PAPER 16

THE MANAGEMENT OF ROAD MAINTENANCE IN SOUTH AFRICA 2022 – OBSERVATIONS ON CURRENT PRACTICE AND A MODUS OPERANDI TOWARDS ADDRESSING SERVICE DELIVERY

Authors: Simon Tetley[1]; Yeshveer Balaram[2]; Bjarne Schmidt[3]; Tony Lewis[4]

[1] Director/Principal Engineer: ARRB Systems Africa

[2] General Manager: ARRB Systems Africa

[3] Principal Engineer; ARRB Systems Europe

[4] Pavement/Materials Engineer; ARRB Systems Africa

ABSTRACT

The single most important (and valuable) infrastructure asset, that affects every citizen one way or another, is a country's road network. However, in South Africa, as with other developing and, developed nations, public expectation in terms of infrastructure service delivery varies for several reasons. To many people, the provision of decent housing, sanitation and electricity is the most important issue, to others the timeous collection of refuse and the cleansing of streets is the main concern whilst to many citizens the provision of well managed health services is the over-riding subject. All these topics are, obviously, of significant importance and all require substantial government funding.

Despite the importance of the road network to a nation's economic wellbeing, the funding of road maintenance is, globally, often curtailed to increase budgets for other perceived more important infrastructure. With constrained (and often inadequate) budgets, the undertaking of optimized cost effective and appropriate road maintenance of even a small road network is challenged without some form of road maintenance management plan. For larger networks, this task becomes even more difficult. Ad hoc road maintenance on a reactive basis is not only inefficient in terms of cost, usually leading to premature failure due to incorrect remedial intervention, but also creates a perception of inadequate service delivery, and the risk of bringing the road infrastructure into a backlog situation

This paper presents observations on the current road network maintenance practices of South African road authorities and postulates a strategy to address public expectation in terms of acceptable service delivery in this regard.

INTRODUCTION

Municipal service delivery expectations vary from resident to resident, usually being directly related to the economic status of the individual. Poorer people will want access to housing and electricity, whilst more affluent persons, who already have these items, will prioritise other issues. The condition of the road network is perhaps the only service that impacts on ALL residents regardless of financial standing.

There is an obvious, but often disregarded reason for efficient and effective road maintenance that can be analogized with that of owning a motor car: If the car is serviced regularly and repaired correctly, it will give sustained and (usually!) trouble free motoring (i.e., service delivery). If the services are carried out on an ad hoc basis and repairs undertaken incorrectly, the vehicle will, in all probability, be prone to frequent breakdown and will eventually be in such a poor condition that it must be scrapped.

A road network is the same. Given timeous and appropriate routine and periodic maintenance, the road will provide an acceptable level of service until such time that the structural design loading is reached – many roads actually exceed this point significantly before requiring major structural repairs. If roads are not adequately maintained, they will fail prematurely and, like the motor car, will require reconstruction long before they should i.e., they are "scrapped".

There is an axiom that states "A stitch in time saves nine" where a stitch, costing say 10c, applied at the first indication of wear will save 9 stitches (90c) later. If the problem is ignored then a new pair of socks is required at a cost of R10, this equates to 9,900% additional cost to the first stitch! In the case of a road, this adage could be re-written as "A patch (or re-seal) in time saves millions of Rand"

THE FINANCIAL QUANDARY

On a national scale, the estimated replacement value of the 750,000 km South African road network is R2 Trillion [1] with the surfaced road network of approximately 160,000 km being estimated to account for +/- R1.1 trillion of the total replacement cost. This is most probably the highest single asset value that the country is responsible for, but probably receives by far the lowest budget allocation in relation to its actual value.

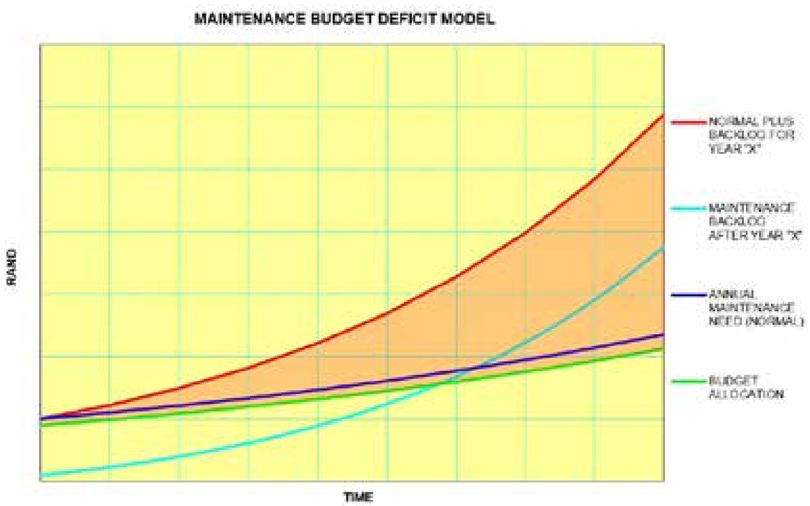


FIGURE 1: *Road maintenance budget deficit induced by insufficient funding in Year 1*

This notwithstanding, road maintenance, nationally is more often than not the "poor cousin" when it comes to budget apportionment. With limited, and usually inadequate fiscal ability there, are a myriad of other priorities which are typically perceived, by senior officials (and Politicians), as being more important.

The allocation of routine and periodic road maintenance funding is, therefore, habitually insufficient to address actual needs and preserve the road network in an acceptable condition. The consequence of under-funding is an expanding backlog of maintenance and an exponentially increasing budget deficit.

The South African Minister of Transport has stated that the road maintenance backlog for surfaced roads in 2022 is estimated to be R200 Billion [2]. Given that this figure would be required if just 20% of the nation's paved roads are in a very poor condition, the actual backlog is likely to be much higher.

Figure 1 illustrates the effects of maintenance need exceeding maintenance budget allocation

Figure 1 is a "simplistic" model which is based on a theoretical 10-year routine and periodic maintenance budget requirement (to achieve an acceptable "normal" standard) and a 10% maintenance "backlog" after year one (1). The subsequent "required" (normal plus previous year's backlog) and "allocated" budgets are both increased annually by 10% to allow for escalation. In addition, the previous year's maintenance backlog has been increased by a further 10% to account for distress intensification.

Given this scenario, the backlog of maintenance needs will exceed the budget allocation after a comparatively short time frame (+/- 7 years) resulting in a situation where neither the backlog nor the current distress can be adequately addressed. The hatched area indicates the annual, accumulated, budget deficit that would be created under these circumstances – a dire situation!

As illustrated in **Figure 2**, it would take 13 years (from year 7) at an annual 14.4% increasing budget allocation to eradicate an initial 10% maintenance backlog with the resulting +200% increase in maintenance cost over 20 years.

Until budget allocations reach equilibrium with actual road maintenance requirements, it is clear that there can be no improvement in the condition of our road network infrastructure and that acceptable service delivery in this intrinsic sphere of public responsibility will not be realized.

From a purely economic perspective, it is not realistic to continually increase budget allocations and, therefore, is essential to optimise available budgets to ensure that backlogs are mitigated. This can only be achieved by a paradigm shift in the current road maintenance practices.

FIGURE 3: *Patch the Patch*

ROAD MAINTENANCE IN SOUTH AFRICA 2022 – SERVICE DELIVERY NEGLIGENCE?

What is "service delivery" in terms of the maintenance of a public road network? It can be considered in two separate but intrinsically linked aspects:

- Service delivery, in the first instance, is the provision of a road network that is safe and comfortable to use, and where maintenance is effected before defects become hazardous. This is the "apparent" service delivery that the road user (driver or passenger) can physically see and, perhaps more importantly (from their perspective), feel.
- The second is the efficient, optimized use of available funding in undertaking road maintenance. This is the "un-apparent" or hidden service delivery. By utilizing budgets correctly, more maintenance can be carried out per Rand there by mitigating wasteful expenditure. This is economic service delivery. A further important factor to consider is that of Excess Vehicle Operating Cost (E.V.O.C.). A poorly maintained road (i.e., potholed and/or excessively patched) is in the region of 75% more expensive to drive on than a well-maintained road. The failure to undertake timeous and correct road maintenance imposes an effective financial "double whammy" on the road user.

If the first aspect is systematically managed, the second will automatically be realized and, vice versa.

The undertaking of road maintenance in many municipal and provincial areas would appear to be managed on an ad-hoc, reactive basis. This presumption is based on observations of typical road maintenance practices over the past years and the perceived deterioration in the condition of the road system around the country.

Road maintenance management of even a small network is extremely difficult without some form of maintenance "plan". For medium and large networks, the lack of a management plan renders effective and efficient "pro-active" preventative maintenance impossible resulting in scenarios such as illustrated in **Figure 3** which is, unfortunately, an all to familiar sight in South Africa.

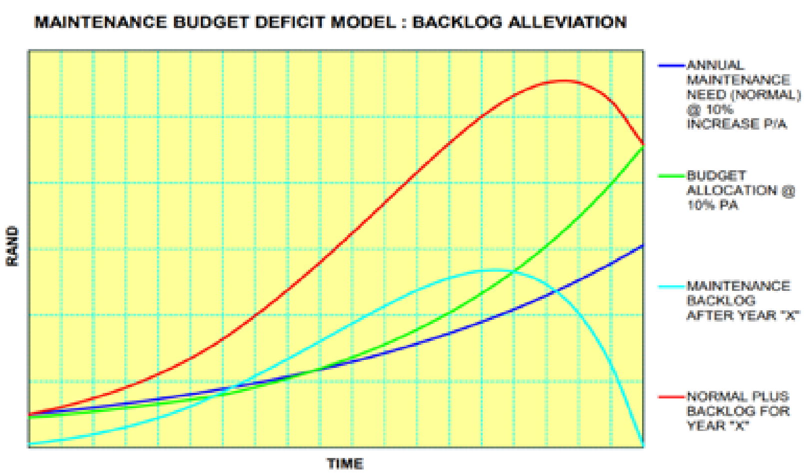


FIGURE 2: *Road maintenance budget deficit: backlog alleviation*

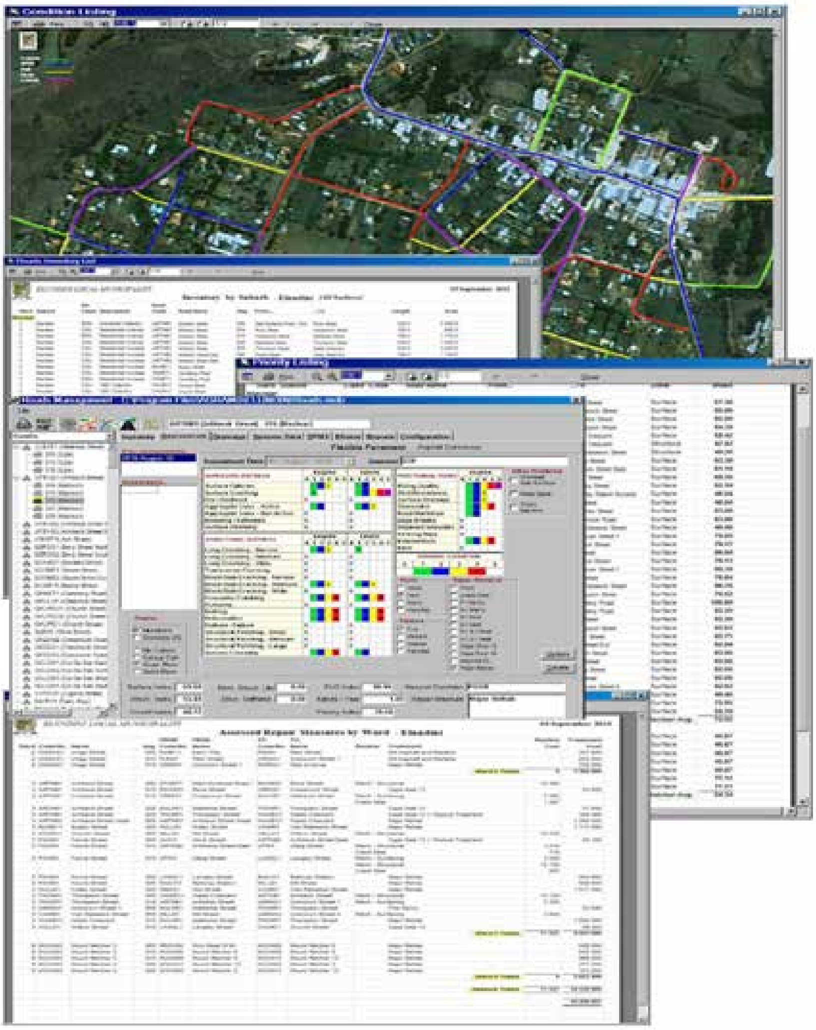


FIGURE 4: *Typical reports generated by R.A.M.S. Program*

The accepted method (globally) of managing routine and periodic road maintenance is by the use of a computerized Road Asset Management System, (RAMS) – previously referred to as a Pavement Management System (PMS). There are various road asset management systems currently utilised in South Africa, with various levels of complexity but, in essence, they are all programmed to provide the same intrinsic information, viz:

- **WHERE** on the network is the maintenance needed (identification).
- **WHAT** is the most appropriate maintenance measure in terms of cost and life cycle benefit (optimisation)
- **WHEN** is the maintenance to be carried out (multi-year prioritisation)
- **HOW** much does the identified maintenance cost (provision of annual maintenance budgets – typically 3-5 years).

An example of typical reports, produced by a locally developed R.A.M.S. is presented in **Figure 4**

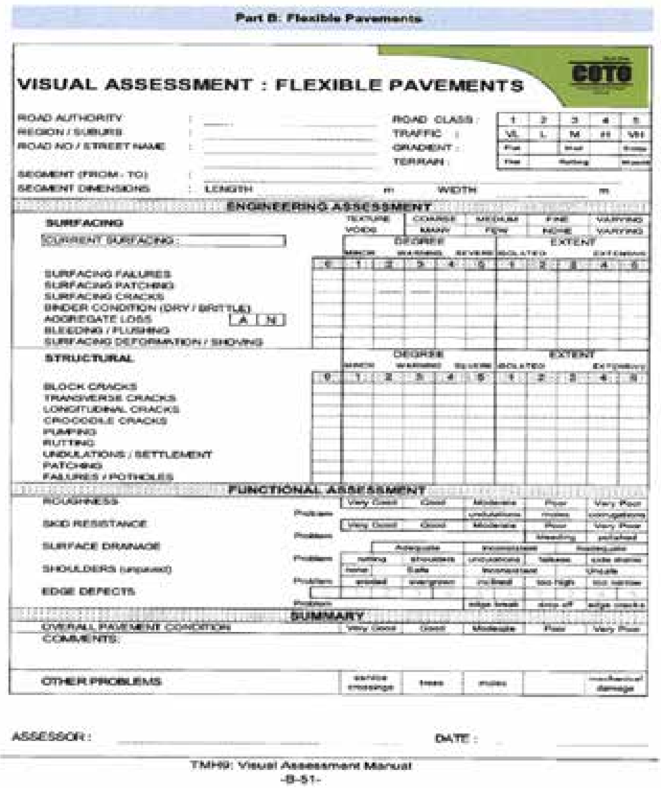
Whilst there are numerous other reports that can be generated, the use of just the few outputs, as presented in Figure 4, would be of great assistance in managing a road network.

Many Municipalities and Provinces around the country implemented RAMS. during the mid to late 1980's and 90's, but, as we enter the third decade of the 21st century, only SANRAL, major municipal areas and some of the provincial roads departments still operate their systems in a proficient manner. Some, particularly the newer rural local authorities, have never even had a system. The reasons for the decline in the use of RAMS. is not known, but it may be due to available Municipal staffing resources and, probably more to the point, the need to use available funds for actual physical improvement projects as opposed to an "invisible" management system.

Even if a RAMS is actually functioning in a road authority, the methods of collecting the road condition data are typically outdated and have been undertaken using the same subjective methods since PMS was initiated in South Africa in the early 1980's. These network level road condition surveys are an integral aspect of RAMS and the information collected has a direct impact on the lifetime cost of a road structure. The accuracy of input data is the most important component of any RAMS as it ensures factual outputs and appropriate maintenance programmes. The quality of this data attests to the degree of efficacy but this notwithstanding, data collection methods used by the majority of road authorities in South Africa are the same today as in the early 1980's – this despite the advent of equipment enabling automated full spectrum data acquisition. The following components are typical of most provincial and municipal road condition collection methods in 2022

VISUAL CONDITION ASSESSMENT

The predominant method in South Africa for undertaking visual assessment of road conditions, is by physical visual inspection. These assessments are carried out in accordance with the TMH9 Manual [3] [Committee of Transport Officials (COTO), 2013] for Visual Assessment of Road Pavements with requisite distress ratings being captured onto an electronic device or onto paper assessment sheets – see **Figure 5**. Contrary to popular belief, the former method is neither


Part B: Flexible Pavements

VISUAL ASSESSMENT : FLEXIBLE PAVEMENTS

COTO

ROAD AUTHORITY :
REGION / SUBURB :
ROAD NO / STREET NAME :
SEGMENT (FROM - TO) :
SEGMENT DIMENSIONS : LENGTH m WIDTH m

ROAD CLASS : 1 2 3 4 5
TRAFFIC : VL L M H VH
GRADIENT :
TERRAIN :

ENGINEERING ASSESSMENT

SURFACING
CURRENT SURFACING :
TEXTURE: COARSE, MEDIUM, FINE, VARYING
VOIDS: MANY, FEW, NONE, VARYING
DEGREE: MINOR, WARNING, SEVERE — 0 1 2 3 4 5
EXTENT: ISOLATED, EXTENSIVE — 1 2 3 4 5

SURFACING FAILURES
SURFACING PATCHING
SURFACING CRACKS
BINDER CONDITION (DRY / BRITTLE)
AGGREGATE LOSS A N
BLEEDING / FLUSHING
SURFACING DEFORMATION / SHOVING

STRUCTURAL
DEGREE: MINOR, WARNING, SEVERE — 0 1 2 3 4 5
EXTENT: ISOLATED, EXTENSIVE — 1 2 3 4 5

BLOCK CRACKS
TRANSVERSE CRACKS
LONGITUDINAL CRACKS
CROCODILE CRACKS
PUMPING
RUTTING
UNDULATIONS / SETTLEMENT
PATCHING
FAILURES / POTHOLES

FUNCTIONAL ASSESSMENT

ROUGHNESS: Very Good, Good, Moderate, Poor, Very Poor
SKID RESISTANCE: Very Good, Good, Moderate, Poor, Very Poor
SURFACE DRAINAGE
SHOULDERS (unpaved)
EDGE DEFECTS
Problem

SUMMARY

OVERALL PAVEMENT CONDITION: Very Good, Good, Moderate, Poor, Very Poor
COMMENTS:

OTHER PROBLEMS: service crossings, trees, mechanical damage

ASSESSOR : DATE :

TMH9: Visual Assessment Manual
-B-51-

FIGURE 5: *Standard visual assessment sheet*

FIGURE 6: *Network Survey Vehicle incorporating LCMS*

automatic nor new, with such methods having been used in many parts of the world since the early mid 80's

This method requires experienced, skilled people who, by necessity, are exposed to not only potential bodily harm, but also psychological stress through traffic, noise and fatigue. This procedure is labour intensive with typical production +/- 70km per day in a rural environment and around 20km per day for urban roads. The key problem with a reliance on physical visual surveys is that the recorded condition of the road will, by its very nature, be subjective exercise based on opinion and/or interpretation with the serious resultant effect on data validity - errors in evaluation of the road condition and the mechanisms of distress will lead to either under design of remedial interventions, with resultant premature failure, or an overly robust design with associated wasteful expenditure in additional design and construction costs

SEMI-AUTOMATED FUNTIONAL (SURFACE) ROAD CONDITION DATA COLLECTION

Many road authorities now collect functional condition data using Network Survey Vehicles (NSV). These vehicles utilise digital laser profilers to measure riding quality, texture, rut depth and geometry. In addition, they record high-definition digital images used to post rate the road condition. More up to date vehicles, **Figure 6**, are also fitted with Laser Crack Measurement Systems (LCMS). Compared with manual methods, the use of these vehicles in conjunction with visual assessment post rating provides a significant increase in productivity (up to 500km per day) and, more importantly, a marked improvement in safety whilst undertaking the road assessment.

The visual condition process can also be semi-automated and improved using the post rating technique, digital images from the NSV's are assessed in terms of the TMH9 manual in the safety and comfort of an office as shown in **Figure 7**.

FIGURE 7: *Post rating of visual condition*

Post rating has become the norm in many parts of the world but is not generally utilised in South Africa with the exception of 2 or 3 provincial authorities. It is obviously much safer than undertaking physical field surveys, less stressful and significantly more productive (+/- 150km per assessor per day). The element of subjectivity is significantly reduced compared to field assessments primarily through the ability to re-assess images as required whilst referring to the TMH9 Manual and, more importantly, the facility to use actual measurement in the evaluation of certain distresses e.g., rutting, cracking, potholes etc. Quality assurance is via independent "double rating" of random road sections and field panel inspection. Validation algorithms are also built into the data capture software.

STRUCTURAL CONDITION DATA COLLECTION

Pavement structural data (if actually measured at all) is carried out using a Falling Weight Deflectometer (FWD), as illustrated in Figure 8, usually measuring at 200m intervals at network level. Typically, 40 to 50km of deflection measurements can be undertaken daily meaning that even a modestly sized network will take an extended period to complete. Additionally, this is a static test requiring well organised and managed traffic accommodation that can only mitigate and not eliminate the inherent danger involved with this testing.

FIGURE 8: *Falling Weight Deflectometer and towing vehicle*

PRECIS

In summary, the methodology paradigm for undertaking network level road condition assessments in South Africa can be described as being discrete, non-synchronised and semi-automated at best and at worst, obsolete. It is apparent that undertaking road condition assessments is considered to be a mere "tick box" exercise by many road authorities in order to comply with DORA requirements and this, together with a reluctance to implement more cost effective and accurate condition evaluation methods, has been the main catalyst for the poor road maintenance service delivery, excessive maintenance backlogs and resultant road networks deficient in acceptable standards of condition and safety.

ROAD MAINTENANCE IN SOUTH AFRICA 2022 – SERVICE DELIVERY EXCELLENCE

As discussed previously, with so many other infrastructure requirements being prioritised, inadequate road maintenance funding is more than likely to be the norm. The result of this is that the backlog deficit will continue to increase unless current maintenance practices are overhauled to provide a more systematic, objective methodology, that utilises actual condition data to enable identification and prioritisation of optimal and cost beneficial remedial actions.

Technology is currently available in South Africa that enables objective road condition evaluation offering significant improvements to the status quo.

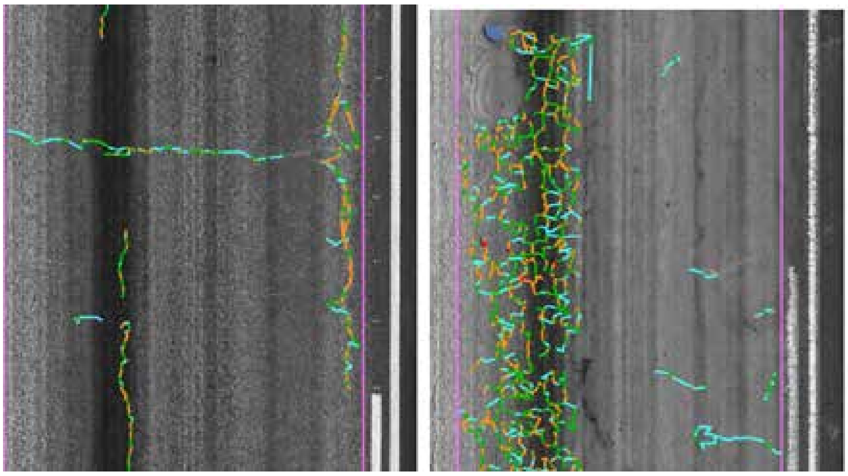


FIGURE 9: *ACD output example*

the autonomous system uses percentage of the length or area of the road segment under consideration.

In terms of distress type identification, this is mainly automatically managed by system processes although some mechanisms need further differentiation through additional algorithms e.g., surface vs structural failures being distinguished by depth or surface cracking vs crocodile cracking being discerned by location in wheel path or not. Functional TMH9 items such as width, length, gradient, terrain, texture/voids, riding quality, surface drainage etc can all be directly measured by NSV.

The assessment items that have not yet been automated are those that cannot be directly measured with the current processing systems ice, binder condition, pumping of fines and surface/structural patches. These will be assessed via machine learning methods as will some functional aspects such as surface type and shoulder condition. The obvious advantages of automating the visual assessment procedure are

- The implementation of automating the TMH9 visual assessment will eradicate subjectivity in the evaluation of road surface condition and result in road asset management outputs being based on fact rather than opinion
- Integration and synchronization of individual data sets enables a more informed assessment of distress mechanisms
- The above capabilities assist greatly in the identification of appropriate remedial actions and reducing wasted expenditure – even a 1% saving in a country's road maintenance budget will be significant in systematically reducing deficit and backlog.
- Significantly increased production compared to manual assessment methods. Will enable even large road authorities to undertake visual assessments and obtain factual results in weeks rather than months
- Real and meaningful improvement in safety conditions for testing personnel and the travelling public
- By using continuous distress measurement, it is possible to utilise data collected at network level in project level decision making and design – this rather than undertaking a second round of testing at the requisite project level spacing.

VISUAL CONDITION ASSESSMENT

As discussed previously, the predominant method for undertaking network level visual assessment of road conditions, is by physical visual inspection from a moving car. Irrespective of the experience and skill levels of these persons, there is bound to be an element of subjectivity, to a greater or lesser extent, in the inspection results which will affect the validity of subsequent RAMS outputs.

The capability to undertake fully automated road condition data acquisition is readily available in South Africa although not perhaps fully appreciated by industry, including the undertaking of TMH9 compliant visual assessments. Systems using artificial intelligence (AI) neural networks have and are being developed that are capable of identifying and rating the individual pavement distress items, thereby removing the "human element" and associated serious effects of subjective condition rating. Work on this "quantum leap" has been ongoing globally for some time though South Africa has mostly lagged behind in this development with the exception of one or two private companies.

The creation of fully automated road visual assessment systems using AI image recognition is a lengthy and human resource intensive process and, therefore, another method of visual assessment automation, using expert system algorithms rather than machine learning to generate TMH9 compliant degree and extent ratings for pavement distress is being developed by a South African company [4].

As discussed in previous chapters, NSV's collect factual road condition data such as cracking, aggregate loss, rutting, deformation, potholes, failures etc. An example of the automated crack detection (ACD) imaging output is illustrated in **Figure 9**

Figure 9 clearly shows crocodile cracking in outside wheel track (left hand plate) whilst the right-hand plate indicates the start of block cracking. Colours denote crack severity in terms of width and, for the crocodile cracking, density.

By utilising severity and quantity data as processed by the operating systems in the data collection vehicles, it is possible to create a "proxy" TMH9 compliant visual assessment that is completely autonomous and, therefore completely objective.

The severity for the 16 distress items, established individually and in terms of the stipulations of the TMH9 for "degree", is based on direct measurement, i.e., width and density in the case of cracking, depth and size in the case of rutting and potholes, volume of aggregate lost for ravelling etc. The intensity of the distress cannot be assessed strictly in terms of the TMH9 definitions for extent because this is based on human interpretation. As an alternative,

AUTOMATED FUNTIONAL (SURFACE) AND STRUCTURAL ROAD CONDITION DATA COLLECTION

It has already been discussed that many road authorities collect functional condition data such as riding quality, rut depth, digital imaging etc through the use of Network Survey Vehicles (NSV).

In an initiative towards providing more complete automation of road condition data collection, the South Africa National Roads Agency (SANRAL) obtained a traffic speed deflectometer device in circa 2014 to measure structural and functional condition, at traffic speed, on the country's national roads. Appreciating that this equipment provides a significant improvement over the output of prevailing road condition evaluation techniques, consulting engineering firms have been operating intelligent Pavement Assessment Vehicles (iPAVe) incorporating traffic speed deflectometer (TSD) and other road pavement distress collection equipment, **Figure 10**, in South Africa since 2016.

This is considered to offer a significant advancement in the management of road assets as it is able to collect simultaneous surface and structural pavement condition data at road speeds of up to 80km/h.

The iPAVe TSDD utilises high precision Doppler lasers to measure the pavement deflection velocity/slope from which the deflection bowl is calculated [5] whilst the Hawkeye platform is responsible for measuring road surface characteristics such as cracking, potholes/failures, roughness, rutting, ravelling, texture and geometry together with spatial information and digital imaging. In essence, the vehicle is an NSV with the ability to measure structural response in addition to surface characteristics offering a fully automated and integrated "one stop shop" option that generates all the information required by a RAMS, HDM-4 and project level pavement design inputs, at a much-improved production rate, lower overall cost and at a significantly reduced risk when compared to traditional methods.

The improvements in safety are self-evident, as is the significant increase in production capability. Depending on network characteristics, the iPAVe TSDD is capable of collecting +/-70 000 lane kilometres of surface and structural condition data annually.

While the FWD typically test at 200m intervals for network level surveys, the iPAVe is providing continuous measurement, which can be delimited at any interval from 25mm upward. At a 5m spacing for example, the vehicle could measure 14 million deflection points per year compared to 50 000 for the FWD at 200m spacing. At project level, additional deflection measurements are typically done at spacings of 50m and upwards meaning that there are large gaps in the data. If it is assumed that each deflection point covers 5m, at 50m spacing, a mere 10% of the project will have structural test data with which to undertake an appropriate pavement design – obviously not an ideal situation.

Using TSDD technologies removes the guess work as there are no gaps in the structural test data. Getting a pavement design wrong, due to having to make assumptions of the structural integrity of the pavement between test points has huge financial implications in terms for road authorities and road users. For example, the problem might only be skin deep i.e., poor road surface condition may not be an indication of overall pavement failure, negating the need for an over-engineered and overpriced remedial intervention. Conversely, under-design will lead to premature failure with resulting excess vehicle operating costs for the road user and additional needless expenditure being required from the road authority and national fiscus.

In addition to the better accuracy, the implementation of full spectrum road condition data collection is also more cost beneficial - it has been calculated that, for project level, the cost per test/metre is almost 10 x more costly for FWD at 50m test spacing than the iPAVe at 5m test frequency. This does not include the cost savings from using the data collected during the network level survey or the additional cost of undertaking two (2) FWD surveys, i.e., the original network survey plus a second for project level.

In addition to the data per metre cost benefit, a study into the asset life cycle benefit of utilising automated road condition evaluation versus manual and semi-automated methods i.e., visual assessment only and NSV/FWD combination [6]. This study evaluates the life cycle costs to a roads agency when making use of different road condition assessment methods, i.e., basic manual visual assessment, semi-automated data collection and fully automated evaluation. A HDM-4 economic analysis was carried out to define the network, work standards and strategic analysis for each of the three scenarios and to quantify the capital and recurring cost over a 20-year analysis period for the simulated road network.

Using the maximisation of net present value function in the HDM-4 strategic analysis model, the most cost-effective set of maintenance and improvement standards over the analysis period were identified. Based on this analysis, there is a R13,400 cost benefit per kilometre in using iPAVe/TSDD when compared to the NSV and FWD combination. If this is applied to the entire South African paved road network, a saving of over R2 billion would be achieved over a 20-year analysis period. When compared to the manual visual evaluation method, the saving increases to almost R19 billion.

The real benefit in utilising the fully automated full spectrum condition assessment is that an increase in quality and accuracy of road condition data can be achieved at a significant cost saving to the road authority, the road user and most importantly to the national fiscus.

ROAD SAFETY ASSESSMENT

Credible road condition and characteristic data is increasingly considered as critical in addressing road safety. The International Road Assessment Program (iRAP), which is developed in line with the Safe System and endorsed by the United Nations, has certified the Hawkeye technology that is used in the iPAVe as a Class B Inspection System.

Automated recording of road features that impact on road safety allows for streamlined assessments of high-risk areas of the road network. The data is used to undertake a network level assessment and determine Star Ratings [7] which is done by analysing:

- **Geo-referenced imagery**- used to code (post rate) the road. The 360-degree coverage through multiple camera lenses has the added benefit of being able to accurately measure road attributes within the toolkit application. This enables assessors to determine the distance to roadside hazards such as trees, light poles, etc. from the road edge.
- **Alignment Data**- the road geometry is also integrated with the safety assessment to identify road sections with steep grades, incorrect cambers and crossfalls (transverse slopes), which leads to better understanding of drainage.
- **LCMS and profile data**- for quick pothole identification, areas with low macro-texture (more prone to skidding at high speeds) and rutting (leads to poor directional stability and areas where water can pond and lead to possible aquaplaning).

Once the road has been Star Rated, the data is presented spatially to provide a road agency with a holistic illustration of hazardous locations. The information is also used to determine appropriate countermeasures to improve the level-of-safety, prioritise investment, and benchmark performance for year-on-year comparison. This is a more proactive approach in reducing road traffic accidents and collisions as opposed to retroactively addressing the "accident black spots" which are typically determined by the number of historic accidents and are often incorrectly referenced.

The iPAVe has successfully been used to determine IRAP Star Ratings of around 16000km's of provincial roads in South Africa, and acts as a catalyst to implement road safety initiatives and ultimately save lives. In 2021, there were 12,454 road accident fatalities on South African roads [8], At a cost of just R1.2 million per fatality [9], this costs the economy almost R15 billion. If IRAP assessments can help reduce fatalities by just 10% the fiscus will save R1.5 billion which can then be ploughed back into the road maintenance backlog.

CONCLUSIONS

Based on this assessment, it is obvious that road maintenance in South Africa is, in general, not of an acceptable standard either in its management or physical implementation. It is apparent to most, that a "paradigm shift" is required from road authorities on the subject of routine and periodic road maintenance service delivery. The perceived poor condition of the country's road networks is a direct consequence of the reactive maintenance practices that seem to be the norm with the exception of SANRAL and some provinces and metros. Should the status quo not be radically and urgently improved, the current situation, as bad

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as it is, will continue to be exacerbated, at an exponential rate until the country's road network reaches a point of no return with the associated disastrous consequences.

The available funding for road maintenance is unlikely to ever be adequate to meet the need – even if there was no backlog – and, as such, the only way to address the issue is to find a way to significantly increase the maintenance kilometres for the same budget. It is clear that this cannot and will not be achieved by continuing with the current obsolete and flawed road condition evaluations. It is equally clear that by utilising automated full spectrum continuous road evaluation, meaningful savings can be generated that can start reducing the maintenance backlog deficit and concurrently address "normal" maintenance needs.

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87%
of marketing professionals use video as a successful marketing tool.

(WYZOWL, 2019)

Marketers making use of video get 66% more qualified leads per year.

(Optinmonster, 2019)

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(FORBES, 2018)

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CONTACT
Joanne Lawrie **t** +27 (0)11 233 2668 **c** +27 (0)82 346 5338 **e** Joanne.Lawrie@3smedia.co.za
Hanlie Fintelman **t** +27 (0)67 756 3132 **c** +27 (0)82 338 2266 **e** Hanlie.Fintelman@3smedia.co.za

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