CSIR's Advocacy and Support of Infrastructure Asset Management

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Abstract

That increasing attention is being paid to infrastructure asset management (IAM)[1] is timely, and owes something to the work of the CSIR in discovering and documenting the state of infrastructure, and in leading specific aspects of the process of improvement of IAM policy and practice in the public sector. The CSIR has long been involved in IAM, initially in respect only of roads infrastructure, then also in the area of immovable asset management focusing on public sector buildings, and more recently in respect of water services infrastructure.

1. PREFACE

The President of the CSIR referred to expectations that CSIR "must deliver visible routine services, or that it must intervene in a service delivery crisis" – with the end result being "better roads, cleaner water" and so on. Also that "a solution need not be a new technology -- it can be an existing technology applied in a different manner". (Sibisi 2008). He noted criticism that the CSIR is in some quarters perceived to be "disconnected from service delivery", and mentioned a question that is "perennially" put to him: "what is CSIR doing about potholes on the roads?"

It would be difficult to find a better example of the CSIR's track record in addressing these expectations, demonstrating how very much the CSIR has been connected to service delivery, than by drawing attention to its involvement in high-level assistance with and influence on planning, operating and maintaining service delivery infrastructure -- as described in this paper. That involvement has been right from Cabinet level, through national strategies, through to provincial and local public level, and has included a wide range of contributions, from policy to technology.

2. PROBLEM STATEMENT

All three spheres of government, together with the state-owned enterprises (SOEs), manage major portfolios of immovable assets. (For present purposes, "public sector" includes SOEs such as Eskom, Transnet and Telkom.) The CSIR in 2006 estimated that the then current replacement cost of the infrastructure owned by the public sector excluding the SOEs exceeded R 1000 billion.

While there has been much political emphasis on "delivery" of infrastructure, delivery does not in fact end with the commissioning of the physical asset. Once the infrastructure has been commissioned, various activities must be carried out which are necessary to ensure that it continues to perform – such as the allocation of necessary budgets and the recruitment and retention of appropriate staff, and/or outsourcing of skills, to maintain the operation of the assets. "Delivery" needs to be universally understood as embracing not just constructing the infrastructure, but the appropriate operation and maintenance thereafter, for the whole design life of the asset.

In 1994 the new government evaluated the imbalance in infrastructure that characterised the nation, and embarked on an ambitious plan to put matters right by addressing the

[1] For the purposes of this paper, "infrastructure asset management" embraces planned maintenance and repair, refurbishment and renewal.

backlog. For example, the government has invested significantly in providing 18 million people with access to basic water services. Other infrastructure provided at the same time, such as sanitation and road infrastructure, has further improved the quality of life of the people of South Africa.

Government is committed to increasing levels of infrastructure investment at national, provincial and municipal government level as a foundation for service delivery, economic growth and social development. The challenge is to both maintain new and old infrastructure and provide the new infrastructure needed.

Some public sector institutions maintain their infrastructure at a high standard. Budgets are adequate (even if barely so), skilled staff are in place, leadership is committed, and policies support sound infrastructure maintenance practices. However, despite the good performance in some sectors, there is strong evidence that in other sectors much of the infrastructure, of both pre- and post-1994 vintage, is not being properly maintained. Older infrastructure is often not being refurbished and renewed when it needs to be, and there is inadequate planned preventative maintenance on new infrastructure.

Late in 2006, the South African Institution of Civil Engineering (SAICE) released the first ever "report card" of the state of engineering infrastructure in South Africa (SAICE 2006). This report highlighted "the observations of the professionals responsible for the planning, construction, operation and maintenance of our nation's life-support system". It graded infrastructure (water, sanitation, solid waste, roads, airports, ports, rail, electricity and hospitals and clinics) on a scale from A+ through E-. Overall, it gave the infrastructure a D+ grade. [2]

[2] The main author of this report card was a CSIR employee, and SAICE drew heavily upon an extensive database, accumulated by CSIR, on the state of infrastructure and the state of its management.

3. CSIR ACTIVITY IN SEVERAL SECTORS

Over the years, the CSIR has undertaken many studies of the state of the nation's infrastructure and the state of its management. At times this work has been related to a specific sector within a sector (e.g. bridges), and at other times it has been more broad-ranging. Especially in more recent years, the CSIR has actively sought to draw attention to the state of infrastructure and the state of its management. It has done this by means that include undertaking surveys and publishing the results of these (e.g. CSIR and CIDB 2006), while lobbying government departments and professional bodies. CSIR's contribution to the 2006 SAICE report card (see above) was to the same end.

The purpose of this advocacy work has been to draw the attention of government, and of the public at large, to the importance of maintenance, and to factors underlying the state of repair of infrastructure – factors such as skills and finance, for example. CSIR saw its work as a means to better inform decisions on infrastructure development and maintenance.

It can be noted that CSIR employees have on more than one occasion in the past been told by national government department representatives that this drawing of attention was not welcomed. The CSIR was then typically told that government's focus was on rolling out new infrastructure, and it did not wish to have any shortcomings in the operation and maintenance of existing infrastructure to be raised.

The CSIR has long been involved in immovable and infrastructure asset management (IAM)[3]. Initially this involvement was only in respect of roads infrastructure. Considerable work has also been undertaken

[3] The acronym IAM, as used in this paper, covers both 'Infrastructure Asset Management', generally used in the roads and municipal services sectors, and 'Immovable Asset Management', in its accounting definition context for buildings and related infrastructure comprising a built facility such as a hospital, school or office block.

in the area of immovable asset management focussing on public sector buildings. More recently, water services infrastructure has also come to the fore.

The CSIR was during the 1970s the pioneer of pavement and road management systems in South Africa. The CSIR then became involved in the development of heavy vehicle overload control strategies, and also the development of bridge management systems.

In respect of water services infrastructure, the CSIR from 2001 accumulated evidence of the need for the management of public sector infrastructure, and began to lobby for broad-based national strategies in this respect. In 2005, the Department of Water Affairs and Forestry (DWAF) appointed a team led by CSIR to assist it with the first phase of formulating a national water services IAM strategy. This task is currently in its second phase -- DWAF, with the assistance of a new external team (of which CSIR is part), is formulating, programming and commencing the more detailed actions.

The CSIR, working together with a number of national and provincial departments, has developed approaches to assist government to assess the degree to which public buildings are "fit for purpose" and "fit for service". Through providing an accurate record of the extent and profile of the estate, standards and condition-based backlogs, strategic service and infrastructure planning, capital and maintenance budgeting, and maintenance planning are all enabled.

This paper provides more detail on the above, proceeding from issues cutting across all infrastructure sectors, to roads infrastructure, followed by water services infrastructure, and concluding with building infrastructure.

During 2006, the CSIR was contracted by the Construction Industry Development Board (CIDB), on behalf of the national Department of Public Works (DPW), to assist it with drawing up the "National Infrastructure Maintenance Strategy" (DPW et al 2006). Approved by Cabinet in August 2006, this is a co-ordinated programme of actions that is an essential part of government's vision of delivering infrastructure services to all. It is an umbrella strategy, in terms of which each national department responsible for a sector of infrastructure (e.g. DWAF for water resources and water services infrastructure) is drawing up a sector-specific IAM strategy that will reflect the needs of its sector.

This strategy sets overarching policy for sector-based initiatives, and sets out the framework for a coordinated programme of actions. It also identifies 11 priority actions, grouped as follows:

- Strengthening the regulatory framework governing planning and budgeting for IAM.
- Assisting institutions with non-financial resources.
- Developing the maintenance industry.
- Strengthening monitoring, evaluation and reporting, and feeding this into a process of continuous improvement.

To complete the picture, the CSIR is playing a role [4] in a number of other national IAM initiatives, among them supporting documents for the implementation of the Government Immovable Asset Management Act (GIAMA), the design of a valuation model for use with the implementation of GIAMA, and National Treasury's measures to increase provincial and local government accountability for assets.

That increasing attention is being paid to IAM is timely, and owes something to the work of the CSIR in discovering and documenting the state of infrastructure, and in leading specific aspects of the process of improvement of IAM practice in the public sector.

4. ROAD INFRASTRUCTURE

Declining funding (in real terms) for road construction and maintenance in South Africa during the 1980s and 1990s resulted in generally deteriorating road infrastructure. The low level of control of heavy vehicle overloading on most provincial and municipal roads has exacerbated the situation. More attention is therefore having to be paid to

[4] This role is at times that of a consultant, and at other times that of a science council adviser.

procedures, models and management systems designed to preserve the existing road infrastructure.

Road pavements

During the 1970s the CSIR was the pioneer of pavement and road management systems (PMSs and RMSs) in South Africa. By the beginning of the 1980s four road authorities had implemented PMSs. These authorities were the national Department of Transport (DoT), the Johannesburg City Engineer's Department, the Cape Roads Department and the Transvaal Roads Department (Yorke-Hart *et al*., 1984). The CSIR was involved in the development and implementation of the PMSs for all four authorities. The development of the PMSs addressed issues such as: the type of data to collect; the best methods to collect the data; the establishment of a suitable computer environment, with an emphasis on the database for the storage and retrieval of data; the control of the data input to ensure security, integrity and completeness of data; models to calculate pavement condition and to identify maintenance needs; and, lastly, data output and reporting.

This research and development also resulted in the publication of two national documents, namely the "Technical Recommendations for Highways 22: Pavement Management Systems" (referred to as "TRH 22" -- DoT 1994) and "Technical Methods for Highways 9: Pavement Management Systems: Standard Visual Assessment Manual for Flexible Pavements" (referred to as "TMH 9" -- DoT 1992). Once the PMSs reached a specific level of development, implementation was left in the hands of road authorities and consulting engineers. The SA National Roads Agency, most provincial and metropolitan councils, and a large number of the district and local councils have implemented PMSs, although currently a number of the PMSs are not operational.

During the mid-1980s, the need to develop Gravel ("unsealed") Road Management Systems (GRMS) was also identified. The Maintenance and Design System (MDS), developed in Texas and based on experience in Brazil, was initially used as the basis for these systems. Road deterioration models initially used the Brazilian data, but work was simultaneously carried out in southern Africa by the CSIR to develop more appropriate local deterioration models. These local models, released in 1989, were satisfactorily implemented in a number of provinces and organisations. After restructuring of the provincial structures in the mid-1990s, a number of the systems were abandoned, although others (e.g. Gauteng and Western Cape) have continued.

In order to disseminate knowledge of consistent and repeatable data collection for use in the systems, "Pavement Management Systems: Standard visual assessment for unsealed roads" was published in 2000 (Jones and Paige-Green, 2000). This follows the same format as TMH 9 and is now used routinely in South Africa.

Heavy vehicle overloading

Heavy vehicle overloading and road safety are major problems in South Africa, notwithstanding efforts to achieve more effective enforcement by the road and traffic authorities. Heavy vehicle overloading causes premature road deterioration and, together with inadequate vehicle maintenance, driver fatigue and poor driver health, contributes significantly to the nation's poor road safety record. The 1996 increase in the legal axle load from 8.2 to 9 tonnes, and pressure from the Southern Africa Development Community (SADC) to implement a further increase to 10 tonnes, has not helped the situation.

During the mid-1980s, the CSIR designed and developed a database and computerised system to monitor and evaluate the status and trends of heavy vehicle overloading in South Africa. This system, the Vehicle Overloading Management System (VOMS), has for more than 20 years been used by national DoT and by various provinces as a tool for monitoring heavy vehicle overloading and the enforcement thereof. Typical medium and long-term trends are illustrated in the KwaZulu-Natal Department of Transport 2007 annual report on overload control (Nordengen et al., 2008) In 1987 the CSIR developed an Overload Control Strategy for KwaZulu-Natal to address the planning of new and upgraded weighbridge facilities, sustainable funding, human resources and other operational issues. This strategy was followed by a National Overload Control Strategy for the national DoT (DoT, 2004) and similar strategies for five other provinces, two metropolitan councils and Senegal. The number of heavy vehicles weighed for overload control has increased from approximated 50 000 vehicles per annum in the early 1990s to more than one million in 2007.

Structures

Bridges and other road structures are key elements in any road network; maintenance costs may increase substantially as serviceability levels of structures decline. Effective management and proper maintenance of these structures is therefore essential.

A Bridge Management System (BMS), originally developed and implemented by the CSIR for the Taiwan Area National Freeway Bureau, was subsequently modified and implemented for a number of road and rail authorities in southern Africa. The BMS was initially implemented for the City of Cape Town and Spoornet during 1996/97, the Botswana Roads Department during 1997/98 followed by the South African National Roads Agency Limited (SANRAL) (Nordengen et al., 2000) and the Western Cape DoT.

During the past 10 years the BMS has been implemented for other road authorities including the Namibia Roads Authority, Swaziland Ministry of Public Works & Transport, KwaZulu-Natal DoT, Mpumalanga Department of Roads and Transport, Johannesburg Roads Agency, and the Nelson Mandela Metropolitan Municipality. Indeed, at least 60% of all bridge structures of significant size in South Africa are now monitored through a BMS -- and many of these BMSs have been derived from the CSIR work. In contrast, 15 years ago the figure was probably less than 10%.

As is the case with most asset management systems, the bridge management system consists of a number of inter-related modules which are linked together as illustrated in **Figure 1**. In many cases, the BMS database is integrated with the road authority's integrated road management database.

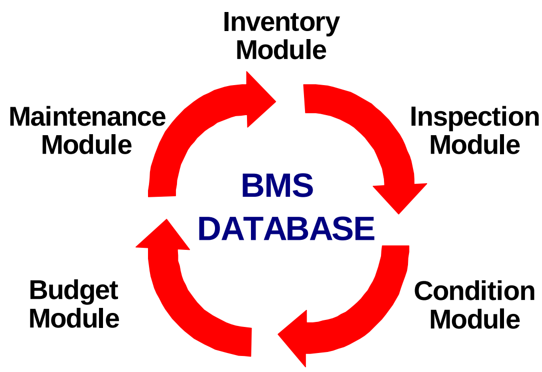

Figure 1: Modules in the BMS

One of the features of the CSIR BMS is the approach that has been adopted for the rating of the structure elements and the subsequent prioritization algorithm. The essence of a bridge inspection is to identify the defects on a bridge and their relative importance so that they may be prioritised and the available funds allocated efficiently for their repair. It is thus important to rate the degree of each defect (how bad is the defect) and how common is it. However the most important purpose of the rating is to identify the consequences of the defect with regards the safety and serviceability of the bridge. This forces an inspector to not just give a visual rating of the defect but to look at the defect from a global point of view and to try and understand its influence on the structural integrity of the bridge. Because of the complexity of a bridge this last aspect is very important -- two defects that look the same may have significantly different influences on the bridge.

Thus the rating considers possible future events that could adversely affect the defect, and provides a procedure for applying time limits on the repair requirements. The inspector is required to identify the remedial work activity (and estimated quantity) that must be carried out to repair the defect. The repair activity is selected from a standard list that is different for each of the 21 predefined bridge inspection items. Activities include, for example: repair spalled concrete (all concrete items); backfill erosion/scour damage (approach embankment); remove sand, debris and vegetation (surfacing); and reinstate expansion gap between deck and abutment (abutments). Each of the repair activities has a unit rate that is used in the budget module to estimate a budget for the repair of the structure.

The rating system has the following components:

- degree or severity of the defect
- extent of the defect in the item under consideration
- relevance of the defect. This rating considers the consequences of the current status of the defect with regard to the serviceability of the bridge and the safety of the user (pedestrian, cyclist, motorist and passenger)
- urgency of the need to carry out the remedial work.

Following a systematic approach during inspections ensures that all defects are noted and rated. It is essential that inspectors pay attention to detail, as it is often the apparently minor defects that provide the solution to the cause of other major defects such as settlement and rotation.

The BMS condition module is used to prioritise the bridges in the system based on the most recent inspection data. The overall priority index is based on priority and functional indices. The functional index gives an indication of the strategic importance of the bridge in the network and is calculated from various parameters in the inventory module. These include class of road or railway line, detour length, traffic volume, width between kerbs, type of structure and profitability of line (in the case of rail structures). Each parameter is given greater or lesser relative importance by user-defined weighting factors. More importance is given to certain items such as deck slab, longitudinal members and piers, as opposed to items such as guardrail and surfacing by means of user-defined weighting factors.

A number of BMS clients have been using the results of the structure assessment and prioritization process as a basis for motivating for increased structure maintenance budgets (which are traditionally insignificant compared with the road maintenance budgets). The results are also used to identify individual structures as well as groups of structures in the same area that require urgent repair, and to plan and initiate bridge rehabilitation and maintenance projects.

5. WATER SERVICES INFRASTRUCTURE

Unlike the work of the CSIR in pavement and bridge asset management, which has been more focused on management systems and on technologies, the work of the CSIR in respect of water services asset management has very much been at the strategic level. From 2001, the CSIR began accumulating evidence of the need for the management of water services infrastructure.

In 2005 DWAF called for proposals to assist it with the formulation of a national "water services infrastructure asset management strategy". A team led by the CSIR was in due course appointed.

It may be of interest to describe findings in some detail -- much of the more general findings would be found also in IAM diagnoses and strategies in sectors other than water.

The first part of this appointment (DWAF 2005) sought not just to discover the state of water services infrastructure, but also the state of its management, and the background to and reasons for this state.

This work was followed by a collation and interpretation of this information (DWAF 2006; DWAF 2007). Systemic issues that had emerged were identified and discussed.
“Proceeding from fact-finding to solution-identifying", as the CSIR team termed it, commenced with a process of identifying the key factors that drive the existing state of water services infrastructure and the state of its management. This involved not just problem identification, but also analysis and classification of problems. It led to identification of elements needed for an enabling environment to ensure improved IAM, and also started to broadly identify which institution should be responsible for leading each element of the improvement process.

More than 400 generic challenges were identified. They were rigorously analysed and classified into "challenge areas". The analysis then identified a solution for each of the challenges. Evaluation and finding commonality of solutions enabled classification of solutions into one or other of 9 “solution types”. These types were categorised by priority. In pie chart form, and depicting only the highest priority solutions (**Figure 2**):

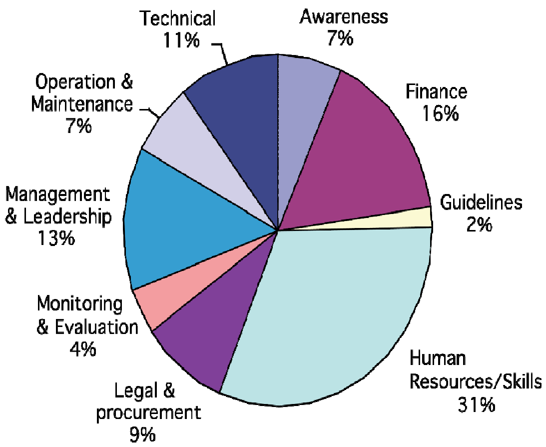

Figure 2: Highest priority water services IAM solutions identified

The above indicates that much needs to be done on the human resources, skills development and capacity building aspects. While the focus of capacity building is on water services institutions capacity, capacitation must also include DWAF and other national and provincial roleplayers that have to manage the process and regulate effective service delivery.

Finance, also, is a key success factor for sustainable IAM. The solutions include, amongst others, improved budgeting and allocations for IAM, financial incentives for effective IAM performance, cost recovery, and various other planning, regulation and administration issues.

Management and leadership is another important area. Specific actions need to be taken by DWAF as sector leader, and by water sector managers and their political leadership in general. To make a strategic intervention of this kind, it is essential that politicians and senior managers fully understand, appreciate and support IAM.

This work is currently in the second phase -- DWAF, with the assistance of a new external team (of which CSIR is part), is formulating, programming and commencing the more detailed actions. The strategy itself, together with a brief implementation plan, is in final stages of approval by DWAF structures. (DWAF 2008)

6. BUILDING INFRASTRUCTURE

The delivery of public services such as health, education and justice takes place through, or in, public buildings. The accessibility, condition, suitability and function of these buildings play a large part in the quality of the services rendered, the ability of public servants to render services, and the level of satisfaction and success achieved in the service delivered. Poor buildings impede service delivery, while quality buildings can enhance service delivery.

Quality public buildings are a product of successful management through all the life stages of the estate from initial strategic planning and the decision of what and where to build, through procurement including project planning, design and construction, commissioning, operation and eventual disposal. Poor service delivery in any of these areas will adversely impact on the facility and on public service delivery.

The CSIR has been actively involved in researching and developing approaches and tools to empower decision makers and managers to improve the quality of decision making regarding the public-sector built estate in South Africa. These approaches and tools have related to various types of building infrastructure and real estate, in respect mainly of evaluations, management systems, and procedures and models.

Integrated approach to asset management

In work initiated in the early 1990s, the CSIR identified the need for an integrated approach to IAM. This integrated approach involves the recognition of the assets (and their recording in an immovable asset register). It also involves the consolidation of information and current assessed profiles of the facilities, to enable strategic, space, project and maintenance planning, as well as to enable real estate management functions including leasing and rentals, acquisitions and disposals and utilities management.

This concept was consolidated into the PREMIS (Professional Real Estate Management Information System), a suite of software developed by the CSIR. Although initially envisaged and designed to support both the public and private property management sectors, work has focussed on its application in the public sector.

The first full scale use of PREMIS was in the 1995/96 National Health Facilities Audit (NHFA) which sought to establish a baseline assessment of the condition, suitability, utilisation and standard of public sector hospitals and health centres in South Africa. This study provided the first consolidated profile of the health estate in South Africa. It incorporated an estimate of the replacement value of the estate, and a condition-based maintenance backlog based on field data. Based on this data, the national Department of Health (DOH) made an approach to National Treasury for special funding to rehabilitate the health estate. The resultant national Hospitals Revitalisation and Rehabilitation Programme later evolved into the current Hospitals Revitalisation Programme.

Follow-up studies in Limpopo indicated that the NHFA had enabled the province to target and replace poor quality facilities, to renovate facilities, and to use available capital funding proactively to shift the location of facilities to more optimally placed locations better placed to serve the needs of target communities. Through effective planning based on facilities assessments, the overall condition of the estate showed a substantial improvement between facilities assessments undertaken in 1995 and 2005 (Abbott et al 2007).

PREMIS is currently used in a variety of provincial and national applications across South Africa, and is being introduced into the Department of Defence. The system is also used by the CSIR for tenant management.

The CSIR has also supported the national DPW in the development and introduction of GIAMA. This legislation provides a uniform framework for the management of state immovable assets through the acquisition, planning, operation and disposal cycle. The CSIR recently developed a valuation model enabling the preparation of both a modern equivalent and depreciated valuation of immovable assets (land and buildings) in a uniform standardised format from the asset registers and condition profiles of facilities. The valuations are accepted by Treasury as satisfying the audit requirements of the PFMA and will save government the cost of the previously required individual market valuations.

Strategic planning

Strategic planning is a key phase in the life cycle of immovable assets where decisions are made with the greatest impact both on service delivery as well as on short-term capital expenditure and long-term operating costs. The relationship between health service delivery and infrastructure illustrates that facilities are a key resource that need to be managed alongside staff, equipment (health technology) and drugs. However this role is often not seen by health planners or works departments as integral to health service planning and management, resulting in a dislocation between service planning and facility provision. The development of decision support systems and skills development programmes by the CSIR is addressing this area of need (Abbott et al 2008).

Affordability and funding

In a study commissioned by the Development Bank of South Africa for its forthcoming national Infrastructure Barometer, the CSIR highlighted the relationship between the size and condition of the health estate (over 4 000 buildings and with a current modern equivalent value in excess of R180 billion), and current levels of funding for capital projects, maintenance and operation. While it is accepted that funding levels are being increased by Treasury it is argued that this may not be at a high enough level to maintain or to develop the estate to meet health care needs in the future. Alternative models of health care delivery may therefore be required to ensure a sustainable and effective public health service. (ibid)

Building maintenance

The NHFA highlighted the poor condition of many facilities which were old, had reached the end of their design life and needed to be replaced. However more recent studies (CSIR, 2008) have identified far newer buildings that have deteriorated to such an extent that their continued use places an unacceptable risk on both patients and staff. In one case a large hospital had reached the end of its service life after 30 years instead of achieving its design life of 50 or more years – this represents a loss of 40% of the capital investment. An analysis of the operating environment of the hospital highlighted, as major contributory factors, the lack of planned maintenance and adequate maintenance structures, and the ongoing erosion of professional and technical skills from the public sector.

Substantial work has been undertaken to develop a maintenance module which can be used in PREMIS to track the condition of the estate and to report on the required budgets for maintenance, repair and rehabilitation of the estate. Regular field assessments (as required by GIAMA) are used as input data allowing the development of a balanced prioritised maintenance budget. These form part of a consolidated buildings preservation framework designed to ensure that adequate funding is allocated towards planned preventive maintenance as well as the more visible backlogs maintenance and repairs that draw obvious attention. A key driver is to ensure that necessary maintenance is undertaken before degradation is so severe as to require far more expensive repairs.

Further research work was undertaken in this area by McDuling who developed an approach to service life prediction using fuzzy logic as opposed to the established factor method (McDuling 2006). With this approach it is possible to predict the degradation rate and service life of facilities, and from this prediction to report on the level of maintenance required to achieve an optimum balance between service life and ongoing maintenance investment.

Buildings and health

Infection control in health facilities is increasingly recognised as a major concern in health service delivery. Studies in the USA indicate that hospital-acquired infection (HAI) costs the American taxpayer $5bn each year (Issakov, 2006). While there is no equivalent cost estimate for South Africa, recent studies have highlighted the risk of HAI in local hospitals. Extensive analyses of a broad range of international health service research papers at Texas A&M University (Ulrich 2008) have supported the development of the new field of Evidence-Based Design has highlighted the potentially negative role of infrastructure in HAI as well as the positive role of quality design in supporting the healing process and reducing the length of stay.

The role of the airborne route for disease transmission particularly in TB has been highlighted through joint studies undertaken recently at the Witbank AIR laboratory by the CSIR together with the MRC, the CDC and Harvard University (Parsons, 2007). Health authorities in South Africa are currently challenged with the impact of the growing epidemic of multi- and extensively drug resistant M(X)DR TB. Recent studies by the CSIR at a hospital in KwaZulu-Natal highlight the role of the design and operation of the facility as probable co-factors in the genesis of the new XDR strain of TB (Parsons et al 2008).

The CSIR is currently developing guidelines for naturally ventilated wards and long-term care facilities for M(X)DR-TB patients as part of a support programme to the DOH. These are to be incorporated in a roll-out programme for M(X)DR-TB infrastructure using concept designs developed by the CSIR. The natural ventilation designs will be tested using a combination of techniques such as gas decay and computational fluid dynamics both to assess the designs and to validate the tools for use under South African conditions. These tools will be incorporated into the Buildings Performance Laboratory (BPL) currently being developed at CSIR.

Building performance

The BPL will also be used to consolidate and evaluate tools to assist facility planners and designers to optimise the performance of buildings. It is envisaged that the BPL will consolidate, validate and make available a range of design assessment tools available in the market as well as those already developed by the CSIR such as the ESPACE tool for space use analysis and planning and the KRONOS building simulation toolkit.

7. CONCLUSION

Simultaneous infrastructure investment and IAM will not only improve infrastructure performance and underpin services sustainability, but will also contribute significantly towards economic growth and add long-term jobs. The IAM sector forms an integral part of South Africa's total construction delivery capability. Its activities are ongoing and substantially local in nature. Rapid growth of the sector, with its inherent labour intensity, will stimulate sustained job creation, skills development, SMME development and BBBEE.

That increasing attention is being paid in South Africa to IAM is timely, and owes something to the work of the CSIR in discovering and documenting the state of infrastructure, and in leading specific aspects of the process of improvement of IAM policy and practice in the public sector.

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