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Developing a School Infrastructure Performance Indicator System (SIPIS)

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ABSTRACT

The Thuba Makote (TM) Programme, initiated in 2002 by the Department of Education and managed by the CSIR, was developed to introduce and pilot innovative approaches to school building design, construction and operation in order to address the need for both high quality education and community development support in rural areas of South Africa. It consisted of the construction and / or renovation of nine schools, one school in each province.

Purpose of this paper
Using eight of the TM schools, research undertaken identified critical performance areas that need to be measured and tracked in the planning and management of school infrastructure. The aim of the study was to support the development of a system of indicators and measurement protocols that can be used to measure the performance of school infrastructure in an objective and rigorous way. A literature review was undertaken, a theoretical framework developed and fieldwork was carried out.

Methodology
The methodology adopted to assess the schools, included the use of building audits, observation techniques, interviews with principals, classroom exercises for learners and educator questionnaires.

Findings
The research provides a useful start to the development of a set of indicators that can be used to measure the performance of school infrastructure, however further study is required.

Keywords: Thuba Makote Programme, school infrastructure, school building performance, School Infrastructure Performance Indicator System, SIPIS

1. INTRODUCTION

Since 1994, a number of policies have been developed and legislation has been promulgated to create a framework for transformation in education and training (Department of Education, 2003-2004). In a number of these policies and legislative framework, backlogs and providing adequate and appropriate school infrastructure has been identified as one of the priorities of the National Department of Education (NDoE).

With all the gains that have been made in addressing these challenges, a lot remains to be done. There are about 30,000 school sites in South Africa. The value of this estate is approximately R160 billion and in each province, there are large capital works programmes to address service backlogs that are estimated to be around R7 billion. According to the South African Schools Act (Act No. 84 of 1996), provincial departments have to set their own priorities and implementation programmes, and the capital and maintenance work in these programmes should be aligned with emerging policy and initiatives from both the NDoE and Department of Public Works (DPW). These include Education White Paper 6 on Inclusive Education, Education White Paper on e-Education, GIAMA (Government-wide Immovable Asset Management Act), IDIP (Infrastructure Development Improvement Programme) and NIMS (National Infrastructure Maintenance Strategy).

There is therefore an urgent need for a framework that can be used to guide decision making in the planning, design and management of school infrastructure. This needs to be set out, in simple terms, the essential functions of school infrastructure and provide guidance on how these can be achieved equitably and cost effectively in all schools. In particular, there is a need for a framework that can be used at both a macro scale (National, Provincial or District) by physical planners and at a micro scale (schools) by the school staff and governing bodies to measure the performance of school infrastructure, in order to improve school infrastructure and address backlogs.

The research therefore sought to establish key criteria that could be measured at schools in order to improve the effectiveness of planning and development processes both at school level and provincial level. It argues that the first step toward better management and development of infrastructure is to establish the key objectives that should be achieved in this infrastructure. Having established the key objectives, indicators should be developed that can be used to measure whether these objectives are being achieved. Careful measurement of these indicators provides planners and managers, both at a school level and a provincial level, with data that they can use to support effective decision making and ensure appropriate use of resources.

The research undertook field research on schools developed during the Thuba Makote (TM) Programme. The Thuba Makote ('breaking soil clods to prepare for planting') programme was developed to introduce and pilot new approaches to school building design, construction and operation in order to address the need for both high quality education and community development support in rural areas of South Africa. It consisted of nine school projects, one in each province of South Africa and was initiated in 2002. The programme approach towards the design, construction, management and operation of school buildings questioned and explored a number of fundamental aspects of education in South Africa, including the introduction of Curriculum 2005 (now known as the National Curriculum Statement), ICT technologies in curriculum, devolution of school management and increasing class sizes.

Eight of the nine schools developed as part of the TM programme were chosen for fieldwork in this study as they exemplified many of the objectives that the Department of Education has been trying to achieve in school infrastructure. The research team also had excellent access to and information on, these schools. The school that was not part of this study was excluded because it is not operational.

1.1. Research Aims And Questions

The research aimed to contribute to knowledge creation within the area of school infrastructure performance assessment and had the following objectives:

- To understand the relationship between school infrastructure and the functions and activities of a school.
- To establish the key aspects and characteristics that should be measured in order to develop a clear picture of the performance of school infrastructure.
- To develop a set of indicators and protocols that enable the performance of school infrastructure to be measured effectively.

The central research question was; “How can the performance of school infrastructure be assessed in order to provide guidance to relevant stakeholders for the planning and management of school infrastructure?”

1.2. Methodology

The methodology developed for the fieldwork component aimed to gather information that would help establish the key criteria that should be used to measure school infrastructure performance. Aspects of school infrastructure investigated during fieldwork were defined through the literature review and formulation of the theoretical framework. The literature review indicated that a common problem with current indicator systems

was that they mainly focus on one area. Therefore there was a deliberate decision in the study to ensure that building performance assessment was carried out in a more holistic way.

In order to refine the process and instruments for the fieldwork, they were piloted at the Maphala Gulube Primary School in Mpumalanga. This piloting enabled the process and instruments to be substantially rationalised enabling 2 people to carry out the required fieldwork within a morning. All members of the team undertook the pilot study from which a fieldwork manual and standardised assessment process were developed. This ensured that the process was as objective as possible.

2. LITERATURE REVIEW

The literature review explored the relationship between the performance of school infrastructure and the functions and activities of a school. It sought to develop an understanding of which aspects of the infrastructure should be measured in order to develop a clear picture of the performance of school infrastructure.

The literature review carried consisted of examining current local policies and legislation relevant to school infrastructure. This was followed by a description of the systems in use and the current situation within the education department with particular reference to physical planning. Lastly, international practice in relation to school infrastructure was reviewed.

From the literature that was reviewed, it was evident that South African policies on education focus on human rights, transformation, equitable access to quality education for all, addressing infrastructure backlogs and providing basic services like water and sanitation; while the systems and databases that are in place provide quantitative information that is often inaccurate and out of date.

Internationally school infrastructure strategies often focus on effective local management of facilities and flexible and adaptable buildings. These effectively help accommodate fluctuating learner numbers, changes in curricula, and teaching and learning methodologies. However, there is a strong focus on only one aspect of school infrastructure per guideline or indicator system. There are very few that look at the users, building and programme and their interrelatedness and impact on quality education.

However, having said this, major changes are taking place in the purpose, content, means and place of education. Changes internationally are rapid, in line with technological advancement. There is a growing recognition that education should be broad, comprehensive and useful, and that responsibility for this cannot be handed over in its entirety to the educator; parents and pupils are taking greater responsibility.

In addition, along with technological advancement, a greater emphasis is now being placed on life-long learning and continuous skills development. Adults have to also continuously develop their skills to remain competitive in the workplace. Schools and other centres for education play a vital role in this.

South Africa is in a position to learn from the experience of other countries, so contributing towards bridging the gap between past systems and future aspirations. It is therefore not tied to a linear progression of development and is free to 'leapfrog' to a more advanced point without the unnecessary delay.

The study introduces the possibility of doing assessments at a local level, so as to enable the school to be involved in the assessment, thus providing relevant and current data.

3. THEORETICAL FRAMEWORK

From the literature review, an outline set of school infrastructure objectives and indicators was developed in order to guide the fieldwork. The hypothetical set of objectives and indicators were a useful guide in establishing which performance areas and stakeholder perspectives were important to measure in the fieldwork component. The theoretical framework was also useful as it helped structure the building assessment process and provided an initial basis which could be tested and improved on through the study.

In order to encompass these broader requirements, an integrated building performance model (IBPM) was proposed (Figure 1). This model suggests that the performance of school infrastructure should be defined in terms of three focus areas. These are outlined below:

- **People:** School infrastructure should ensure that its users are comfortable, healthy and productive and have their basic needs met. It should also ensure that human rights are respected.
- **Infrastructure:** School infrastructure should be able to inherently perform well. This includes ensuring that buildings are weather tight, structurally sound, have low operating costs and are spatially and resource efficient.
- **Programme:** School infrastructure should effectively support the activities that they are required to accommodate and service. For instance, school buildings should ensure that the current curriculum and preferred modes of teaching and learning can be accommodated effectively.

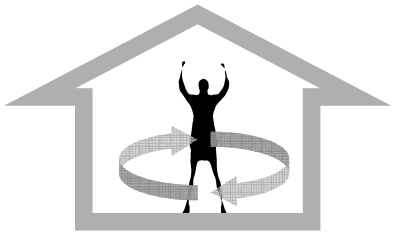


Figure 1 Integrated Building Performance Model

4. FINDINGS AND DISCUSSION

Basic information about the eight TM schools included in the research can be found in Table 1 below.

Table 1 Basic information of the TM Schools

Nearest City, Province	Name of School	No. Learners	No. of Educators
Ficksburg, Free State	Boitumelo Secondary School	1267	40
Umtata, Eastern Cape	Zinyosini Secondary School	654	18
Klerksdorp, North-West	Dirang ka Natla Comprehensive	773	21
Cape Town, Western Cape	Masibambane Secondary	1068	33
Bushbuckridge, Limpopo	Thulani Primary School	1053	26
Nelspruit, Mpumalanga	Jacob Mdluli Secondary School	815	29
Pietermaritzburg, Kwa-Zulu Natal	Muzi Thusi Primary School	657	19
Kuruman, Northern Cape	Bankara-Bodulong Combined	1254	26
		7541	**212**

Only three of these findings, shown per performance area, are presented with some discussion below. These three are reflective of the innovative approach to infrastructure provisioning aimed at in the TM programme, in terms of occupant comfort (people), spatial efficiency (infrastructure) and shared facility use (programme).

4.1. People

4.1.1 Occupant Comfort of Learners as perceived by Educators

A comfortable indoor climate is essential for the productivity of the learners (Reinink, 2004), for instance “if we are too hot we become lethargic and lose concentration; if we are too cold, our bodies stiffen; if the light is too bright or too dull we get sore eyes and heads. If it is too noisy we can’t hear and lose concentration; if our chairs and tables are too big or too small we get pains” (Brink in Reinink 2004).

The TM programme aimed to introduce innovative designs, which would provide learners with a comfortable indoor environment.

The current research interviewed educators to ascertain when the classroom environment was most comfortable through the year in terms of ventilation, lighting, temperature and noise.

The table below indicates that between 57% to 100% of the educators interviewed stated that temperature was the most problematic environmental aspect for learners. Of the educators interviewed, 19% found ventilation problematic, citing some of the following reasons to support their selection (Table 2):

- Broken window panes resulting in a drop of internal room temperatures
- Close proximity to toilets, leading to windows remaining shut
- Lack of heaters during winter
- Overcrowded classrooms, resulting in high internal room temperatures

Table 2 Environmental Aspects Educators indicated were most problematic

Name of School	Participants	Vent.	Lighting	Temp.	Noise
Boitumelo Secondary School	5	20%	20%	80%	80%
Zinyosini Secondary School	6	0%	0%	100%	33%
Dirang ka Natla Comprehensive	7	43%	14%	71%	71%
Masibambane Secondary	10	20%	20%	70%	40%
Thulani Primary School	7	43%	0%	57%	43%
Jacob Mdluli Secondary School	5	0%	0%	80%	20%
Muzi Thusi Primary School	15	20%	7%	73%	27%
Bankara-Bodulong Combined School	11	9%	9%	91%	55%
		19%	9%	78%	46%

International research has shown that occupant comfort and well-being are two of the most vital factors in ensuring the optimal performance of building users. The Council of Educational Facility Planners, International (CEFPI) worked in collaboration with the National Clearinghouse for Educational Facilities (NCEF) on a study that explored the effect of school facilities on academic outcomes. The conclusions from the research were that spatial configurations, noise, heat, cold, light, and air quality bear on students' and teachers' ability to perform; and that what is needed are: clean air, good light, and a quiet, comfortable, and safe learning environment (Schneider, 2002).

In this study, the educators found the temperature and noise levels of their teaching spaces uncomfortable and not conducive to learning. The method used to determine the relationship between occupant comfort and learner performance was effective enough to make a definite statement. The questions could have explored whether there was a lot of absenteeism during extreme temperature seasons, e.g. mid-summer and mid-winter, or whether learners show lack of concentration because of the noise levels. A proper measure of the temperature and noise levels could have been more appropriate in determining their impact.

4.2. Infrastructure

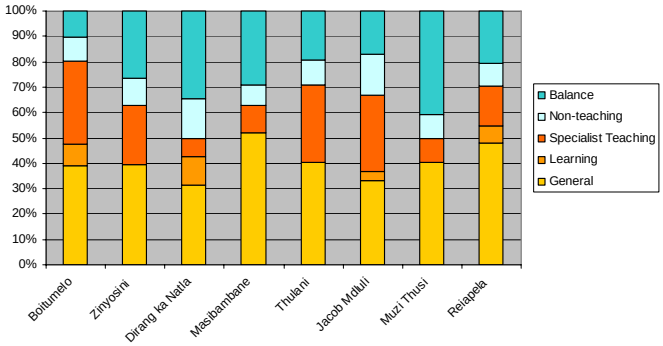
4.2.1 Spatial Efficiency

“Building cost money and make use of resources whether they are used or not. Effective and efficient use of buildings and resources supports sustainability by reducing waste and the need for additional buildings”

(Gibberd J, 2003). When designing and managing teaching and learning spaces within a school, it is, therefore important that one ensures that these spaces are aligned to the proportions of time allocations for learning programmes indicated in the NCS, in order for the spaces to be used optimally.

The TM programme aimed to provide teaching and learning spaces that could be used efficiently and effectively. This ensured that there was a close "fit" between requirement and provision of spaces and that overprovision and overcrowding were minimised.

The relatively high proportions of balance and non-teaching areas shows that the resources are not allocated efficiently and could have been shifted to the teaching and learning areas, areas which support the core business of a school. In good practice, the learning/teaching: non-teaching area/balance sets should generally be split into a 70:30 ratio.



Graph 1 Proportions of Space

Graph 1 represents the proportions of areas per space category. The space categories include General teaching (e.g. classrooms, excluding storage), Specialist teaching (e.g. laboratories and workshops), Learning (e.g. halls, LRCs), Non-teaching (e.g. spaces used exclusively by the staff, general storage areas) and Balance (e.g. toilets, non-allocated storage, internal circulation, covered external circulation and hall storage.

Five (62,5%) schools (Muzi Thusi, Dirang ka Natla, Zinyosini, Masibambane and Jacob Mdluli) have a split of between 65:35 and 50:50. The most extreme split of 50:50 is in the former two schools. This is due to the large areas of external covered circulation, which can be minimised by using the covered circulation as outdoor learning areas (part of the specialist teaching or learning space category). One (12,5%) school (Boitumelo) is the only one which has a split of 80:20 (Graph 1).

A key concern in most schools is the increase in learner numbers. In terms of spatial efficiency, most of the schools were already beyond their capacity to accommodate learners comfortably and to allow for flexibility as required by the curriculum. Increasing learner numbers means that the learner:educator ratio also becomes unmanageable. The pass rates are affected and the educator morale is lowered. Principals need to ensure that the maximum number of learners a school can accommodate is not

exceeded and alternative schools are recommended to parents. This can be problematic in some areas because of the current backlogs in the education system; however it still impacts on the quality of education.

4.3. Programme

4.3.1 Shared Facility Use

Schools are often the largest buildings in rural communities. They therefore need to fulfil an important role. The standard government school are created with to simplify the design and construction processes. This means that local culture, traditions, the natural environment and community involvement are often not taken into account.

TM aimed to make the schools with which it was involved with, centres for community development. It intended to do this through the introduction of specialised spaces, including halls, Learning Resource Centres (LRCs), business units and school gardens. The findings did not, however, reflect this intention.

Three (37,5%) schools are used by the school community after formal school hours; another 3 (37,5%) schools allow the community use of school's facilities after hours; the remaining 2 (25%) schools do not make use of their facilities after school hours.

Only 4 (50%) of the schools use their facilities on Saturdays and 5 (62,5%) schools on Sundays. The community uses the school facilities mostly on Sundays for church gatherings.

Only 3 (37,5%) schools have halls, and of these, only 2 schools allow the community to use this facility for weddings, community meetings and church services.

Seven 7 (82,5%) schools have LRCs, of these 7, only 4 allow the community access to the library or provide computer training. Zinyosini did not allow the community or the learners to access the LRC. Observations of the LRC showed evidence of a total lack of use of the facility, as computers had never been switched on and book shelves are in still packaged in boxes. The principal of the school attributed this to lack of computer training for the educators.

All 8 (100%) schools visited have classrooms, however only 7 (87,5%) schools allow community use of this facility for church meetings or ABET classes. Masibambane Secondary is the only school, which does not share this facility with the community.

Only 2 (12,5%) schools were provided with business units for the community, however, only Dirang ka Natla allows the community access to this facility. Jacob Mdluli does not allow community use of the facility at all. What is interesting in these 2 schools is that during break, three vending stations move into the school premises and any other vendors remain at the boundary, selling through the fence. Five (62,5%) schools (including Dirang ka Natla and Jacob Mdluli) allow vendor stations within school

premises; of the remaining 3 schools, 1 school (Boitumelo) allows learners to either go home to eat or to buy food from the local vendors outside the school premises; 1 school (Zinyosini) did not have any vendors within or outside the school site as it was during the Matric examinations and 1 school (Bankara-Bodulong) only allowed vendors to sell through the fence, as the school had a feeding scheme.

From these findings it was concluded that the community would like to gain more access to the schools and be able to use the school facilities more regularly. What also came out was that the costs of using these facilities in some schools were too high and this limited their use by the community.

From the findings it is evident that indicators are necessary for the assessment of the performance of school infrastructure and its impact on quality education. Every school will need to prioritise their areas of improvement. This will depend on the unique circumstances in each school and the level to which policy implementation, adherence to curriculum requirements, status of management structures, condition of buildings, and many other factors are met.

5. CONCLUSIONS AND RECOMMENDATIONS

In order for the performance of school infrastructure to be measured, assessed and improved on, a policy on physical infrastructure has to be put in place, the capacity within implementing departments (education and public works) needs to be expanded and improved on both at national and provincial level. Appropriate systems need to be developed, maintained and updated. Norms and Standards, guidelines, performance indicators and tools need to be developed for use at local level (by districts and schools) to assist them in the planning, design and management of their schools.

Internationally, school building guidelines are developed for use by local authorities, school governors, principles, planners and designers, etc. South Africa should also follow this route and focus on enabling people at the school level to assess their own facilities and make decisions regarding their development.

This research provides a useful start to the development of a set of indicators (Table 3). Therefore suggested future work would be to explore how these can be used as part of a larger integrated system between the DoE, DPW and other government departments that play a role in the provision of school infrastructure. It would also include looking at capacity within the lead department, database systems, policies and guidelines. These indicators should be tested by:

- Working with physical planners, using current data, audit systems and processes, i.e. SRN and NEIMS and
- Working with SGBs to develop self-assessment systems.

Table 3 Proposed SIPIS indicators

Performance Area	Objective	Indicators
People	Human Rights: Buildings must ensure that human rights are respected.	Disabled access
	Health: Buildings must ensure that their users are healthy and productive.	Day light Feeding scheme Water Sanitation
	Comfort: Buildings should ensure the comfort of their users	Daylight Temperature Ventilation Noise levels
	Community: Buildings should respond to needs in the community	Shared use
	Security and safety: Buildings should ensure that users are safe and secure	Hazards Access control Supervision
Building	Maintenance: Buildings should be easily and inexpensively maintained	Management structures Condition Detailing
	Cleaning: Buildings should be easily and inexpensively cleaned	Management structures Ease of cleaning Condition
	Efficient: Buildings should be spatially efficient	Area per user Proportions of area
	Energy: Buildings should be energy efficient	Energy consumption
	Water: Buildings should be water efficient	Water consumption
Programme	Teaching and Learning: Building should accommodate required teaching and learning modes	Flexibility Adaptability Adequate space Modular furniture Services and structural strategy
	Learning in the community: the school should support learning in the community	Shared access to learning resources Out of hours programming for adult education
	Stimulation: the environment should be stimulating and educational	Learner work, models, posters, design of the buildings and landscaping
	Educator support: Accommodation should ensure that educators can operate effectively and efficiently	Work areas size Work area location Facilities near work area Storage
	Facilities: Facilities and resources required by the current curriculum such as lab equipment and computers should be readily accessible	Adequate services Adequate equipment Appropriate spaces

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