are the budgets reliable and correct.

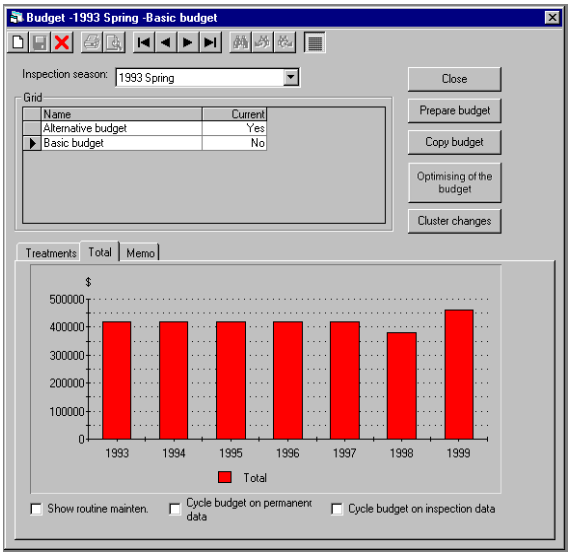

FIGURE 5 The budget (average $ 3.600.000)

The figure shows the budgets required for the next 5 years.

3.5 Costs for the long term (more than 5 years)

The required budgets for the next 5 years are interesting, but the budgets for the period after these years are just as important. There is however hardly realistic predictions possible for the long term budgets based on results of the condition survey. This budget is rather calculated on the life cycle of the three major pavement types with several pavement structures and several road categories. The most important factor is the lifecycle itself. The pavement manager is able to define the lifecycles. A basic assumption in defining the lifecycles is the fact that the pavement condition is at the desired level. The result is an annual budget that is sufficient to keep the maintenance at an acceptable level. It is very important is to define the works (treatments) covered and not covered within this budget. In the chapter on funding this point is discussed further.

3.6 Consequences of alternative strategies

As we have seen the current condition level is obtained through the road condition survey. With the results of the treatments on the defects, we can determine the effect on the total condition level. The target can be: not to have very poor (failed) roads. But on the other hand the roads need not all be in an excellent (very good) condition. There should be a balance between failed and excellent roads in the network. With the defined basic budgets the effect on the condition level of the pavements can be illustrated (Figure 6).

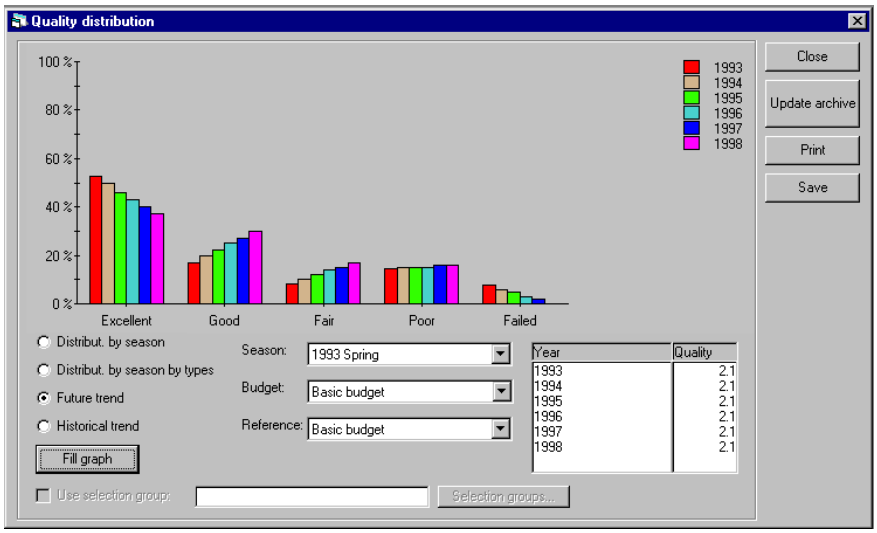

FIGURE 6 Condition level by base budget

When for instance the available budgets are only half of the required budgets, the effect on the overall condition can be illustrated with the PMS.

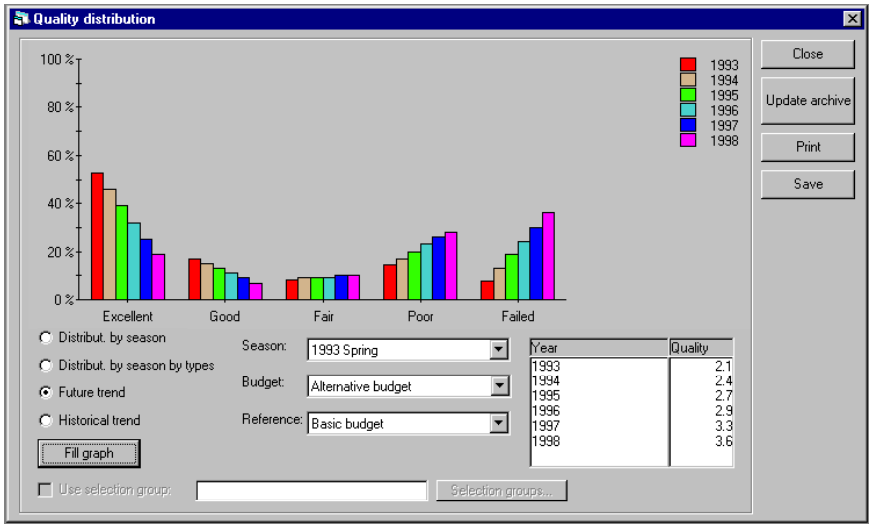

FIGURE 7 Condition level by alternative budget

Conclusion: when the available budget is equal to the required budget, there will be no failed roads. When the budget is halved, almost 40% of the roads will be in a failed condition in year 5. Failed roads could cause accidents and other dangerous situations.

For many authorities the financing of the maintenance is a difficult process. One of the solutions could be a dedicated road fund.

4. A DEDICATED ROAD FUND

There are many ways of financing the road maintenance. When the available budget is sufficient, the planning, programming and scheduling can be undertaken

at the right time. The budgets generated with a PMS often leads to a discontinuous budget-line. To ensure the continuous volume of work every year for all the involved parties an equalised budget is however desirable. A PMS can prioritise the maintenance for equal budget-lines.

For financing the budgets an organisation has two options. One option is to finance the treatments every year directly. This means that every year budget-decisions have to be made. The second option is to create a dedicated road fund. The principle of a road fund is that a budget will be given to the road fund every year and the pavement managers are responsible for the management of this budget. The decision on the level of the budget should be made only once for a period of 5 years.

In several cases in the Netherlands, a dedicated road fund as shown in Figure 8 has been created. With the creation of road agencies in Southern Africa (e.g. National Road Agency, Johannesburg Road Agency, Northern Province Road Agency, etc.) in recent years, this tendency will also develop there.

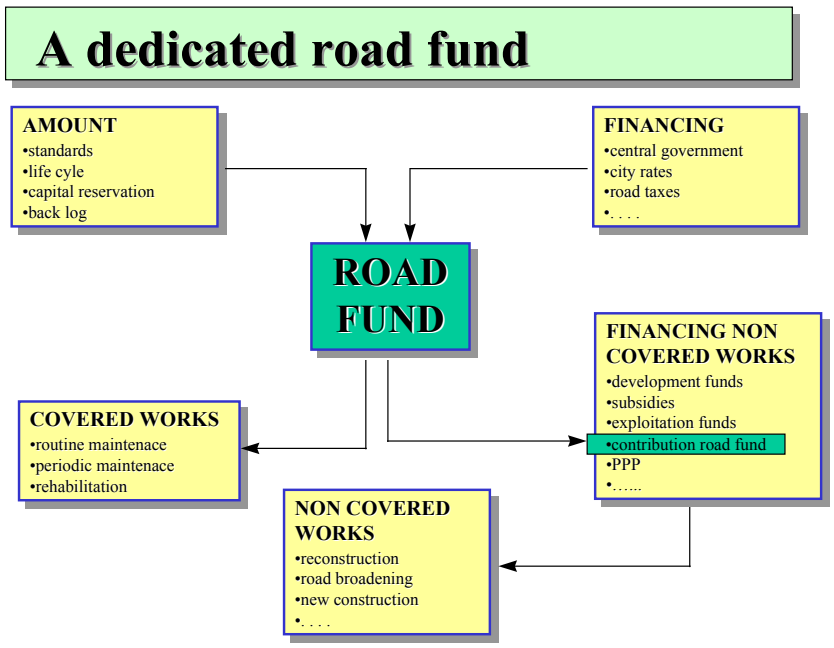

FIGURE 8 A road fund

It is very important to define the works financed by the Road Fund, and also those that are excluded (non covered works). The covered works could be the periodic maintenance, routine maintenance and rehabilitation. In other words, those works are covered, that ensure the present functionality of pavements for an indefinite period:

- Periodic Maintenance
  This is the maintenance type that is best suited to a PMS. This is to prioritise the timing and the type of treatment (e.g. surface treatment, overlay, ...) based on the results of the road condition survey. The annual budget that is required for this type of maintenance is based on the life cycle strategy. This budget must be sustained in the road fund every year. For backlog work, a once-off budget has to be allocated to the road fund.
- Routine Maintenance

The routine maintenance budget is related to the budget for periodic maintenance. A study by DHV in the Netherlands has concluded that the budget for routine maintenance on asphalt is about 10% (5% - 15%) of the budget for periodic maintenance. This is the average over all the road types. For block pavements it is 20% (15% - 25%). For concrete it is not possible to define a percentage, but historic budgets will define this budget. Therefore, when the required budget based on lifecycle is defined, the budget for routine maintenance can be defined and allocated yearly to the road fund.

- Rehabilitation
  The budget for rehabilitation is based on the average costs for the pavements (per square meter per year) over the lifecycle period of a pavement. The costs are based on a major treatment at the end of the lifecycle to upgrade the pavement. With the information on the surface area for the different pavements, the budget for rehabilitation can be defined. This budget must also to be sustained in the road fund.

The non covered works should not be included in the road fund but financed in other ways. Development funds, subsidies, exploitation funds and PPP-construction should lead to the financing of the non covered works. When a section is due for maintenance, for instance a road widening is required, a contribution from the road fund to these non covered works would be appropriate.

Periodically the pavement manager reports to the politicians on the process. In the Netherlands road funding is not widely accepted because the road funds can limit the liberty they have in spending money for other purposes. However, the experience of DHV in those cases in the Netherlands where a road fund has been created, both the politicians and the pavement managers are very satisfied. The politicians, because they are not forced every year to deal with a difficult subject and decisions. The pavement managers because they have the responsibility for the budgets and can prioritise within this budget without having to apply every year and hope that the required budget will be allocated.

5. FUTURE DEVELOPMENTS

Major developments that influence PMS's are happening in the Netherlands and in South Africa.

5.1 THE NETHERLANDS

The development in the Netherlands is development of the Integrated Management Public Space methodology.

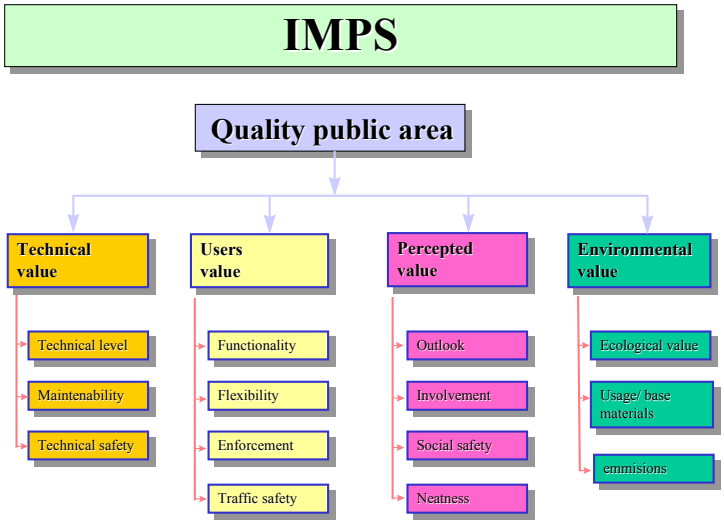

FIGURE 9 The IMPS-methodology

As previously mentioned, the public is getting more influence in the field of road maintenance. Therefore DHV has developed a methodology called IMPS. This methodology makes it possible to compare different values in the public space on which choices can be made.

Priorities from the policy makers, pavement managers and public can thus be translated to maintenance priorities. The key elements of the methodology are shown is Figure 9. Pavements, structures and landscaping are scored on very different aspects. By using multi-criteria analyses overall priorities can be defined.

5.2 SOUTH AFRICA

Of particular interest in South Africa with respect to municipal infrastructure management, are the performance management system requirements in the Municipal Systems Act. Cost effective infrastructure management is a variable in the performance targets for municipalities and their employees. Large performance bonuses are to be paid to senior officials who meet their targets. Financial ratios, which, amongst others, include operating expenditure, will be used to compare the efficiency of municipalities countrywide.

6. CONCLUSIONS

A PMS in the maintenance process is a valuable tool for providing objective information and allowing policy makers and budget directors to reach their strategic decisions. A PMS also aids the pavement manager in the translation of the policy statements into a final maintenance plan. A PMS is an integral part of the decision making process and ensures that those making the decisions take the responsibility for those decisions.

To avoid carriageway failures on the existing highway network, the available maintenance budget must at least be equal to the requirement. The PMS with its many attributes is able to simultaneously generate the effect of several remedial

strategies on the condition level of the road network concerned. In a report from the pavement manager to the decision makers the actual condition level can be submitted together with the required and available budgets. By using the PMS the comparative consequences of the alternative options on the condition level of a road network can easily be presented visually. A dedicated road fund may be the key to the elimination of highway failures that are a result of a lack of programmed maintenance.

The budget for a dedicated road fund should be based on the results of the Pavement Management System. This budget is objective and should be maintained at a constant annual level over the predefined period. The presence of a road fund allows politicians to make critical policy decisions only once during their term of office, say every 5 years. The pavement manager however must still report the current performance against targets and cost of the maintenance program every year. The works financed by the road fund are the routine maintenance, periodic maintenance and rehabilitation as previously defined. Other works do not fall within the scope of the road maintenance fund.

The Dutch and South African nations have more than 20 years of experience with PMS, and the development of the methodology is still in progress. The developments in what the Dutch call 'the public space' has lead to a new methodology, the IMPS-process. IMPS makes it possible to prioritise the programmed maintenance works in accordance with input data from numerous sources.