ROLE OF THE ROAD MANAGEMENT SYSTEM IN THE ROAD TRANSPORTION SECTOR (Namibian Experience)

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1. INTRODUCTION TO THE NAMIBIAN ROAD MANAGEMENT SYSTEM (RMS)

The aim of this paper is to show how the role of RMS is crucial in the transportation sector, by describing practical examples of the Namibian RMS. Increasing demands for better services under constrained budgets are increasingly creating challenges for transportation Authorities. Better management systems are urgently needed to support more effective decision making. An Integrated Road Management System is such a tool for properly co-ordinating, evaluating and maintaining infrastructure systems.

The development of Road Management Systems (RMS) has started in the early 1960's as a concept, but since it has been implemented in many Countries and Authority's. It has become a part of a process, which is a modern day necessity in road organisations.

At the "Fourth International Conference on Managing Pavements" it was clear that the integration of all systems under an Infrastructure Management System / Asset Management System was important for proper control.

A Road Management System (RMS) provides a set of decision support tools, based on standardised data sets, that is used in the road management process to help make decisions in a structured manner. Such a system will identify and prioritise needs on the road network to sustain an appropriate condition at the least possible cost.

As an essential component of any company or organisation dealing with roads, a RMS is inevitable for proper and optimised planning. Its purpose is to identify needs, quantify needs and prioritise needs and assist in planning and management. This goal can only be achieved if the decision-makers in the organisation are convinced, hence the RMS Engineer, or Managers have a big role to play in having a sustainable system running with the correct output.

2. NAMIBIAN EXPERIENCE

Many systems were stand alone and running by themselves without being integrated and on top of that there was a high loss of expertise in the old Department of Transport. This led to the drawing up of a Master Plan where the objectives were to:

- Evaluate the existing systems and situation.
- Provide recommendations and guideline regarding; System approach to flow of activities, Computer requirements for Integration, Requirements for Integration, System dependencies and Development Plan.

The RMS as in only a computer system cannot replace engineering judgement; the tools need to be used together with engineering judgement to get to the correct reasonable results. Hence the development of the RMS should be inclusive of engineering judgement and proper calibration so that the output is acceptable. In many Road Authorities or Department of Transports when asked how many km of roads do they have under their control - many different answers are given. This is still a reality in many organisations.

The Namibian system first put in place what is called the Road Referencing System (RRS) where every road had a start and an end point defined explicitly. This RRS had a core database where everything is stored and accessed from. To build a house a design is essential and a solid foundation likewise for the Namibian RMS the Master Plan lead to Architectural System Design (ASD). The Architectural System Design provides the logical and physical application and data architecture as well as the user requirement specification for the various sub-systems. In addition, the various sub-systems cannot be developed in isolation. They are all interdependent. The ASD stipulated the system development life cycle discussed in the following section.

SYSTEM DEVELOPMENT LIFE CYCLE

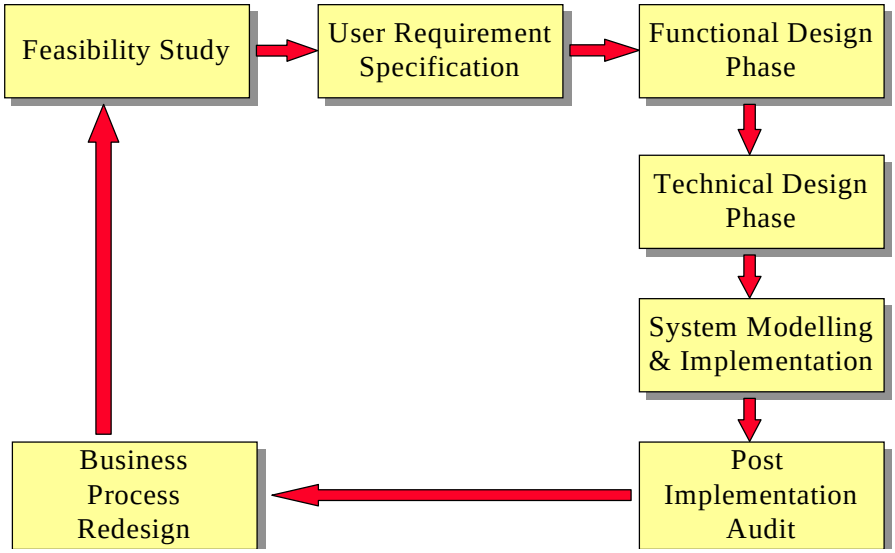


Figure 1. *System development life cycle*

The User Requirement Specification (URS) forms the basis for all future activities in the system development life cycle (Fig. 1). It entails a detail layout of the outputs required and the components of the system to achieve this. A high-level entity model is required. The aim of this activity is to provide decision-makers with a holistic view of the entire system and to give an IT company sufficient scope to enable them to quote for the actual development and implementation of the system.

The Functional Design Phase deals with the system operational requirement, infrastructure requirement, application maintenance, data flow through the applications and detail regarding processes and data validation. (Description of engineering models, inputs and outputs form part of this phase.)

The Technical Design Phase looks at the required hardware, networking requirements and database management. Detail table designs for identified entities within the system are finalised with the proposed capacity planning for data capturing and maintenance. (This phase defines the structure of the database.)

System Modelling entails the physical layout and coding of applications and reports. The implementation includes user testing of data capturing, validation, processing and reporting as well as the integration with other existing sub-systems. (Users, after training, start using the system with documentation at hand.)

The Post Implementation Audit is the comparison of the delivered system against the URS. The methodology was followed for each and every sub-system developed. The foundation was sound and hence the systems are working and are giving long awaited results. In Africa many systems are in existence but they are not giving the required results because they do not have Master Plans or ASDs. This results in spending invaluable resources for nothing and most systems end up failing.

It needs to be understood that the systems developed by developed countries may or many not work in an African environment, care needs to be taken in selecting suitable systems. Just off the shelf system cannot be taken and applied. First of all the African pavements are different from European/American countries and hence need special attention and different consideration. Secondly some of the sophisticated systems developed might be too complicated and African countries cannot sustain these systems because of the luck of resources such as funds and qualified personnel. Even if the funds for developing these systems are coming from donors it needs to be used to the benefit of the organisation. That is why Master Plans and ASDs are necessary. It is not what the donor wants that has to be implemented in African organisations but what the organisation itself wants, which is sometimes difficult to define because of luck of vision and expertise.

Hence the methodology applied in Namibia in implementing systems have been successful and hence the reason for this paper. A number of times consultants have been appointed for various studies where documents and reports have been produced one after the other, but because they are not accessible these reports are shelved and are full of dust and the knowledge remains with few people only, and hence when they die or retire everything else around them collapses.

With a proper implementation of RMS these documents will be accessible easily. For any RMS success a champion is required to take the flag and run with it - without that the RMS will not be successful.

Another crucial issue is that Africa is exporting all the educated experts to Australia, Europe and the USA. Putting such a system in place at least all the information is accessible for everyone, and the management of the road network will be transparent, efficient and effective. Some processes and rule sets will be followed that are defined explicitly. Countries such as Namibia are also affected by loss of expertise.

Systems should not be black boxes, changes should be flexible. Systems should work for the people and not the people for the system - unfortunately this is not the case in many authorities, and it is my hope that this paper will change that attitude.

3. BACKGROUND ON THE NAMIBIAN ROAD REFORM OF THE MWTC 2000 PROJECT

When government came into power with Namibia's Independence on 21 March 1990, some of its main policy objectives were to:

- revive and sustain economic growth,
- promote an efficient use of scarce resources, which would create employment opportunities, and
- help to alleviate poverty.

Government found that the availability of safe, effective and efficient transport services would be instrumental in achieving these policy objectives.

On 4 October 1994 Government adopted the "White Paper on Transport Policy" which called for the improvement in the performance of the transport sector and for encouraging increased competition as the main instrument to achieve increased efficiency.

It also called for the introduction of a system of road user charging for full recovery from road users of the costs of providing and maintaining road infrastructure according to the principle of minimising transport costs, with co-financing form general revenue sources for that part which does not directly benefit road users.

This led the way to the reform of the road sector with the fundamental and overall long term objective to minimise the total costs of road transportation to society, consisting mainly of the sum of infrastructure costs and vehicle operating costs.

This is inextricably linked to sustainable availability of funding at the required optimal level, as well as the institutional capacity to utilise such funds efficiently for the benefit or road users.

To give effect to Government's policies and objectives, the Ministry of Works, Transport and Communication launched the MWTC2000 Project during 1995 to reform the road transportation sector as well as the Ministry. A Steering Committee, consisting of the top management of the Ministry of Works, Transport and Communication, representatives of the Office of the Prime Minister, the Ministries of Finance and Trade and Industry as well as the Namibia Public Workers' Union, with the assistance of a project team and consultants successfully guided the MWTC 2000 Project towards its objectives.

The institutional arrangements for planning, designing, constructing and maintaining Namibia's national roads network has been restructured and the arrangements for the funding via the national budget will be replaced by funding via a Road Fund and a Road User Charging System.

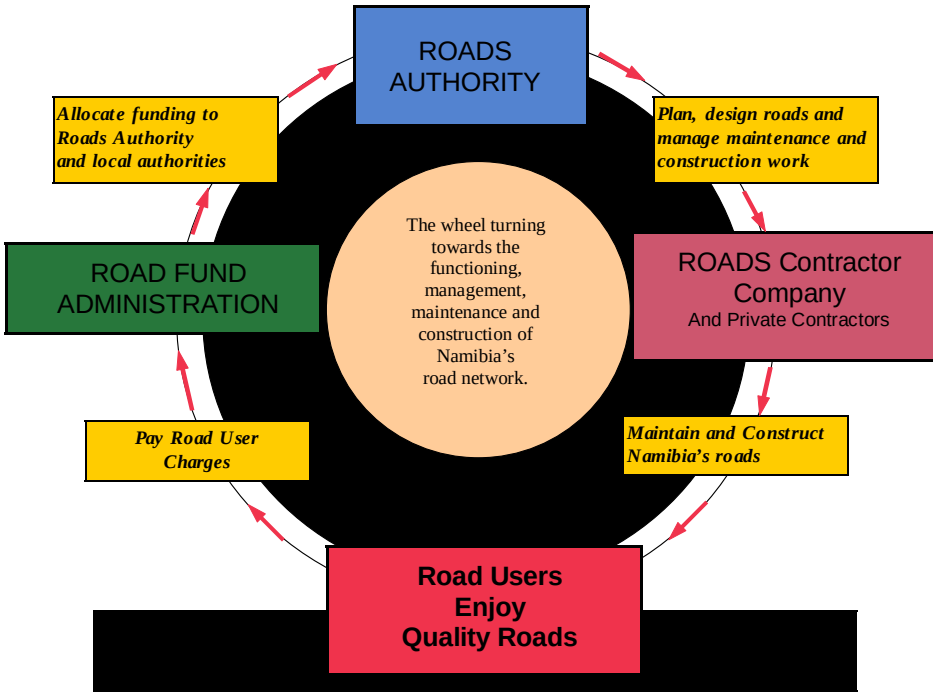


Figure 2. *Roads authority functioning*

The road reform will have many advantages, of which the most important ones are:

- It will bring about a more cost-effective and more competitive road sector
- It will promote a more equitable and equal means of recovering costs from the beneficiaries, the road users, including the heavy vehicle operators.
- The country will be thus be able to maintain one of its most important assets, the roads network of more than 45 000 km, of which 5 500 km are bitumen and the rest are all unsealed roads, on a sustainable and an efficient basis.
- It will reduce the direct role of Government in the road sector and increase the role of the private sector to participate in the maintenance and construction of Namibia's roads.
- Namibia will align itself with international standards regarding roads and the SADC Protocol on Transport, Communications and Meteorology to which Namibia is a party to.

The institutional reform has resulted in the establishment of the Roads Contractor Company, Roads Authority and the Road Fund Administration. The entities were officially launched on12 July 2000 in Windhoek. In short all the three entities will function by a governing board of directors. The Roads Authority (RA) under the auspices of the Minister of WTC, manages Namibia's rural roads network. With a staff compliment of about 250, the Roads Authority performs the planning, designing and management of the construction and maintenance of the national road network. It performs all maintenance and construction work through contracts.

The Road Fund Administration, under the auspices of the Minister of Finance, manages the Road User Charging System to secure and allocate funding to achieve a safe and economically efficient road sector. The Roads Contractor Company Limited, a company in terms of the Companies Act, is fully owned by the Government of the Republic of Namibia. The Roads Contractor Company Act (No 14 of 1999) was promulgated in the Government Gazette of 18 October 1999. His Excellency, the President of the Republic of Namibia, has

designated the Minister of Works, Transport and Communication to hold all shares in the company on behalf of the State. The objective of the company is to undertake work relating to the construction or maintenance of roads in accordance with sound and generally accepted business principles. The company has about 2 000 employees.

The companies have been in operation for the last two years. The practicality of these organisations, functionality, their efficiency and effectiveness has still a long way to go. The act is solid but its applications, as intended in the Act needs time. This paper does not look into this area.

4. INTRODUCTION TO THE MASTER PLAN OF THE RMS

Namibia had a lot of stand-alone systems, which did not interface with other, like many of the past Pavement Management Systems throughout the world. On top of that there has been duplication of efforts and data, which was very costly. Vendors would demonstrate their proprietary systems, DOT would buy them, and then there would be no support, the suppliers would vanish or would only be interested in selling their commodity without the support. Many of them looked impressive and promised to do anything, but when bought and implemented, they could not deliver the services and products as required. This initiated a need for a proper Master Plan.

Introduction and output of the Master Plan

SCHEMATIC ILUSTRATION OF THE INTEGRATED ROAD MANAGEMENT SYSTEM

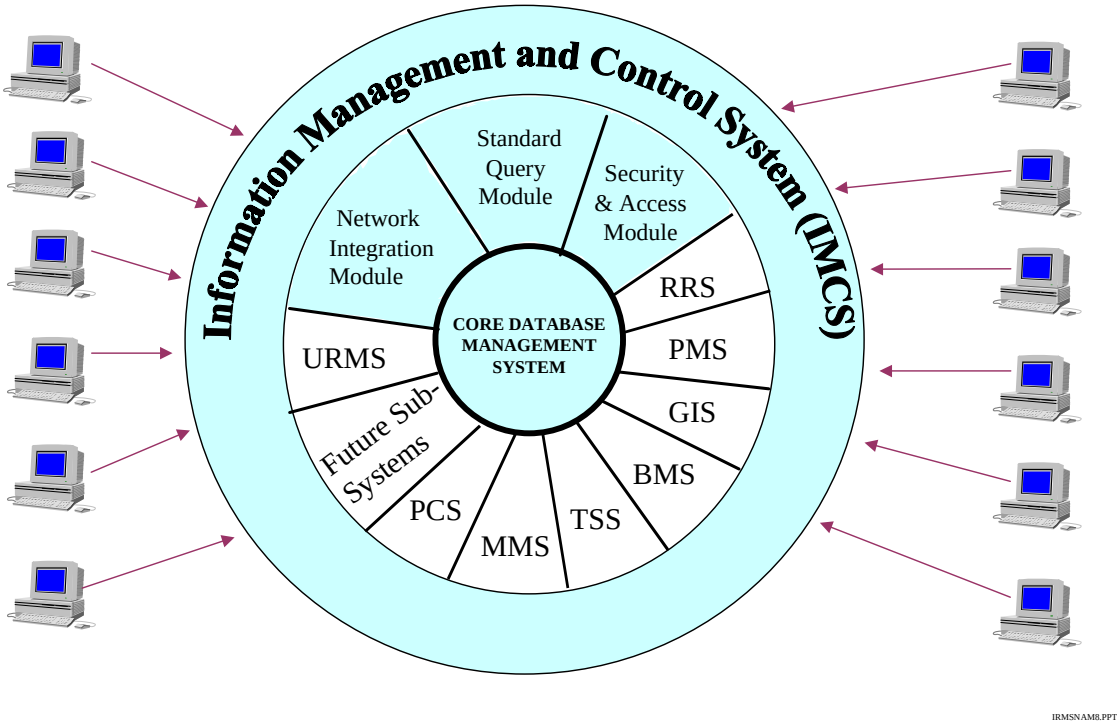


Figure 3. *Integrated road management system*

Development Path - systems already finalised

1. Architectural System Design (ASD)
2. Road Referencing System (RRS)
3. Traffic Surveillance System (TSS)
4. Information Management and Control System
5. Pavement Management System (PMS)
6. Geographical Information System (GIS)

Development Path - systems to still come and be finalised by the year 2003.

- Bridge Management System (BMS)
- Unsealed Road Management System (URMS)
- Maintenance Management System (MMS)
- Project Control System (PCS)
- Network Integration Module of IMCS

Based on technologies of road management in the world and experience in southern Africa, the Road Management System Master Plan identifies the required sub-systems and priority thereof for a sustainable RMS in Namibia.

The sub-systems, which will be incorporated in the RMS, are as follows:

- Road Referencing System (RRS) or network definition
- Information Management and Control System (IMCS)
- Traffic Surveillance System (TSS)
- Pavement Management System (PMS)
- Unsealed Road Management System (URMS)
- Bridge Management System (BMS)
- Project Control System (PCS)
- Maintenance Management System (MMS)
- Geographical Information System (GIS)

The basic principle to develop and operate a sustainable network level RMS for Namibia, is to keep each sub-system simple but to ensure that comparable parameters are produced by the various sub-systems. Simple, but sound procedures are used to identify candidate projects on the network level. Thereafter, candidate projects identified for scheduled maintenance, major rehabilitation or upgrading and the provision of new facilities will be further investigated and analysed to ensure economic justification.

The main purpose of the **RRS** is to allow controlled updating and maintenance of the network definition according to pre-determined road network referencing methodology.

The **IMCS** has the following main functions:

- Hosts and controls the core database
- Defines the main user-interface
- Provides security control to retrieve information from the database and to access any one of the centralised sub-systems
- Hosts the network integration module, standard query module and the RMS policy and rule sets

The **TSS** provides traffic information for the other subsystems to determine needs and work programmes.

The **PMS** determines needs, priorities and budgets for scheduled maintenance and structural rehabilitation. The major input into this sub-system will be formalised visual assessments, road roughness measurements, pavement deflection measurements, traffic information and the existing pavement composition.

The purpose of the **URMS** is mainly to determine needs, priorities and budgets for optimum blading frequencies, periodic maintenance (regravelling or special maintenance) and upgrading to surfaced standards. Major inputs will consist of visual assessment data, traffic parameters and material properties.

The **BMS** will determine needs, priorities and budgets for functional and structural repairs. The initial needs identification will be based on formalised visual assessments. Structures identified for repairs will be further investigated to determine accurate priorities and budgets.
The emphasis of a **PCS** is to schedule the main activities to contract stage and keeping track of progress and expenditures during the contract. The project control system should incorporate construction projects as well as any other projects necessary to manage the road network infrastructure.

The main purpose of the **MMS** is to assist in identifying, scheduling and management of day-to-day routine maintenance activities in a region or district. Input into this system will consist of public complaints, personnel observations and formalised visual assessments.

The **GIS** will mainly be used as a mapping tool to display network information produced by the various sub-systems.

The fastest way to provide integrated network results and to test the IMCS, is to develop one of the major sub-systems, identifying needs, at the same time. Combining the development of the RRS, IMCS, TSS, PMS and the GIS into one phase of development will complete the data flow and operation of one major sub-system. With this in mind, and taking into account the dependencies of sub-systems, the development of the RMS is scheduled into three phases namely:

Phase 1	RRS, IMCS, TSS, PMS and GIS	(18 months)
Phase 2	URMS, BMS, and MMS	(18 months)
Phase 3	PCS	(18 months)

Phases 2 and 3 can run concurrently.

Actual cost for the development per sub-system ranges from N$ 600 000 to N$ 1 000 000 - 1N$=1South African Rand at this stage depending on the complexity of the sub-system. The Master Plan forecast N$ 1,5 million per sub-system. This amount is just to put the shell down, and does not include the cost of collecting the data or the maintenance of the system.

5. SUMMARISED RECOMMENDED SYSTEMS FOR NAMIBIA RMS

The main requirements for a RMS in Namibia can be summarised as follows:

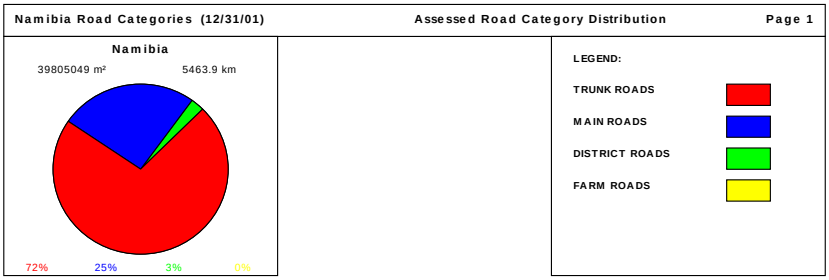
- To determine a stable funding requirement for the provision and maintenance of the road network infrastructure. This information will be used by the Road Fund Administration to determine appropriate road user charges.
- To assist the RA in being effective (doing the right things) and efficient (doing things right) in the provision of a safe and cost-effective road network.
- The primary tool to ensure accountability towards the Namibian public.

Based on experience with road management systems in Namibia and Southern Africa, developments in computer technology, the staff shortages in the RA and requirements specified for the RMS in the TOR, the following further requirements and essential features are listed:

- The RMS must be sustainable, affordable and appropriate to the decision making needs and scarce financial and manpower resources
- Be able to conform and integrate with the day-to-day activities of the RA
- Flexible for stage development and implementation in a changing environment
- In line with the RA (DOT) Information Technology Policy
- Make use of a central database for all sub-systems
- Facilities to monitor the present network condition over time
- Facilities for developing probabilistic models for predicting maintenance and rehabilitation costs
- Facilities for preparing medium- to long-term plans and well motivated estimates of funding needs
- A mapping facility for the graphical representation of the road network and related information
- A uniform user-interface for all systems

6. CURRENT SITUATION AND FUTURE

The purpose of this summary is to provide some background to the current condition of the surfaced roads in Namibia and to estimate the required stable funding level for the maintenance and rehabilitation of the surfaced road network. Namibia has in total of 5 464 km of paved roads.



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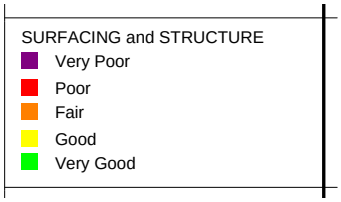

Figure 4. *Example of Road network condition display*

7. REPLACEMENT VALUE

A conservative calculation indicates a value of approximately N$ 7,7 billion to replace only the top layers and bituminous surfacing of our paved roads. This does not include the asset of the land, value of earth works, bridge structures, road furniture or the unsealed roads.

8. AGE OF THE ROAD NETWORK

Road pavements are normally designed to carry the traffic load for 20 years. This means, theoretically, that 5% of the total paved road length should be rehabilitated (strengthened) per annum.

In general, the average age of all the road pavements in the network should not exceed 10 years. Should the average age of the network exceed 20 years, this means that the majority of all the roads are past their original design life.

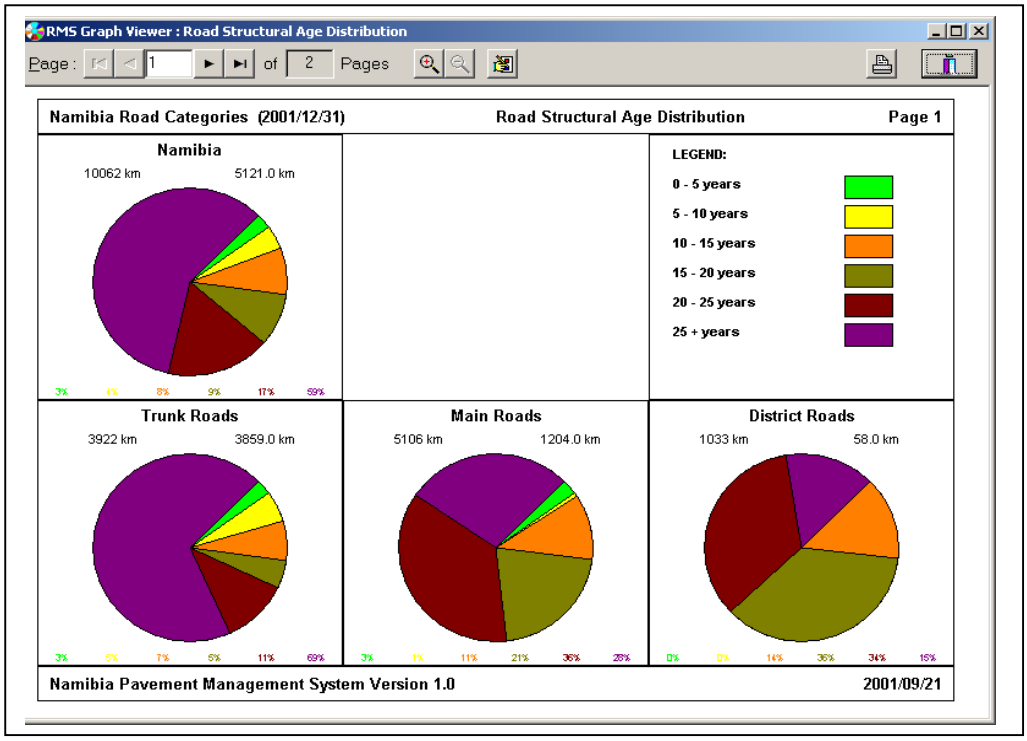

FIGURE 5. *Pavement Structure Age Distribution*

<u>OUR SITUATION:</u>
76 % of the total paved road network is more than 20 years old.

Due to our dry conditions, good road building materials and relative light traffic loads, the expected life can be extended with timeous routine maintenance (crack sealing, patching etc.) and periodic maintenance (reseal).

However 206 km can be described as “Poor” and “Very Poor”, requiring immediate structural rehabilitation and a further 497 km is considered to be in a warning state, requiring attention within the next 5 years.

The purpose of a bituminous surfacing is to prevent moisture ingress into the pavement, to provide skid resistance and to protect the pavement structure from traffic wear. The average effective life of this surfacing layer in southern Africa is 10 - 15 years – mainly due to oxidation and hardening caused by ultra violet rays, making this layer water permeable.

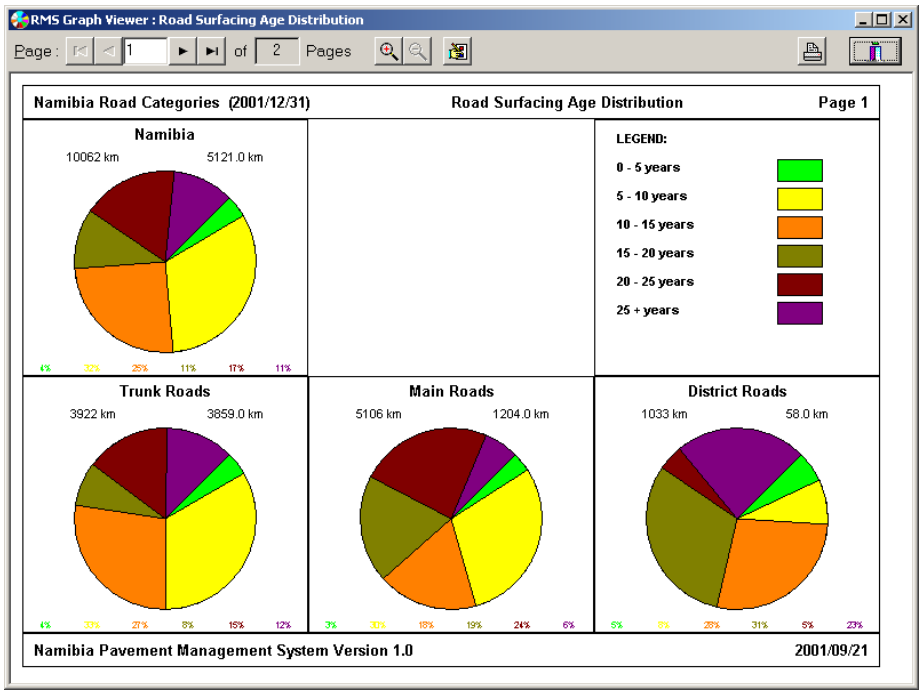

FIGURE 6. ***Surfacing Age Distribution***

<u>OUR SITUATION:</u>

72% of the bituminous surfacing on our road network is more than 10 years old and 39% is older than 15 years

9. CURRENT CONDITION

The current condition and remaining life distribution of the pavement structures and surfacing are displayed on the following pages. Although the average pavement structural condition can be described as “Good”, it must be realised that 5% of the network (approximately 275 km) has a remaining life of less than one year and that 2% of the network (approximately 110 km) would require rehabilitation each year for the next five years.

The average condition of the surfacing can be described as “Fair or Warning” as the majority of the roads in Namibia (61%) require attention to the surfacing within the next three years. Keep in mind that many roads can be treated with relatively cheap measures such as rejuvenation sprays and sand seals to extend the life of the surfacing. The PMS can be used to identify minimum measures to optimise the network condition for the funds available. However, neglecting the surfacing at this stage will result in rapid deterioration of the pavement structures. In this regard it should be mentioned that the cost of rehabilitation is approximately ten times the cost of reseal. Sufficient funding for an extensive reseal programme is considered absolutely essential.

10. NETWORK PERFORMANCE

Figures 7 & 8 display the performance of pavement structures and surfacing.

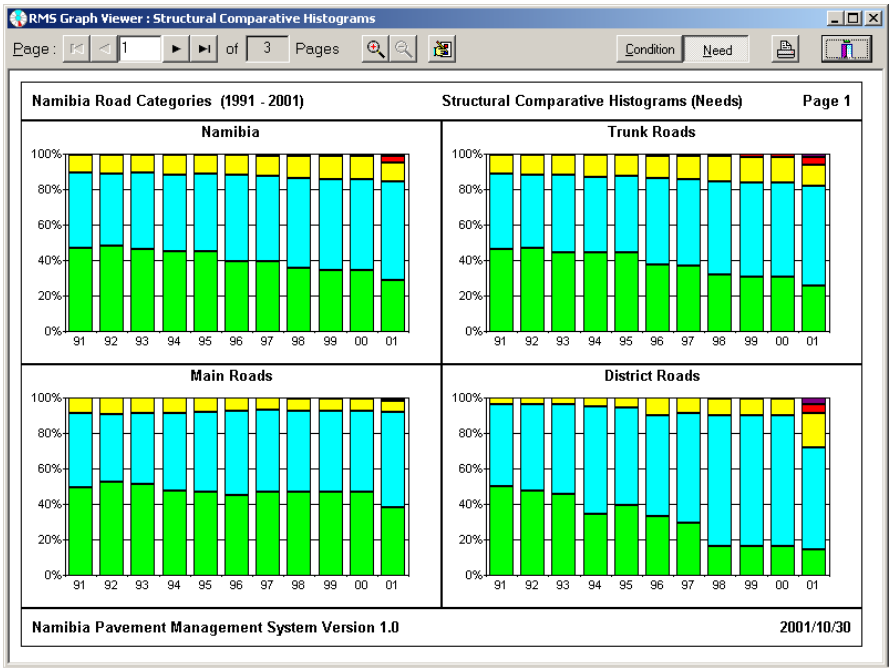

FIGURE 7 *Deterioration of Pavement Structures over the past ten years*

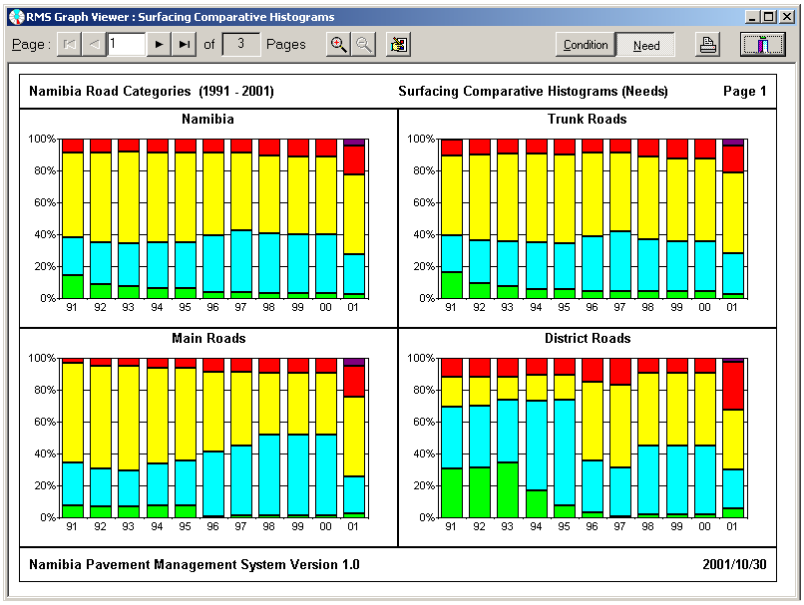

FIGURE 8 *Deterioration of bituminous surfacing over the past ten years*

11. FUNDING REQUIREMENT

Pavement Management System identified needs (2001)

FUNDING REQUIRED FOR	*1st Year need*	*Ave/annum (5 year)*
REHABILITATION	N$ 252 million	N$ 121 million
RESEAL	N$ 175 million	N$ 108 million
ROUTINE MAINTENANCE	N$ 57 million	N$ 57 million
TOTAL NEED (Surfaced Roads)	**N$ 484 million**	**N$ 286 million**

Long term requirement

The performance of every surfaced road segment has been analysed and the implications of different funding scenarios evaluated over a period of ten years.

The following graphical displays show the impact on the network condition and remaining life for different funding allocations.

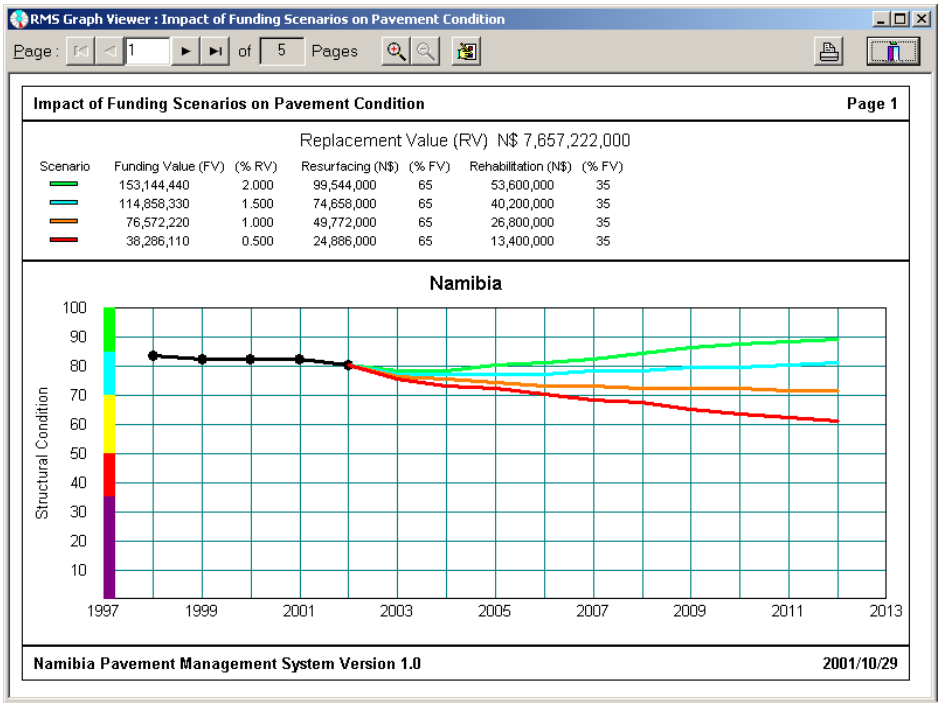

FIGURE 10. *Impact on the Pavement Structural Condition*

A minimum of N$ 115 million/annum is required for reseal and rehabilitation to maintain the current condition. Adding an average routine maintenance requirement of N$ 57 million/annum, the minimum annual requirement for surfaced roads is calculated at N172 million.

However, from Figure 11 it is evident that a higher funding level is required to increase the average remaining life to more than 10 years. A funding level of N$153 million/annum will ensure an average remaining life of 11 years. Figure 12 indicates that an amount of N$ 153 million/annum spent on reseal and rehabilitation would eliminate the backlog within ten years. Adding an average routine maintenance requirement of N$ 57 million/annum, a total amount of N$ 210 million is required per annum for maintenance of surfaced road pavements

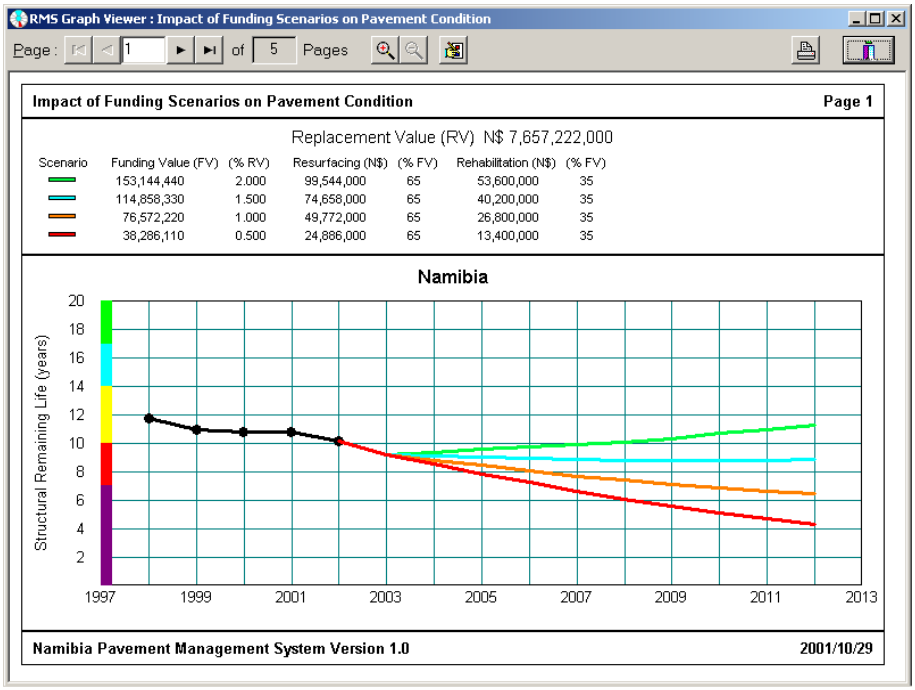

FIGURE 11. *Impact on the Average Remaining Structural Life*

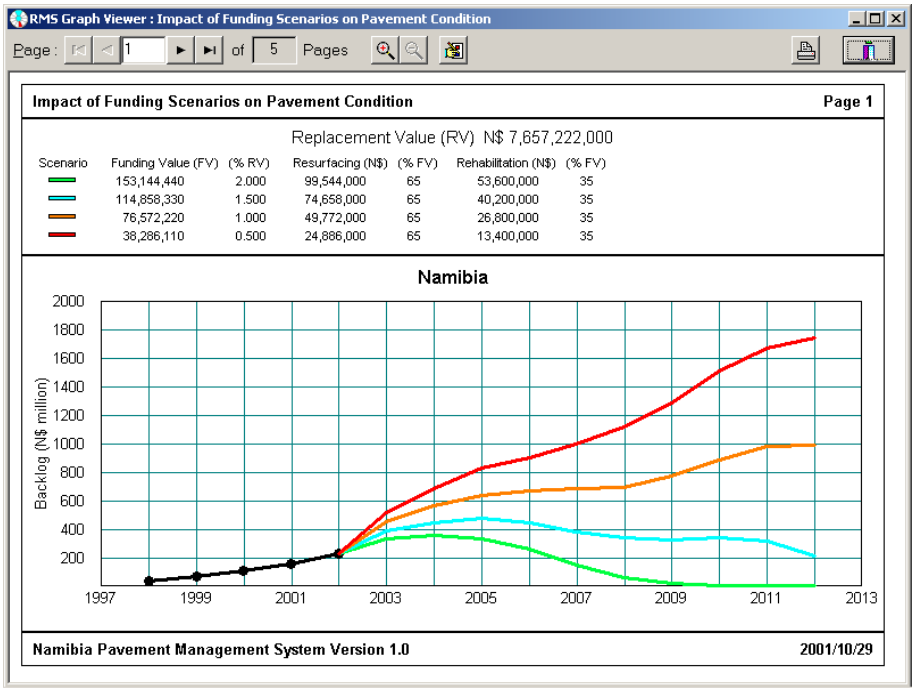

FIGURE 12. *Impact on the Backlog (Accumulative shortfall)*

Future Developments

In the optimum budget, the condition of the road network is no longer based to an extent on "thumb sucking" but on actual values and engineering judgement. The paved roads can already give the results as shown above.

The data for the entire unsealed road network will be available only end of September 2002.

In the mean time the Network Integration Module is also launched. The network integration module will collate the important summarised information from the various sub-systems of the RMS as well as manually entered information obtained from other needs not yet identified through a formal system. The Project has started with V&V Consulting Engineers being appointed as specialist to develop the system. HDM-4 will be incorporated into the NIM, as the best international tool already developed. The RMS of Namibia and HDM-4 will complement each other – HDM-4 component is funded by KfW. It is envisaged that the project will be completed by March 2003.

12. CONCLUSION

The Namibian RMS is on the right track although some of the institutional problems are still present hence selling the ideas of the RMS is still unavoidable. The role of the RMS in new roads authorities is something that one cannot turn a blind eye to, as Africa is losing expertise, and systems like these are vital for sound decision making.

That of course will result in efficiency and effectiveness, which was the whole aim of the commercialisation process. The future vision of the Namibian RMS includes having a working RMS to assist planners in better decision making and on top of that to make the Namibian RMS an Internet based system.

Although the availability of bandwidth is a major problem in Southern Africa, the possibility of adding arial photography will be regarded as the ultimate cherry on the already successful RMS cake. It is believed that the purpose of this paper is achieved, in showing how a properly managed RMS, can start giving rational management information for assistance in decision making from a strategic level, to the tactical level and even providing certain information on aspects at the project level. These results ultimately assist in sound decisions, which can be justified to the road user and serves the mission of our Roads Authority.

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HIGHLIGHTS OF QUALIFICATIONS

- Working Experience in Engineering especially in Road Management System
- Good organizational and management skills

WORK EXPERIENCE:

ROAD MANAGEMENT SYSTEM

- **Managing the Traffic Surveillance System of the Section** that is mainly supervising technicians and technical assistants in obtaining data, analysis and finally outputs.
- **Managing the Pavement Management System of the Section**. It mainly deals with the supervision of principal road superintendent, foremen, technician and hand works in obtaining data and outputs of the road network of the country.
  Visual, riding quality, deflections and pavement data are collected on the paved road network are analysed to get out puts such as remaining life, reseal priority and Rehabilitation Indees which shows the urgency of a road to be rehabilitated .
- **Managing the Unsealed Road Management System of the Section** which mainly deals with an economic analysis of the condition of gravel roads in Namibia.
- **Maintenance Management System**. Maintenance costing system of the maintenance units of all regions and districts in Namibia. Making sure data is punched in correctly outputs are produced and distributed to all relevant officials of the Department.
- **Helped specialized Consultants to develop systems for the Department of Transport. Reseal Algorithm to prioritize reseal requirements, Material Information System and a Road Referencing System. At present consultants are busy with a Pavement Management System, Traffic Surveillance System and Information and Control Management System. For these projects the RMS Chief Engineer was and still is the project leader from the Department's side.** The work includes from the appointment of consultants to the day to day control of the Consultants to produce the results expected. The goal is to produced systems to help managers mange their work effectively and efficiently. With a click of a button any information on the network of Namibia would be possible with the map viewer for the public as well. The IT component is also the major part of the development of these systems.

REGISTRATIONS AND MEMBERSHIPS

An Executive Council Member of the Engineering Council of Namibia and is registered as a professional engineer with the council, PE 95013

A council member of the EPA (Engineering Professions Association of Namibia) representing the Civil Engineering field.

PERSONAL BACKGROUND

Nationality:	Namibian
Marital Status:	Married with one child
Languages:	English, Ethiopian - excellent; Arabic and Persian (fair)
Hobbies:	Reading, music, sports, travelling, community activity