PAPER 14

AN APPROACH TOWARDS CAPACITY BUILDING AND TRAINING IN MUNICIPAL ENGINEERING DEPARTMENTS: PROMOTION OF GREEN INFRASTRUCTURE DEVELOPMENT AND PRACTICES

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ABSTRACT

IMESA in 2014 initiated the development of Capacity Building Guidelines in Urban and Regional Planning for Engineers and Engineering Staff within Municipalities. The project was introduced and overviewed at the 2015 IMESA Conference held in Cape Town. The Guidelines have been completed in 2016 (a) and 2016 (b). a Business Plan for the rolling out of the Guidelines within the various IMESA Branches are being developed and was considered by IMESA EXCO in 2018 for possible implementation in 2019 to 2021.

The capacity building and training also focus on certain aspects of technical training, continued professional development and managerial skills for municipal engineering departments in a multi-disciplinary and innovative way. There are numerous employees (on both functional and managerial level) within municipal engineering departments who do not have and/or completed formal engineering, technical training or urban and regional planning course work. The Capacity Building Guidelines will deal with some of the challenges in municipalities through formal contact sessions.

This paper, assesses a case study for an alternative and innovative approach available within the education sector focusing on the specific need within the municipal sphere of government for technical, functional and managerial education, training and skills development through formal online distance learning programmes based on work integrated learning (WIL) principles. Course material for Post Graduate Diplomas in Engineering Infrastructure Management (EIM) and Engineering Construction Project Management (ECPM) is at present being developed to cater for persons employed within the Public Sector (in general) and the Municipal Sector (specifically) who holds at least a NQF 7 qualification in an approved field within the built environment. There exists a market need to capacitate and empower such incumbents in municipalities, government departments and the private sector.

This challenge becomes even more important if present realities such as the need to promote Green Infrastructure (GI) development and practices in urban and rural spatial systems and infrastructure provision is considered. The promotion of green infrastructure and best practices implies specific implications for spatial planning, engineering practices and design, project implementation (construction), infrastructure operation and maintenance and specifically for engineering management within the public sector. It requires the rethinking of the role of municipal engineering in terms of transdisciplinary practices in project planning, design and infrastructure development and in context to the built-environment as a whole. It entails much more than *'greening the grey'*.

This paper thus aligns the Capacity Building Guidelines, formal approaches to education and training development and the application of Green Infrastructure (GI) practices in promoting trans- and multi-disciplinary practices in sustainable urban planning and infrastructure development.

1. INTRODUCTION AND BACKGROUND

The promulgation of the Spatial Planning and Land Use Management Act (SPLUMA) (Act 16 of 2013) and its Regulations (2015) enforce cooperation and functional linkages amongst various professions within the built environment and especially within certain disciplines and departments in municipalities. This focus became even a greater need due to the ongoing transitional and implementation arrangements, policies and regulatory guidelines approved on National, Provincial and Municipal Spheres of Government. Laubscher, Hoffman, Drewes and Nyschen in 2016 published "SPLUMA-A Practical Guide" endeavouring to provide a general framework for all disciplines and practitioners functioning in this challenging and transformational context.

In 2016 IMESA published the Capacity Building Guidelines in Urban and Regional Planning for Municipal Engineers and Engineering Staff within Municipalities. The interface between SPLUMA (2013 and 2015) and the IMESA Capacity Building Guidelines (2016) is further complicated in the light of the lack of capacity, skills and training development in municipalities in general and engineering departments specifically (refer to Allyson Lawless, 2017).

SALGA and LGSETA fulfil an important role in building capacity within municipalities on an ongoing basis. The formulation of the National Development Plan (NDP) (2012) resulted in the publication of the Skills for and through SIPs (2014) Report by the Department of Economic Development and Department of Higher Education and Training (DHET). It addresses the need for skills development from school, theoretical, practical, workplace, assessment and expertise perspective.

The general planning and engineering challenges and problems experienced in most municipalities need to be addressed in a sustainable manner as has been documented in several research reports. The challenge, however, is further complicated by the need to address the "Greening of the South African Economy" (2016) that implies various scoping issues, challenges and opportunities. Green infrastructure utilisation in planning and engineering requires suitably qualified professionals within municipalities to promote the greening agenda within the built environment in terms of a local green infrastructure planning, development and management.

2. CAPACITY BUILDING IN URBAN AND REGIONAL PLANNING IN MUNICIPALITIES

Recognising the challenges for planning and development at all levels, IMESA (Institute of Municipal Engineers of Southern Africa) in 2014 identified the need for capacity building in Local, District, Metropolitan, Provincial and National spheres of government. The IMESA Capacity Building Project was completed in October, 2016. The output is planned to be rolled out between 2019 and 2021 within the municipalities. However, to be effective from a planning and implementation perspective, decision makers (politicians), engineering and building management staff, personnel working within the financial, administrative, and related domains such as environmental management inclusive of solid waste management functions need to be capacitated in a transdisciplinary manner. Such rethinking and capacity building also concerns key role players/stakeholders involved

on National and Provincial Spheres of Government as depicts by SPLUMA (2013) and its Regulations (2015).

The two Capacity Building Guidelines of IMESA (2016) (ISBN: 978-1-86822-677-1) are available online and consist of a detailed Source Document and Executive Summary. The content of the Capacity Guidelines was reported on in detail at the 2015 IMESA Conference in Cape Town (Paper 17).The fact that urban and regional planning is politically sensitive and operates in a complex policy and legislative framework impacts on all employees and professions within municipalities as well as the built environment. Effective delivery by municipal functionaries depends on political decision making and availability of resources. Backlogs in internal and external infrastructure are problematic. The recent report of the Auditor General (2018) on the financial status of municipalities is fundamental to the context within which the municipal engineer needs to address infrastructure backlogs.

Figure 1 shows the planned focuses for Capacity Building in Urban and Regional Planning by IMESA. Four (4) Capacity Building Courses is planned and will include eight (8) modules in total. The planning is to present six (6) courses per year within two six month cycles. It is planned to be held at selected venues in the geographical areas of IMESA Branches. It will be rolled out over three budget years from 2019 to 2021.

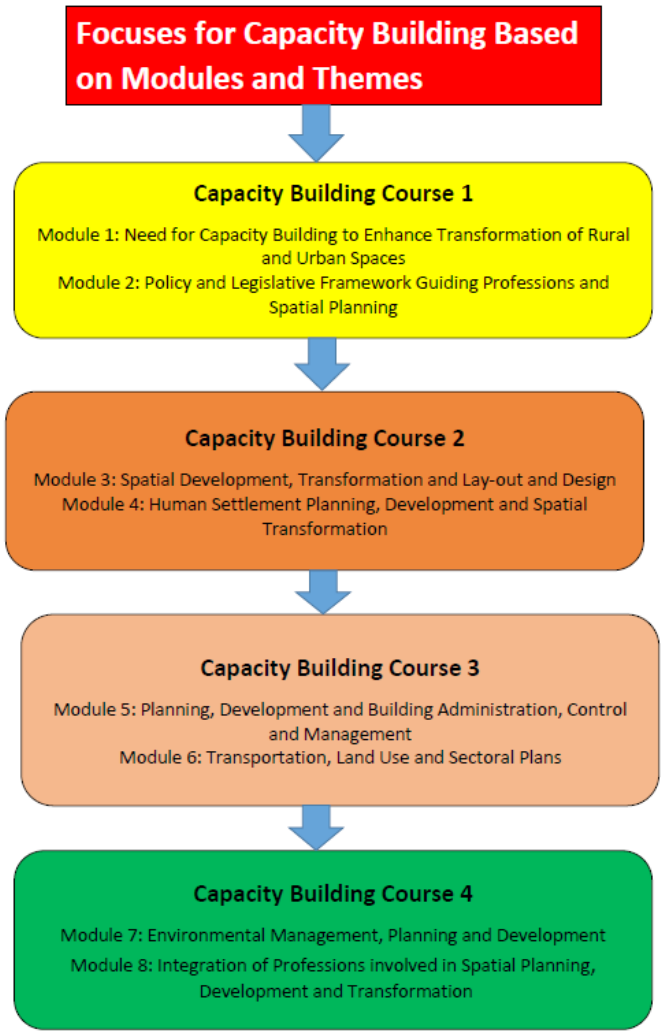

Figure 1: Focuses for Capacity Building as developed by IMESA.
Source: IMESA, 2018.

3. TECHNICAL AND ENGINEERING CAPACITY BUILDING WITHIN MUNICIPALITIES

3.1 Current needs and reality in municipalities

The importance of technical and engineering skills development has been included in various papers presented at IMESA Conferences and in research publications. Notably is contribution by Allyson Lawless in 2005 and 2007 on the "Numbers & Needs: Addressing Imbalances in the Civil Engineering Profession" and "Numbers and Needs in Local Government: Addressing Civil Engineering-The Critical Profession for Service Delivery" for SAICE. In 2014 the Economic Development Department and the Department of Higher Education & Training published the report "Skills for and Through SIPs" in support of the needs resulting from the NDP (2012) and its implementation.

Lawless updated the research in a paper presented at the 2016 Conference held in East London. In 2017 the researcher published in Civil Engineering (and based on other related initiatives and outputs) a further paper on "Numbers and Needs in Local Government - Where are we Now" that summarises the need to rethink technical and engineering practitioner's capacity building and development within municipalities. It includes related initiatives such as the ENERGYS Programme; role of ECSA; National Treasury Infrastructure Skills Development Grant (ISDG); Municipal Infrastructure Support Agent (MISA); CETA and LGSETA and related research by SAICE Professional Development and Projects (SAICE-PDP) (Lawless, 2017).

Lawless (2017) points out that the profile of Civil Engineers, Technologists and Technicians has significantly changed in terms of racial, gender and age composition in the period 2005 to 2015. This finding is due to democratisation and restructuring within municipalities. Some other positive findings include that in 2015 the total engineering staff increased to a total of 500 staff members and that the racial composition normalised significantly. The number of municipalities without civil engineering staff reduced from 82 in 2015 to 28 in 2015.

Some concerns identified was the increase in the number of households impacting on services and infrastructure delivery, access to a hierarchy of technical staff in municipalities to plan, develop, operate and maintain services and infrastructure. A further related problem is the decrease in professionally registered staff (from 455 to 294) and increase in the number of non-registered staff (1420 to 2094). The average age of civil engineering staff has dropped from 46 years to 38 years. This implies a reduction in numbers of staff with experience and registered professionals to manage, supervise and training of a growing group of inexperienced staff.

For the purposes of this paper it should be noted that Lawless (2017) states that Engineers should be 'innovators' responsible for complex tasks. They need to use engineering principles where necessary to develop applicable solutions. Engineering Technologists solve engineering problems categorised as the 'doers' to implement engineering tasks. Engineering Technicians are responsible for infrastructure support and managing operations, maintenance, production etc.

As far as professionalization is concerned, Lawless (2017) makes two important conclusions: the assumption that 'any manager can manage anything' which had devastating effects in many fields and especially in municipal engineering where specialist competencies were entrusted to unqualified persons.

This resulted in poor financial control, quality of engineering infrastructure and sometimes even a breakdown in service delivery, operations and maintenance of engineering systems.

3.2 Role of Higher Education Institutions in addressing engineering education and training in municipalities

The higher education sector (Higher Education Institutions-HEI's)fulfils an important role in training and capacity building for municipalities in addressing the challenges as far as municipal engineering is concerned. Several Universities such as University of Pretoria (UP), University of Stellenbosch (US), University of Cape Town (UCT) etc. (to mention some of such institutions) offer programmes in management, and more specifically in engineering and construction (within its Faculties of Engineering) through under- and post graduate programmes, short courses and CPD training courses in the built environment for the public as well as private sectors. It includes contact and distance modes of teaching, learning and training. The University of the Witwatersrand (WITS) was one of the first HEI's, in early 1980's, to address the market need for education and training programmes through its programme of a Post Graduate Diploma in Engineering (PGDE).

For the purposes of this paper, the intention is not to compare existing programmes and courses offered by various Higher Education Institutions (HEI's), but rather to focus on a specific case study to provide teaching and learning within the municipal and public sector and its supporting private sector service providers exclusively through distance (electronic) mode of training and instruction. Students will thus be trained on-line within the workplace based on theory and practice through Work Integrated Learning (WIL).

The North West University (NWU) Faculty of Engineering in 2011 investigated the potential for development of 7 new undergraduate programmes within the built environment and more specifically as far as capacity building within municipalities is concerned. After comprehensive research from 2011 to 2014, it was concluded that, due to unfolding of transformation within the tertiary sector, not to continue with implementation of the new undergraduate programmes in the built environment due to the required capital expenditure for infrastructure and costs for appointment of new staff (NWU, 2015).

From further research in the period 2016-2017, the niche was identified to develop two new Post-Graduate Diploma Programmes in Engineering Infrastructure Management (PG Dip in EIM) and Engineering Construction Project Management (PG Dip in ECPM) on NQF Level 8 (NWU, 2016) to address some of the training needs of engineering staff in local municipalities (as identified by Lawless from2005-2017) and the public sector.

The rationale behind the development of the new two PG Dip programmes is based on the current training and education background (profile) of existing municipal engineering staff as deduced from completed research. A further limited market survey and research was undertaken in 2017 for training needs in the different spheres of government. It also included respondents in the private sector dealing with infrastructure management and provision of services to the public sector.

At present there are many engineers, technologists and technicians within the public sector with NQF 7 qualifications (Engineering Diplomas, B. Tech Degrees, Post Graduate Diplomas etc.) working in the built environment who cannot access traditional university programmes (undergraduate) and/or enrol for post graduate degree programmes to upgrade their existing qualification profiles. The application of Recognition of Prior Learning (RPL) in admission is still developing and access to programmes at Universities are seldom accepted based on RPL policy only. The new programmes on NQF Level 8 will address and promote access to NQF Level 9 engineering courses and related post graduate programmes within various HEI's.

3.3 PG Dips Programme planning

The two PG Dip programmes will be offered through Open Distance Learning (ODL) mode of instruction and will consists of two years (four Semesters) course work with the following credits per programme: PG Dip in EIM: 128 credits consisting of 4 modules per year and PG Dip in ECPM: 120 credits consisting of 7 modules over two academic years. Each PG Dip will be concluded with a module consisting of a research project to illustrate the student's ability to link theory to practice.

The modules will include the following focuses: engineering planning, lay-out and design; bulk infrastructure services planning; internal infrastructure services planning; infrastructure management; infrastructure construction; project management; technology and infrastructure design and management; construction law, policy and legislation; strategic and construction management; formulation of business plans for infrastructure development; construction project design and development practices and are searched infrastructure management or construction management project.

The mode of instruction will have the advantage that existing staff in engineering departments in municipalities will be able to continue with their daily duties as all course material, assignments, assessments will be made available online. Progress from one learning module to the next will depend on successful completion of the preceding course material guiding and ensuring quality control in all modules and in attainment programme outcomes. The programme content will include fundamental engineering and construction theory and practice principles and will be designed to provide a basic knowledge to students within and/or related to infrastructure provision and management within municipalities (inclusive of the public and private sector).

Both PG Dips were approved by the DHET in February, 2017 and the HEQC Programme Accreditation application was submitted during 2018. The Programmes will be offered from 2020 through the Faculty of Engineering, School for Mechanical, Nuclear and Management Engineering at the NWU. Marketing of the PG Dips will commence in 2019 and all spheres of government, agencies and private sector will be included.

4. GREEN INFRASTRUCTURE DEVELOPMENT AND PRACTICES AND MUNICPAL ENGINERING

The green agenda is well defined in the publication: "Greening the South African Economy: Scoping the Issues, Challenges and Opportunities" (Editors Swilling, Musango and Wakeford) (2016). The book is the first comprehensive publication on the greening debate in South Africa and serves as an important reference work for *inter alia* the municipal engineer to facilitate the required paradigm shift towards green infrastructure development. It covers the following themes: rationale for the green economy; resources, extractivism and production; infrastructure transitioning; investing in the green economy and changing futures.

The need for and challenge to consider green infrastructure in services provision and practices in municipal engineering, is founded on the principle to support and implement the policy and legislative framework as applicable to planning and development in the built environment. SPLUMA (2013 and 2015) makes provision for the following principles that underpin the need for green infrastructure development: spatial justice; spatial sustainability; principle of efficiency; principle of spatial resilience and good administration. The NDP, National Infrastructure Plan (NIP) and the Strategic Infrastructure Projects (SIPs) necessarily impact on municipal engineering and related professions in the built

environment. The preceding themes dealt with in this paper thus culminates in aligning the initiative of capacity building in urban and regional planning to various programmes for formal training as offered for engineering and construction staff on tertiary level by the various HEI's. It provides a platform to rethink the role of the municipal engineer in planning, design, construction, operation and maintenance in context to the built environment within municipal spatial systems. In this, adaptive thinking in application of engineering technology, materials, design and management fulfils an important role in promoting sustainability and directing quality within the built environment.

4.1 Green infrastructure (GI) debate and principles:

Patel and Giordano (2014) state the case for instruments such as environmental impact assessments for the greening of public infrastructure in South Africa. Rivett-Carnac, Swilling and Giordano (2016) summarise the greening options for infrastructure sectors (focuses) as contained in Table 4.1.

Table 4.1: Examples of conventional and transformative infrastructure

Infrastructure Category	Improved Efficiency of Conventional Infrastructure	Transformative Infrastructure
Energy	Improved thermal efficiency of coal-fired and gas-fired plants and improved transmission (smart grid, grid management), lower consumption (energy-efficient appliances, i.e. LED lighting)	Renewable energy (wind, solar, wave, etc.); that is, new energy mix, off-grid or mini-grid systems, etc. New pattern of industrial production, less energy intensive.
Water	Better management of water catchments (limit siltation), better management of pipes and leaks, lower consumption (e.g. new irrigation system for agriculture)	Recycling/re-use/dual supply at both household and industry levels.
Sanitation	More efficiency sewage plants, improved network.	Natural or artificial wetlands (instead of water care works/facilities); limit the amount of water to be treated (new water pollution regulation, new regulations for agricultural input use, mining practices, industrial processes, etc.)
Stormwater	Improve scale and scope of stormwater management system to avoid flooding, spills of polluted effluences; water-sensitive urban design; sustainable urban drainage systems.	Reduce the volume of stormwater by using plant and soil systems to reduce runoffs.
Solidwaste	Improved landfill management, waste-fired plants to reduce landfill needs, etc.	Reduce, re-use, recycle; zero waste.
Transportation	Green roads, improved efficiency of locomotive, trucks, cars, planes.	Rethink mobility: promotion of public transport, road-to-rail, etc.
Housing	Improvement at the building level (insulation, solar waterheater, etc.)	New way of devising human settlements (smart cities with reduced material flows)

Source: Rivit-Carnac, Swilling, Musango and Giordano (2016, Chapter 17)

Schoeman (2018) states that the debate on resilience and sustainability is dealt within different ways by professionals, researchers and practitioners working in the environmental, ecological and built environment. In terms of this paper, the publication by Cilliers E.J. and Cilliers S. on "Planning for Green Infrastructure: Options for South Africa" (2016) contains some underlying green infrastructure planning principles and its relationship to infrastructure development in general.

Green infrastructure (GI) development is promoted worldwide. It implies resilience and sustainability considerations in environmental engineering context within the green, brown or grey built environment. The reality of scale from a municipal engineering perspective is central in the debate of applying green infrastructure technology, standards and practice (Schoeman & Schoeman, 2018).

The European Commission (EC) developed the following definition for GI: *'Green infrastructure is a strategically planned network of natural and semi-natural areas with other environmental features designed and managed to deliver a wide range of ecosystem services such as water purification, air quality, space for recreation and climate mitigation and adaptation'*(European Commission, 2016). This definition is general and narrow if applied and assessedfromthe infrastructure reality and challenges facing the municipal engineer.

Cilliers and Cilliers (2016) point out that it is challenging to integrate spatial planning and green infrastructure in urban contexts where land use decisions (inclusive of spatial planning) has to address the demand for housing and other services (*inter alia*). Mell (2014) concludes that green infrastructure (GI) is grounded in global literature but that greater variety is evident in its application on different scales (national, regional and sub-regional).

The municipal engineer needs to facilitate, educate and advocate the rethinking of infrastructure needs; financial prioritisation and technical capacity to promote green infrastructure (GI) inplanning, design, application and its resulting development benefits within municipalities.

Existing and future spatial and urban form represent a physical reality that needs specific intervention to align and convert conventional infrastructure (CI)to green infrastructure (GI)oriented planning approaches; engineering standards and practices and its application within the built environment. Such application is currently founded in use of terminology such as "greening the grey", "urban resilience", "green urbanism" etc. It is being applied differently by researchers, professionals (urban and regional planners, municipal engineers, civil engineers etc.) and related practitioners involved in infrastructure planning, development and upgrading.

From the literature it is evident that the concept of "green planning" is often used differently by some professionals and practitioners and that this phenomenon is indicative of the need to promote and enhance GI development in terms of standards and application of new technology within the natural and built environment.

Development of spatial and environmental systems through GI orientated planning requires trans- and multi-disciplinary interventions. This challenge, however, is much more complicated than the arguments and/or justifications contained in specialized fields focussing collectively on certain components in GI and eco-system (ES) development. Spatial planning and municipal engineering in general should be more inclusionary than the present exclusionary approaches underpinning training, research, standards and practices applied within the built environment. Table 4.2 contains some focuses and benefits of GI development within the municipal and civil engineering domains.

In promoting GI application, the need for mainstreaming actors at

Green Infrastructure*	Grey/Brown Spaces and the Built Environments*	Transportation*
Reduced and delayed storm water runoff volumes	Water flow regulation and flood control	Permeable pavements
Enhanced groundwater recharge	Water purification On-site primary sewerage purification	Bio-swales
Storm water pollution reductions	Reduce grey/brown infrastructure costs	Planter boxes
Reduced sewer overflow events	Use of alternative building materials	Landscaping
Increased carbon sequestration	Application of alternative construction technology	Permeable road shoulders
Urban heat island mitigation	On-site renewable energy generation	Infiltration trenches, basins and galleries
Reduced energy demands Application of renewable energy sources	Rain water retention	Bio retention with draining systems
Improved air quality	On-site waste water pre-treatment	Media filter drains
Additional Wild Life Habitat and Recreation Space	Solid waste recycling	Emission reduction policy Non-motorised transport
Improved human health	Increased property values	Land use and ecology
Increase land values	Enhanced marketability	Improved energy utilization (EVs) Promotion of public transport
Income generation	Green building design	Green road systems and corridors
Green planning promotion	Lower operating costs	Alternative pavement designs

Table 4.2: Some focuses and benefits of GI in development
Source: Schoeman & Schoeman, 2018.

various levels and scales through green planning initiatives is central (e.g. regionally, urban or neighbourhood level). This scale reality is applicable to all spatial planning, design and development of infrastructure at municipal level.

4.2 Green Infrastructure (GI) planning and development

Hansen and Pauleit (2014) point out that green infrastructure and ecosystem development are promoted as concepts that have potential to improve environmental planning in urban areas based on a more holistic understanding of the complex interrelations and dynamics of social–ecological systems dealt with by various professions. The introduction of this notion still lacks application-oriented frameworks to mainstream and apply the underlying principles in terms of planning and practice. Multi-functionality is an important principle in GI planning and application.

It supports the view as developed by Albert and Von Haaren (2014). It provides for a conceptual framework to assess multi-functionality from a social–ecological perspective that may inform the planning and design processes and support stronger exchange between GI and ES research and application.

4.3 SPLUMA in enhancing GI application within municipalities

As stated the IMESA Capacity Building Guidelines in Urban and Regional Planning (2016) is an important transformation tool in *inter alia* democratising planning on various spheres of government and in promoting the interface and linkages between professions and disciplines. It aligns the need to direct planning and development holistically in terms of the core policies and legislative frameworks. Various scales of planning exist. However, in terms of the focus of this paper, all planning instruments applicable to municipalities guide the process of multi-functional planning. Figure 2illustrates the role of scale in the application of GI in terms of SPLUMA provisions.

Generally, the application of GI is viewed to be applicable to the natural environment as a whole and not as a function impacting on resilience and sustainability in municipal engineering services only. The capacity Building Guidelines however illustrates that the municipal engineer is involved in all phases of land and infrastructure development. Infrastructure planning should not only focus on system development in terms preferred level of services and application of engineering standards and practice. It entails complexities such as existing levels of services and infrastructure backlogs, need for new infrastructure, serviceability of existing infrastructure systems, engineering technology applied, engineering materials used and impacts on humans and the environment (underground water etc.). Current engineering solutions

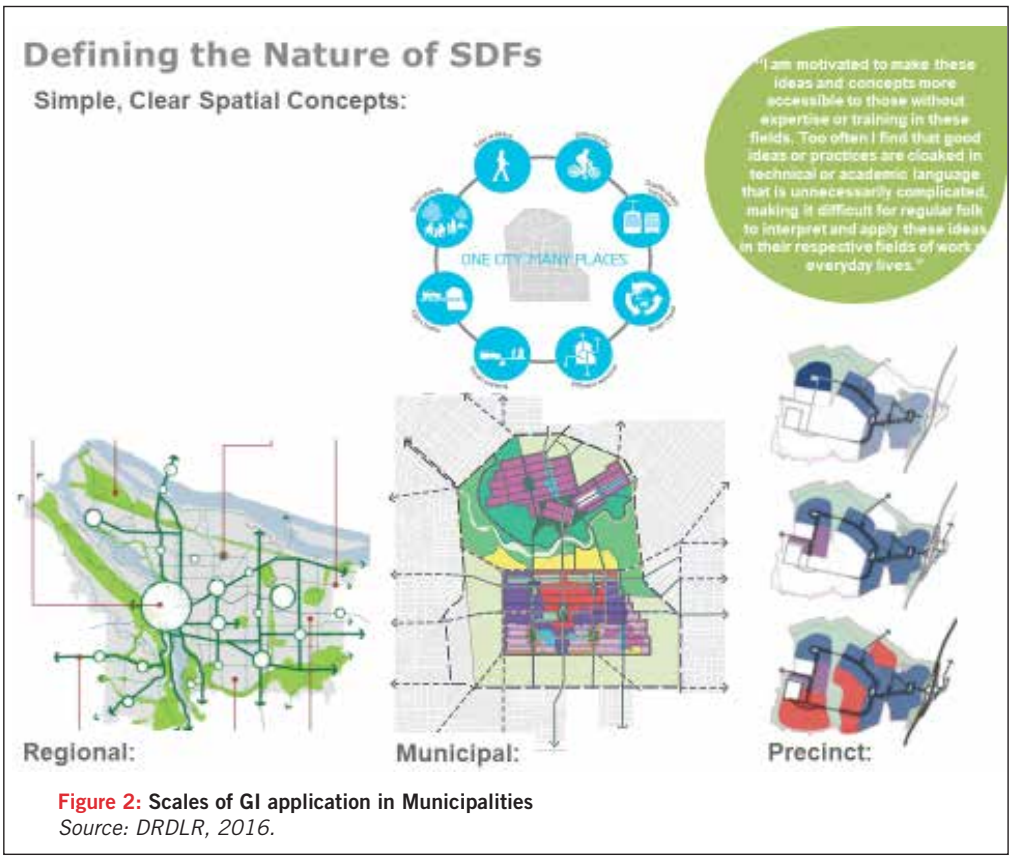

Figure 2: Scales of GI application in Municipalities
Source: DRDLR, 2016.

in addressing existing (and sometimes manmade) infrastructure backlogs will require innovation and creativity from the municipal engineer to address such challenges (refer to Stats SA, 2016 Report and CoGTA, 2016).

To address currently known infrastructure backlogs, upgrading infrastructure systems and to develop new internal and external (bulk) infrastructure systems through GI application require involvement of all professions in the built environment. It includes all phases of scoping, planning, design, implementation and operation (maintenance) (inclusive of building control and management) through application multi-functional alignment of spatial development disciplines. In this, cooperation between all spheres of government is fundamental.

Figure 3 illustrates the complexities involved in GI application in planning and infrastructure development in ensuring resilience and sustainability in the built environment. It aligns soft core issues, approaches and methodologies in planning linked to hard core issues in terms of procedures, projects and practices in development and physical implementation.

For the purposes of this paper, Figure 4 integrates the principles as dealt with in this paper to enhance GI transfer within municipalities. It consists of following distinct GI transfer focuses, components, alignments and actions that need to be applied in planning, design and implementation:

- Alignment and integration of strategic and spatial planning policies and instruments.
- Rethinking spatial planning, layout and design standards and practice inclusive of urban upgrading and renewal programmes.
- Redefining level of services in infrastructure provision and building design and construction.
- Promotion and use of green orientated materials in services, infrastructure and construction design.
- Application of green architecture and environmental engineering practices in all building development.
- System wide GI orientation and implementation in planning, design, construction, systems maintenance and operational practices.
- Promotion of adaptive technology and practice amongst all professions involved in the built environment and development sector.

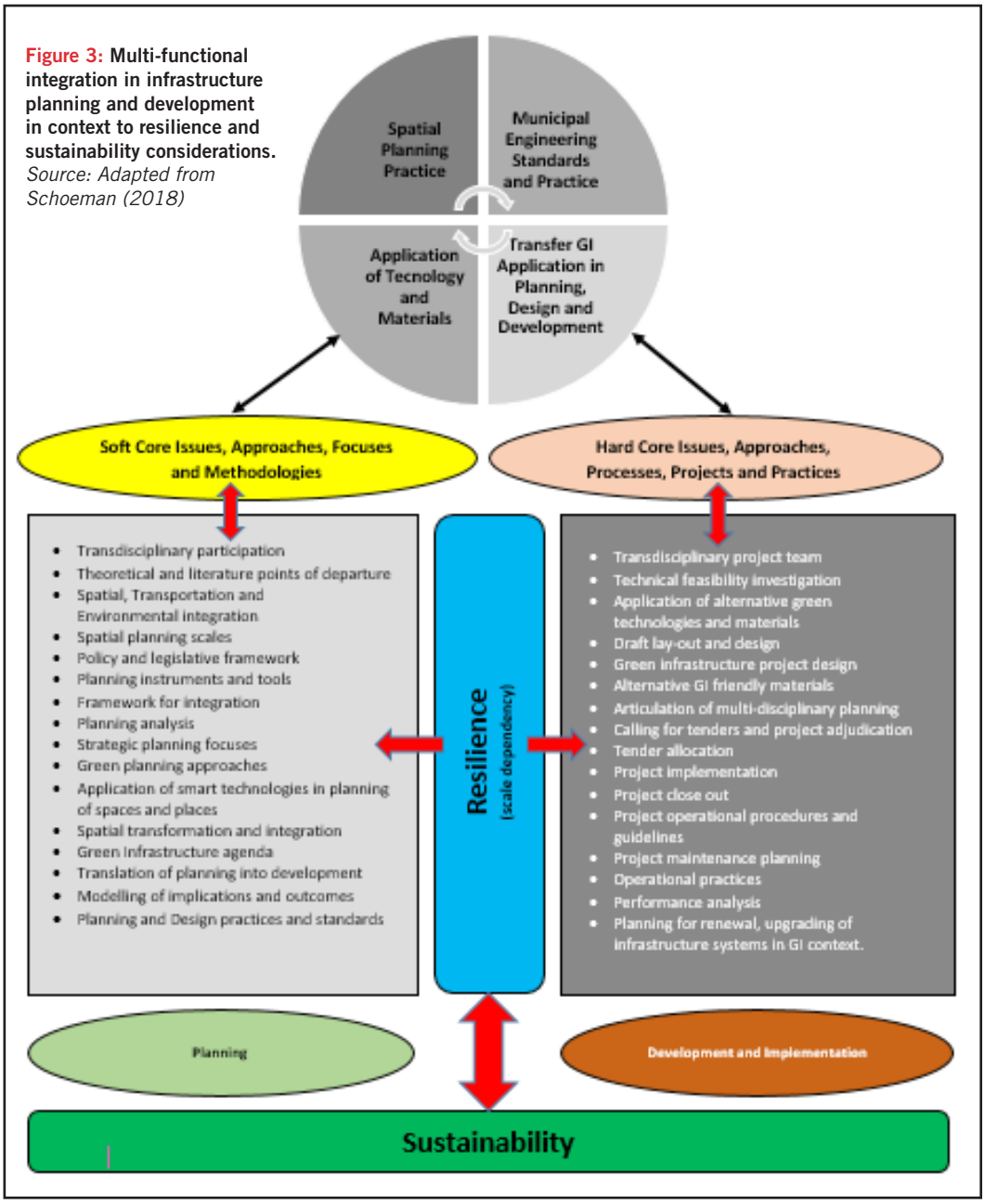

Figure 3: Multi-functional integration in infrastructure planning and development in context to resilience and sustainability considerations. *Source: Adapted from Schoeman (2018)*

5. CONCLUSIONS

- The rolling out of IMESA's Capacity Building Guidelines (2016) in Municipal Engineering Departments are essential in all planning and development of infrastructure and services through promotion of trans-disciplinary planning practices.
- Promotion of education and training programmes through WIL to be presented online by Universities to upgrade the knowledge profile of engineering staff in municipalities are key in providing municipal engineering departments with a well-trained and skilled human resource base.
- Rethinking the GI debate in terms of planning, application of technology in design, preferred use of alternative green engineering designs and construction materials, construction, operating and maintenance practices.
- Addressing municipal infrastructure backlogs through GI application in terms of resilience and sustainability considerations in planning, development and upgrading.

Figure 4: GI transfer for municipalities
Source: Schoeman & Swart (2018)

- Empowering all staff within Municipal Engineering Departments to promote multi-and transdisciplinary functionality in addressing infrastructure development and maintenance through GI mainstreaming.
- Capacity building in Planning, Development and Building Control Sections within Municipal Engineering Departments in guiding, application and promotion of GI principles and practice.

It necessitates thus alternative ways of thinking in planning, engineering design and implementation through a paradigm shift in spatial, land use, transportation and infrastructure planning and development. Promotion of green infrastructure sensitive development requires appropriate application of alternative technologies, application of alternative designs, use of alternative engineering materials and a commitment in shifting boundaries and cooperation between professions.

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