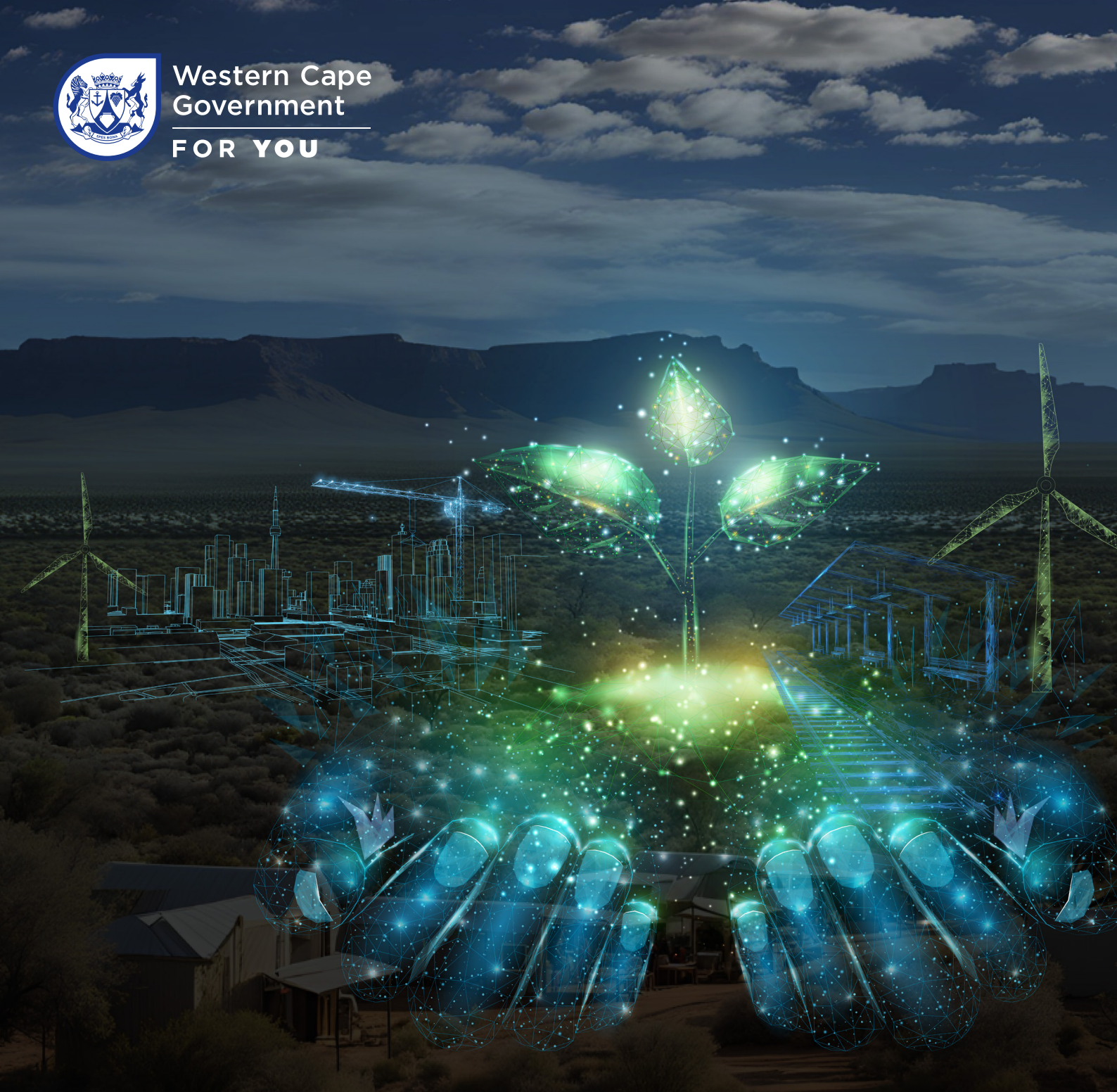




Western Cape
Government
FOR YOU



Department of Infrastructure

Western Cape Infrastructure Framework 2050

Foreword



The vision of the Western Cape Infrastructure Framework (WCIF) 2050 is to enable infrastructure-led growth and investment in the Western Cape that creates sustainable, equitable, and resilient communities. Infrastructure is the backbone of development, and through this framework, we aim to position it as a driver for socio-economic transformation and environmental sustainability.

The Western Cape Department of Infrastructure (DoI) leads the charge in building and maintaining infrastructure. We are committed to fostering skills development, supporting artisanal training, and empowering infrastructure professionals through statutory registration processes. Through our focus on local procurement, labour-intensive construction, and contractor development, we strive to generate employment opportunities, empower communities, and grow local economies.

At the heart of our work lies a firm commitment to sustainability and climate resilience. We recognise the profound impact of climate change and have embedded sustainability imperatives into the design, planning, and implementation of our infrastructure projects. By embracing panarchic governance and the Panoptic Principles, we ensure transparency, collaboration, and long-term adaptability in addressing these challenges. Our partnerships across government, the private sector, civil society, and academia are key to amplifying the impact of our work and ensuring that infrastructure serves the evolving needs of all our stakeholders.

However, we cannot ignore the constraints we face: inadequate funding, high levels of unemployment, and slow economic growth. While these challenges are significant, we remain focused on what we can control by leveraging the resources we have to improve the life chances of every person in the province. Our commitment is to be proactive, learning through action, continuously innovating, and addressing the unintended consequences of our decisions.

The WCIF 2050 is our roadmap for the next 25 years. It acknowledges the complex, adaptive nature of infrastructure systems and commits to fostering the conditions necessary for the province's future growth. By strategically aligning resources, embracing innovation, and embedding sustainability at the core of our efforts, we aim to drive catalytic change that will benefit both current and future generations.

The journey ahead is long, but the WCIF 2050 sets the foundation for transformative infrastructure that enhances economic opportunities, promotes social equity, and safeguards our environment. Together, we will build a Western Cape where all can thrive, creating a legacy that will endure for decades to come.

Our future depends on it.



**Minister
Tertuis Simmers**

Ministry of Infrastructure
Western Cape



**Head of Department
Adv. Chantal Smith**

Department of Infrastructure
Western Cape

Executive summary

The Western Cape Infrastructure Framework 2050 (WCIF 2050) presents a forward-thinking and transformative vision for infrastructure development in the Western Cape, focusing on building a sustainable, inclusive, and resilient future. It positions infrastructure as a key driver of social equity, economic growth, and environmental stewardship, while addressing the region's unique spatial challenges.

Central to the WCIF 2050 is the need for integrated infrastructure planning that considers land use, spatial realities, and equitable development across urban and rural areas. This approach requires strong collaboration between different levels of government and a wide array of stakeholders. By emphasising outcomes-based planning, the framework ensures that every infrastructure investment delivers tangible value for money, addressing long-standing spatial inequalities and improving quality of life for all communities.

The WCIF 2050 also highlights the importance of aligning infrastructure strategies with existing national policies, legislation, and regulatory frameworks. This alignment strengthens accountability and promotes responsible infrastructure management, particularly in the context of rapid urbanisation and the increasing demand for public services. The framework emphasises the need for intra-governmental cooperation and effective public participation to ensure that projects are managed sustainably and with transparency.

A crucial aspect of the WCIF 2050 is its recognition of infrastructure as a Complex Adaptive System (CAS). By framing infrastructure as part of a dynamic, interconnected ecosystem, the framework emphasises the importance of continuous stakeholder engagement, which acts as a feedback loop that drives iterative improvements. Engaging diverse stakeholders ensures that the infrastructure ecosystem remains adaptable, resilient, and responsive to the specific needs of local communities.

A standout feature of the WCIF 2050 is its adoption of panarchic governance and Panoptic Principles as guiding tenets. Panarchic governance embraces a multi-layered, adaptive approach to managing infrastructure systems, recognising that these systems are interconnected and subject to change. It allows for flexible governance structures that can respond to the complexities and uncertainties inherent in large-scale infrastructure projects. Panarchic governance fosters collaboration among government, private sector, and civil society stakeholders, encouraging shared ownership and collective decision-making for the common good.

The Panoptic Principles serve as a foundational guide for ensuring that infrastructure planning and delivery are aligned with both societal well-being and ecological imperatives. These principles advocate for transversal governance, where decision-making processes are clear, inclusive, and aligned with the constitutional mandate to promote the welfare of South African citizens. The Panoptic Principles also prioritise long-term sustainability, focusing on how infrastructure projects can mitigate the effects of global warming while addressing the

Western Cape's specific spatial challenges. In terms of governance, the WCIF 2050 recommends establishing an Infrastructure Ministerial Committee to ensure coordinated planning, implementation, and monitoring at various levels of governance. This committee would drive critical transitions related to spatial alignment, climate adaptation, and the promotion of labor-intensive, innovative practices in infrastructure development.

Innovation is another key element of the WCIF 2050, particularly through the adoption of a mission-oriented approach. This framework encourages the public sector to take a leadership role in coordinating cross-sectoral efforts to address societal challenges like climate change, economic sustainability, and social inclusion. The mission-oriented approach fosters public value creation, ensuring that infrastructure projects solve immediate problems and drive systemic change across multiple sectors. In addition to embracing innovative governance and principles, the WCIF 2050 integrates global standards and best practices to ensure infrastructure is developed in line with international benchmarks. This ensures that infrastructure in the Western Cape is resilient, safe, and adaptable to technological and environmental advancements, while meeting the needs of the region's diverse communities.

Technology and digital infrastructure are positioned as enablers of efficient governance and public value creation within the WCIF 2050. The framework calls for the integration of digital tools and data-driven systems to enhance decision-making, governance, and accountability. By adopting public value-based designs, infrastructure can be developed to maximise benefits for society while preventing misuse and promoting transparency.

The WCIF 2050 further advocates for a transition towards regenerative infrastructure, moving beyond sustainability to systems that restore and regenerate environmental and social capital. This evolution is crucial in addressing the intensifying pressures of climate change and ensuring that infrastructure development contributes positively to both ecological and social well-being.

Sustainable funding and resource allocation are central to the WCIF 2050's success. The framework prioritises strategic decisions that maximise value for money and promote long-term economic returns. By leveraging partnerships with the private sector, the WCIF 2050 aims to stimulate substantial catalytic investments, positioning infrastructure development as a key driver of sustainable economic transformation.

In conclusion, the WCIF 2050 is a holistic framework that integrates governance, innovation, sustainability, and collaboration. It sets the stage for a future where infrastructure in the Western Cape plays a pivotal role in fostering economic prosperity, social equity, and environmental resilience. By embracing this vision, the Western Cape can unlock the full potential of its infrastructure to create a better future for all its citizens.

Contents

“Infrastructure, at its most fundamental level, is not about roads and bridges, cables and concrete. It’s about **who we are, what we value, and what kind of society we want to create.**”

- Eric Klinenberg

Foreword 2	Executive summary 4	Parliament Address 8	Introduction 10
CHAPTER 1 The Evolving Infrastructure Context 18	CHAPTER 2 Infrastructure’s Strategy, Policy, Legislative and Regulatory Environment 30	CHAPTER 3 Adopting a Mission-Oriented Approach to Infrastructure 36	CHAPTER 4 Relevant Standards and Leading Practice 40
CHAPTER 5 Principles Underpinning Infrastructure Strategy 44	CHAPTER 6 Infrastructure as a System 50	CHAPTER 7 Technology, Data and Digital Infrastructure 58	CHAPTER 8 From Sustainable and Resilient to Regenerative Infrastructure 68
CHAPTER 9 Funding and Resourcing Infrastructure 76	CHAPTER 10 Partnerships to Optimise Infrastructure Service Delivery 82	CHAPTER 11 Prioritising Infrastructure Decisions 84	CHAPTER 12 Sound Governance For Infrastructure 96
CHAPTER 13 Developing an Aligned, Capable and Capacitated Infrastructure System 104	CHAPTER 14 Way Forward To Crafting The Western Cape Infrastructure Strategy and Implementation Plan 108	Glossary, acronyms and abbreviations 110	References 120

National Parliament Address

In the next five years, working together, drawing on our collective capabilities, we will forge a new, inclusive growth path for South Africa by pursuing a massive investment in infrastructure. Significant projects are underway around the country in areas such as transport, roads, water, energy, and human settlements.

We will massively increase the scale of investment in infrastructure through a more holistic and integrated approach, positioning Infrastructure South Africa as the central institution of co-ordination and planning. We are simplifying the regulations on public-private partnerships to enable greater investment in both social and economic infrastructure development.

From our largest metros to our deepest rural areas, we have a clear intention to turn our country into a construction site, as roads, bridges, houses, schools, hospitals and clinics are built, as broadband fibre is laid, and new power lines are installed.

President Cyril Ramaphosa

Opening of Parliament Address
18 July 2024

Provincial Parliament Address

I have once again made infrastructure-led economic growth and job creation a core priority of my term.

I am going to work tirelessly to get the critical mega-projects off the ground that we need to enable our economy to thrive. One of the critical steps is to create an infrastructure pipeline because we know that it takes time to get these projects “shovel-ready” and then to get the infrastructure built.

We set up the Department of Infrastructure with the sole purpose of building a future-proof province with its foundations in innovation, empowerment, and integration.

Premier Alan Winde

Opening of Provincial Parliament Address
31 July 2024

When we talk about infrastructure, we must remember that behind every project, every building, and every road, there are human lives that are impacted. Infrastructure shapes the everyday experiences of our people.

It determines the quality of our schools, the reliability of our public transport, the safety of our homes, and the accessibility of our healthcare services. Our investment in infrastructure is an investment in the dignity, safety, and well-being of our citizens.

Minister Tertuis Simmers

Debate on the Premier's Opening Address
1 August 2024

Introduction

WELCOME TO THE WESTERN CAPE INFRASTRUCTURE FRAMEWORK 2050 (WCIF 2050)

The WCIF 2050 is aligned to the key priorities of the Government of National Unity, which are to drive inclusive growth and job creation; to reduce poverty and tackle the high cost of living; and to build a capable, ethical and developmental state (President Ramaphosa, Opening of Parliament Address, July 2024).

The WCIF 2050 establishes a contextual framework for infrastructure development that aligns with the Western Cape Government's priorities, which are building a growing, inclusive infrastructure-led economy that creates jobs; building our energy and water security; and creating safer communities and devolving law enforcement resources and decisions; and further improving the province's education and healthcare systems (Premier Winde, Opening of Provincial Parliament Address, July 2024).

The WCIF 2050 lays the groundwork for infrastructure development that ensures the implementation of the Ministerial priorities to accelerate the delivery of essential infrastructure and embrace innovation for efficiency and sustainability. These priorities acknowledge that traditional methods of construction and planning are no longer adequate to address the growing demands and challenges of our time and emphasise the need for alternative models that utilise cutting-edge technologies and innovative practices. (Minister Simmers, Debate on the Premier's Opening Address, August 2024).

The purpose of the WCIF 2050 is to develop a flexible, innovative, and inclusive framework for collaborative infrastructure planning and asset life-cycle management that is evidence-informed and aligns with sound decision-making aimed at future-proofing the Western Cape. It aims to serve the often-conflicting needs of the citizens of the Western Cape, its communities, enterprises, and the natural environment.

It is important to acknowledge upfront that all infrastructure exists within a complex spatial context that has been shaped by the legacy of apartheid. It is for this reason that the WCIF 2050 will be closely aligned and integrated with the focus contained within the Western Cape Spatial Development Framework 2035 (WCSDF 2035).

Delivering on the necessary integration between these two important Frameworks will require close co-operation and collaboration between officials drawn from different sectors and levels of government in order to make this integrated planning and implementation approach a reality. In particular, close collaboration will be required to ensure that we collectively unlock funding from the national fiscus to action the important programmes and investments (within the National Spatial Action Areas of the NSDF) required to transform our economy. Crafted with the future in mind, the WCIF 2050 seeks to deliver intelligent, resilient infrastructure that adds dignity to citizens' lives, connects communities, and positively addresses the inequities of the past, while accelerating our journey to a prosperous, sustainable future.

WCIF 2050 Strategic Objectives:

- 1. Stimulate Economic Growth and Job Creation:** Foster economic development by driving infrastructure-led growth and expanding employment opportunities.
- 2. Maximise Infrastructure Benefits:** Ensure infrastructure projects generate significant economic and social returns for all citizens of the Western Cape.
- 3. Enhance Informal Infrastructure:** Upgrade and formalise built informal infrastructure while preserving community functionality and value.
- 4. Deliver Coordinated and Efficient Services:** Provide well-coordinated, effective, and efficient infrastructure and services that enhance quality of life across the region.
- 5. Attract Private Sector Investment:** Leverage private sector participation in infrastructure development, ensuring broad-based cost-benefit alignment for inclusive growth.
- 6. Drive Innovation and Integrated Planning:**

The story of infrastructure is, and always will be, a human story. At the best of times, a story of human endeavour, aspiration and triumph, but at the worst of times, it has been a story of human oppression, indignity and injustice. Yet it's meant to form the backbone of modern civilization the world over. It's a story that continues to write history, shaping eras – past, present and future and moulding people, place and the promise of possibilities. The South African infrastructure story is no different – steeped implicitly in our history, infrastructure has had an influential impact its people, its spatial landscape and access to basic human needs for self-determination.

The WCIF 2050 Vision	The WCIF 2050 Impact Statement
The WCIF 2050 will enable infrastructure-led growth and investment for the Western Cape that will benefit the communities we serve.	A flexible, innovative, and inclusive framework for collaborative infrastructure planning and asset management that informs and aligns sound decision-making and serves the needs of citizens, communities, enterprises, and the natural environment.

The WCIF 2050 is based on five focus areas that will serve the Western Cape's present and future, through to 2050.

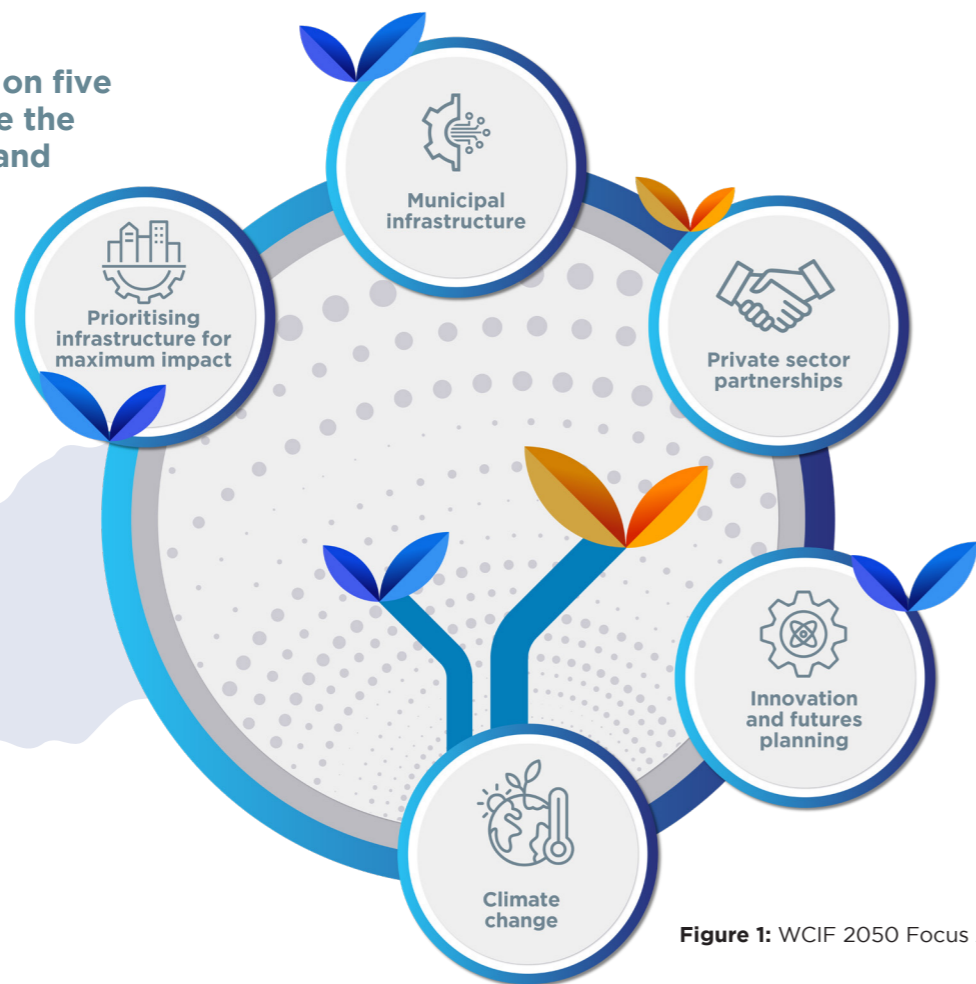


Figure 1: WCIF 2050 Focus Areas

Emphasise innovation, long-term planning, and an integrated approach to ensure infrastructure development meets future demands.

- 7. **Promote Climate-Resilient and Transformative Infrastructure:** Design and implement infrastructure projects that address climate change, ensuring long-term resilience and sustainability.
- 8. **Align with Existing Plans:** Ensure all infrastructure initiatives are aligned with both public and private sector strategies and frameworks for cohesive development.

The WCIF 2050 is underpinned by a complex adaptive systems view which recognises that, while infrastructure is an obvious solution to societal needs, it may also have unintended consequences that need to be understood, avoided, addressed, or mitigated. It also acknowledges that we operate within a broader system of public infrastructure providers, encompassing various levels of government, the private sector, and communities, particularly those in rural and urban areas who are among the most vulnerable and important beneficiaries of infrastructure.

In this dynamic system, our decisions and actions shape infrastructure, which in turn shapes our society's future, economic impact, and environmental footprint. Infrastructure planning and implementation cannot occur in isolation; it must be contextually grounded, with a deep understanding of societal needs and expectations.

We currently face two critical contextual challenges that must guide our infrastructure planning. The first challenge is improving the quality of life for the most vulnerable people in the Western Cape while simultaneously addressing our historical legacy of spatial injustice and inequity. Given the fiscal constraints, government must navigate the significant financial investment that infrastructure demands over its lifetime. With numerous competing funding needs, it is essential for government to be both innovative and selective to deliver maximum benefits at the lowest possible infrastructure lifetime cost.

The second challenge is to fundamentally rethink our relationship with the natural environment. We must urgently address climate change, mitigate its impact, and adopt a regenerative approach that reverses both current and past environmental damage.

Our planetary boundaries are already overstretched, making it imperative to develop sustainable and resilient infrastructure that can withstand extreme weather events while contributing positively to environmental regeneration.

Sustainable infrastructure is designed and built with long-term environmental, social, and economic impacts in mind, focusing on reducing environmental impact, preserving natural resources, and enhancing the lives of people and communities. It aims to reduce the impact of infrastructure on the environment, preserve natural resources, and improve the lives of people and communities.

The WCIF 2050 will shape and guide evidence-informed infrastructure strategies and implementation plans, by ensuring that these are consistent, efficient, and effective.



Figure 2: WCIF 2050 Guidance for Strategies and Implementation Plans

Regenerative infrastructure goes beyond sustainability and resilience by aiming to restore balance to our systems rather than merely reducing negative impacts. This approach involves using biophilic and green design building techniques and technologies, renewable energy, and natural resource conservation to repair the damage caused by pollution and other harmful by-products of infrastructure. It also aims to improve the health and well-being of communities by creating green, healthy spaces where people can live and work with dignity - a concept often referred to as the biophilia of infrastructure.

With these important concepts in mind, the WCIF 2050 has embraced Panoptic Principles to ensure that all forms of infrastructure are developed with these holistic considerations. This approach encourages stakeholders to explore alternative solutions that are desirable, feasible, and viable to address the complex challenges faced by the people of the Western Cape.

The WCIF 2050 is a comprehensive framework that provides infrastructure life-cycle guidance to the Western Cape Government (WCG) in making strategic decisions across physical and digital infrastructure assets essential for socio-economic development, growth, and well-being. It includes behavioural solutions to ensure that the way people engage with infrastructure contributes to its utility and mitigates its impact.

At the heart of the WCIF 2050 is its foundational Panoptic Principles, which have been distilled from a broad spectrum of global, regional, national, and provincial infrastructure-related strategies, policies, legislation, and regulations. These principles advocate for a holistic, systems-based approach to infrastructure and underpin the beliefs, behaviours, and decisions that will be articulated in the WCIF 2050's Strategy and Implementation Plan phases. They serve as practical reference points, helping to navigate the volatile, uncertain, complex, and often ambiguous infrastructure environment in which solutions need to be found.

By adopting a whole systems approach to infrastructure, the WCIF 2050 views infrastructure as fundamentally interconnected rather than as consisting of isolated components. This perspective recognises that infrastructure is influenced by various agencies, forces, and societal

and environmental factors. It acknowledges the complexity and interdependence of infrastructure systems, ensuring that our strategies and actions account for these dynamic relationships and their broader implications.

The WCIF 2050 aims to be a beacon of innovation, sustainability, and resilience, steering the Western Cape towards a future where infrastructure not only supports growth and development but also contributes positively to the well-being of its people and the ecological integrity of its natural environment. Through collaborative efforts and a shared vision, the WCIF 2050 will help shape a prosperous, inclusive, and sustainable Western Cape for future generations.

The WCIF 2050 has 3 Phases:

Phase 1	Phase 2
Development of the WCIF 2050.	Development of the WCIF 2050 Strategy.
Phase 3	
Development of the WCIF 2050 Implementation Plan.	



The WCIF 2050 is underpinned by a complex adaptive systems view which recognises that, while infrastructure is an obvious solution to societal needs, it may also have unintended consequences that need to be understood, avoided, addressed or mitigated. It also acknowledges that we operate within a broader system of public infrastructure providers, encompassing various levels of government, the private sector, and communities, particularly those in rural and urban areas who are among the most vulnerable and important beneficiaries of infrastructure.



THE WCIF 2050 IS STRUCTURED IN THE FOLLOWING WAY:

Chapter 1: The Evolving Infrastructure Context

- provides an important background and context to infrastructure in the Western Cape and sets out an overview of the WCIF 2050, including its scope and outcomes.

Chapter 2: Infrastructure's Strategy, Policy, Legislative And Regulatory Environment

- provides the strategies, policies, legislation, and regulations that align with the WCIF 2050, offering crucial insights into the legislative and other capabilities required by government.

Chapter 3: Adopting a Mission-Oriented Approach to Infrastructure

- provides a context to innovation in the public sector and emphasises a strategic and transformative perspective on infrastructure development.

Chapter 4: Relevant Standards and Leading Practice

- provides an overview of how the Western Cape benefits from, and is guided by, an understanding of global infrastructure standards and leading practices.

Chapter 5: Principles Underpinning Infrastructure Strategy

- provides an overview of the principles guiding the WCIF 2050, its Strategy, and Implementation Plan.

Chapter 6: Infrastructure as a System

- provides clarity on how the WCIF 2050 interacts with a complex, adaptive, and emergent system of stakeholders who have significant relationships with infrastructure.

Chapter 7: Technology, Data and Digital Infrastructure

- provides an overview of how technology, data, and digital infrastructure are essential for the success of infrastructure projects in our current and future world.

Chapter 8: From Sustainable and Resilient to Regenerative Infrastructure

- provides an important environmental perspective on infrastructure and advises how infrastructure can play a significant role in mitigating climate change and contribute to a resilient environment and communities.

Chapter 9: Funding and Resourcing Infrastructure

- provides insight into some of the ways in which infrastructure may be best sustainably funded and resourced going forward.

Chapter 10: Partnerships to Optimise Infrastructure Service Delivery

- provides insight into the necessity of partnerships with other levels of government, stakeholders, and the private sector to optimise infrastructure service delivery.

Chapter 11: Prioritising Infrastructure Decisions

- provides an outline of how infrastructure decisions and investments may be best identified and prioritised going forward. It also identifies some of the potential risks inherent in the infrastructure planning and implementation processes and suggests strategies for their effective mitigation.



Chapter 12: Sound Governance for Infrastructure

- provides an outline of how stakeholders may best work together to optimise infrastructure planning and delivery. It also sets out how the overall implementation of the WCIF will need to be monitored, evaluated, and adjusted in response to ongoing change and volatility.

Chapter 13: Developing an Aligned, Capable and Capacitated Infrastructure System

- provides a focus on how the provision of infrastructure needs to be supported by capable organisations and competent people. It identifies the crucial capabilities and competencies required and outlines strategies for their development moving forward.

Chapter 14: Way Forward to Crafting the Western Cape Infrastructure Strategy and Implementation Plan

- provides an outline for the development of Phase 2: Strategy and Phase 3: Implementation Plan.



THE EVOLVING INFRASTRUCTURE CONTEXT

Chapter 1

'When South Africans threw off the structures of apartheid three decades ago, the nation captivated the world. But more than a generation later, jobs are scarce, and South Africa's economic potential remains unrealised. The national economy has experienced slow, slowing, and highly vulnerable growth. Inequality is the highest in the world, and structures of exclusion remain embedded in South African society both within and across racial groups and geographies.' - Ricardo Hausmann, et al.¹

INFRASTRUCTURE'S HISTORICAL CONTEXT IN SOUTH AFRICA

Infrastructure has been central to meeting society's needs throughout human history, from early tribal settlements to the Industrial Revolution of the late 18th century, consistently acting as a catalyst for change. The electrification of machinery has enabled mass industrialisation, while the development of connective transport systems, such as railways and steamships, opened access to raw materials and markets. In South Africa, early infrastructure development was often ad hoc, driven by industrialists and investors with government and municipal support. However, as the benefits of infrastructure became evident, the government frequently intervened to accelerate growth. For example, the telegraph system and private railway networks in the Cape were eventually acquired by the government to ensure their expansion and effective management.

The Johannesburg sanitation crisis of the late 1890s underscored the necessity of treating infrastructure as a public responsibility, requiring effective coordination and technical management. In the later years of the Union period, infrastructure development became a key driver of industrialisation, with projects like the Vaal Dam supporting mining operations and providing cheap coal for the iron and steel industries. Public works programmes were also implemented to address the "poor white problem", by reserving jobs for white residents and reinforcing their socio-economic mobility.

The policies implemented during the apartheid period were explicitly designed to create

segregated socio-economic systems that have left enduring, intergenerational impacts still visible today. During this period, public infrastructure investments were concentrated on enhancing the living standards of a privileged few, while segregated cities, townships, and rural "homelands" were designed to supply cheap labor for the mining and agricultural sectors that dominated the economy. Restrictions on the movement of people from non-white communities, reinforced by the Group Areas Act of 1950, dictated where people could live and work, which further entrenched patterns of spatial, social, and economic exclusion.

The first democratic government of 1994 inherited a legacy of severe infrastructure deficits, which continue to be addressed today. Historically, infrastructure spending as a percentage of GDP was relatively high, reaching its peak in the 1970s. However, this level of investment was unsustainable given the nature of the infrastructure being developed. By the mid-1980s, infrastructure spending had sharply declined. This reduction in investment, both in new infrastructure and in maintaining existing assets, led to mounting backlogs that worsened in the final years of apartheid. For instance, a 1996 survey conducted at the beginning of the democratic era revealed that out of 26,736 schools, about 59% lacked electricity, 34% had no on-site water supply, 12% were without toilets, 61% had no telephone lines, and 82% did not have libraries.

During Apartheid, infrastructure development was a key tool for enforcing segregation through policies governing housing, urban planning, as well as road, water, and sanitation systems. As a result, Townships were designed with inherent spatial patterns of segregation and unequal services that still remain today. In the post-apartheid era, infrastructure development has been focused on addressing these injustices through spatial and economic transformation, aiming to redress the legacy of apartheid. Efforts to extend public goods, create mass employment through infrastructure projects, and promote spatial and economic inclusion have sought to leverage infrastructure for social impact.

INFRASTRUCTURE IN THE WESTERN CAPE AND KEY CONSIDERATIONS FOR THE WCIF 2050

The Western Cape has become a beacon of opportunity, attracting people from other countries

and provinces. Within the province itself, there has been a notable migration from rural areas to urban areas as people seek better prospects. Interestingly, while many rural residents move to urban centres, newcomers from other regions often settle in these rural areas, forming large informal settlements on the outskirts of rural towns. These new settlements, often lacking in economic opportunities, tend to rely on informal trading and government grants for survival. One of the key challenges for the WCIF 2050 is to develop infrastructure that promotes socio-economic growth in rural areas, helping them retain and attract economically active residents. This would allow municipalities to sustain infrastructure through local rates and taxes.

As the population of the Western Cape continues to grow, new communities are emerging, necessitating the development of essential social infrastructure, including water, energy, sanitation, health, education, and community facilities. However, infrastructure alone is not sufficient to sustain these communities. To truly enhance quality of life, economic opportunities must be created to enable sustainable incomes.

Economic infrastructure, such as communication networks, transportation systems, distribution networks, financial institutions, and energy supply systems, need to be developed not only to facilitate capital accumulation but also to support sustainable income and improve quality of life. The Fourth Industrial Revolution (4IR) exemplifies how advancements in connectivity, data storage, cloud computing, and data centres can empower communities. By providing access to information and leveraging Artificial Intelligence (AI), these technologies have the potential to transform lives, enhance capabilities, and expand work opportunities.

The growth of communities and infrastructure often has adverse effects on the environment, including increased emissions and waste that can pollute natural habitats. To address these challenges, the WCIF 2050 must prioritise environmental sustainability and consider the impacts of climate change, which have led to more frequent and severe weather events. There is a need for infrastructure to be sustainable, resilient, and even regenerative, to mitigate and reverse the effects of climate change and to bolster economic resilience.

4IR AND BEYOND

Economists, sociologists, and environmentalists universally acknowledge that infrastructure is fundamental to quality of life and plays a vital role in societal evolution and the pace of economic growth and development.^{3,6}

Historical patterns³ demonstrate how infrastructure has both shaped and been shaped by various industrial revolutions across different eras and regions. Cycles of technological and infrastructure innovation have shaped these revolutions and have been pivotal in the evolution of societies and economies.

4IR represents a significant shift in technological development that builds upon the advances of the previous three industrial revolutions. It is characterised by the integration of digital technologies, automation, and data analytics into various aspects of life and industry. As an example in infrastructure, Building Information Modelling (BIM) involves creating digital representations of physical infrastructure projects. It allows for better planning, design, and management of buildings and infrastructure through 3D modelling and data integration. 4IR is transforming how we live, work, and interact, driving innovation and creating new opportunities across various sectors.

The Fifth Industrial Revolution (5IR) is an emerging concept that is seen as a natural progression from 4IR. While 4IR focuses on the integration of digital technologies, automation, and data exchange in manufacturing and other sectors, 5IR emphasises the collaboration between humans and machines, aiming to leverage the strengths of both to achieve enhanced productivity, personalisation, and sustainability. As an example in infrastructure, Human-Centric AI and Robotic systems are designed to collaborate closely with human operators in infrastructure projects, such as construction robots that work alongside workers to enhance productivity while ensuring safety and adaptability. This revolution is still in its early stages, and its full impact is expected to unfold over the coming decades as industries and societies adapt to, and integrate, these new principles.

As we advance through the Fourth and Fifth Industrial Revolutions, we face the dual challenge of meeting new infrastructure demands while also

addressing the shortcomings of outdated systems from previous industrial eras. The WCIF 2050 must address this challenge by seamlessly integrating emerging infrastructure requirements with the strategic repurposing or decommissioning of legacy infrastructure.

COLLABORATIVE AND INCLUSIVE INFRASTRUCTURE PLANNING

Modern infrastructure planning and development in South Africa takes place within a highly complex landscape that demands the integration of numerous stakeholders. This includes close collaboration between funders, government entities, and private sector partners through multi-stakeholder engagement, along with a forward-thinking, futures-oriented approach essential for sustainable progress.

This approach ensures that infrastructure stakeholders and beneficiaries are actively engaged in the planning process, allowing communities to influence and shape planning efforts. By fostering authentic partnerships, this model increases the likelihood that infrastructure projects will deliver tangible benefits, create a sense of ownership, and transform access to opportunities, ultimately improving the quality of life for all involved.

The WCIF 2050 acknowledges the critical importance of integrating the efforts of all stakeholders - including government agencies, the private sector, State-Owned Enterprises (SOEs), developers, funders, and investors - to maximise long-term success and make the most of limited and scarce resources.

CHALLENGES AND OPPORTUNITIES FOR SPATIALLY INCLUSIVE GROWTH

In its assessment of post-apartheid progress in the report 'Growth Through Inclusion in South Africa', Harvard University's Growth Lab states that "South Africa is failing to achieve growth and inclusion. Income per capita has been falling for over a decade. Unemployment at 33% is the world's highest, and youth unemployment exceeds 60%. Poverty has risen to 55.5% based on the national poverty line, yet many more households depend on government transfers to sustain meagre livelihoods. Most cities are failing to adequately connect people to productive opportunities and are failing to innovate,

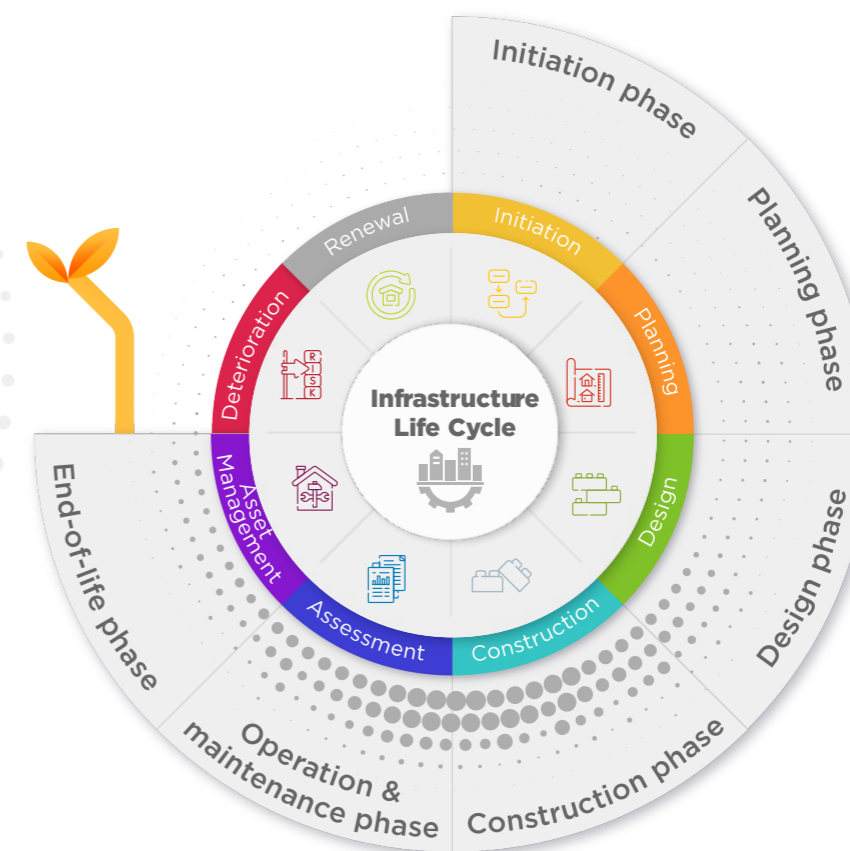


Figure 1: Infrastructure Life Cycle

grow, and drive inclusion. Rural areas in former homelands, where almost 30% of South Africans live, exhibit dismally high unemployment rates and remain exceptionally poor. Individuals living in these areas need to leave for an equal chance to earn a decent living”¹.

The research concludes that the evidence points to two main causes, namely collapsing state capacity and the persistence of spatial exclusion. The report highlights that “Spatial exclusion has been entrenched by well-intentioned policies in urban areas and an absence of effective strategies to include rural former homelands. We find that urban planning regulations and zoning policies prevent dense, affordable housing in desirable locations and consequently limit both formal and informal employment. We also find strong evidence that formal jobs are limited because long commutes from low-density areas in and around cities make transportation costs and reservation wages high, while low residential densities prevent the development of a thriving informal economy”.

The Western Cape is uniquely positioned to benefit from both a “youth dividend”, with a significant portion of young people set to become the future workforce, and a “silver dividend”, as the region

continues to attract affluent retirees. To fully harness the potential of both groups, infrastructure growth and development must cater to their distinct needs, fostering economic and societal contributions. Historically, infrastructure has fallen short in serving women, people with disabilities, and other vulnerable population groups. Addressing these inequalities proactively is critical to ensuring inclusive growth.

These findings reinforce the necessity of the WCIF 2050 to closely align with the WCSDF 2035 at both policy and implementation levels to achieve meaningful and sustained impact.

ADDRESSING THE MULTIDIMENSIONAL CHALLENGES OF INFRASTRUCTURE DEVELOPMENT

The complexity of infrastructure development demands a multidisciplinary approach, incorporating insights from sociology, economics, and ecological science. It requires empirical evidence and community insights from past experiences and forward-looking foresight to anticipate future challenges. Effective planning must integrate spatial and infrastructure development while leveraging intelligent technologies to guide decision-making.

Infrastructure is widely acknowledged as vital for driving economic and social progress, reducing unemployment, and alleviating poverty. However, South Africa continues to underinvest in critical sectors like energy, transport, and water.

The WCIF 2050, and its Strategy and Implementation Plan, must address the underlying causes of the deficit. While fiscal constraints are a significant factor, systemic issues such as a shortage of technical and financial expertise, inefficiencies in public sector procurement, and the need to strengthen government capacity to support infrastructure growth development must also be addressed.

OVERVIEW OF THE WCIF 2050

The WCIF 2050 serves as a strategic framework to drive inclusive infrastructure growth by addressing key questions, which include:

- What constitutes infrastructure, and how should investment priorities be determined?
- What approaches to infrastructure development are best suited to the Western Cape's unique context?
- How can we ensure that infrastructure projects are inclusive and equitable for all communities?
- What criteria should guide infrastructure decision-making processes?
- How should infrastructure be funded, managed, and maintained effectively?
- How will future digital and hybrid infrastructure needs be addressed?
- How will government and other stakeholders be prepared to tackle future infrastructure challenges?

The WCIF 2050 must establish a clear definition of its scope, outlining what constitutes infrastructure and identifying the various types included in its framework. For the WCIF 2050, infrastructure is defined as “fixed assets” within the built environment that “facilitate the delivery of services and unlock economic and growth opportunities”. This definition includes traditional engineering infrastructure, social services, property and buildings, ICT infrastructure, and ecological infrastructure.

The following infrastructure sectors are integral components of the WCIF 2050 and collectively form the backbone of infrastructure by delivering essential services and facilities necessary for societal functioning, economic growth, and improved quality of life:



The complexity of infrastructure development demands a multidisciplinary approach, incorporating insights from sociology, economics, and ecological science. It requires empirical evidence and community insights from past experiences and forward-looking foresight to anticipate future challenges.



1. **Social** - refers to the facilities, services, and institutions that support the quality of life and well-being of a population.
 - a. Public administration (offices, government buildings)
 - b. Housing (top structures, serviced sites, including affordable housing and informal settlements)
 - c. Education (primary and secondary schools, student housing)
 - d. Health (hospitals, clinics, health centres, emergency medical services)
 - e. Social development (community-based care and support services centres, homeless shelters, places of safety)
 - f. Culture (libraries, theatres, museums)
 - g. Public safety and security (police stations, fire stations and emergency response units, prisons)
 - h. Recreational and cultural spaces (picnic areas, parks, community centres, museums, theatres, sports facilities)
2. **Energy** - refers to the physical systems and facilities that generate, transmit, distribute, and store energy. It encompasses the entire network required to provide reliable and efficient energy services to homes, businesses, and industries.
 - a. Power generation facilities
 - b. Transmission networks
 - c. Distribution networks
 - d. Energy storage systems
 - e. Renewable Energy
 - f. Natural gas
 - g. Oil
3. **Economic** - refers to the foundational systems and facilities that support and enable economic activities and growth. It is crucial for improving productivity, fostering investment, and creating job opportunities.
 - a. Roads
 - b. Rail networks
 - c. Public local transport
 - d. Ports and cruise terminals
 - e. Warehousing and storage (online retail)
 - f. Freight forwarding
 - g. Aviation (airports, air traffic control)
 - h. Economic hubs
4. **Technology** - refers to the physical and digital systems, facilities, and resources that support the creation, management, and utilisation of technology and information.

- a. Communication systems (telecommunication networks)
- b. Broadband (high speed internet access)
- c. Data centres
- d. Cloud computing services
- e. Infrastructure required to support the 4th and 5th Industrial Revolutions.

5. **Ecological** - refers to natural or semi-natural systems and processes that provide essential environmental services and support ecosystem health. Ecological infrastructure plays a crucial role in maintaining biodiversity, regulating climate, and supporting human well-being. Ecological Infrastructure is the “naturally functioning ecosystems that generate valuable services to people. It is the nature based equivalent of built infrastructure and is just as important for providing services and underpinning economic development”. (SANBI, 2016)

- a. Man-made water supply resources (domestic and industrial)
- b. Natural ecosystems that support and provision water and cycle nutrients
- c. Sewerage and waste disposal (domestic and industrial wastewater)
- d. Waste (domestic and industrial)
- e. Pollution control, including improving air quality
- f. Rivers and wetlands
- g. Nature reserves
- h. Strategic catchment areas and healthy catchments
- i. Estuaries
- j. Watercourses
- k. Beaches and coastal dunes
- l. Ecological corridors
- m. Recreational routes
- n. Urban open spaces

Infrastructure can also be catalytic, driving economic growth and employment, such as the Green Energy initiatives in the Western Cape, which promote renewable energy industries and innovation.

The following are the major activity classifications for existing infrastructure:

- a. **Maintenance and repairs:** Includes activities aimed at maintaining the capacity and effectiveness of an asset at its intended functional level. Maintenance actions involve restoring the asset to its original condition without significantly enhancing its capacity or value. Expenditure under this classification is of

- a current nature.
- b. **Upgrades and additions:** Includes activities aimed at improving the capacity and effectiveness of an asset beyond its original intended purpose. The decision to renovate, reconstruct or expand an asset is a deliberate investment decision which may be undertaken at any time and is not dictated to by the condition of the asset, but rather in response to a change in demand and/or a change in service requirements. Expenditure under this classification is of a capital nature.
- c. **Rehabilitation and refurbishment:** Includes activities that are required due to neglect or unsatisfactory maintenance or degeneration of an asset. These actions involve restoring the asset to its original condition and enhancing its capacity and value, particularly when the asset has become inoperative due to deterioration. Expenditure under this classification is of a capital nature.

In addition to existing infrastructure, there is new infrastructure. This is when entities may purchase

a completely new infrastructure asset or have a project to construct new infrastructure. In both cases, the expenditure incurred is of a capital nature. It is important that the WCIF 2050, and its Strategy and Implementation Plan, does not only focus on the planning and acquisition of infrastructure. It must also address the overall asset lifecycle cost of infrastructure and set out a strategic approach to managing assets throughout their entire lifecycles.

OUTCOMES REQUIRED FROM THE WCIF 2050

Governments worldwide encounter the complex challenge of allocating resources for infrastructure development while navigating fiscal constraints, skill shortages, and procurement limitations. Economic analysis helps to inform these decisions by focusing on economic and social welfare improvements rather than financial viability alone. This approach evaluates non-monetary benefits such as enhanced public health, reduced accident risks, and decreased congestion and pollution. It excludes financial transfers like taxes and subsidies from cost-benefit

OUTCOMES THAT DELIVER “VALUE FOR MONEY”

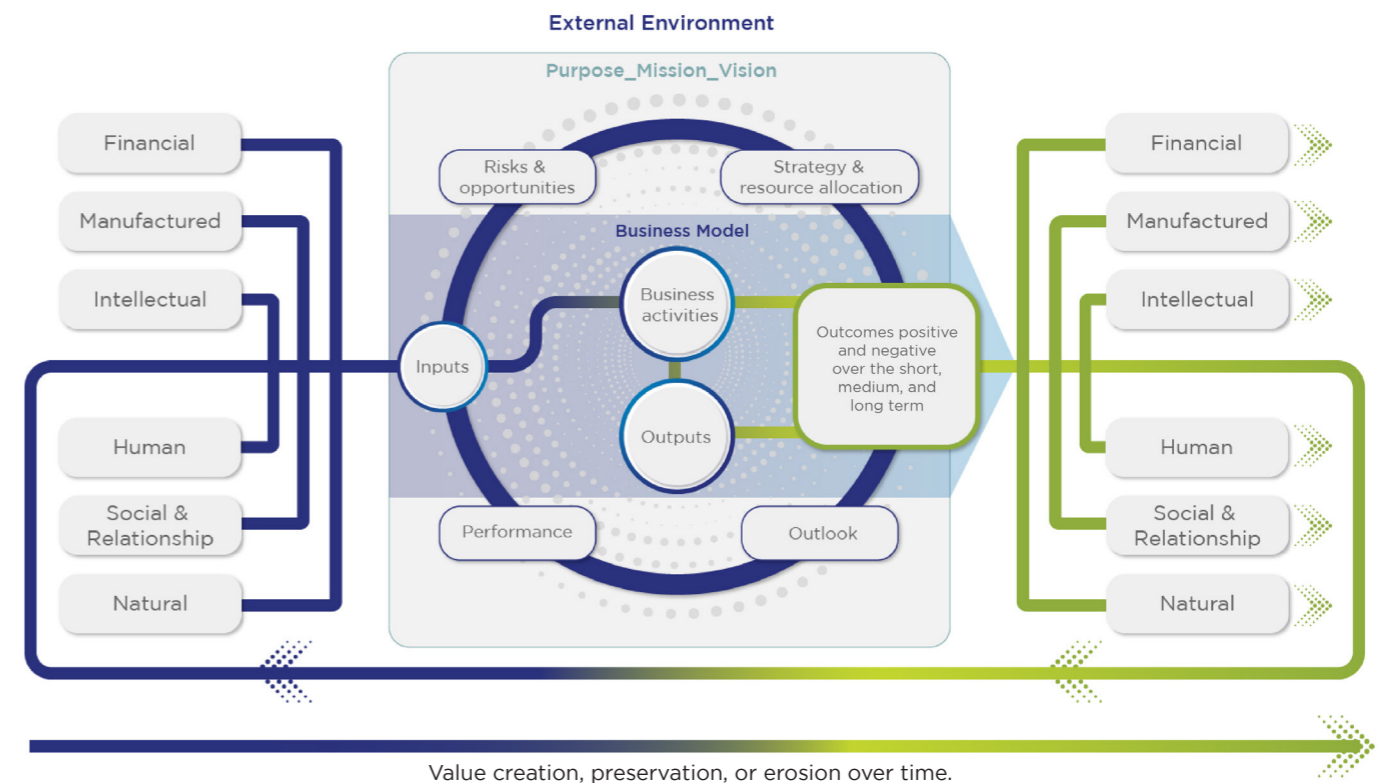


Figure 2: The Six Capitals for Value creation, preservation, or erosion over time.

assessments, offering a more comprehensive view of resource costs, including environmental impacts.

In South Africa, economic analysis must be framed within the context of the country’s constitutional, legislative, and regulatory frameworks, as well as national, provincial, and departmental strategic objectives. Key guiding governance and legislative frameworks include King IV⁸, which emphasises outcomes-based approaches to governance and accountability, and the Spatial Planning and Land Use Management Act of 2013 (SPLUMA)⁷, which advocates for integrated and coordinated planning.

Adopting an outcomes based approach

Outputs are the direct and measurable results of activities, such as products or services delivered. Outcomes, on the other hand, assess the long-term impacts of these activities, which may not be immediately visible or easily measurable. The WCIF 2050 prioritises evaluating outcomes rather than merely measuring outputs, focusing on the broader and more meaningful effects of infrastructure investments over time.

The King IV Report⁸, including earlier versions of the King Reports, recommend that good governance would require an enterprise to adopt an approach that is outcomes-oriented. This places accountability on the Accounting Authority (such as a company’s board) to achieve the key outcomes related to fostering an ethical culture, ensuring good performance, and maintaining effective control within the organisation or among a group of organisations. King IV seeks to move beyond a mere “tick box” or compliance-based approach to governance, rather it promotes a more integrated and meaningful application of governance practices that deliver genuine value and legitimacy to stakeholders. It contains 17 principles applicable to all enterprises, and a wide range of recommended practices to ultimately achieve the desired outcomes.

Against the 17 principles there are four core outcomes, namely:

- Ethical Culture
- Good Performance
- Effective Control
- Legitimacy

King IV refers to the “Triple Bottom Line” formed by the economy, society and the environment (see

Figure 2). This approach emphasises that outcomes should be evaluated across all three dimensions, rather than focusing solely on the “profit” bottom line, which is often prioritised by commercial enterprises. These components of the Triple Bottom Line are commonly referred to as the “pillars of sustainability”. Therefore, the WCIF 2050 should address outcomes in each of these areas, as well as at their critical points of intersection, to ensure a holistic and sustainable approach to infrastructure growth and development.

King IV also identifies six capitals essential for value creation:

- Financial capital
- Manufactured capital
- Intellectual capital
- Human capital
- Social or relationship capital
- Natural capital

The WCIF 2050 will aim to deliver outcomes across these capitals, considering the overall costs and benefits of leveraging them. This comprehensive approach ensures a balanced prioritisation of infrastructure projects, incorporating social and environmental costs and benefits alongside economic factors.

The Infrastructure Development Act (IDA) of 2014⁵, as amended by IDA Regulations 2022, stresses the importance of Value for Money as a key outcome to be delivered, “The optimisation of the Return on Investment (ROI) in respect of a project or group of projects across their life-cycles in relation to functional, financial, economic environmental, sustainability and social return.” This confirms the importance of measuring ROI outcomes across all six capitals. These ROI parameters should also inform the foundation of budgetary allocation and prioritisation models. These will be addressed in a subsequent chapter of the WCIF 2050.

Infrastructure is essential to achieving the WCG’s strategic objectives, and it plays a key role in contributing to the realisation of the United Nations Sustainable Development Goals and meeting the targets of the Paris Climate Agreement.

Infrastructure enables the delivery of critical public services and is recognised as the backbone of economies across advanced, emerging, and

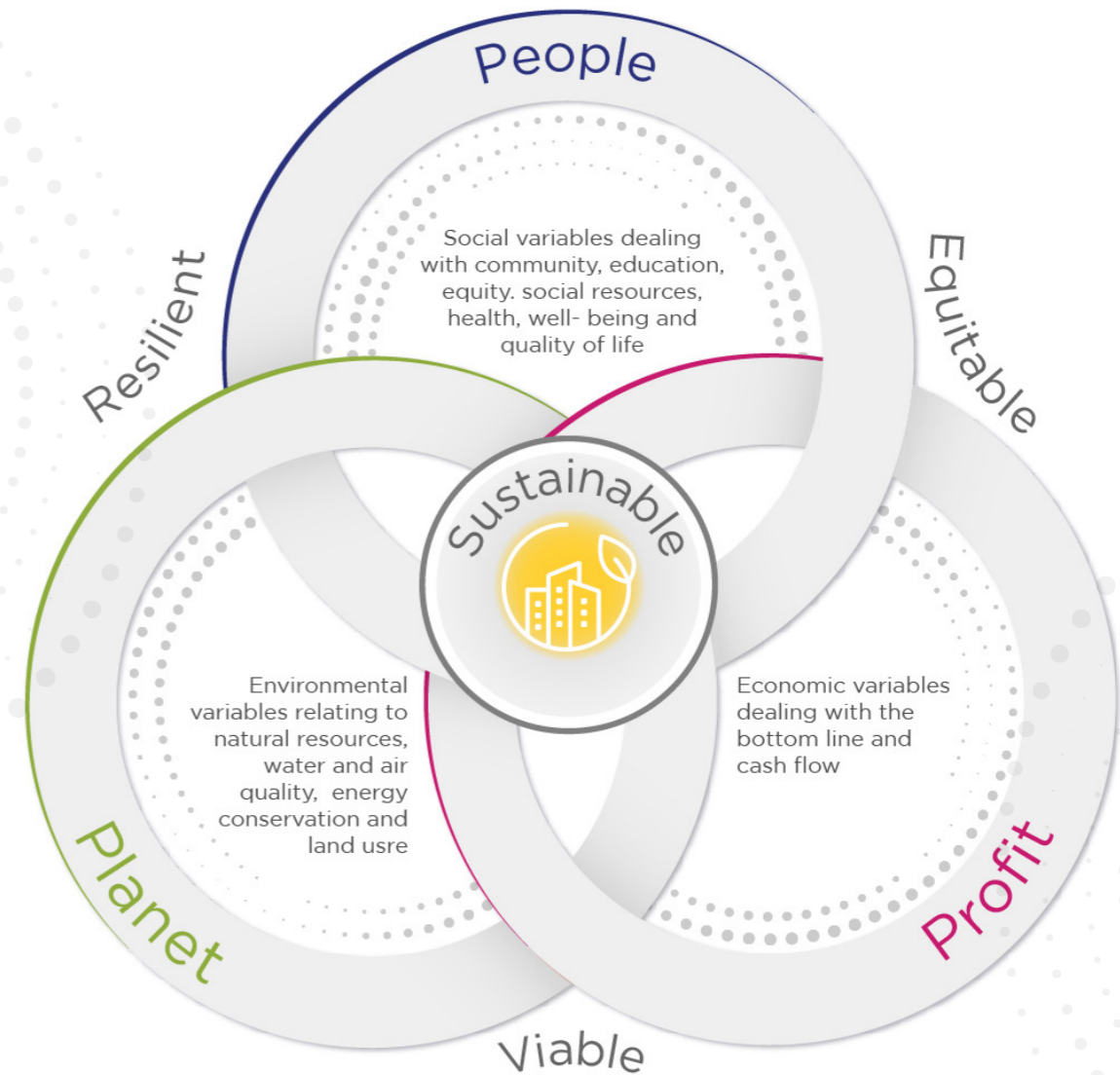


Figure 3: The Triple Bottom Line

developing markets. However, it also accounts for a significant portion of global greenhouse gas emissions, directly contributing to the acceleration of climate change. The Global Infrastructure (GI) Hub⁶, a knowledge organisation established by the G20, advocates for investment in transformative infrastructure that delivers transformative outcomes. Transformative outcomes go beyond economic development outcomes, such as job creation or economic growth, to have the greatest impacts on the most pressing global challenges including the climate crisis, social inequality, adaptability, and resilience.

Aspiring to achieve these transformational outcomes is especially important during times of economic

shocks and heightened uncertainty to ensure that investments leverage the greatest possible benefits and return.

The GI hub identified 13 transformative outcomes that infrastructure can achieve:

1. Affordability and access to services
2. Circularity
3. Cybersecurity
4. Digital connectivity
5. Digitalisation
6. Disaster and climate adaptation
7. Disruptive innovation
8. Environmental regeneration
9. Inclusive mobility
10. Job creation and economic growth

- 11. Low-carbon transition
- 12. Pollution reduction
- 13. Social cohesion

These outcomes require a shift in infrastructure planning, development, and delivery, moving from solutions that address singular problems to those achieving multiple transformative outcomes.

OUTCOMES THAT POSITIVELY IMPACT SPATIAL DEVELOPMENT AND ADDRESS INEQUALITY

Addressing spatial inclusion and injustice remains a challenge in post-apartheid South Africa. Infrastructure development can significantly impact land use and spatial equity. SPLUMA provides a framework for effective planning and land use management, emphasising spatial justice, sustainability, resilience, efficiency, and good administration. Additionally, SPLUMA sets down the principles and procedures whereby infrastructure investment is prioritised and located.

Key elements of SPLUMA relevant to the WCIF 2050 include:

- a. **Municipal Land Use Schemes:** These guide land use decisions within municipalities.
- b. **Spatial Development Frameworks (SDFs):** Essential tools for guiding spatial development and emphasising the municipal mandate in planning, land development, and land use.
- c. **Spatial Transformation:** SPLUMA promotes efficient planning and management to create more equitable and sustainable urban spaces.
- d. **Process and associated administrative structures:** Allows people to comment on, or contest, land use development proposals.

Infrastructure planning must take into account spatial implications, land availability, and land use impacts. The WCIF 2050, its Strategy and Implementation Plan, will implement an integrated approach to infrastructure and spatial development, necessitating collaboration across different levels of government and partnerships with various stakeholders.

The WCIF 2050 aims to achieve transformative outcomes by embracing an outcomes-based

approach, ensuring value for money, and addressing spatial development and inequality. By focusing on these objectives, the framework seeks to create a sustainable, inclusive, and resilient infrastructure ecosystem in the Western Cape. This approach will benefit both urban and rural communities and contribute to broader economic, social, and environmental goals. ●



The Western Cape has become a beacon of opportunity, drawing people from other countries and provinces. Within the province itself, there's been a significant migration from rural to urban areas as people seek better opportunities.



INFRASTRUCTURE'S STRATEGY, POLICY, LEGISLATIVE, AND REGULATORY ENVIRONMENT

Chapter 2

INTRODUCTION

The context for the WCIF 2050 emphasises the necessity of a policy and legal environment that supports a narrative of infrastructure as a catalyst for addressing past inequities and fostering economic growth and development. This environment must align with key principles focused on reversing the legacy of spatial imbalances, overcoming barriers to access, and leveraging infrastructure as a driving force for both economic and social advancement. Through concerted investment in all infrastructure components, the WCIF 2050 aims to create a more equitable and prosperous future.

The WCIF 2050 emphasises the importance of aligning with complementary guiding frameworks, strategies, and policies, including the National Spatial Development Framework (NSDF), Provincial Spatial Development Framework (PSDF), Western Cape Government Department of Infrastructure's Strategic Plan, Western Cape Growth for Jobs (G4J) Strategy, Western Cape Provincial Land Transport Framework, Integrated Urban Development Framework, Integrated Drought and Water Response Plan, Public-Private Partnership (PPP) regulations, Western Cape Climate Change Response Strategy (2023), and service delivery partnership mechanisms, such as the Municipal Systems Act (2000).

It is essential that all relevant aspects of the Government Immovable Asset Management Act (GIAMA) (Act No. 19 of 2007)⁴, particularly regarding the Department of Infrastructure's role as custodian of immovable assets, is thoroughly applied. In addition, the Spatial Planning and Land Use Management Act (SPLUMA) (Act No. 16 of 2013)⁵ outlines the principles and procedures for implementing infrastructure investment in priority areas.

Furthermore, the Infrastructure Development Management System (IDMS) and the Framework for Infrastructure Delivery and Procurement Management, 2019 (FIDPM)⁶, provide governance structures to support effective infrastructure delivery.

This chapter highlights the critical importance

of a supportive strategic, policy, and regulatory environment for infrastructure development. It establishes the foundation for defining the accountability components of the DoI within the WCIF 2050, ensuring alignment with statutory and policy frameworks. Additionally, it substantiates the institutional arrangements and governance framework detailed in Chapter 4, reinforcing the need for clear accountability and effective governance in the infrastructure development process. Context regarding the mandate and governance framework necessary for a "resilient infrastructure" approach is further detailed in Chapter 11.

CHALLENGES AND OPPORTUNITIES

The "Infrastructure Development Scenarios for South Africa towards 2050" (Infrastructure South Africa, 2023)¹ examines the challenges and opportunities associated with integrating advanced technologies into South Africa's infrastructure. This analysis explores how incorporating 4IR science and technology into smart infrastructure design and implementation can contribute to a robust, sustainable, and intelligent infrastructure system by 2050.

The scenarios consider the impact of emerging technologies on infrastructure, as well as the potential challenges posed by global warming and pandemics, which are expected to increase. These factors could affect the reliability and integrity of smart infrastructure systems, making it essential to address these risks to meet South Africa's long-term aspirations.

Additionally, maintaining and enhancing telecommunications infrastructure is crucial to support both economic growth and social development goals in South Africa. This comprehensive approach aims to ensure that infrastructure development is resilient, adaptable, and capable of meeting future demands.

In order to effectively advance infrastructure development and address key challenges, the following strategic focus areas are essential:

- a. Improving access and the optimal utilisation of social infrastructure**, including schools, hospitals, and housing.
- b. Addressing business infrastructure constraints**

- such as energy, connectivity, and transport.
- c. Finding the correct balance in expenditure allocations.**
- d. Utilising infrastructure financing mechanisms by complementing public funds** with blended financing solutions, such as the Development Bank of Southern Africa (DBSA) Infrastructure Fund, which involves the private sector, institutional investors, development finance institutions, and multilateral development banks.
- e. Ensuring good governance** by leveraging the role of the WCIF 2050 in identifying key performance areas, establishing mechanisms to monitor results, and ensuring appropriate fiscal and governance accountability.

The objectives outlined in the WCIF 2050 need to inform the development of an effective legal and regulatory framework for infrastructure planning and implementation, which should include the following tenets:

- Spatial justice
- Sustainable development
- Value for money
- Good governance
- Accountability
- Inclusiveness
- Citizen-centric planning and delivery
- Improved resilience

In applying the legal and policy provisions to a governance framework, the WCG would be able to accurately report, on an annual basis, on the state of infrastructure and the gains made in addressing social and business challenges as well as availing opportunities.

South Africa's overarching Doing Business Reform Vision³ is "to improve government business regulatory processes by optimising processes and using technology and digitisation to drive business process efficiencies, complemented by associated legislative reform". South Africa recognises infrastructure as a critical enabler for inclusive and sustainable economic growth, as articulated in the NDP. The country's ongoing investment in infrastructure will ensure both stability and consistency in the planning, investment, implementation, and maintenance of infrastructure in the short, medium, and long-term and will also restore the confidence of the private sector.

The provision of infrastructure as an enabler for

investment is linked to the provision of physical and digital infrastructure including energy, water, commercial transport, and telecommunications. While the South African government has invested in infrastructure over the past decade, there is a need to significantly upscale the delivery of infrastructure to support the country's ambitious growth targets. South Africa currently spends about 5.8% of its GDP on infrastructure, whereas the NDP targets a 10% GDP spend (National Treasury, 2020)¹⁴. Infrastructure investment is a priority in creating an enabling environment for investment.

The South African government has expressed commitment to implementing a long-term, government-led infrastructure investment programme and, in the process, leveraging the participation of the private sector, labour, and civil society.

GLOBAL, NATIONAL AND PROVINCIAL FRAMEWORKS

Globally, the World Bank provides guidance on governance issues related to infrastructure investment. To address governance challenges surrounding infrastructure development and enhance the efficiency of infrastructure investments, the World Bank has introduced the Infrastructure Governance Assessment Framework, known as InfraGov¹¹. This framework aims to assist countries in optimising their infrastructure investments and achieving better outcomes.

The InfraGov framework¹¹ assesses three major areas of infrastructure governance, namely:

- The lifecycle of an infrastructure project, focusing on selection, design, procurement, and implementation of investment projects.
- The key cross-cutting issues for good infrastructure, including integrity, transparency, and consideration of social, environmental, and climate change risks and opportunities.
- The ways in which infrastructure services are provided to the citizen encompassing market structure and competition, the regulatory framework for addressing natural monopoly activities, and corporate governance and governance arrangements around State Owned Enterprises.

Continently, the African Union Agenda 2063

provides a strategic framework for Africa's socio-economic transformation over the next 50 years. It aims to create a conducive environment for PPPs and Foreign Direct Investments (FDIs) by addressing high project failure rates and unfair risk perceptions. The de-risking strategies include targeted use of FDIs and Official Development Assistance (ODA), innovative financing, and public sector involvement. These strategies align with the Sustainable Development Goals (SDGs), promoting inclusive growth.

Nationally, the National Infrastructure Plan 2050 (NIP 2050) Phase I (Government Notice no. 1874 of 11 March 2022) addresses the foundations required to achieve the National Development Plan 2030 outcomes. An extensive review of the National Planning Commission (NPC) on public sector and SOE infrastructure delivery and performance, found that the delivery of public sector infrastructure is inadequate to support the NDP objectives. The NPC provides recommendations for course correction.² Provincially, the mandate of the WCG in respect of infrastructure provision is derived from the Constitution of the Republic of South Africa, 1996, in terms of Schedule 4 Part A. The DoI's five-year Strategic Plan serves as a roadmap for the Department, positioning it as a key enabler of integrated public and private sector collaboration.¹²

The role of Local Government related to infrastructure provision in the Western Cape includes responsibility for physical infrastructure, including roads, water supply, waste management, and electricity.

Locally, the City of Cape Town is responsible for a large percentage of local government infrastructure spend in the WCG³.

Additional policy instruments¹⁰ include the:

- Integrated Urban Development Framework** as a policy instrument to guide urban development and infrastructure planning in the province.
- Integrated Drought and Water Response Plan:** The Water Resilience Plan is a key initiative to develop the water and sanitation project pipeline, based on the Integrated Drought and Water Response Plan and the 15-year drought research by the Department of Local Government (DLG).
- Growth for Jobs (G4J) Strategy**, especially the infrastructure and connected economy focus

area, as referenced in other chapters.

- Public-Private Partnerships (PPPs)** mechanisms to infrastructure provision and regulated through National Treasury, and further complemented by service delivery partnership mechanisms, e.g., as provided for in the Municipal Systems Act (Act No. 32 of 2000).
- Infrastructure Development Act** (Act No. 23 of 2014) that aims to expedite infrastructure development by streamlining regulatory processes and enhancing coordination among stakeholders.
- Expanded Public Works Programme (EPWP)** that focuses on job creation through public infrastructure projects.
- National Department of Human Settlements White Paper (2023)** asserts that the development of sustainable human settlements is a spatial assertion premised on the integration of 4 key elements: 1) physical elements (infrastructure, services, and housing); 2) land use patterns; 3) operational and governance relations; and 4) socio-economic patterns.

KEY LEGAL PROVISIONS

The legislation considered essential for the implementation of the DoI mandate is summarised below.

The Government Immovable Asset Management Act (GIAMA) (Act No. 19 of 2007) outlines the provisions relevant to the relationship between custodians and users of immovable assets. Under this Act, the DoI is designated as the custodian of the WCG's infrastructure portfolio. This role is crucial, as it involves ensuring that infrastructure positively contributes to inclusive socio-economic growth and that it is managed optimally throughout its lifecycle. The DoI is legally obligated to ensure the efficient management of all immovable assets, with its powers and responsibilities detailed in GIAMA⁴.

The powers relevant to the custodian mandate outlined in GIAMA include:

- In the case of provincial departments, acquire, manage, and dispose of the immovable asset that it occupies (Sec. 4 (2) (b) (ii)).
- Liability for any act or omission concerning an immovable asset of which it is the custodian, excluding an act or omission in good faith (Sec. 4 (2) (c)).

- In applying the principles of immovable asset management, must adhere to the service delivery and social development objectives of government (Sec. 5).
- Accountability for fiscal compliance within the relevant provisions of the Public Finance Management Act (PFMA) (Act No. 1 of 1999), including adherence to the Annual Consolidated Financial Information (ACFI) required by departments and entities per Generally Recognised Accounting Practice (GRAP) for the province in terms of section 19(1) of the PFMA.

The relevance of SPLUMA⁵ in respect of the DoI includes provisions specifying:

- The application of development principles (Sec. 6 and 7).
- Provincial support and monitoring that inter alia specify that the Premier may identify matters of provincial interest in respect of which any framework consistent with SPLUMA may apply (Sec. 10(4)).
- Spatial development frameworks must outline specific arrangements for prioritising, mobilising, sequencing, and implementing infrastructure investment (Sec. 12(6)).
- All provincial development plans must be consistent with the provincial spatial development framework (Sec. 17(2)).
- Municipal spatial development frameworks must identify, quantify, and provide location requirements of engineering infrastructure and services provision for existing and future development needs for the next five years (Sec. 21(h)).

The WCG issued a cabinet endorsed paper on the Constitutional and Legal Principles that apply to Public Participation (DG Circular 32 of 2016). The paper emphasises the general provisions and principles relevant to any administrative decisions in terms of the Promotion of Administrative Justice Act (Act No. 3 of 2000), and the general interpretation of the courts on the application of these principles. These principles include recognition of the need to tailor public participation processes to the unique circumstances surrounding specific mandates, taking into account the nature, scope, and external impact of every decision that is taken, and the minimum requirement to act fairly, including adequate notice of the nature and purpose of a proposed action where deemed relevant.

In acknowledging the importance of co-operative governance, specific cognisance of the local government powers and functions in respect of provincial projects for social development facilities establishment is required.

CONCLUSION

The strategic, policy, legislative and regulatory context aligns with the DoI's strategic objectives and provides essential guidance for development of the Strategy in Phase 2 and the Implementation Plan in Phase 3 of the WCIF 2050.

In South Africa, public custodians of land face increasing challenges due to rapid urbanisation and the growing demand for essential social services, leading to competition for infrastructure space among user departments. This situation necessitates effective management interfaces between custodians and users, with a strong emphasis on intra-governmental engagement strategies.

Additionally, successful infrastructure management requires effective external stakeholder engagement and public participation, as outlined in the relevant policies. These measures are vital for ensuring lifecycle sustainability and addressing potential risks related to geographic locations, such as public violence, land invasions, and arson.

The strategic, policy, and legal analysis emphasises the importance of ensuring accountability in all aspects of infrastructure provision as detailed in the WCIF 2050. This accountability forms part of the transversal management system of the WCG and the DoI. ●



...the African Union Agenda 2063 provides a strategic framework for Africa's socio-economic transformation over the next 50 years. It aims to create a conducive environment for Public-Private Partnerships (PPPs) and Foreign Direct Investments (FDIs) by addressing high project failure rates and unfair risk perceptions.

ADOPTING A MISSION-ORIENTED APPROACH TO INFRASTRUCTURE

Chapter 3

INTRODUCTION

The WCIF 2050 has adopted a mission-oriented approach to inform infrastructure innovation.

A mission, as commonly defined, is “an important assignment given to a person or group of people” (Oxford). Providing infrastructure for the benefit of society is one of government’s most important tasks, requiring the balance of competing priorities while delivering impactful outcomes in terms of its strategies and policies. This challenge highlights the necessity for innovation, which drives new approaches, ideas, and solutions that enhance the effectiveness and value of infrastructure delivery.

Innovation here refers to introducing new ideas and methods that create significant, positive value. The WCIF 2050 incorporates Mariana Mazzucato’s Mission-Oriented Innovation Policy approach to advance infrastructure provision and lifecycle management for optimal societal benefit.^{1,2,3} By adopting this approach, the WCIF 2050 seeks to address complex societal challenges through strategic, outcomes-driven innovation in infrastructure development, aligning with the broader goals of economic growth, sustainability, and resilience.

WHAT IS MISSION-ORIENTED?

Missions are ambitious, measurable, and time-bound objectives designed to drive transformative change. They aim to address complex societal challenges such as climate change or health disparities through a purpose-oriented, solution-driven, and market-shaping approach. By setting clear objectives and deadlines, missions focus efforts on creating impactful, sustainable solutions. For example, the mission of achieving carbon neutrality by 2030 reflects a mission-oriented approach to combating climate change, pushing for innovation and systemic change across sectors to meet the objective.

Mission-oriented innovation involves the public sector taking an active role in coordinating

WHAT CONSTITUTES A MISSION?

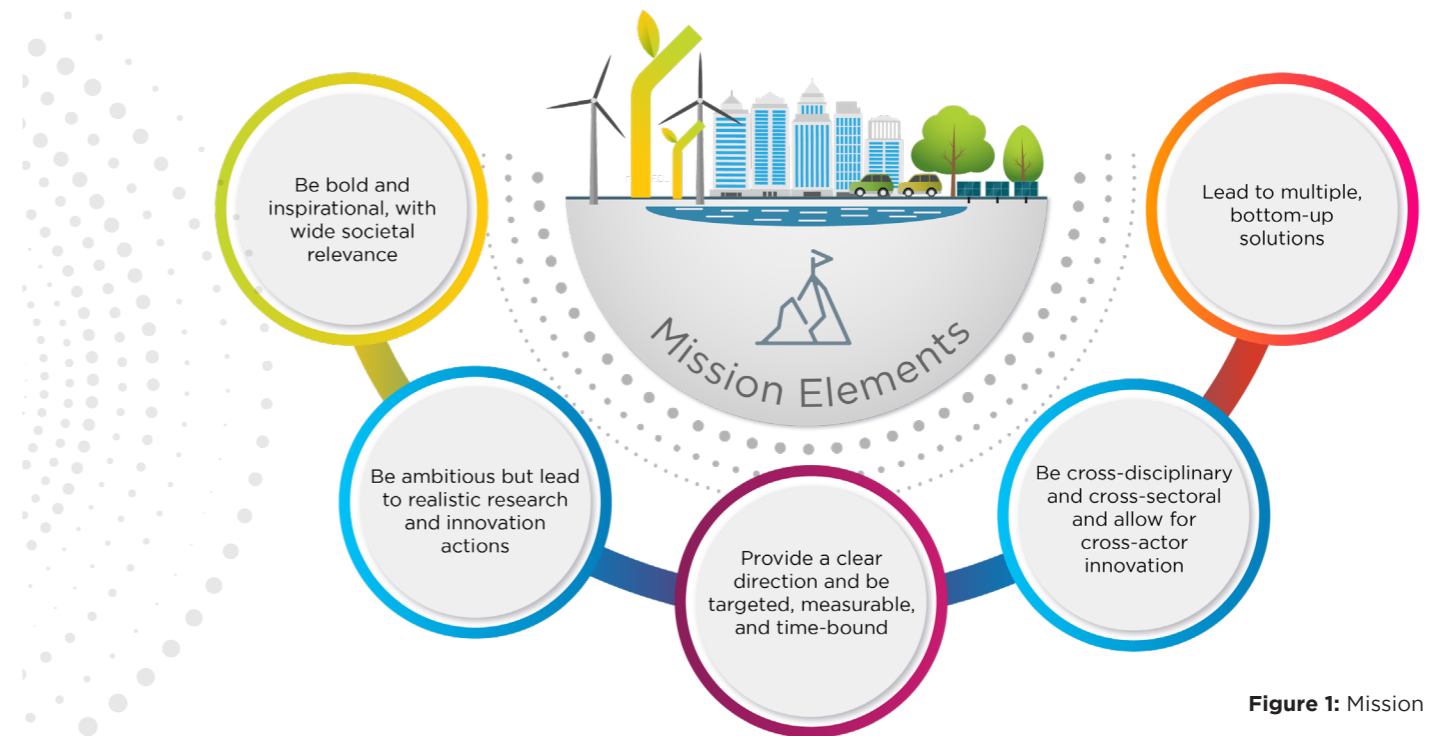


Figure 1: Mission Elements¹

diverse actors to address large-scale complex and cross-sectoral societal challenges that cannot be solved by individual efforts or conventional methods. It encompasses new or improved technological, social, or organisational solutions, such as products, processes, or services aimed at tackling grand societal challenges (missions). The focus is on creating public value by addressing issues such as climate change, sustainable economic growth, or improving societal well-being. The approach emphasises collaboration and systemic change across sectors.

Mission-Oriented Innovation Policy refers to a coordinated set of policy and regulatory measures specifically designed to mobilise innovation towards achieving clear societal goals within a defined timeframe. These measures often span different stages of the innovation cycle, from research and development to demonstration and market deployment. By combining both supply-push and demand-pull instruments, mission-oriented innovation policy cuts across multiple policy fields, sectors, and disciplines. Supporting the development and diffusion of such innovations often requires targeted policy interventions to ensure that innovations can address specific societal challenges efficiently and effectively.

Public sector research conducted by Mariana Mazzucato has been instrumental in shaping the development of a mission-oriented approach to innovation. Mazzucato critiques traditional innovation policies that focus narrowly on specific sectors or technologies, advocating instead for a broader and more inclusive framework. She proposes that governments adopt mission-oriented innovation policies to enable large-scale interventions aimed at addressing societal challenges. This approach encourages governments to take an active role in driving innovation by setting clear, ambitious missions that align public and private sector efforts, rather than simply supporting individual sectors or technologies.^{1,3}

This body of research^{1,2,3} recognises that infrastructure investments and mega-projects have multiple dimensions that must be considered:

- Economic Growth is not only the rate of growth but also its direction, ensuring that investments contribute to sustainable and inclusive development.
- Innovation requires investments and risk-taking from both private and public actors to drive progress and address emerging challenges.
- The State’s role is beyond merely correcting market failures, the state should guide markets

to align with strategic objectives.

- Effective Innovation Policy integrates top-down direction-setting with the flexibility to enable bottom-up experimentation and learning.
- Missions (mega projects) typically necessitate consensus-building efforts that include input from civil society to ensure broad support and successful implementation.

The renewed focus on the State’s role in driving Innovation is crucial. Mission-Oriented Innovation Policy aims to set ambitious, clearly defined goals (or “missions”) to drive innovation and achieve significant impacts, rather than focusing on incremental improvements or supporting individual sectors. In addition to having the right policies, there must be suitable organisational arrangements, such as dedicated institutions, cross-sector collaborations, or new governance models, that can support and execute these innovation missions. The research highlights the importance of rebuilding dynamic capabilities within the public sector as a core component of modern innovation policies. This is especially relevant today as nations strive for economic growth that is smart (innovation-led), inclusive, and sustainable.

These bold visions, challenges, and goals necessitate a re-evaluation of the role of government and public policy in the economy. They align with the concept of tackling grand challenges, such as those outlined in the WCIF 2050, which require investments from both the public and private sectors.

A key to success is to recognise that the public sector’s role extends beyond merely de-risking and levelling the playing field. It involves actively directing the market towards desired goals, thereby creating conditions that enhance business expectations around future growth opportunities and stimulating private sector investment.

Such missions and crowding-in models necessitate innovative approaches to public organisation design, implementation, and evaluation policies. In recent decades, innovation policy has undergone several transformations, including: **(a) a focus on non-technological innovation; and (b) a shift from merely addressing specific failures to transforming broader systemic elements of innovation.** This evolution sees innovation policy moving from measuring the quantity or rate of innovation, such

as the number of patents and jobs, to emphasising the quality and direction of innovations, such as addressing climate change.

Mission-oriented policies enable the public sector to address persistent policy coordination failures by mobilising diverse technological and innovation efforts. It recognises that the 21st-century public sector needs dynamic capabilities to tackle grand challenges and must transition from traditional support-and-measure models to more proactive lead-and-learn models. It is believed that adopting a mission-oriented approach allows the public sector to operate more effectively and drive meaningful progress.

A mission-oriented approach is grounded in the science of “holism”, which enables the creation and shaping of markets through policy instruments with open-ended horizons. This approach fosters feedback loops and learning capacities through broad social engagement and coordination. It calls on the State to develop dynamic capabilities to implement mission-oriented policies effectively, including through equitable PPPs.

Whole systems underpin a mission-oriented approach by ensuring that mission themes incorporate comprehensive public sector improvements.

Key features include:

- Public Sector Value Creation:** This involves understanding and leveraging extended value chains and global value chain dynamics to transform society. It ensures that planning and delivery processes address the needs of the most vulnerable population groups.
- The Entrepreneurial State:** This refers to the government embracing an entrepreneurial mindset, which may include taking on higher levels of risk to drive innovation and development.
- Alternative Service Delivery Models:** This includes exploring innovative solutions to infrastructure challenges that do not necessarily involve traditional infrastructure provision. It may involve digital or spatial solutions that address underlying issues related to access and opportunity. ●



The renewed focus on the State’s role in driving Innovation is crucial. Mission-Oriented Innovation Policy aims to set ambitious, clearly defined goals (or “missions”) to drive innovation and achieve significant impact.

RELEVANT STANDARDS AND LEADING PRACTICE

Chapter 4

INTRODUCTION

In today's interconnected global economy, it is vital for governments to adopt infrastructure standards that establish a common language for global compatibility.¹ These standards are key to promoting international trade. Well-designed infrastructure projects are essential for enhancing economic productivity and driving the transition to low-carbon economies.

The importance of robust standards cannot be overstated. Given the vast range of standards and their governing bodies, a systemic approach is essential to unite both public and private sector stakeholders. The WCIF 2050 seeks to address this by ensuring that infrastructure projects comply with recognised standards, with the goal of identifying "bankable infrastructure" that carries minimal environmental, social, and governance (ESG) risks.

Implementing international quality infrastructure standards requires continuous adaptation to fit local contexts. The WCIF 2050 emphasises the integration of these standards into South African-specific infrastructure policies, involving a range of stakeholders such as the Department of Trade, Industry and Competition (the dtic), Department of Education (DOE), Department of Health (DOH), Department of Public Works and Infrastructure (DPWI), South African Bureau of Standards (SABS), South African National Standards (SANS), and the South African Institution of Civil Engineering (SAICE).

South Africa is renowned for its strong standards led by the SABS. Operating under the Standards Act (Act No. 24 of 1945) and its later revision (Act No. 8 of 2008), SABS provides a legal framework for developing and maintaining South African National Standards.⁴ As a founding member of the International Organisation for Standardisation (ISO), the SABS is well-regarded globally.⁴ It collaborates with various international standards bodies, including the International Electrotechnical Commission (IEC), Institute of Electrical and Electronic Engineers (IEEE), International Telecommunication Union (ITU), European Broadcasting Union (EBU), European

Telecommunication Institute (ETSI), Comité Européen de Normalisation Électrotechnique – European Committee for Electrotechnical Standardization (CENELEC), United Nations Economic Commission for Europe (UNECE), and Southern African Development Community Standards Harmonisation (SADCSTAN).

In the WCIF 2050, "infrastructure standards" refer to the systems, facilities, environments, information, and human resources essential for supporting, facilitating, and advancing the development, adoption, and implementation of standards.¹ The WCIF 2050 seeks to harness the expertise of the SABS and other standards bodies by integrating their efforts into the WCIF 2050's unified approach, ensuring consistency and alignment with global best practices.

This integration seeks to:

- Facilitate and enable business interactions.
- Help organisations comply with relevant laws and regulations.
- Speed up the introduction of innovative products to the market.
- Enhance compatibility between new and existing policies, products, services, and processes.

THE ROLE OF NOVEL PRACTICES IN COMPLEX INFRASTRUCTURE SYSTEMS

"Novel practice" refers to innovative methods employed in complex and contested situations where traditional best practices may not be applicable. Novel practices are especially effective

in addressing localised niche needs that arise in dynamic environments.

For instance, South Africa's ASA Act¹⁰ has several objectives:

- Ensuring the fitness-for-purpose of non-standardised construction products.
- Supporting integrated socio-economic development in the construction sector.
- Encouraging the use of certified non-standardised construction products in local and international markets.
- Helping policymakers minimise risks associated with non-standardised products.
- Serving as a neutral and internationally recognised centre for non-standardised construction systems.

The concept of "Vivo", meaning "living" in Latin, embodies the principle of life-long learning. In the context of standards and best practices, it means that conventional methods and best practices are effective for simple problems with predictable outcomes. However, when faced with complex challenges involving many interconnected parts, "novel practices" are necessary to navigate and address these complex issues.¹⁵⁻¹⁹

Infrastructure systems are inherently complex, involving multiple stakeholders with diverse perspectives. This complexity can lead to self-organising patterns, such as informal settlements, where traditional planning and standard practices may not fully address the unique and evolving needs



Figure 1: Best and Novel Practices in the Context of Infrastructure Complexity

of these communities. The emergence of informal settlements illustrates how infrastructure systems can adapt organically in response to local conditions and challenges. Therefore, while best practices are rooted in global standards, real-world conditions frequently differ from stable environments, necessitating flexibility, experimentation, and innovation to effectively manage and improve these systems.

In highly complex or chaotic situations where cause-and-effect relationships are unclear, leadership, rapid experimentation, and improvisation become essential. In such contexts, novel and emergent practices are far more effective than traditional approaches.¹⁵⁻¹⁹

CHALLENGES REGARDING STANDARDS

Developing multiple standards presents a common challenge for nations striving for unified infrastructure standards. Countries face issues such as³:

- a. Differentiating between meta-standards and competing standards that risk diluting unified standards.
- b. Recognising the need for meta-standards to be adopted by multiple stakeholders, including investors, developers, and governments.
- c. The effectiveness of standards is limited if only one group adopts them, highlighting the need for inclusive meta-standard development processes.

Diverse standards systems can hinder international trade, prompting global efforts to reduce technical barriers. Notable examples include:

- a. The Asia-Pacific Guideline on Standards for Infrastructure, aimed at harmonising standards across 15 economies.
- b. The “Quality Infrastructure Investment” standard promoted by the G7 Nations to encourage Ise-Shima principles for promoting quality investments.
- c. The Economic Co-operation and Development (OECD) “Blue Dot Network Certification System”, which supports implementing quality infrastructure investments.⁵
- d. Multilateral efforts from the United Nations (UN), United Nations Industrial Development Organisation (UNIDO), and others, such as the Finance to Accelerate the Sustainable Transition-Infrastructure (FAST) and the Blue Dot Network (BDN).
- e. China’s Green Development Guidance for their

Belt and Road Initiative International Green Development Coalition (BRIGC).³

These global efforts in standardisation seek to incorporate features such as¹:

- Organisation and integration of efforts from national standardisation bodies (NSBs).
- Budget allocation for standardisation activities.
- Standards implementation.
- Dissemination of standards and professional involvement.
- Strategies and performance measurement for standardisation.

Research into developing a unified approach to global infrastructure standards offers valuable insights for mobilising capital for sustainable and high-quality projects. It provides recommendations to minimise competition and foster a cohesive approach.

These global initiatives align with the UN 2030 Agenda for Sustainable Development, emphasising that economic recovery and long-term sustainability necessitate a consensus³ on quality infrastructure standards. Such standards are designed to enhance local implementation capacity and strengthen accountability systems, as highlighted in Sustainable Development Goal 9 (SDG 9) on Industry, Innovation, and Infrastructure. **Infrastructure targets are:**

Target 9.1
Develop quality, reliable, sustainable, and resilient infrastructure, including regional and transborder infrastructure, to support economic development and human well-being, with a focus on affordable and equitable access for all.
Target 9.4
By 2030, upgrade infrastructure and retrofit industries to make them sustainable, with increased resource-use efficiency and greater adoption of clean and environmentally sound technologies and industrial processes, with all countries taking action in accordance with their respective capabilities.
Target 9.A
Facilitate sustainable and resilient infrastructure development in developing countries through enhanced financial, technological and technical support to African countries, least developed countries, landlocked developing countries and small island developing states.
Target 9.C
Significantly increase access to information and communications technology and strive to provide universal and affordable access to the Internet in least developed countries by 2020.

to development outcomes, bridging economic and social sectors.³ Quality infrastructure is defined as “a system comprising public and private organisations, policies, legal and regulatory frameworks, and practices needed to support and enhance the quality, safety, and environmental soundness of goods, services, and processes”.

STANDARD FRAMEWORKS AND THE WCIF 2050

The journey to establishing meta-standards involves several steps³:

- a. **Measurement Consistency:** Aligning metrics and thresholds among standards for clarity and consistency.
- b. **Rewarding Certification:** Independent reviews of sustainability and quality metrics by credible experts.
- c. **Consistent Project Pre-Screening Tools:** Providing universally consistent tools for quick self-assessments.
- d. **Co-ordinated Secretariats:** Aligning governance structures of sectors and specialist areas.
- e. **Compatible Data Platforms:** Creating trusted repositories for data compatibility and information sharing.
- f. **Technical Assistance:** Providing support for Public-Private infrastructure stakeholders.
- g. **Systemic Planning Assistance:** Designing and planning infrastructure systems to meet sustainability and quality standards.
- h. **Development Finance Institution Alignment:** Offering common indicators to accelerate awareness and adoption by stakeholders.
- i. **Global Engagement:** Participating in globally neutral bodies to convene summits on sustainable infrastructure standards.
- j. **Guidelines for Human Settlement Planning or “Red Book”:** incorporates water sensitive design.

Relevant legislation and organisations include:

- a. **The Building Standards Act⁶:** Promotes uniformity in building laws.
- b. **Construction Industry Development Board (CIDB)⁷:** Focuses on procurement uniformity, efficient delivery, and industry performance. CIDB reports to Department of Public Works and Infrastructure (DPWI).
- c. **Infrastructure South Africa (ISA)⁹:** Aims to accelerate infrastructure investment and support the National Infrastructure Plan 2050.
- d. **The Agrément South Africa Act¹²:** Ensures fitness-

for-purpose for non-standardised construction systems and offers an impartial, internationally acknowledged centre.

- e. **South African Institute of Civil Engineers¹¹:** Publishes updated standards for materials and technology.
- f. **Public Administration Management Act (PAMA, 2014):** Sets norms and standards for public administration.
- g. **Dignified Client Experience (DPWI, 2022):** Commits to improving processes and service delivery standards in line with Batho Pele Principles (The White Paper on Transforming Public Service Delivery, 1997).
- h. **The Engineering Council South Africa¹⁴ and the Council for the Built Environment (CBE, 2000):** Define scopes for engineering and built environment standards.
- i. **National Infrastructure Plan (NIP, 2030):** Calls for focused implementation across the Public-Private sector by establishing a single view of service delivery. It integrates SPLUMA, GIAMA, and other legislation to provide uniformity in managing immovable assets held by National and Provincial governments.

The WCIF 2050 aims to integrate these practices by ensuring that standards are unified and aligned with existing codes and regulatory bodies. For example, the South African Building Regulations (SANS 10400), administered by the SABS, encompass all facets of infrastructure, including safety, health, and sustainability. These regulations are frequently updated to reflect technological and environmental advancements.

Harmonising and integrating standards across various agencies and sectors in infrastructure is important. The WCIF 2050 is designed to support innovative methods for integrating, implementing, and measuring these standards. Effective planning and coordination, as outlined in the National Infrastructure Plan and mandated by the Infrastructure Development Act (Act No. 23 of 2014), are key deliverables of DPWI, as outlined in Proclamation Number 49 of 2019, dated August 23, 2019.

The WCIF 2050 approach to standards integration aims to prevent duplication, enhance integration, streamline coordination, reduce bureaucracy, and facilitate the ease of doing business. ●

PRINCIPLES UNDERPINNING INFRASTRUCTURE STRATEGY

Chapter 5

INTRODUCING FRAMEWORK DESIGN CONSIDERATIONS

This chapter discusses the core principles of framework design. Authentic frameworks are based on scientific methods, ensuring that user communities can identify and visualise parts of the infrastructure system needing improvement. These frameworks aim to enhance positive outcomes while minimising unintended negative effects.

Robust frameworks are guided by panoptic principles, which are clear, unambiguously transversal, and aligned with the well-being of Western Cape citizens, as mandated by the Constitution.

Adopting an open systems framework, built on foundational principles, has been a long-term process undertaken by the DoI (formerly the Department of Transport and Public Works).

Early departmental investments focused on several areas:

- a. Intellectual Property and Human Capital:** Retaining effective practices and improving upon them, including investments in human capital through training, development, and well-being. This also involves refining internal processes and adopting technologies to achieve DoI outcomes.
- b. Research and Stakeholder Engagement:** Engaging with a broad range of stakeholders to understand diverse views and challenges regarding infrastructure in the Western Cape. Over the past four years, the DoI has engaged with SOEs, sister departments, municipalities, and other stakeholders, as required by the policy framework for integrated planning (DPME).
- c. International, Continental, and Regional Commitments:** Aligning DoI efforts with global development agendas such as the United Nations SDGs, African Union's Agenda 2063, and SADC development priorities. This integration is reflected in South Africa's NDP and the WCG's support of these commitments. Key documents include WCIF 2014, Theory of

Change (TOC) 2023, WCIF 2050 Infrastructure Status Quo Report, and the SAICE Infrastructure Report Card (IRC 2022).

- d. Innovation across Engineering and Built Environment methods:** Investing in new methodologies, techniques, and tools to build DoI's capacity for innovation, be futures-oriented and to prepare leadership for dealing with uncertainty, diversity, complexity, and conflicting requirements, i.e., skills of the future.

These efforts generate extensive information, data, and intelligence that must be analysed and synthesised to address local infrastructure needs. The Panoptic Principles developed through research, consultation, and workshops provide a robust guide for all infrastructure projects.

These efforts generate extensive information, data, and intelligence that must be analysed and synthesised to address local infrastructure-related needs. The Panoptic Principles developed through research, consultation, and workshops provide a robust guide for all infrastructure projects.

Despite the known fragmented nature of the infrastructure landscape due to multiple stakeholders with varying priorities and capacities, a collective approach to conception, design, planning, execution, and maintenance is essential. The interconnected infrastructure ecosystem includes stakeholders from sectors such as energy, water management,

manufacturing, ecological management, and more, all of which affect areas such as food security, social protection, and safety.

Addressing these complex issues requires systemic practices such as:

- a. Adopt a Systems View:** Recognise that we operate within whole systems, often only seeing a part of the larger picture.
- b. Collaboration:** Ensure collaboration across all stages of the WCIF 2050 to achieve equitable, effective, and transformational outcomes.
- c. Citizen-Centric:** Keep citizens and their communities at the centre of design and solution processes.
- d. Transparency:** Maintain visible, transparent, and accessible decision-making and funding protocols.

FRAMEWORKS AS TOOLS OF SCIENCE AND THE BASIS OF PRACTICE

Framework design relies on the scientific method to ensure consistency, which is crucial for genuine argumentation and refutation. For the WCIF 2050, a robust framework is essential, providing comprehensive guidance for all infrastructure within the Western Cape. Given the diverse values, priorities, and objectives of stakeholders, crafting a framework that encompasses all forms of infrastructure presents a significant challenge.

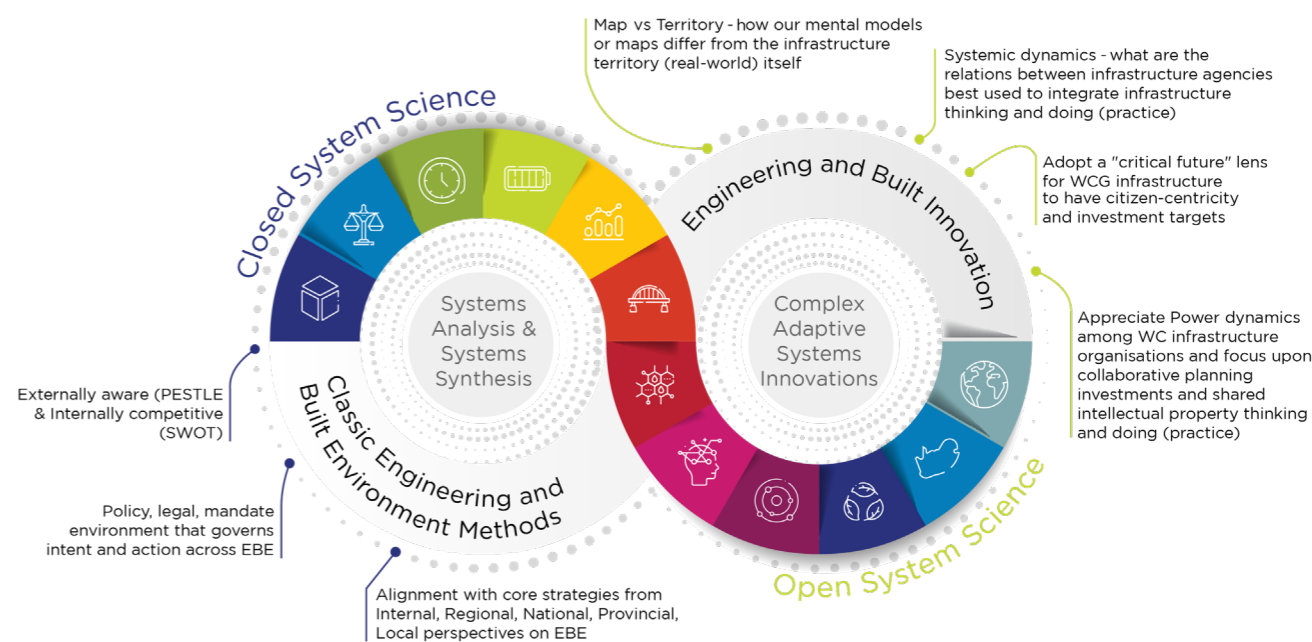


Figure 1: Adopt a critical Futures lens for WC Infrastructure with citizen centric and investment targets

Effective frameworks facilitate transversal governance (Panarchy) and are grounded in inclusive Panoptic Principles.

The WCIF 2050 is based on leading scientific practices,¹ featuring defensibility, consistency, and replicability.³ Addressing the limits of human knowledge, the framework adopts neutral language and terms^{1,2} to connect to holistic paradigms. Panarchy guards against false methodological superiority, ensuring data-driven practices.

Figure 1 contrasts classic Engineering and Built Environment (EBE) methods with innovative approaches, emphasising how the WCIF 2050 integrates both traditional techniques and new tools to address complex systems. The WCIF 2050 does not seek to replace traditional EBE methods but aims to complement them with advanced framework tools designed to manage networked complexity, such as Critical Infrastructure Systems (CIS).

Rather than discarding established methods, the WCIF 2050 enhances them with new tools and methods, accommodating a wide range of stakeholders. This inclusive approach, which incorporates a thorough review of both theoretical and practical perspectives, ensures that the WCIF 2050 upholds consistency, replicability, robustness, and shared principles. These elements support a deeper understanding and effective management of complex issues. Additionally, the Panarchy framework embraces multi-methods, recognising infrastructure as an interconnected system that is influenced by human biases and power dynamics.

Deriving Panoptic Principles to enhance Western Cape Infrastructure

The DoI synthesised the WCG’s values to guide the focus group discussions held on values, assumptions, and principles. This synthesis, together with the focus group discussions, was crucial in developing the Panoptic Principles for the WCIF 2050.

A key observation from this process was that, even in advanced economies, principles were frequently duplicated. Additionally, many frameworks produced multiple principles some of which were in direct conflict with one another.

Extensive reviews and consultations have led to a set of Panoptic Principles that provide the WCIF 2050 with comprehensive coverage without overburdening stakeholders:



Panoptic Principle 1

Infrastructure innovation drives equitable economic, social, and environmental development.



Panoptic Principle 2

Innovative infrastructure value chains/ecosystems contribute to building resilient, sustainable, and regenerative systems.



Panoptic Principle 3

Sustainable stakeholder value is created by infrastructure and services that build trust, leverage spatial justice, and the six capitals (inclusive of value for money as defined by the IDA).



Panoptic Principle 4

Infrastructure design, commission, delivery and management is best supported and enabled by transversal planning and governance.

The Gigamap depicted in Figure 2 demonstrates the process of using a “funnel of thinking, information, and intelligence” to shape the development of the WCIF 2050’s Panoptic Principles.

The subsequent phases of the WCIF 2050, being the Strategy and Implementation Plan, will further elaborate on how the WCIF 2050 and its Panoptic Principles support and benefit user communities.

Acknowledging the historical challenges of integrating isolated disciplines, the WCIF 2050 seeks to unify thought and action to achieve integrated and high-quality infrastructure management. ●

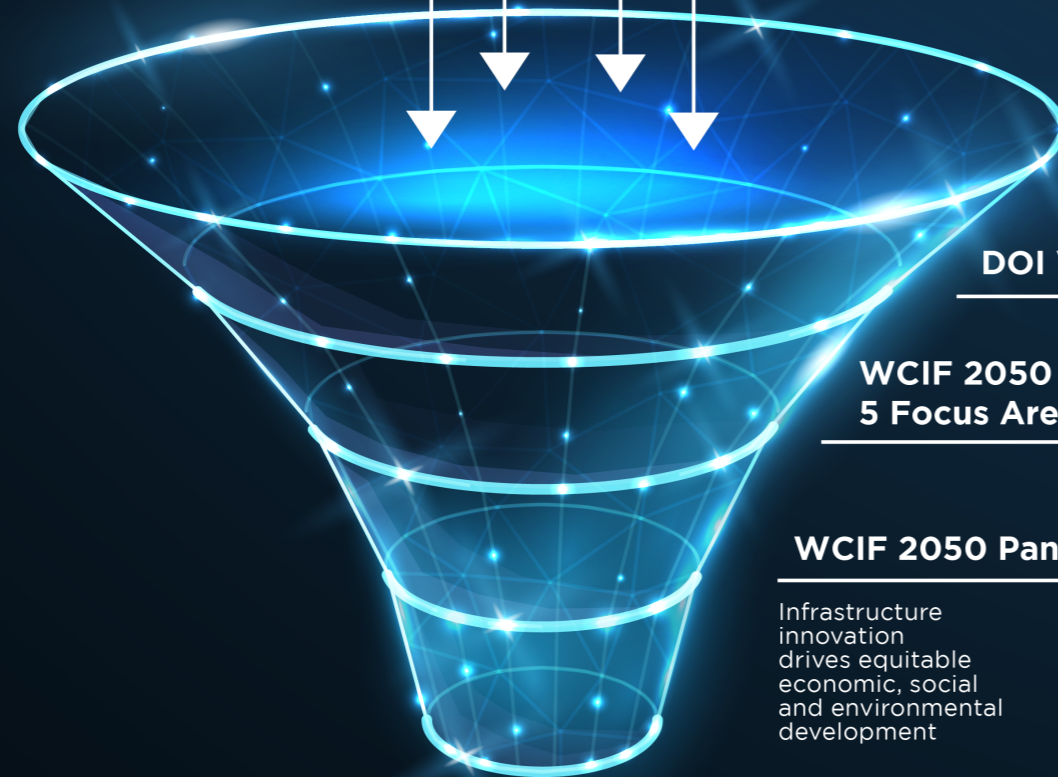


SA National shaping principles:
NDP, NIP, DPW&I, NSDP, NT, NLTF, SABS, SIPS, SPLUMA, other

International shaping principles:
UN, OECD, WB, WEF, AU, other

SA Provincial shaping principles:
PLTF, PSDF, PT, WCIF, DOE, DOH, DOSD, G4J, other

SA Municipal shaping principles:
IDPs, PPPs, ITPs, PSP, OHS, CCRS, EIF, other



DOI Vision and Objectives

WCGValues

WCIF 2050
5 Focus Areas, 5 Sectors

WCIF 2050 Panoptic Principles

Infrastructure innovation drives equitable economic, social and environmental development

Innovative infrastructure value chains / ecosystem contributes to building resilient, sustainable and regenerative systems

Sustainable stakeholder value is created by infrastructure and services that build trust, leverage spatial justice and the six capitals

Infrastructure design, commission, delivery and management is best supported and enabled by transversal planning and governance



WCIF 2050
Reflecting expert topical summaries in relation to the principles to offer guidance to user communities and practitioners

WCIF 2050
Phase 2
Strategy

WCIF 2050
Phase 3
Implementation Plan

Figure 2: Gigamap depicting the source journey of the WCIF 2050 embedded in the Panoptic Principles

INFRASTRUCTURE AS A SYSTEM

Chapter 6

INTRODUCTION AND CHALLENGES

In exploring the infrastructure systems environment, an ecosystem perspective has been recommended for the WCIF 2050. This involves understanding how all components of Western Cape infrastructure function together, much like a natural ecosystem. In this context, the DoI plays a pivotal role in guiding and energising the ecosystem, ensuring that all parts operate cohesively. A definition of the infrastructure ecosystem and the DoI's role in shaping its direction have been developed to support this approach.

"An ecosystem is an economic community supported by a foundation of interacting stakeholders – the organisms of the infrastructure world. It has a complex, relational structure with a high level of reciprocal dependence. Over time, members co-evolve their capabilities and roles, and tend to align themselves with the directions set by one or more central entities (DoI). Co-ordination and collaboration are aimed to create and share value amongst all of the network."

As Bengt-Ake Lundvall reminds us "Innovation is not an isolated process of individuals or firms but is rather the outcome of the interaction between firms, customers, suppliers, competitors and various other private and public organisations in a system".¹ Infrastructure systems function as Complex Adaptive Systems (CAS), with multiple interconnected components, including both natural and human systems. Within this broader infrastructure ecosystem, different ecosystems coexist, each contributing to the overall complexity.

Integrating stakeholder engagement into the CAS framework transforms the infrastructure ecosystem into a dynamic, resilient, and responsive system. Evidence of this transformation is seen through several mechanisms:

- Stakeholder engagement serves as a critical feedback loop, enabling the system to continuously learn and adjust.
- The collection of insights and data from stakeholders drives iterative improvements, fostering ongoing enhancements.

- Collaborative problem-solving stimulates the emergence of innovative and effective solutions, addressing complex infrastructure challenges.
- Engaging a diverse range of stakeholders ensures the system has the variety needed for adaptability and innovation.
- Empowering stakeholders at the local and decentralised levels lead to infrastructure solutions that are more responsive and context-specific.

By promoting adaptation, learning, continuous improvement, and diversity of perspectives, stakeholder engagement strengthens the effectiveness, sustainability, and resilience of infrastructure projects. This process ensures that infrastructure systems can evolve to meet future challenges while remaining responsive to local needs.

In developing the WCIF 2050, stakeholder engagement plays a critical role in ensuring the framework is inclusive, authentic, accountable, and aligned with the diverse needs and expectations of all relevant stakeholders. The WCIF 2050 is a comprehensive infrastructure framework that will serve as the foundation for the Strategy (Phase 2) and Implementation Plan (Phase 3).

Therefore, active engagement with stakeholders is essential at every stage of the infrastructure project lifecycle, from planning and implementation to monitoring and evaluation. This ongoing collaboration ensures that the WCIF 2050, and its Strategy and Implementation Plan, reflects shared interests and adapts to evolving needs, fostering accountability and transparency throughout the process.

The key challenge with stakeholder engagement is the tendency to view it as a procedural formality rather than as a core principle essential to the success of the WCIF 2050. Often, stakeholder engagement is mistakenly reduced to a "tick-box" exercise or seen as a compliance obligation. This limited perspective overlooks the pivotal role it plays in shaping infrastructure projects. When the true value of stakeholder engagement is acknowledged, it not only increases the relevance and effectiveness of projects but also fosters trust and commitment among stakeholders, leading to more sustainable and resilient outcomes.

Further challenges facing stakeholder engagement include:

- Engagement preferences are given to stakeholders with existing forms of influence, such as those with established relationships, authority, and financial resources.
- The existing project management and procurement processes, particularly the budgetary constraints set by the Public Finance Management Act (PFMA) and the Municipal Finance Management Act (MFMA), often limit the time available for meaningful public engagement. These regulations typically prioritise efficiency and cost control, potentially at the expense of allowing enough time for thorough stakeholder involvement.
- Marginal stakeholders, such as small community groups, individual advocates, independent researchers, and local businesses, may be excluded from the stakeholder engagement process.
- Distinctions between stakeholders and partnerships in the stakeholder identification process.
- Friction and tensions that may occur between stakeholders, such as disagreements between local community groups and government officials or conflicts between project funders and environmentalists.

Similar challenges face public participation in infrastructure projects, where community benefits from infrastructure projects are diminished because participation is viewed as mere compliance rather than genuine participation. When public participation is undervalued, it stifles the potential for innovative solutions and diminishes the overall resilience and sustainability of the projects.

To overcome these challenges, it is crucial to embed public participation as a foundational principle, ensuring that it is an integral part of the decision-making process and continuously evolves in response to feedback and changing conditions. Research by Hermanus et al found that broadening participation and building local capacity to adapt through experimentation and learning has led to incremental improvements in infrastructure projects.²

The Community Participation Policy for the WCG's Infrastructure Projects sets out policy to overcome

the challenges listed above by broadening participation in infrastructure projects. The policy aims and objectives set out the outcomes that it intends to achieve and compels the service provider to set up the necessary structures and provide the necessary resources to be able to implement the Policy. Its success and impact on community engagement and infrastructure development will be tracked and evaluated.

DEFINING STAKEHOLDER ENGAGEMENT

“South Africa needs to invest in a strong network of economic infrastructure designed to support the country’s medium and long-term economic and social objectives. This economic infrastructure is a precondition for providing basic services such as electricity, water, sanitation, telecommunications and public transport, and it needs to be robust and extensive enough to meet industrial, commercial and household needs” (NDP 2030).³

Achieving this requires more than just financial investment; it necessitates a comprehensive approach where effective stakeholder engagement plays a crucial role. The NDP 2030 encourages this by stating that “Leaders must make the constitutional mandate of public participation much more real, creating shared understanding by building processes that allow stakeholders to participate in decisions”.³

Stakeholder engagement requires organisations to acknowledge that their businesses and activities do not and cannot exist in isolation.³ They rely heavily on their relationships with customers, employees, suppliers, communities, investors, and others. This acknowledgment aligns with a systems perspective that emphasises the interconnectedness and interdependencies within the infrastructure ecosystem. Stakeholder engagement can therefore be best defined as, “the formal and informal ways of staying connected to the parties who have an actual or potential interest in or effect on a company’s business”.⁴

Taking this definition into consideration, stakeholder engagement as it applies to the WCIF 2050, can be further described as the process of interacting with individuals or groups who have an interest in or are affected by infrastructure projects in the Western Cape. This involves identifying who these stakeholders are, understanding their needs and

expectations, and ensuring they are kept informed and involved throughout the entire project lifecycle.

INTERPRETING STAKEHOLDER ENGAGEMENT IN THE CONTEXT OF THE WCIF 2050 PANOPTIC PRINCIPLES

Stakeholder engagement is integral to the WCIF 2050, driving innovation, governance, resilience, and equity in infrastructure projects.

This section examines how the Panoptic Principles influence stakeholder engagement by promoting active participation, continuous feedback, and inclusivity. These principles are pivotal in fostering sustainable and equitable infrastructure growth and development throughout the Western Cape.



Panoptic Principle 1

Infrastructure Innovation that drives equitable economic, social, and environmental development

- Active participation from all stakeholders is a precondition for Infrastructure innovation that drives equitable economic, social, and environmental development. This means engaging stakeholders not just as end-users but, where appropriate, as co-creators in the innovation process. By doing so, we can gather diverse ideas and perspectives that can lead to groundbreaking infrastructure solutions. Similarly, continuous improvement is also a precondition for infrastructure innovation. By integrating stakeholder feedback at every stage of the project lifecycle, projects can adapt and evolve based on real-world insights and experiences. This iterative feedback loop helps refine and optimise infrastructure solutions.

Equally, economic, social and environmental disparities can be actively addressed by involving stakeholders from economically disadvantaged communities. This engagement ensures that infrastructure projects directly benefit these groups, creating job opportunities, improving access to essential services, and fostering local business development. By prioritising sustainability and ecological resilience, these projects also contribute to long-term environmental health, further supporting equitable development.



Panoptic Principle 2

Innovative infrastructure value chains/ecosystems contribute to building resilient, sustainable, and regenerative systems

- As previously mentioned, stakeholder engagement should focus on incorporating diverse perspectives - but this time particularly those that enhance infrastructure resilience such as ecological sustainability. This is an important consideration when identifying stakeholders. This includes involving the relevant subject matter experts, local communities, and industry stakeholders in both the planning and implementation phases. By involving these groups, the infrastructure projects can be designed to not only meet current needs but also to withstand, adapt, and recover from disruptions, disasters, or other disturbances that may occur.



Panoptic Principle 3

Sustainable stakeholder value is created by infrastructure and services that build trust, leverage spatial justice, and the six capitals

(inclusive of value for money as defined by the IDA) - This principle involves prioritising inclusivity and fairness in infrastructure planning and delivery. Engaging stakeholders means actively involving communities, especially those historically marginalised, in decision-making processes. This will ensure that infrastructure projects equitably distribute benefits and services. This approach fosters trust by demonstrating a commitment to addressing spatial inequalities and ensuring that infrastructure development enhances public utility across the Western Cape.



Panoptic Principle 4

Infrastructure design, commission, delivery, and management is best supported and enabled by transversal planning and governance

- This principle emphasises the inclusion of diverse stakeholder perspectives during the project lifecycle to ensure governance and compliance across all levels. This involves identifying not only the stakeholders within the infrastructure value-chain but also those outside of it. It entails actively involving all these various stakeholders in the decision-making processes to ensure that infrastructure projects are designed, commissioned, and delivered with a comprehensive understanding of their impacts. By fostering a collaborative approach, the principle aims to achieve effective governance and compliance, ensuring that infrastructure development is inclusive, resilient, and aligned with the broader goals of societal benefit and sustainability.

Based on the WCIF 2050 Key Principles, the following Stakeholder Engagement Framework can therefore be considered when developing the WCIF Strategy and Implementation Plan:

- Diverse Ideas and Perspectives:** Actively involve all stakeholders to gather diverse ideas and perspectives, leading to groundbreaking infrastructure solutions.
- Iterative Feedback and Optimisation:** Build iterative feedback loops at every stage of the project lifecycle to refine and optimise infrastructure solutions.
- Address Economic Disparities:** Involve stakeholders from economically disadvantaged communities to actively address economic disparities.
- Comprehensive Stakeholder Identification:** Identify all stakeholders within and outside the infrastructure value chain to ensure comprehensive involvement.
- Inclusive Decision-Making:** Ensure all relevant stakeholders are involved in decision-making processes for maximum impact.
- Resilience:** Involve stakeholders that enhance infrastructure resilience by onboarding relevant subject-matter experts, local communities, and industry stakeholders in planning and implementation.
- Accessibility and Equity:** Ensure infrastructure and services are accessible to all community members, regardless of location or socio-economic status. Distribute resources and services equitably, focusing on historically

underserved or marginalised communities to promote spatial justice.

- 8. Effectiveness and Efficiency:** Design and manage infrastructure to provide reliable and effective services, maximising public benefit while minimising costs and environmental impact.
- 9. Inclusivity and Ownership:** Actively involve diverse community members in planning and decision-making to ensure the infrastructure meets their needs, fostering a sense of ownership and trust.
- 10. Administrative Adaptability:** Adapting financial management laws to better support meaningful and collaborative public participation can significantly enhance innovation in infrastructure projects.
- 11. Sustainability:** Ensure infrastructure projects contribute to long-term environmental sustainability and resilience, supporting the community's well-being for future generations.

By aligning stakeholder engagement with the Panoptic Principles, the WCIF 2050 ensures that infrastructure projects are innovative, resilient, and equitable. This inclusive approach fosters sustainable development and enhances the well-being of all communities across the Western Cape.

IDENTIFYING RELEVANT STAKEHOLDERS

Identifying relevant stakeholders involves listing all possible parties who may impact or be impacted by the project, including all levels of government, local communities, advocacy groups, businesses, non-profit organisations, and environmental groups. This chapter builds upon the comprehensive stakeholder identification and assessment conducted in the WCIF 2050 Stakeholder Analysis Report (1 September 2023)⁵ providing a detailed sector-specific breakdown and incorporating additional methods to ensure thorough stakeholder identification.

The WCIF 2050 Stakeholder Analysis Report was a desktop study identifying stakeholders for each WCIF 2050 sector (Social, Energy, Economic, Technology, and Ecological), and provides a detailed sector-specific breakdown of government, private sector, and NGOs, along with their mandates and responsibilities. This study is not exhaustive, and



... the Panoptic Principles shape stakeholder engagement, ensuring active participation, continuous feedback, and inclusivity, thereby fostering sustainable and equitable infrastructure development across the Western Cape.



additional methods like interviews and surveys will enhance stakeholder identification.

In addition to the method of identifying stakeholders mentioned above, an alternative approach is to identify stakeholders via the infrastructure value chain. By listing the elements of the infrastructure value chain and then identifying stakeholders within each element, a different perspective on stakeholders can be gained.

The value chain perspective of stakeholder engagement focuses on stakeholders involved in each stage of the infrastructure project’s lifecycle, from planning and design to construction, operation, and maintenance. It ensures engagement across all phases of the project. This is different from the sector perspective which focuses on stakeholders within specific sectors, such as social, energy, economic, technology, and ecological, where engagement is limited to sector-specific interests and issues.

Both value-chain and sector perspectives are valuable and integrating elements of each can lead to more comprehensive and effective stakeholder engagement in infrastructure projects.

COMMUNICATION PLAN

Given the principles of WCIF 2050, developing a comprehensive communication plan is crucial for ensuring stakeholder awareness of the infrastructure approach, fostering their willingness to adapt and participate, and successfully contribute to the framework’s objectives. From a communication standpoint, it is also essential to establish a framework for interpreting the communication plan through the lens of the Panoptic Principles.

Important communication considerations when developing the WCIF 2050’s Strategy and Implementation Plan:

- a. Transparency and Accountability:** Ensure all stakeholders are informed about project progress and decision-making processes.
- b. Stakeholder Inclusion:** Actively involve economically disadvantaged communities to gather diverse perspectives and drive equitable economic growth.
- c. Governance and Compliance:** Enhance governance by maintaining open communication channels and promoting adherence to transversal governance and compliance.

- d. Ecological Resilience:** Support sustainable practices by integrating feedback that enhances ecological resilience.
- e. Equitable Distribution:** Address concerns related to equitable distribution to ensure that infrastructure and services effectively meet the needs of all communities, maximising public utility and fairness.
- f. Trust Building:** Foster trust among stakeholders by regularly updating them and addressing their concerns promptly and effectively.

By implementing these considerations, it will ensure that the WCIF 2050’s Strategy and Implementation Plan are transparent, inclusive, and sustainable, fostering trust and achieving maximum public benefit.

WCIF 2050 - WHAT WOULD SUCCESS LOOK LIKE IF WCIF 2050 WAS SUCCESSFULLY IMPLEMENTED?

The WCIF 2050 Reboot Synthesised Output Report (July 2022)⁶ contains the responses from stakeholder workshops, where participants were asked to envision the “Picture of Success” for the WCIF 2050.

The following is a summary of the workshop participant’s feedback:

1. Participants envisioned a resilient, thriving province achieved through integrated and sustainable infrastructure.
2. Success includes accessible, shared, and resource-efficient infrastructure, supported by digital connectivity and renewable energy.
3. Communities would enjoy dignified lives with equitable access to employment, education, and healthcare.
4. Public transport would be decentralised and eco-friendly, while human settlements incorporate green spaces and food gardens.
5. The WCIF 2050 acts as a unified framework aligning public, private, and state-owned sectors, integrating planning at all government levels.
6. Governance is transparent, corruption-free, and facilitates intelligent decision-making, with communities actively engaged in the process.⁵

In 2050, the global humans of the Camissa region are a connected community working together to maintain their healthy soils, landscapes, oceans, waterways, and renewable energy systems in turbulent times. The wise decisions made in 2024, particularly the redefinition of the WCIF 2050 to prioritise sustainability, equity, and resilience, have fundamentally transformed the region. Stakeholder engagement was a cornerstone of the WCIF 2050’s success, ensuring that every voice was heard and every perspective was considered. This inclusive

approach has fostered a society where equity and prosperity are the order of the day. Communities, once marginalised, now thrive with access to essential services and economic opportunities. The foresight to invest in resilient and sustainable infrastructure has paid off, as Camissa now enjoys robust systems that withstand environmental stresses and support a high quality of life for all residents. (continued from the Western Cape Climate Change Response Strategy - Vision 2050: A vision for a resilient Western Cape).

DOI STAKEHOLDERS IN THE INFRASTRUCTURE VALUE-CHAIN

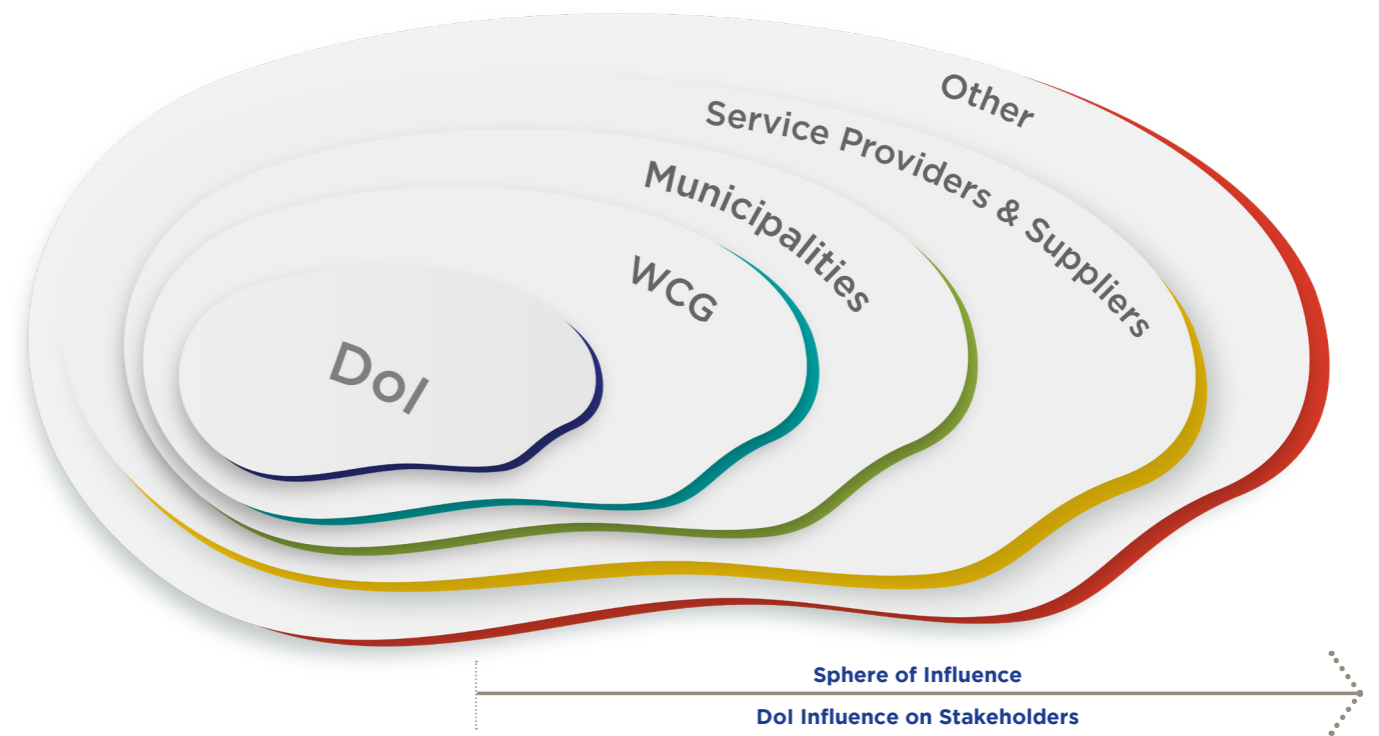


Figure 1: DoI Stakeholders

TECHNOLOGY, DATA AND DIGITAL INFRASTRUCTURE

Chapter 7

INTRODUCTION

The 21st century has ushered in the 4th Industrial Revolution (4IR), fundamentally transforming how societies function through an evolving technological landscape. This revolution introduces both disruptive forces and valuable opportunities for planning and growth. For the WCIF 2050, strategically implementing technology promises to enhance operational efficiency and drive transformative outcomes, shaping infrastructure innovation across various domains.

The WCIF 2050 acknowledges technology’s multifaceted role in advancing infrastructure innovation, recognising its public value for both the WCG and its citizens. As society reaches a pivotal moment in recognising the potential of digital technologies, it is important to note that digital transformation has traditionally focused on digitising public and private services, creating software and platforms, and leveraging data for improved decision-making. However, as digital infrastructure rapidly ascends, it is increasingly becoming the cornerstone for future economic and social development, complementing the longstanding foundation of physical infrastructure.

This “phygital” infrastructure requires a holistic framework that considers the integration of physical and digital factors and features to enable seamless interactions between the physical and digital worlds to ensure the anticipated digital benefits are maximised.¹²

DIGITAL PUBLIC INFRASTRUCTURE (DPI)

In the 21st century, societies increasingly rely on software and digital systems to coordinate essential functions such as vaccine distribution, social welfare provision, identity management, payments, and medical data sharing. These systems have become critical infrastructure rather than optional components.¹ Emerging digital social structures, such as Digital Public Infrastructure (DPI), are being developed and regulated by governments, philanthropies, transnational organisations, and the private sector. However, these transformations are not neutral; they often serve specific interests

such as profit, control, or lock-in. Modern research indicates that DPI should be not only regulated but also created and governed to maximise public value and serve the common good.¹

A significant introduction of DPI into global policy emerged from the G20 Economy Working Group, which released a joint statement in 2023 that defined DPI as “a set of shared digital systems, designed with minimal digital building blocks that can be used modularly by governments, businesses, academia, and civil society to support society-wide development”.¹ It emphasised that the “public” aspect of digital public infrastructure involves both public benefit and access, governed and overseen by appropriate public authorities.

The G20 statement outlined key objectives for the digital economy, aligned with the SDGs, stating that “We recognise the importance of creating an enabling, inclusive, open, fair, non-discriminatory, and secure digital economy. In the context of digital economy, we also respect applicable legal frameworks. We take cognisance of the critical role played by digital technologies in helping the world navigate the myriad challenges posed by the COVID-19 pandemic and the lack of technological and financial capacity in many countries to develop and deploy well-designed, inclusive, secure, trusted, resilient, sustainable, open, safe, and interoperable digital systems that respect human rights to unleash the potential of the digital economy. Therefore, we acknowledge the importance of adopting an inclusive, sustainable, development-oriented and human-centric approach that protects privacy and data, to respond to various challenges and leverage opportunities of digitalisation”.² The statement recognises that each country should follow its unique path.

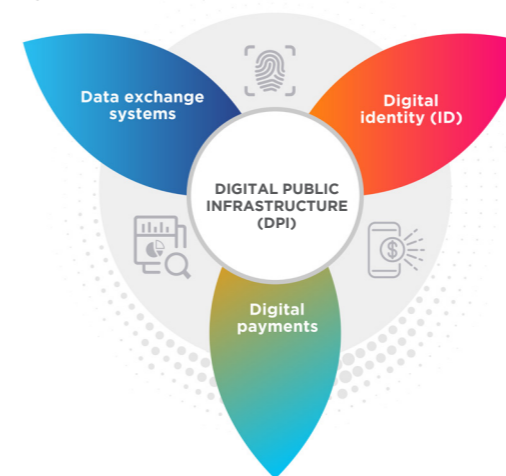


Figure 1: Core Aspects of Digital Public Infrastructure

While attention still needs to be given to widening access to fast, affordable and reliable broadband infrastructure, DPI focuses beyond this physical infrastructure layer. Insightful research³ recognises DPI to have at least three core aspects, namely: data exchange systems, digital identity, and digital payments (as depicted in Figure 1). Early evidence suggest DPI may provide a much-needed boost to fulfil SDG commitments and foster financial inclusion making them an ideal focus for governments and civil society organisations.

DIGITAL INNOVATION AND LEGACY SYSTEMS

Digital innovation in infrastructure is essential for promoting sustainable development and creating genuine “public value”. When designed and utilised effectively, digital solutions, such as renewable energy systems, green building practices, and intelligent data management, can significantly enhance resource management and operational efficiency. Moreover, digital innovation facilitates greater community engagement and transparency, enabling citizens to participate in decision-making processes, fostering a sense of ownership and accountability, and generating trustworthy feedback for the WCG.

In this context, the DoI’s digital vision must empower the WCG to fully leverage Digital Public Value in its infrastructure plans and projects. Subsequent sections will provide deeper insights into digital public value, highlighting how cutting-edge digital advancements can contribute to building resilient, efficient, and inclusive infrastructure.

Before introducing emerging digital innovations for the WCIF 2050, we first present a high-level overview of the current technologies servicing the WCG. The strategic application of technology in provincial infrastructure, across all domains whether transportation networks, public utilities, healthcare systems, educational facilities, or other infrastructure, often falls short of delivering substantial “public value”. This is primarily due to the reliance on legacy systems or new systems based on outdated technology stacks, frameworks, tools, and models. These design constraints limit the potential for these systems to provide meaningful public value. Instead, they primarily offer administrative value, which is increasingly diminishing in relevance due to the rapid pace of technological advancement.

The reluctance to transition from legacy systems is further compounded by the perceived costs and risks associated with such migration. Providers often exploit these fears, using them as a lock-in technique to retain expensive, outdated technologies. As a result, the WCG inadvertently continues to face the inherent risks and threats posed by these legacy systems, which must be addressed in the WCIF 2050 as it relates to infrastructure implementation.

The following examples illustrate the rapidly expanding risk profile for the WCG:

1. **Global Competitiveness:** Falling behind other countries or regions, reducing South Africa's competitive edge.
2. **Technological Obsolescence:** Legacy technologies failing to meet evolving public and private sector needs.
3. **Diminished Public Value:** Legacy systems delivering negative or minimal public value, reducing their effectiveness.
4. **Governance Challenges:** Emerging technologies evolving faster than governance, policies, regulations, and ethical frameworks can adapt, potentially leading to unmanaged socio-economic impacts (e.g., high energy requirements).

These challenges are evident in the current transversal systems used across South Africa. The WCG still relies on outdated national systems (e.g., PERSAL, LOGIS, and BAS) and provincial systems (e.g., Integrated Transport System, Asset Management System, Project Management Systems, PERMIS, and GIS). These systems are costly to maintain and inadequate for addressing future infrastructure needs, especially in delivering the public value essential for the digital age.

LEGISLATIVE PROTOCOLS

The current legislative protocols in the digital space relevant to the WCG and the WCIF 2050 include the following:

- a. **The Protection of Personal Information Act (POPIA, 2013)** regulates personal data to protect individuals' privacy (reinforcing individual rights to privacy which are enshrined in the 1996 Constitution).
- b. **The Electronic Communications Act (ECA, 2005)** is the legal framework for electronic communications and transactions, ensuring the security and integrity of electronic records (with

changes currently proposed as the Electronic Communications Draft Amendment Bill 2023).

- c. **National Development Plan (NDP 2030)** is the country's national strategic plan to reduce inequality and eliminate poverty by 2030.
- d. **Cybercrimes Act (2020)** addresses cybercrimes and cybersecurity, providing measures to protect information systems and networks. Its risks are increasing in frequency and consequences (e.g., municipalities, SOEs, and government departments).
- e. **Broadband Policy for South Africa (SA Connect, 2013)** aims to provide high-speed broadband to all South Africans, being crucial for digital inclusion.
- f. **Public Finance Management Act (PFMA, 1999) and the Municipal Finance Management Act (MFMA, 2003)** governs the financial management of government departments and entities and local governments respectively.
- g. **Infrastructure Development Act (IDA, 2014)** was enacted to facilitate and co-ordinate public infrastructure development, to ensure infrastructure development is given priority, and to promote the development goals of the state via infrastructure across its life-cycle phases.
- h. **State Information Technology Agency Act (SITA, 1998)**, amended, but defines the agency as being responsible for the provision of IT services to Government – in particular national and provincial government.
- i. **The Broadband Infraco Act (2007)** is relevant insofar as SITA and Broadband Infraco are currently merging to form the State Digital Infrastructure Company (SDIC).
- j. **National Infrastructure Plan 2050** sees the provision of digital communications and allied areas as “mission critical network infrastructure”
- k. **The South African National Policy on Data and Cloud (published mid 2024)** outlines how the country will handle data management and cloud computing. This policy aims to use data and cloud technologies to boost the economy, improve public services, and protect personal data. It prioritises an acceleration of the rollout of digital infrastructure (to ensure fast, secure and reliable broadband connectivity), data privacy and security, open data and data interoperability, and the adoption of a cloud-first approach (requiring collaboration, funding, stakeholder engagement, and the capacitation of SDIC).
- l. **New Licensing Framework for Satellite Services**

(ICASA discussion document, published August 2024) represents an important step by ICASA in responding to the many new satellite services in the process of being deployed, including low-earth orbiting satellites (such as OneWeb, Kuiper, and Starlink).

- m. **The National Policy on Rapid Deployment of Electronic Communications Facilities and Networks** (published 2023), and subsequent inquiry in process by ICASA, is important for removing the impediments to the rollout of physical infrastructure (especially of fibre and towers).
- n. **National Artificial Intelligence Policy Framework** (published by the DCDT in August 2024) provides the basis for a fully developed AI policy.
- o. **The Recommended South African Strategy for 5G, Future and Emerging Technologies** (currently in draft for comment) will frame how ICASA intends to regulate IMT in future and to engage government in general regarding the formulation of policy.
- p. **Beyond the Gap - Information and Communication Technologies** is due to be published by the DBSA, together with the NPC (and in partnership with the World Bank) in late 2024 and aims to quantify the total investment requirement for South Africa to achieve its stated connectivity goals, as well as how this investment can be expedited.

Further to the above, the WCIF 2050 should ensure alignment to all the relevant provincial priorities, such as infrastructure and socio-economic development goals, emphasising the pivotal role of technology and innovation in driving economic growth and enhancing competitiveness.

The WCIF 2050 also needs to ensure alignment to the Priority Focus Areas (PFAs) stated in the G4J Strategy,¹ for Technology, these include:

- a. **PFA1: Driving Growth Opportunities through Investment** - in this context, investment would focus on enhancing digital infrastructure.
- b. **PFA3: Energy Resilience and Transition to Net Zero Carbon** - is most relevant given the increasing power demands of data networks, data centres, and AI servers. Additionally, the integration of Internet of Things (IoT) sensors and controllers, automation software, and AI-based efficiency applications must be monitored and optimised for ESG compliance.

c. **PFA5: Technology and Innovation** – envisions the Western Cape becoming the leading hub for technology, start-ups, venture capital, innovation, and the Design Capital of Africa.

d. **PFA6: Infrastructure and Connected Economy** – quantifies the increase in government Gross Fixed Capital Formation (GFCF) expenditure, defining the parameters within which this strategic framework should operate.

e. **PFA7: Improved access to economic activities and employability** – is closely linked to enhancing digital access, improved economic opportunities, market growth, and digital competitiveness. The WCG's broadband initiative is preparing to enter its second 10-year implementation phase.

ELEMENTS OF DIGITAL INFRASTRUCTURE

This section considers elements of digital infrastructure, beginning with connectivity (the physical layer), and what is sometimes referred to as the “first mile” (international connectivity), moving to the “middle mile” (national connectivity), and then the “last mile” (connectivity to premises).

For each element, the current state is described, followed by opportunities to simplify the connection:

- a. **International or First Mile Connectivity** – refers to the proliferation of undersea fibre cables, with several key ones connecting near Cape Town, creating abundant broadband connectivity and reducing prices. The Equiano cable, deployed in March 2023, more than doubled all previous capacity, while the 2Africa cable (currently being deployed) is expected to nearly double that again. A key implication for the WCG and the WCIF 2050 is that it paves the way to plan for a “paradigm of abundance” and to replace the previous scarcity business model and thinking. It is important to utilise multiple subsea cables for connectivity, ensuring diversification and redundancy by deploying cables on both Africa's east and west coasts. This approach mitigates risk by allowing for interruptions in individual cables, and will enhance overall network resilience.
- b. **Middle Mile Connectivity (Long Distance or National routes)** – the deployment of submarine cables has significantly improved the quality and reduced the costs of national fibre routes. A key challenge for the WCIF 2050

is addressing the digital divide by extending affordable broadband backhaul to smaller towns.

- c. **Last Mile Access Connectivity** - the most pressing constraint to more widespread digital accessibility is last mile access.
- d. **Data Centres and Edge Centres** - looking beyond connectivity to data centres, the WCG has seen significant investment by local and international private sector players, both in

building the data centres themselves and in moving up the value chain to provide cloud services.

- e. **Platforms, applications and other technologies** - application layer and other technologies that provide public value and that serve WCG infrastructure planning, operation, and maintenance requirements will be explored in the strategy phase that follows the WCIF 2050.

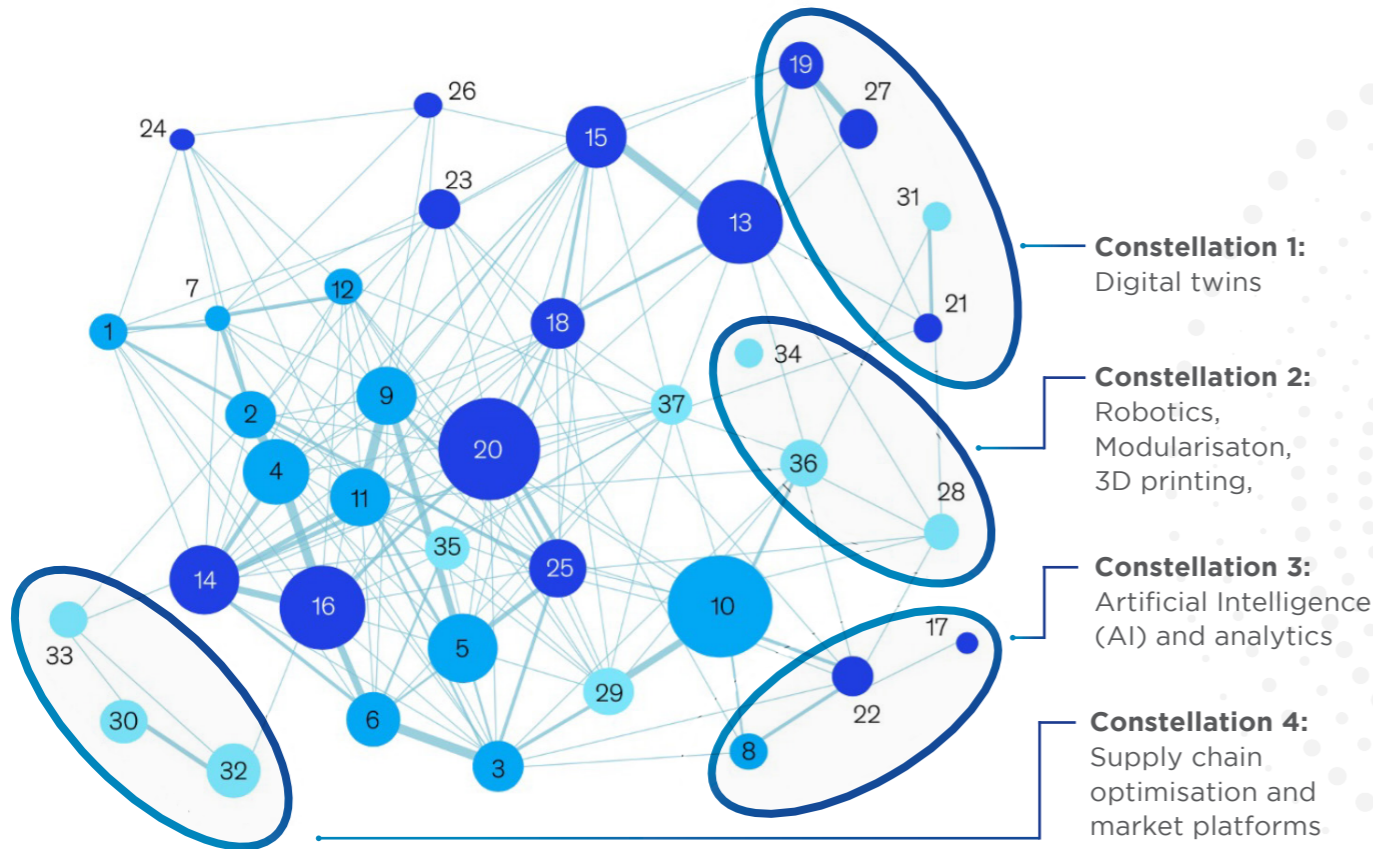


Figure 2: A survey of construction industry technology investments

On-Ste Execution

- 1. Capital financing
- 2. Customer relationship management
- 3. Equipment management
- 4. Estimating
- 5. Manpower optimisation
- 6. Materials management
- 7. Portfolio planning and management
- 8. Predictive assessment performance
- 9. Project scheduling
- 10. Real-time monitoring and control
- 11. Resource planning
- 12. Risk management

Digital Collaboration

- 13. 3-D modeling
- 14. Bidding process
- 15. Building-information modeling
- 16. Contract management
- 17. Deep learning
- 18. Design management
- 19. Design simulation
- 20. Document management
- 21. Laser scanning
- 22. Machine learning
- 23. Process simulation
- 24. Productivity management
- 25. Progress tracking and performance dashboards
- 26. Value engineering
- 27. Virtual learning

Back Office

- 28. 3-D printing
- 29. Compliance
- 30. Construction materials marketplace
- 31. Drone-enabled yard inspection
- 32. Equipment marketplace
- 33. Labor and professional marketplace
- 34. Off-site fabrication
- 35. Quality control
- 36. Robotics/automation
- 37. Testing and training

Technology investments in the construction industry, a key enabler of government infrastructure provision, offer insights into the platforms, applications, and technologies that are increasingly supporting infrastructure development.

A survey of construction industry technology investments¹⁰ is summarised and mapped in Figure 1. The thickness of lines indicate the number of companies offering connected use cases; while the total circle size reveals the number of organisations focusing on similar constellations.

Key observations from this survey are:

- a. that the construction technology ecosystem is shifting toward integrated software platforms that better serve customer needs; and
- b. that the largest construction industry clusters of use cases include:
 - iii. Platforms;
 - iv. Modularisation & Robotics;
 - v. AI & Analytics; and
 - vi. Digital twins.

The WCIF 2050 Strategy should assess the debate between government-constructed infrastructure and service procurement. Historically, the WCG has preferred procuring services, while national government policies have recently shifted away from direct construction towards procurement models. Similarly, countries like the United States have increasingly adopted procurement approaches for hosting and managing highly sensitive information.

Whatever investment and procurement models are selected, the WCG should ensure that, where appropriate, open access models are incorporated to foster innovation and competition and reduce unnecessary duplication of infrastructure.

In addition, maintaining a geospatial database of physical digital infrastructure can ensure efficient planning, management, and protection of critical assets such as fibre optic cables, data centres, and communications towers. This information is essential for coordinating infrastructure development, optimising service delivery, and minimising disruptions during construction or maintenance activities. Such a database enhances the government's ability to respond quickly to emergencies, mitigate risks, and support decision-

making in areas such as urban planning, disaster recovery, and public safety, contributing to a more resilient and connected society.

Edge centres are still in the early stages of development. Just as the WCG has prioritised connectivity for all relevant government buildings, the WCIF 2050 must consider where Edge services (computing, storage, and connectivity) will be required and how these services can be scaled to meet the anticipated surge in demand. Given that Edge is a relatively new concept, it would be beneficial for the WCIF 2050 to include a taxonomy to clarify and define what is meant by Edge services.¹¹

DATA GOVERNANCE

The WCIF 2050 must convey the importance of defining a comprehensive framework for data governance within the WCIF 2050 context, addressing possible decentralised policies, responsibilities, ownership, quality, security, and compliance.

Other key issues a sound WCIF 2050 digital landscape would require should include:

- a. Specific methods and sources for data collection and storage infrastructure.
- b. Emphasise data integrity, security, privacy, and quality management.
- c. Open-systems based digital platforms and technologies, ensuring interoperability and integration with IoT.
- d. Gigamapping data and other visualisation tools displacing traditional data mining and data warehousing models, emphasising roles in analysis and communication.
- e. Capacity building for digital skills. Requirements will evolve and change on a dynamic and accelerating basis. The skills development framework should address the need for widespread digital literacy and digital competence by citizens, the private sector, and government. It should also cater for the skills requirements of the ICT industry itself.
- f. Future-proofing of digital infrastructure.
- g. Defining policies regarding data ownership and accessibility within the WCIF 2050 framework.

CONNECTIVITY

Connectivity is an essential service category that drives digital transformation, and its requirements will continue to evolve to support emerging use cases.

The evolving set of radio standards known as International Mobile Telecommunication (IMT) plays a critical role in global connectivity due to its widespread adoption, enabling the development of a mature technical ecosystem. Currently, 4G dominates in coverage and subscribers, while 5G is the fastest-growing generation to date. In South Africa, both 2G and 3G are still operational, primarily supporting voice and messaging, with 3G offering limited mobile internet. Notably, 2G continues to serve essential functions: it is a primary communication method for low-income individuals

without smartphones and underpins the IoT industry. However, both 2G and 3G is scheduled to be phased out by December 2027 to make room for more efficient technologies, although specific transitional plans are yet to be finalised to mitigate negative societal impacts. 5G (also called IMT-2020), designed in 2015, was developed to enhance user experience beyond 4G capabilities. Its primary use cases include enhanced mobile broadband (eMBB), massive machine-type communications (mMTC), and ultra-reliable low-latency communications (URLLC). While 5G is intended to span the period from 2020 to 2030, the reality in 2024, five years after its initial deployment, shows that the major focus has been on eMBB, which improves mobile broadband capacity and speed.

Most of the differentiation in 5G services today stems from the provision of Fixed-Wireless Access

(FWA), which complements fibre-to-the-premises connectivity. An enhanced version of 5G, referred to as 5G-Advanced, is expected to roll out from 2025, while 6G is anticipated to be deployed from 2030. The post-2030 landscape is envisioned in an updated framework known as IMT-2030, which outlines six new usage scenarios across four key themes (see Figure 3). IMT-2030 is the agreed basis on which 6G standards will be finalised, shaping the roadmap through to 2040 and beyond.

The WCIF 2050 Strategy must account for the IMT roadmap to 5G/6G, identify key use cases, and consider how to maximise coverage not just for broadband but for a wide range of services. While build-vs-buy options should be explored, by leveraging the WCG’s existing fibre deployment projects, the most feasible approach is for the government to act as an anchor tenant. By doing so, procurement specifications can be used to drive the necessary coverage levels, with incentive grants providing additional support in more remote areas.

An important use case for the government is emergency response and public protection, which relies on advanced combinations of surveillance and communication services. These systems require reliable, dedicated bandwidth and often necessitate mobile coverage expansion, such as extending connectivity into basements. In such cases, public operators will need to commit to, or prioritise, network resources to ensure consistent reliability during emergency situations. Coverage extension units, such as mobile base stations, could be procured to complement public network coverage.

The WCIF 2050 Strategy should also explore the deployment of private 5G networks for key provincial sites, such as government headquarters, hospitals, and other critical infrastructure. This would enable greater control over service quality, the types of services offered, and the security of sensitive public information. Therefore, 5G/6G coverage should be approached through a combination of strategies and solutions tailored to specific use cases and needs.

APPLICATION OF PANARCHIC GOVERNANCE TO TECHNOLOGY, DATA AND DIGITAL INFRASTRUCTURE

The above elements are practical strategies for

developing a digital architecture that supports Panarchic Governance within the WCIF 2050 context. Embracing Panarchy is crucial for maximising the public benefits of digital technologies and ensuring the sustainability of infrastructure across both rural and urban areas.

For improvements in the digital space within the WCIF 2050 context, the following aspects need to be considered:

- a. Policies:** clear policies regarding data collection, storage, and usage (noting that the notion of what constitutes public data needs to be updated to reflect new thinking and broad societal considerations).
- b. Responsibilities:** roles and responsibilities are needed for data owners, stewards (officers), and users.
- c. Ownership:** clear systems data ownership and the authority to make decisions about different data sets.
- d. Quality:** measures to ensure data quality via authentic audits, validation checks, and data scrubbing.
- e. Security:** data security mechanisms must be established and prioritised to protect against breaches and cyber threats (e.g., encryption, access controls, training, and regular security audits).
- f. Ethics:** the WCIF 2050 sees appropriate collection, storage, management, use, and deletion of data tied to ethical principles, with mechanisms to review and update these principles established.
- g. Compliance:** compliance should be established with regard to all relevant laws, and regulations and agreed standards.

The WCIF 2050 must recognise and embrace the growing interest in the societal impact of DPI, which prompts a re-evaluation of how “public” is defined. DPI cannot be assumed to be neutral, as historical evidence suggests otherwise. The concept of “public” often carries embedded values, assumptions, and impacts shaped by the infrastructure itself. Researchers argue² that the essence of “publicness” in DPI should ensure that essential capabilities are provided for meaningful participation in a digital society. However, authentic definitions of publicness emphasise attributes such as openness and social value.^{3,9}

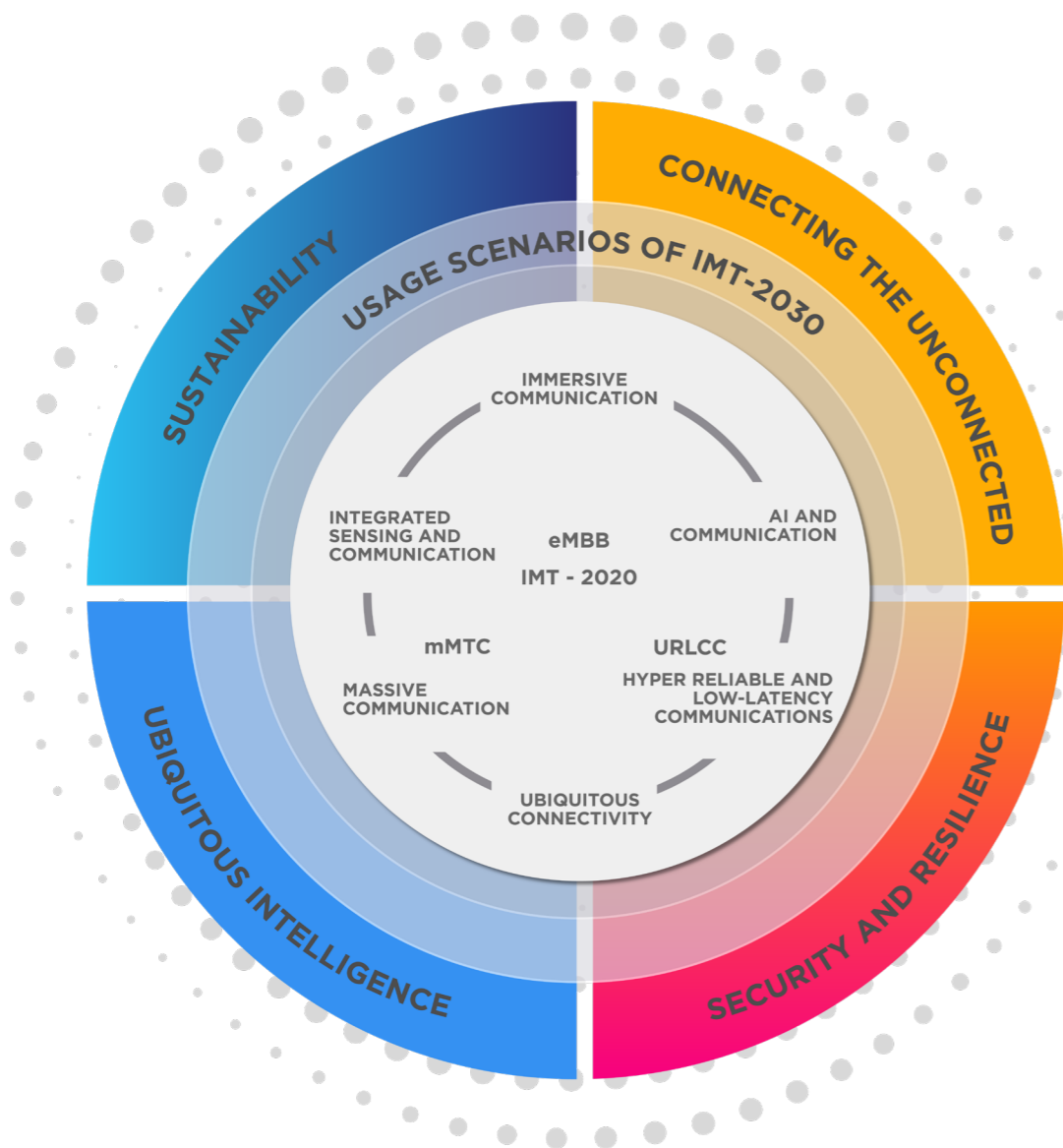


Figure 3: Usage scenarios of IMT-2030

Two high-level frames for value creation in DPI are identified as attributes and functional perspectives.¹ This view posits that “publicness” in DPI should transcend the traditional notion of public interest, which often carries implicit normative assumptions. Instead, it advocates for a focus on the “common good”,⁴ aligning with a perspective of maximising public value. Research suggests that emphasising the “common good” can enhance the public value creation process and guide the governance of emerging DPI.¹

One of the earliest visions of technology’s potential to transform government structures and working practices⁷ was the concept of Government-as-a-Platform (GaaP). This concept is aligned with the idea of Infrastructure-as-a-Service (IaaS), which the DoI incorporates into its WCIF 2050. Many researchers see this shift as crucial for achieving socio-economic equality and fostering decentralised prosperity.⁵

They argue that governments should focus on facilitating “open systems architecture” rather than merely implementing open government initiatives. Additional research⁸ articulates how the GaaP architecture can enhance public administration’s ability to deliver greater public value. For instance, Italy’s approach to public value creation and other digital infrastructures illustrate how governments can develop the capabilities⁶ needed to manage 21st century societies. These infrastructures play a significant role in addressing structural inequalities exacerbated by value-extraction models used by corporate or foreign entities.⁷

The WCIF 2050 should advocate for the adoption of public value-based system designs to strengthen governance, prevent misuse of infrastructure, and maximise public value creation. This approach will position the WCG and the WCIF 2050 to play a critical role in setting the direction of the process through which collective action and coordination occurs.⁴

When public value is created collectively to achieve the common good, and the process is as important as the intention, Panarchic governance structures can facilitate collaborative efforts among various actors towards shared goals for the common good. This requires an understanding of how public institutions can guarantee the five pillars depicted in Figure 4. ●

Winning back citizen’s trust in tracking progress through practices that show commitment to transparency and accountability.

Ensure public value is distributed equitably (inclusive growth).

Rethinking institutional practices that support collective learning and build long-term capabilities and capacities.



Figure 4: Pillars of Public Value Creation⁴

FROM SUSTAINABLE AND RESILIENT TO REGENERATIVE INFRASTRUCTURE

Chapter 8

INTRODUCTION

Western Cape Ecological Infrastructure (Topography and Landscapes). Longest coastline of any SA province (56 Estuaries). Stormy, rocky shores, active coastline. Cape Floristic Kingdom one of only 6 floristic kingdoms in the world and the smallest. Vast biodiversity and endemic species. Mediterranean Climate (winter rainfall, west coast, strong winds). Naturally poor soils. Fire is part of the natural cycle (pyrophytic vegetation).

6 Strategic Water Source Areas (22 in South Africa):

- Groot Winterhoek
- Table Mountain
- Boland Mountains
- Outeniqua Mountain
- Langeberg Mountains
- Swartberg Mountains
- Kougaberg Mountains

Invasive plant species introduced by colonialists for quick growing timber and sand stabilisation.

South Africa and the Western Cape face substantial socio-economic and environmental challenges that require the development, maintenance, and enhancement of infrastructure. The aim is to ensure societal prosperity while simultaneously protecting and improving the environment.

Key questions driving this effort include:

- What constitutes resilient and regenerative infrastructure?
- What are the current approaches and emerging issues influencing the sustainability aspects of the infrastructure framework?
- How can we protect, retain, and adapt existing infrastructure?
- How should new infrastructure development be designed and implemented?

This chapter aims to outline the necessity of sustainable infrastructure in addressing threats to the biosphere, climate change, and the achievement of the SDGs. It provides a

brief overview of sustainable infrastructure, its core principles, and international considerations, with a particular focus on how the Western Cape can achieve a resilient and equitable future.

THE CONTRIBUTIONS PEOPLE GET FROM NATURE



Figure 1: Ecological Infrastructure and its contribution to people

Ecosystem goods and services are:

The goods and services that people enjoy, often free of charge, that result from interconnections between components within our natural and social systems, which are complex.

Four types: Provisioning, Regulating, Cultural and Supporting all underpin human wellbeing.

Context

- An overarching framework (way of thinking) that aims to frame our relationship with nature
- Coined in 1970s with increasing prominence as the human-nature divide increases (including a rise in externalizing costs to the environment)
- A useful tool for incorporating oft overlooked natural inputs into decision-taking
 - » Draws parallels between ecological and built infrastructure, which can be useful in valuing these goods and services.

SUSTAINABLE INFRASTRUCTURE

To address threats to the biosphere, ecosystem degradation, and the impacts of climate change while striving to achieve the SDGs, it is essential to adopt a sustainable perspective to infrastructure growth and development. The key aspects that either enhance or limit infrastructure's contribution to achieving the SDGs⁹ and the NDP are summarised below, with the aim of ensuring a thriving future for all.

At the heart of sustainable infrastructure is the concept of ecological infrastructure. This term refers to naturally functioning, self-regulating ecosystems that provide essential services such as water and climate regulation, soil formation, and disaster risk reduction. Ecological infrastructure is the nature-based counterpart to built or hard infrastructure and can be equally important for delivering services and supporting socio-economic development. It offers cost-effective, long-term solutions that can complement and, in some cases, even replace traditional built infrastructure.

Sustainable infrastructure projects are those "that are planned, designed, constructed, operated, and decommissioned in a manner to ensure economic and financial, social, environmental (including climate resilience), and institutional sustainability over the entire life cycle of the project"¹.

Sustainable infrastructure programmes and projects consider ecological interventions as options when being developed. Implicit in this definition is retrofitting and reconfiguring existing infrastructure and systems. As it encompasses the broader aspects of sustainability, the definition does not explicitly consider climate change and the need to urgently reduce GHG emissions to shift towards a low carbon economy.

Resilience is the capacity of social, economic (human), and ecological systems to cope with a hazardous event, trend, or disturbance, responding and re-organising in ways that maintain their essential function, identity, and structure, while also maintaining the capacity for adaptation, learning, and transformation.² Resilient infrastructure is thus designed to cope with internal and external shocks to the infrastructure system and emerges from that system's ability to endure and recover from, and adapt to stress.

Adaptation is any adjustment in natural or human systems in response to actual or expected environmental (including climatic) stimuli that moderates harm or exploits beneficial opportunities.³

A **circular economy** aims to maintain resource value by minimising waste through reusing, remanufacturing, and recycling based on closed-loop systems. A **regenerative economy** focuses on holistic sustainability, restoring natural resources, and promoting social well-being. Regenerative infrastructure should contribute to the restoration of ecosystems while improving social well-being.

Ecological infrastructure includes “healthy mountain catchments, rivers, wetlands, coastal dunes, and nodes and corridors of natural habitat, which together form a network of interconnected structural elements in the landscape”.⁴

A **Just Transition** is the shift towards a low- carbon, climate-resilient and ecologically sustainable economy and society, which contribute to the creation of decent work for all, social inclusion, and the eradication of poverty.¹³

A **Green Building** is a building that, in its design, construction, or operation reduces or eliminates negative impacts and can create positive impacts on our climate and natural environment. They preserve precious natural resources and improve the quality of life.¹⁴

OVERARCHING INTERNATIONAL CONSIDERATIONS

Key international considerations informing the need for infrastructure to be sustainable are briefly described:

Sustainable Development Goals (SDGs)

Infrastructure is essential for enabling humanity to thrive, influencing the natural environment either positively or negatively, and supporting sustainable development. The 17 SDGs⁹ (Figure 3) comprising the 2030 Agenda for Sustainable Development (to which South Africa is a signatory) were established on a cross-sectoral basis considering the socio-political, environmental, and economic aspects of sustainable development. While Goal 9 is the only SDG that directly mentions infrastructure, all the SDGs are affected by and dependent on infrastructure.



Figure 3: UN Sustainable Development Goals

Intergovernmental Panel on Climate Change

The Intergovernmental Panel on Climate Change (IPCC) conducts regular reviews and produces a series of reports on the status of climate change. The most recent is the Sixth Assessment Review (AR6),² which recognises the interdependence of climate, ecosystems and biodiversity, and human societies; the value of diverse forms of knowledge; and the close linkages between climate change adaptation, mitigation, health of ecosystems, human well-being, and sustainable development, reflecting the increasing diversity of actors involved in climate action.

Key messages from AR6² include:

- Climate Change and Global Warming continue to be significantly accelerated by human-generated greenhouse gases, resulting in both long-term climate and weather pattern shifts and significant extreme weather events.
- To limit impacts, global warming should be restricted to 1.5°C above preindustrial levels (at 1.2°C per the World Meteorological Organisation for the 10 years 2014 to 2023).

The report concludes that “in order to achieve net zero emissions, it is necessary to employ carbon dioxide removal technologies”, stating “All global pathways that limit warming to 1.5°C ...with no or limited overshoot, and those that limit warming to 2°C ...involve rapid and deep and in most cases immediate GHG emission reductions in all sectors”. This requires that GHG emissions are reduced by 45% from 2010 levels (33.31 billion tons according to Statista) by 2030 and to net zero by 2050.

Kunming-Montreal Global Biodiversity Framework⁶ (GBF)

Adopted in 2022, and to which South Africa is a signatory, the GBF supports the achievement of the SDGs and has the global vision of humanity living in harmony with nature where “by 2050, biodiversity is valued, conserved, restored and wisely used, maintaining ecosystem services, sustaining a healthy planet and delivering benefits essential for all people”. To achieve this, the mission of the GBF for the period up to 2030, is “To take urgent action to halt and reverse biodiversity loss to put nature on a path to recovery for the benefit of people and planet by conserving and sustainably using biodiversity and by ensuring the fair and equitable sharing of benefits from the use of genetic resources, while providing the necessary means of implementation”.⁶

Key elements of the GBF include 4 goals for 2050 and 23 targets for 2030:

The key immediate targets are to restore 30% of degraded natural areas and to conserve 30% of land and seas by 2030. Any infrastructure development should include an evaluation of its impact, whether positive or negative, on biodiversity (see Figure 2).

Planetary Boundaries

The Planetary Boundaries⁵ are a set of nine boundaries that demarcate the safe operating space within which humanity can continue to develop and thrive. These boundaries describe interrelated processes that comprise the complex biophysical system.

Exceeding any of these boundaries increases the risk of generating large-scale abrupt or irreversible environmental changes, which may not necessarily be abrupt but together mark a critical threshold for increasing risks to people and the ecosystems of which they are a part.

Given the interrelatedness of the boundaries, focusing on climate change alone is insufficient

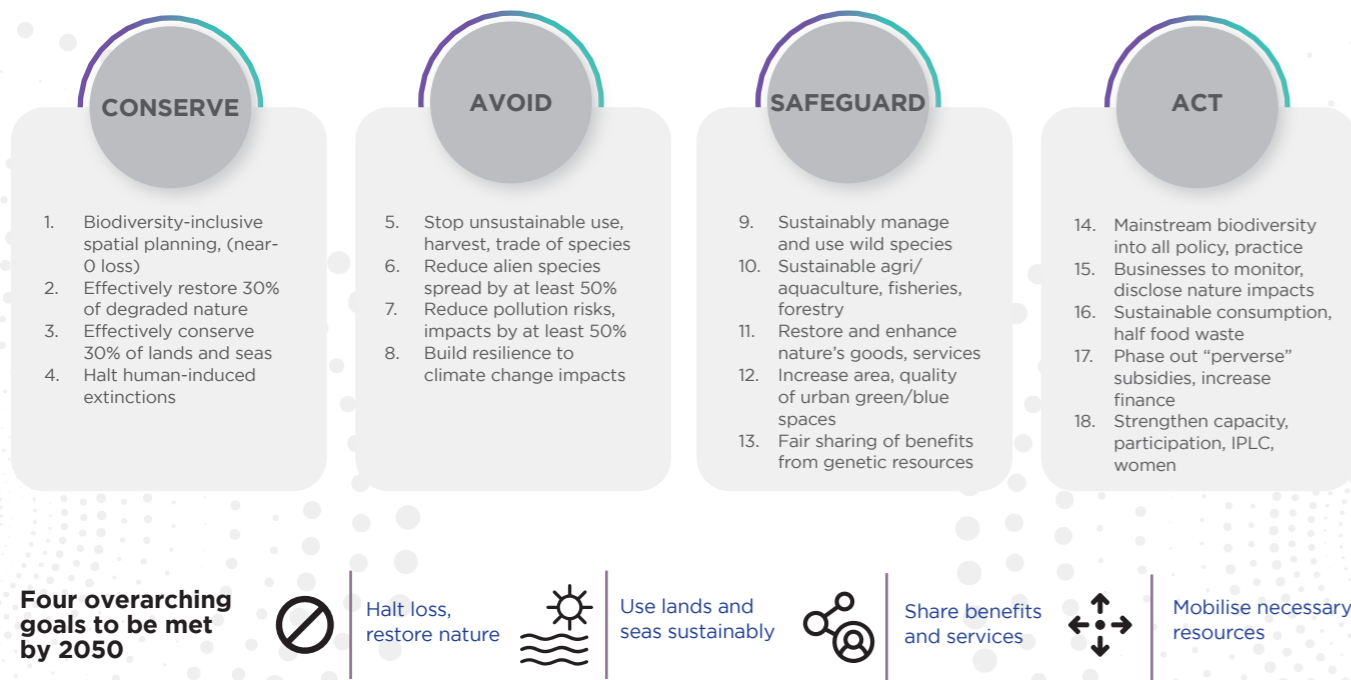


Figure 2: Kunming Montreal Global Biodiversity Framework

for increased sustainability, and understanding the interplay of boundaries, especially climate and biodiversity loss, is essential. Each boundary is critically affected by anthropogenic activities. As of 2023, six of the nine boundaries have been transgressed, with a seventh on the cusp of doing so.

Doughnut Economics⁵

Doughnut economics considers a social “floor”, which is the minimum social foundation and a “ceiling” (Planetary Boundaries), which is the threshold for ecological factors that should not be transgressed. The departure point is to change the goal from endless GDP growth, driving the overshoot of planetary boundaries, to “thriving” within the space of the Doughnut (Figure 4).

Doughnut economics recognises that economies, societies, and the living world are complex and interdependent and are best understood through the lens of systems thinking. The approach is to shift current consumptive, degenerative, and divisive economic approaches into regenerative and distributive ones.

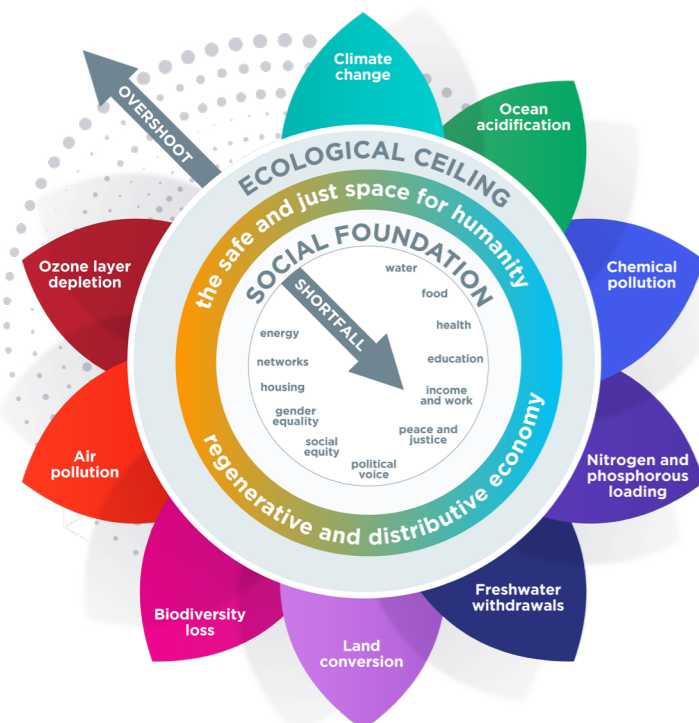


Figure 4: The Doughnut of Social and Planetary Boundaries

Growth through Inclusion in South Africa

The “Growth through Inclusion in South Africa” report,¹⁰ published in 2023 by the Growth Lab at Harvard Kennedy School, identifies two primary

contributors to slow growth and persistent exclusion in the South African economy. The first is a breakdown in state capability and the second is spatial exclusion. The breakdown in state capability has led to stagnating growth, a trend that is likely to continue unless the underlying systemic issues are addressed.

Spatial exclusion, a long-standing issue with roots in apartheid, remains a significant factor in South Africa’s unemployment and inequality challenges. Post-apartheid policies have often reinforced, rather than mitigated, patterns of spatial exclusion. Key issues include the high cost of transportation and low population densities, which limit economic opportunities and exacerbate exclusion.

The dual challenges of collapsing state capability and spatial exclusion together result in the underutilisation of South Africa’s vast potential in terms of its people, land, assets, and capabilities. To secure a better economic future, it is essential to address both of these constraints. The report uses the electricity sector as a case example to illustrate both the current collapse and the potential for growth, highlighting how green energy can support decarbonisation and drive economic growth.

SOUTH AFRICAN AND PROVINCIAL POLICY AND GUIDELINE CONSIDERATIONS

The drive for infrastructure infrastructure growth and development in South Africa and the Western Cape is framed by key policies and guidelines that advocate for a systems approach, embracing sustainability, resilience, and ecological regeneration:

- a. **National Development Plan (NDP):** Aligned with the SDGs, the NDP is South Africa’s primary document guiding sustainable development. It lays the foundation for the country’s long-term growth, ensuring that economic progress does not come at the expense of the environment.
- b. **Nationally Determined Contribution (NDC):** South Africa’s NDC represents its pledge to reduce greenhouse gas emissions, contributing to global efforts to keep temperature increases well below 2°C, with aspirations to limit the increase to 1.5°C above pre-industrial levels. Updated in 2021, South Africa’s NDC sets ambitious targets: a reduction to 398-510 Mt CO₂-eq by 2025 and 398-440 Mt CO₂-eq by 2030. This is a significant tightening of the previous targets. All infrastructure projects

must integrate immediate mitigation measures, particularly in land use and transport planning, given their long-term environmental impacts.

- c. **National Environmental Management Act¹¹:** This Act seeks to prevent pollution and ecological degradation by promoting sustainable development. It establishes air quality measures, norms, and standards, managed and controlled by all levels of government.
- d. **Climate Change Act¹²:** Approved in July 2024, this Act aims to foster a long-term, just transition to a low-carbon, climate-resilient economy and society. It mandates national sectoral emissions targets, covering sectors such as transport, electricity, energy, and agriculture. Provinces and municipalities must map and plan for climate risks and vulnerabilities.
- e. **Just Transition Framework¹³:** This framework outlines policy measures and commitments from various social partners to minimise the social and economic impacts of the climate transition. It aims to improve the livelihoods of those most vulnerable to climate change.
- f. **Western Cape Climate Change Response Strategy (WCCCRS):** Updated in 2023, the WCCCRS addresses the global climate emergency by incorporating the latest scientific evidence. It provides policy direction for a green, low-carbon economic recovery, with planned strategic outcomes including net zero carbon emissions by 2050. The strategy aims to mitigate climate-related risks like droughts, heat, and floods, while fostering opportunities for climate-resilient development and low-carbon growth.
- g. **Western Cape Ecological Investment Infrastructure Framework (EIIIF):** The EIIIF guides public and private sector decision-makers on investing to promote the resilience of the Western Cape’s ecological infrastructure. It offers a starting point for investors to explore and plan their proposals, considering time, spatial, and institutional contexts. The framework highlights specific risks such as water security threats from alien plant invasions and rangeland degradation, the dangers posed by uncontrolled fires and floods, and the risks to food supply and livelihoods due to over-grazing. It also emphasises the importance of addressing unemployment, poverty, and equity when investing in ecological infrastructure, involving relevant stakeholders, and adhering to pertinent research, institutions, and legislation.
- h. **Green Building Council of South Africa**

(GBCSA)¹⁴: Although not a government guideline, the GBCSA guidelines for achieving green building certification provide the basis for achieving net zero buildings and are thus included as a guideline for the WCIF 2050.

Key Sustainable Infrastructure Principles

Supporting and informing the overarching Panoptic Principles described in Chapter 5 is a set of principles guiding the sustainable development of infrastructure systems. In order to achieve this, a key departure point for growth and development should be for the Western Cape to effectively meet service needs with less infrastructure that is resource efficient, less polluting, resilient, and cost effective, while contributing towards realising one or more of the SDGs. Transgression of the planetary boundaries is directly impacted/reinforced by the infrastructure systems developed and thus a broad understanding of the requirements for sustainable infrastructure is essential for limiting impacts on, or contribution to, exceeding the planetary boundaries.

The following set of principles (based on UNEP’s International Good Practice Principles for Sustainable Infrastructure¹⁵) is proposed to augment the set of Panoptic Principles described in Chapter 5:

- **Strategic Planning** to ensure the alignment of infrastructure policies and decisions with global sustainable development agendas and to strengthen the enabling environment. It is at this stage that a Strategic Environmental Assessment (SEA) should be seriously considered to ensure mainstreaming of sustainability into the process.
- **Responsive, Resilient, and Flexible Service Provision** to meet actual infrastructure needs, allow for changes and uncertainties over time and promote synergies between infrastructure projects and systems.
- **Comprehensive Life Cycle Assessment of Sustainability**, including the cumulative impacts of multiple infrastructure systems on ecosystems and communities over their entire lifespans, to avoid “locking-in” infrastructure projects and systems with various adverse effects.
- **Avoiding Environmental Impacts** of infrastructure systems and investing in natural infrastructure to make use of nature’s ability to provide essential, cost-effective infrastructure services and provide multiple co-benefits for people and the planet.
- **Resource Efficiency and Circularity** to minimise infrastructure’s natural resource footprint,

reduce emissions, waste and other pollutants, and increase the efficiency and affordability of services. The potential for regenerative economics should be incorporated here as should the opportunity for repurposing/reuse of materials upon decommissioning.

- **Equity, Inclusiveness, and Empowerment** through a balance between social and economic infrastructure investment to respect, protect, and fulfil human rights and promote well-being, particularly of more vulnerable or marginalised groups.
- **Enhancing Economic Benefits** through employment generation and support for local economies.
- **Fiscal Sustainability and Innovative Financing** to close the infrastructure investment gap within the context of increasingly constrained public budgets.
- **Transparent, Inclusive, and Participatory Decision-Making** that includes stakeholder analysis, ongoing public participation, and grievance mechanisms for all stakeholders.
- **Evidence-Based Decision-Making** that includes regular monitoring of infrastructure performance and impacts based on key performance indicators and the promotion of data sharing with all stakeholders. Metrics should be developed that go beyond outputs and consider impacts and desired outcomes.

In addition, specific areas for consideration include:

- **Social sustainability** – given the implications of severe climate change and potential adverse impacts on the general population, a key consideration here is the broader impact of localised settlements on both natural and human infrastructure systems that are required to support the broader population of the Western Cape
- **Environmental sustainability** in terms of mitigating impact on the natural environment including:
 1. **Transport systems:** all transport systems should be based on the principle of sustainable mobility via the Avoid - Shift - Improve framework and Triple Access approach, specifically incorporating changed land use patterns.
 2. **Sustainable drainage systems (SuDS):** a significant shift towards sustainable drainage systems is necessary, where runoff is managed through natural processes that also facilitate groundwater recharge.

3. **Ecological infrastructure:** wherever appropriate ecological infrastructure approaches should be used.

4. **Heat resilience:** given the science indicating that the Western Cape will experience significantly hotter extremes, infrastructure systems should be designed to reduce heat exposure.

5. **Extreme weather events:** in addition to heat extremes infrastructure should be designed to be resilient towards extreme events. It is essential that innovative approaches be considered. (e.g., a bridge is designed to be overtopped).

6. **Food security and urban settlements:** should be considered as opportunities for greening and produce generation.

7. **Water catchment and treatment:** specifically in urban areas.

- **Institutional capacity** to deliver, including effective community engagement and education
- **Framing a set of overarching metrics** that assess both the immediate and long-term efficacy of infrastructure programmes, with a specific focus on resilience and affordability from the inception stages. These metrics should evaluate the ability of infrastructure to withstand and recover from environmental shocks, as well as address the ongoing impacts of shifting environmental patterns, such as consistent temperature increases. Regular assessment of these outcomes will ensure that the infrastructure remains effective and adaptable over time.

CONCLUSION

As environmental pressures intensify, there is a need to ensure that infrastructure and systems development address both social and ecological criteria while creating equitable opportunities. Infrastructure development should evolve from being merely green, through adopting a circular economy approach, to ultimately becoming regenerative. Although this transition cannot happen overnight, it is essential for any implementation programme to incorporate these principles from the outset.

The WCIF 2050 Panoptic Principles are central to addressing the effects of global warming in the context of the Western Cape's unique challenges and legacy spatial issues.

By embracing the WCIF 2050, the Western Cape can tilt the balance away from consumption-based growth strategies towards growth models that support the transition to the new industrial age through smart, sustainable, and inclusive growth that is underpinned by innovation, the green agenda, and equitable access, respectively. ●



The drive for infrastructure growth and development in South Africa and the Western Cape is framed by key policies that advocate for a systems approach, embracing sustainability, resilience, and regeneration.

FUNDING AND RESOURCING INFRASTRUCTURE

Chapter 9

INTRODUCTION

South Africa's fiscal landscape is constrained, with the government struggling to increase fiscal revenues at a pace sufficient to fund expanded service delivery. Despite slow economic growth and budget cuts, the need for a sharper focus on infrastructure investment remains critical. While the global consensus recognises infrastructure as essential for both social and economic development, budget pressures often redirect funds away from these critical infrastructure projects, as reducing other expenditures is politically challenging.

Infrastructure development is crucial for the socio-economic well-being of citizens. Although fiscal constraints do not diminish the critical need for infrastructure, they do affect the government's capacity to effectively deliver on these needs.

FUNDING ARRANGEMENTS

Provincial infrastructure in South Africa is funded through intergovernmental fiscal transfers, which include conditional grants and the provincial equitable share, supplemented by the province's own revenue sources. Additionally, the province can apply for funding through the Budget Facility for Infrastructure (BFI). The Western Cape has received allocations from the BFI for initiatives such as the Western Cape Rapid Schools Build Programme and the expansion of MyCiTi in Cape Town. While the BFI supports projects across various sectors, the Western Cape has not yet utilised this funding source for other sectors.

Human settlement funding to provinces has seen adjustments, with ring-fenced grant funding allocated to meet specific human settlement objectives, particularly those related to spatial inclusion. However, when combined with reductions in grants, this ring-fencing can become restrictive for provinces and municipalities by limiting their flexibility and discretion in decision-making aimed at achieving spatial transformation. The cutting of budgets across sectors emphasises the necessity for partnerships between

departments, municipalities and other stakeholders to maximise infrastructure efficiencies.

While PPPs offer some potential for infrastructure financing, their applicability is somewhat limited. Although provinces have the option to borrow, national government borrowing tends to be at lower rates, making it more efficient for the national government to raise debt and provide funding to provinces through transfers. Given the WCG's performance over the past two terms, there may be an opportunity to potentially secure debt on more favourable terms than the national government. However, the province would still depend on national government transfers for debt repayment, making it unlikely to achieve significantly better terms. Additionally, the province has few revenue-generating assets, such as toll roads, that could finance infrastructure projects. The Western Cape's road network is not suitable for tolling, limiting this potential revenue source.

Financing of infrastructure plays a larger role in local government, although this depends on the size and financial health of the municipality. Cities and larger municipalities can access borrowing, enter into PPPs, and issue municipal bonds, leveraging their ability to levy tariffs and user fees for municipal services, including property rates. The Western Cape allocates most of its revenues from vehicle licence fees to its road budget, but these are a small proportion of this budget, and they are added on top of what the province allocates from its share of the Provincial Roads Maintenance Grant (PRMG) and its provincial equitable share.

The crux of effective infrastructure funding lies in having robust planning and procurement systems that optimise the budget cycle within the annual cycle. Key to this are competent and ethical officials who are empowered to make decisions, along with regularly updated systems that track infrastructure conditions, performance, and usage. Quality monitoring and reporting systems, coupled with data-driven decision-making processes, are also crucial.

Funding and resourcing should prioritise ensuring adequate schools, hospitals, clinics, and libraries that are accessible to communities across the province. Strategic coherence involves understanding the social value and location of existing infrastructure, balancing the maintenance of current facilities with the pressure to build new ones where needed.

Improving infrastructure outcomes fundamentally requires doing the basics better.

CHALLENGES

Each infrastructure category faces its own unique challenges within the context of WCIF 2050:

- In Roads**, it is about ensuring the spend across the road network optimises the economic and social value of provincial roads to its users. This is complex and requires balancing the need to maintain existing roads at a level that meets economic and social demands, while also identifying opportunities to expand the network where it is socially and economically beneficial. However, when budgets are tight, the most sensible investment, from an economic perspective, is to maintain the existing road network to ensure it can support economic activity.
- In Education**, it must be about ensuring that there are sufficient classrooms and schools for learners, where these are needed, i.e., accurately forecasting the need and planning to deliver in time to satisfy the need.
- In Health**, there are multiple key strategic issues that vary across the levels of the health system. However, data-informed and evidence-based decision-making is critical. Effective, impactful, and cost-effective health outcomes can be achieved through the provision of non-fixed asset services like mobile clinics.
- In Governance**, over the last few years, National Treasury has moved to awarding additional funding through incentive components of conditional grants. These incentives are paid out in terms of compliance with the quality of planning and implementation delivery in provinces. The Western Cape has been relatively successful in earning its share of these incentives, which adds an additional 10-15% to the grant. While this contribution is beneficial, it is not transformative, reflecting the value of its "embedded good governance model."
- Human Settlements**, will be used as a catalyst to restructure and revitalise towns and cities by designing neighbourhoods with access to connectivity, economic, and social infrastructure. The Human Settlements programme is funded 100% from conditional grants and is, therefore, led by national policy. The strategic imperative for the province is to support municipalities in providing functional human settlements.

Tensions often arise between financing the construction of infrastructure assets and ensuring adequate funding for their operating expenses or maintenance, with these challenges varying by sector:

a. In Roads, the tension is between investing in sections of the network that provide economic value to the population versus letting go of sections that provide little to no economic value to the province. A lot more value (measured in terms of vehicle kilometres travelled) is purchased when roads of economic importance are maintained compared to roads that do not support the same traffic volumes. Spending money on new road infrastructure comes at the expense of meeting maintenance needs of the existing road network, which is currently underfunded. Thus, investing in new roads adds to the maintenance burden on the network.

b. In Education, the maintenance of schools is implicitly funded through funding norms set for provinces to cover operating costs and learning materials, but is not based on the cost of maintenance. **Tensions that are likely to exist are:**

- How additional spending on infrastructure affects the province's ability to cover the cost of learning programmes.
- Where the responsibility for managing maintenance of schools is placed between the provincial district office and the school governing body. Again, the allocation for this will be based on a norm per learner, which is not cost-based (the value is an equitable share of a limited pot of funding for norms and standards).

c. In Health, this tension differs across levels of the health system:

- Financing tertiary and regional hospitals requires massive investments, which need to be supported by national government. They have the potential to be PPPs, have complex procurement processes, and have extended planning periods. These tensions are linked to how much funding the province will get from national government and its commitment to support operating expenditures versus what a PPP partner may provide.
- For other levels of the health system, the tension is between spending enough to ensure that the facilities are fit for purpose in their socio-economic context versus how much of the already insufficient healthcare service budget is sacrificed. This very complex tension requires a different type of prioritisation.

d. In Human Settlements, the province's discretion

over how much it can invest in new assets is limited as it is shaped by norms and standards, and the operation and maintenance of the asset becoming the responsibility of the beneficiary. There may be a tension between delivering fewer, higher quality houses that are more resilient versus providing more homes, at the cost of resilience.

e. In Public Works, the tension is simpler since the province has more discretion in its investment decisions between office buildings and infrastructure. Funding for the resulting maintenance burden competes directly with the funding for new office buildings.

f. In Futures Orientation, the tension five years ago between a productive and fit-for-purpose workspace, where people travel to and work every day and the resulting operating expenditure is different today, as less space is needed with the implementation of hybrid working models. The tension exists between which existing facilities to refurbish versus which leases to terminate.

EFFECTIVE INFRASTRUCTURE FUNDING AND RESOURCING

WCIF 2050 funding and resourcing strategies must take several key issues into account to ensure optimal impact:

- First maintain existing assets that provide value.
- Regularly update User Asset Management plans for guidance.
- Follow all planning, procurement, and budgeting processes properly - as per the Infrastructure Delivery Management System (governance of planning).
- Competency and ethics of officials.
- Regularly collecting the right data for data-driven or data-informed decision-making.
- Providing public infrastructure that is fit for purpose.
- Having budget committees that meet in person and follow a planned process of reaching decisions and finalising budgets.

The above features may contribute to outcomes such as:

- Functional infrastructure where it is needed to enable the delivery of provincial services and achieve desired social outcomes (literacy, health, and spatial outcomes).
- Infrastructure that is accessible to those that need it (maintaining existing assets probably contributes

- more to this than building new infrastructure does).
- Infrastructure that provides social value and supports the economy of the province.
- A road network that supports a sustainable transport system that enables safe, affordable, and equitable access to opportunity for all and which incorporates and integrates all modes of transport.
- Health and educational services that can adapt to, and accommodate, innovations and advancements in technology.

To address the financial needs of the WCIF 2050, the WCG must explore a range of funding options beyond its own revenues and the BFI. These options may include PPPs, borrowing from financial institutions, accessing grants and subsidies, and utilising innovative funding mechanisms such as impact investment and blended finance. Existing PPPs contributing to infrastructure include the Chapmans Peak Drive, the De Hoop Nature Reserve, and various office space arrangements. A PPP for health is planned and will proceed if feasibility analysis confirms its viability. Additionally, the subsidised funding of youth and Early Childhood Development (ECD) programmes allow for leveraging private funds for infrastructure investments at these centres. Similarly, funding for schools facilitates the leveraging of private contributions.

The WCG must also engage with key stakeholders, including national government, private sector investors, development finance institutions, and international partners, to mobilise the necessary resources to finance the WCIF 2050.

Provinces have limited scope to raise loans, but the WCIF 2050 can guide the province and its stakeholders to create an environment in which private investors have the confidence to increase their financial commitments to infrastructure. The process for obtaining loans is by application to the Ministry of Finance, which will convene a meeting of the Budget Council. National Treasury evaluates applications and likely recommends against it, as the markets are unlikely to provide the province with better terms than what the State can get. Provinces are better off applying to the BFI for funds.

The extent to which spatial transformation through infrastructure investments is achieved depends on the right policy orientation to which the funding arrangements will respond. However, the most pervasive spatial exclusion in the country is mostly outside the boundaries of the Western Cape and stems from unconstitutional governance arrangements and

inaction on the part of the national government to address key constraints to land ownership.

Provincial funding sources for infrastructure are limited and straightforward, reducing the need for complex risk management strategies. **However, when exploring risk mitigation tools and sustainable financial models, the following considerations may prove useful:**

- The best risk mitigation instruments and the financial model that will optimise funding sources is compliance and adherence to the IDMS.
- A sustainable financial model for large hospitals is PPPs, but these need to be properly managed and is contingent on political stability.
- The financial model for provinces is the Intergovernmental Fiscal System and its Division of Revenue - quick wins that will contribute to a more responsive, adaptable, regenerative and sustainable version of this decentralising functions where it makes sense to decentralise.
- Provinces are required to provide technical support to municipalities to help them improve their infrastructure planning, budgeting, implementation, and monitoring. It is critical that municipal infrastructure, especially network infrastructure (roads, water, and electricity), is properly maintained so that it supports economic and social activity, making this technical support an important risk mitigation strategy. This landscape operates within South Africa's financial reporting mechanisms to ensure legal and regulatory compliance, with the WCG setting the benchmark for adherence.

Key features of this framework include:

- The Public Finance Management Act (PFMA),¹ the Infrastructure Delivery Management System,² and the Integrated Financial Management System.
- The budget guidelines and formats issued under the PFMA, which are updated periodically, require various forms of reporting and the publication of information about infrastructure projects in budget documents. This includes project lists for each sector and transparency regarding the composition of planned infrastructure expenditure.
- Expenditure data is recorded using the standard chart of accounts,⁸ with the capital expenditure segment specifically disaggregated for infrastructure expenditure.⁹ This approach supports and facilitates transparent financial reporting.

A key element for WCIF 2050 infrastructure delivery is ensuring that all aspects of its value chain have sound integrated management. This is particularly challenging as the WCIF 2050 spans multiple departments, public entities, and spheres of government. Additionally, infrastructure stakeholders have varying planning horizons, processes, and data requirements. These diverse needs highlight the necessity for a meta-governing structure that integrates stakeholder budgets, design, planning, implementation, maintenance, and disposal. To be effective and add value, this structure must be staffed with skilled practitioners having the relevant expertise and experience, and be given the authority to ensure that funds are allocated according to identified priorities.

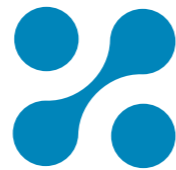
Project support facilities have the potential to improve the value for money obtained from infrastructure expenditures in the province. More importantly, if they are given the authority to provide the support as envisaged and are resourced properly, they will provide vital financial risk mitigation measures:

- a. **Western Cape Government Project Preparation Facility (WCG PPF)**,⁴ based in the Provincial Treasury, has the aim of expanding the WCG’s efforts to build a credible, long-term pipeline of infrastructure investment programmes and projects across provincial and local spheres. This support aims to ensure that the infrastructure project preparation value chain is standardised and adopted across multiple sectors. The primary objectives of the WCG PPF are:
 - To assist with the development of a credible pipeline of provincial/municipal priority, investment-ready infrastructure projects;
 - To create enabling support for potential projects which could have a long-term impact in the Province;
 - To enable support for departments, public entities, and municipalities to develop projects which could have catalytic development potential;
 - To unlock or crowd-in private sector investment or other public funding facilities; and
 - The allocation of an appropriate level of funding for project preparation activities, i.e., activities such as technical, financial, legal expertise, etc.
- b. **The Sustainable Infrastructure Development and Finance Facility (SIDAFF)** is led by the

Western Cape Department of Local Government (DLG) and supported by the Agence Française de Développement (AFD). This facility funds the provision of technical support and expertise to intermediate cities in the Western Cape and will help them to find funding solutions for catalytic infrastructure. Currently, the facility focuses on developing a framework for accessing donor and grant funding to accelerate the preparation of catalytic municipal infrastructure projects. It also aims to identify mechanisms for advancing projects from feasibility to bankability and matching them with appropriate financing options.

APPLICATION OF THE PANOPTIC PRINCIPLES TO FUNDING AND RESOURCING INFRASTRUCTURE

This section describes the application of the WCIF 2050 Panoptic Principles to the funding and resourcing of infrastructure.



Principle 1:

Infrastructure innovation drives equitable economic, social, and environmental development

Budget planning and prioritisation are guided by comprehensive, high-quality data that provide an economic, ecological, and social systems-wide perspective, ensuring the optimal allocation of resources across competing needs. Data collection processes conform to rigorous quality and management standards. Resource prioritisation is data-informed, considering the condition and life cycle needs of existing assets, the costs of improving and sustaining infrastructure access, and the economic and social profiles of the communities that require infrastructure.



Principle 2:

Innovative infrastructure value chains/ecosystems contribute to building resilient, sustainable, and regenerative systems

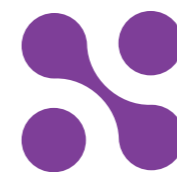
The infrastructure budget planning process is consistent, credible, and adheres to a predetermined schedule of events. Each event, along with the associated stakeholder groups and decision-making processes, is clearly defined in advance, including the availability and timing of required information. Stakeholder committees operate with established terms of reference and must detail how they address issues of resilience, sustainability, and regeneration. This enables transparent and constructive engagement, allowing for the consideration of conflicting and contradictory positions, which can be addressed or dismissed as appropriate.



Principle 3:

Sustainable stakeholder value is created by infrastructure and services that build trust, leverage spatial justice, and the six capitals (inclusive of value for money as defined by the IDA)

All infrastructure projects undergo cost-effectiveness and feasibility analyses, which must address predetermined issues, including evaluating alternative approaches to meet needs and manage risks. Projects must also meet established viability thresholds before final design and specification work can commence.



Principle 4:

Infrastructure design, commission, delivery, and management is best supported and enabled by transversal planning and governance

All infrastructure projects must demonstrate that due diligence has been applied to design and engineering specifications before receiving approval for funding. Practitioners preparing project plans must be appropriately qualified and experienced to ensure that engineering and architectural specifications meet the required standards.

CONCLUSION

Provincial governments in South Africa are responsible for delivering infrastructure that supports essential social services and drives the achievement of key social outcomes, which are crucial inputs for socio-economic growth and development.

A relatively small portion of provincial infrastructure budgets is allocated to the provincial road network, despite its critical role in supporting economic activities and access to social services. Due to the mandates within the intergovernmental infrastructure system, provinces have limited ability to leverage their assets to raise finance for investments. The most financially strategic decision provinces can make is to establish effective organisational arrangements, systems, and processes that enable the optimal allocation of resources across competing priorities. This ensures infrastructure spending delivers maximum value for money, as well as significant social and economic returns.

The WCG sets the benchmark for maintaining the necessary systems and ensuring efficient budget spending. These systems serve as vital risk mitigation measures and enable access to additional funding through incentives embedded in intergovernmental transfers.

The province’s support to local government can be a game-changer, driving catalytic infrastructure investments and fostering an enabling environment that attracts private sector investment in infrastructure.

PARTNERSHIPS TO OPTIMISE INFRASTRUCTURE SERVICE DELIVERY

Chapter 10

INTRODUCTION

It is broadly recognised that equitable and transparent partnerships between public and private stakeholders drive large-scale innovations that benefit society. The NDP relies on these partnerships, aiming to increase infrastructure investment from 21% of GDP in 2015 to 30% by 2030.² This requires collaborative funding and resourcing efforts across all infrastructure stakeholders.

The WCIF 2050 vision, particularly the WCG G4J Strategy, necessitates more advanced forms of partnerships than those traditionally used. The WCG's targets call for partnerships that blend corporate social investment (CSI) funding with public sector contributions and acknowledge non-financial partnerships to unlock innovation and creativity in informal areas or infrastructural spaces facing funding challenges due to higher risk profiles.

In this context, the WCIF 2050 needs innovative partnership models that genuinely share risks and rewards beyond mere transactional or monetary terms. These partnerships should promote shared capacities and value creation. In this sense, partnerships must be seen to be distinct from stakeholders, like those aimed for in models like the Triple-Helix or Quadruple-Helix²⁶ whereby transparent value creation partnerships are created between key actors like the public sector, the private sector, academia, and research institutions. These kinds of partnership efforts also seek to democratise research and innovation by including civil society.

For example, traditional innovation occurs top-down and is dominated by research, the public sector, and industry, and is commonly referred to as the Triple Helix. By involving civil society as an essential component, it includes new voices that introduce new forms of knowledge exchange under what is called the Quadruple-Helix. This model seeks to create innovation via interaction across all types of partnerships and is particularly effective in empowering civil society.

The WCIF 2050 must explore innovative partnership models beyond traditional PPPs.

Other forms of supply chain engagement with the private sector are also found in National Treasury prescripts like the Public Finance Management Act (PFMA), and the Municipal Finance Management Act (MFMA) that serves provincial and local governments respectively.

Partnerships generally involve collaborative arrangements between various entities, including public sector agencies, private sector organisations, SOEs, and community or non-profit organisations. In South Africa and the Western Cape, these partnerships are crucial for enhancing efficiency, leveraging resources, and fostering innovation in infrastructure growth and development. **Traditional PPPs** are contractual agreements between a public authority and a private sector entity for the provision of public infrastructure or services.¹² These arrangements are designed to share risks and responsibilities between the public and private sectors. Inter-governmental partnerships facilitate collaboration among different levels of government, national, provincial, or municipal, to coordinate efforts and resources for specific projects or interventions. **Public-Community Partnerships** involve collaboration between government entities and local communities or civil society organisations to address local development needs or social issues.¹³

Partnerships in government play a critical role in infrastructure delivery for several reasons:

- **Leveraging Resources:** South Africa faces challenges in funding large-scale infrastructure projects solely through public budgets. Partnerships with private sector entities provide additional financial resources and expertise.^{12,13}
- **Enhancing Efficiency:** PPPs introduce private sector efficiency and innovation, which can accelerate project implementation and improve service delivery.¹⁵
- **Risk Sharing:** By distributing risks between the public and private sectors, partnerships can mitigate financial and operational risks associated with infrastructure projects.¹⁸
- **Capacity Building:** Partnerships facilitate knowledge transfer and skills development, particularly in emerging sectors or new technologies.¹⁶
- **Community Engagement:** Partnerships with local communities ensure that infrastructure projects address local needs and foster community ownership and support.¹⁷

Despite these benefits, research indicates that society requires equitable partnerships to ensure fair and just outcomes.

For the WCIF 2050, this suggests a need to ensure that partnerships are thoughtfully and reflexively developed, based on the following research:

- Inequitable risk-reward relationships:** The idea of risk transfer is central to PPPs, but may not be well understood.⁴ In simple terms, risk transfer implies that the private sector assumes certain risks related to project delivery that are appropriate to them (e.g., project design, financing, construction, or operation). In reality, “only those risks that the Private party is best able to manage are transferred and may result in risks being allocated to the party most able to carry them”.²⁸ There is a history of failures in water, energy, rail, and health PPPs and privatisations globally; yet, they are regaining popularity, driven by governments seeking private financing for public infrastructure³⁸. Critics argue that PPPs can mask public borrowing and guarantee profits to private companies, potentially conflicting with environmental protection and universal access to public services.³⁸ Despite heavy promotion, PPPs contribute minimally to global infrastructure investment, with public finance still dominating with more than 90% of investment.³⁸
- The interpretations of value-for-money:** The term value-for-money is also key in understanding the motivation behind establishing PPPs. value-for-money has very specific meanings in the context of PPPs,⁴ i.e., in simple terms “value for money is the reduction in cost achieved over the lifetime of a project by employing a PPP approach in comparison to other options”. It is the responsibility of the PPP feasibility study or its detailed assessment, that determines if a PPP will provide value-for-money relative to traditional procurement. Technically there are differences in how the two parties interpret and understand the notion of value-for-money, which drives the final risk-adjusted PPP. This nuance makes it difficult to have authentic risk-reward sharing models as explicated in PPP research across the world where governments are seeking to halt the practice of socialising risk while privatising the profits.
- Legal and regulatory enabling frameworks:** South Africa is known to have legal and regulatory frameworks that support PPPs but less so regarding the protection of public interests.

Inconsistent or weak frameworks can lead to inefficiencies, corruption, and failure to meet project goals.⁶ However, research by the World Bank suggests that well-designed and executed PPPs can generate social value through efficiency gains, innovation in project design, expertise, and accessing new capital sources.⁶ Countries like South Africa, Chile, Brazil, Australia, and South Korea have successful PPP programmes due to robust legal frameworks.⁶

- d. Financial viability:** Ensuring the financial viability of projects while balancing public and private sector interests is critical. It includes securing funding by providing reasonable returns for private investors, without burdening the public sector,⁵ which includes favouring nature-based solutions to prioritise ecological risks. Since the 1990s, PPPs have been promoted to enhance infrastructure services, particularly in poorer countries. Today, PPPs are seen as crucial for achieving the SDGs. However, after three decades, evidence remains critical of PPPs, especially in developing nations.⁵ The research uses evidence of actual practitioner-generated evidence on project performance, which is starkly differently to sponsored research. It highlights numerous cases where PPPs have not been successful since the early 1990s in Sub-Saharan Africa, as well as other regions.⁵
- e. Transparency and accountability:** Lack of transparency and accountability can lead to mistrust, corruption, and poor project outcomes. Ensuring that all stakeholders, including the public, have access to information and can hold parties accountable is essential.^{9,10} On the other hand, Eurodad's research on PPPs across sectors like healthcare, education, roads, and water reveals that these projects often burden the public financially, pose excessive risks, and harm the environment and communities.^{9,10}
- f. Environmental and sustainability concerns:** Balancing infrastructure development with environmental sustainability and addressing climate change impacts are growing challenges globally. Therefore, the WCG's infrastructure projects must ensure greater alignment with climate change commitments, environmental regulations, and sustainability goals.¹¹
- g. Complexity and long-term nature of projects:** Infrastructure projects are inherently complex and long-term, and involve multiple stakeholders and phases. Managing this continuum of complexity

and ensuring continuity over extended periods can be difficult.¹⁸ For this reason, the DoI continues to develop these capabilities and skills, as they are crucial for managing the multi-stakeholder complexity inherent in projects.

- h. Current SA PPP governance:** Current infrastructure procurement follows the FIDPM guidelines issued by the National Treasury. This process, however, lacks provisions to attract private funding. Also, PPPs under existing legislation involve a four-stage approval process, which can be time-consuming. SA has successfully implemented numerous PPP projects across accommodation, transport, energy, and water sectors. Over 34 projects totalling R89.3 billion have been completed, including notable initiatives like the Gautrain Rapid Rail Link and Renewable Energy Independent Power Producer Programmes.^{3,4} These projects demonstrate South Africa's ability to attract private sector investment crucial for electricity, water, and road infrastructure development.

The reform of South Africa's public procurement framework significantly impacts construction and infrastructure projects, particularly PPPs. These partnerships leverage private sector resources, expertise, and skills to enhance public sector services and infrastructure development. PPPs in South Africa involve contracts where the private sector undertakes public functions or uses state property under output specifications, assuming substantial project risks.^{28,29}

Typical PPP characteristics in South African legislation include long-term contracts (5 to 30 years), private sector involvement in design, construction, financing, and implementation, with payments based on agreed outputs and risk transfer from public to private sectors.²⁸⁻³¹

Added to the existing PPP framework, the IDA and NIP 2050 are geared toward boosting investment interests and ensuring effective coordination of all infrastructure. In the long-term, these interventions will contribute to building a resilient economy by accelerating the delivery of infrastructure. Based on this premise, the WCIF 2050 will establish lasting partnerships that embody equitable risk and reward sharing.

CONCLUSION

For the WCIF 2050, the promotion of Panarchic governance and Panoptic Principles are key mitigation measures to complement existing regulations and prescripts governing partnerships. The WCIF 2050 emphasises the need for "Infrastructure design, commission, and delivery having transversal governance and compliance", this means that Panarchy serves as the fundamental approach.

Key aspects include:

- Implement clear risk allocation frameworks that assign risks to parties best equipped to manage them and regularly updating these frameworks based on project developments²⁸.
- Conduct comprehensive feasibility studies and cost-benefit analyses to ensure that projects provide value-for-money compared to traditional procurement methods³¹.
- Develop and maintain robust legal and regulatory frameworks that support PPPs, while protecting public interests³³.
- Foster transparency and accountability through open communication, public reporting, and stakeholder engagement³⁷.
- Ensure that infrastructure projects align with environmental regulations and sustainability goals⁴⁹.
- Harmonise resilient infrastructure value chains with ecological imperatives is crucial and can be facilitated through the application of Panoptic Principles in partnership agreements.

While the Triple Helix and Quadruple Helix models are widely recognised in innovation studies,⁵³ interpretations of these helix models vary.

Key considerations include:

- The strength of relations across partnership levels**, ranging from isolation to integration.
- The advantages and limitations** inherent in both helix models.
- The potential for synergy building** between the helix partnership models during innovation processes.

Based on the review of various partnership types and models, the WCIF 2050 acknowledges that collaboration extends beyond mere funding and highlights the importance of civil society partnerships in localising the benefits of WCG infrastructure delivery. Quadruple-Helix collaborations offer a valuable approach for the WCG and the WCIF 2050 to ensure that their citizen-centric orientations are effectively integrated into partnership models. ●

PRIORITISING INFRASTRUCTURE DECISIONS

Chapter 11

INTRODUCTION

This chapter delves into the process of selecting and prioritising portfolios and projects. It examines existing programme and project selection methods, reflects on leading practices in evaluation and theory, and identifies criteria-based methods to choose and prioritise programmes and their projects to meet specific objectives.

Prioritisation models are introduced that emphasise:

- Developing criteria for project selection, using decision-making tools, adopting a portfolio approach, and conducting benefits-realisation analyses.
- Factoring in the importance of data collection and analysis, project scoping, risk assessment, economic and financial analysis, and environmental impact assessments.
- Documenting the rationale behind project selection through rigorous analysis and alignment with growth and development objectives.
- Outlining approaches to infrastructure prioritisation, with models that support complex decision-making by balancing social (People), environmental (Planet), and financial (Economic) factors.

CONTEXT

Infrastructure plays a crucial role in supporting socio-economic growth and development, reducing unemployment, and alleviating poverty. However, the need for infrastructure far exceeds our ability to deliver it on time and at the right cost, leading to significant repercussions. The Financial Mail states that, “South Africa continues to underspend on infrastructure despite setting a target of at least 30% of GDP by 2030. This underspend impacts the economy, with inadequate investment in critical infrastructure such as energy, rail, roads, and ports”.²³

Governments worldwide face tough decisions on resource allocation for infrastructure development, considering fiscal, skills, and procurement constraints. These decisions

are aided by economic analysis, which the National Treasury defines as “analysing the viability of a project based on economic and social welfare improvements, rather than financial bankability”.² Economic analysis, as opposed to financial analysis, considers non-monetary welfare impacts such as improved health, reduced accident risks, congestion, and pollution, excluding transfers like taxes and subsidies.

In South Africa, the required economic analysis is framed within the country’s constitutional, legislative, and regulatory frameworks, along with national, provincial, and departmental objectives (detailed in Chapters 1 and 2). Key contextual points are provided in both the King IV Report³ and SPLUMA,⁴ as introduced in Chapter 1.

PROJECT IDENTIFICATION AND EVALUATION APPROACHES

Traditional evaluation methods and metrics globally have primarily focused on financial aspects, costs, and returns. To address this focus, the World Bank has championed Social Cost Benefit Analysis (SCBA) over the past decades - **The various SCBA approaches include:**

- Full Cost Benefit Evaluation:** Compares costs, benefits, and consequences of interventions, often using shadow costing to incorporate external or indirect variables.
- Social Cost Benefit Analysis (SCBA):** Measures all costs and benefits in common units, typically monetary values.
- Social Cost Effectiveness Analysis (CEA):** Measures benefits in both monetary and natural units, such as life years saved.
- Social Cost Utility Analysis (CUA):** Measures a programme’s effect using quantitative and qualitative measures, often applied in health-related contexts.

SCBA ensures appropriate infrastructure investment to achieve socio-economic objectives by deciding how to allocate limited resources. Large projects typically undertake upfront cost-benefit or cost-effectiveness analyses. Various SCBA approaches provide a structure for sound project appraisal, including full cost benefit and partial cost benefit evaluations, as well as Return on Investment (ROI) approaches. These approaches enable the

comparison of alternatives with varying outcomes across different functional areas, such as major transport, health, and education projects. They are complex and require significant capacity to attribute monetary values to all costs and benefits, making them generally suitable for large infrastructure projects where resources and capacity exist.

1. Partial social cost benefit evaluation approaches

Partial SCBA approaches are used when resources and capacity limit the application of full SCBA. These approaches measure both financial and socio-economic costs, encompassing both direct and indirect costs.

For example, indirect costs include costs associated with external support and negative impacts. This approach can be further simplified when there are a limited number of comparable alternatives, examining costs for these alternatives and considering some external costs as common. SCBA methods are theoretically preferred and used for prioritising large projects where resources and capacity are available. However, capacity and resource constraints often make extensive economic analyses impractical for many projects. In such cases, Partial SCBA approaches are more commonly applied, providing a feasible alternative for project evaluation.

2. Alternative economic evaluation and prioritisation approaches

Multi-Criteria Decision Analysis (MCDA) is a common alternative to traditional SCBA. These approaches focus on a simplified set of key variables that drive desired outcomes, are distinguishable, and can be effectively measured.

The goal is to differentiate projects based on these key variables while assuming other criteria are common across all projects. This method is particularly useful when resource and capacity constraints make full SCBA studies unfeasible for all projects. MCDA provides an indication of the ranking of projects rather than a precise value of their socio-economic benefits.

MCDA is not a true economic evaluation but shares similarities, assisting decision-making when multiple objectives and criteria, often conflicting, need consideration. The approach excludes variables equal across alternatives and focuses

on differentiating options in terms of ultimate objectives. The effectiveness of MCDA depends on selecting appropriate criteria, attributing correct weights and measures, and maintaining consistency in criteria sets, weightings, and ratings. Results are typically presented as indices, providing a comparative basis for decision-making rather than a finite answer. This allows for a holistic understanding of trade-offs between different options.

3. Evaluation Approaches Commonly Applied in the South African Public Sector

In South Africa, the DPME's Evaluation Guideline on Economic Evaluation is generally used for infrastructure evaluations.¹¹ This guideline, a form of MCDA, assists government departments in planning and managing economic evaluations across various contexts, including interventions, programmes, and projects.

The DPME guideline provides a decision-making base considering costs and potential benefits but is less effective for determining the relative benefits of different project types. It is often used for project identification and investment justification in the South African context, such as municipal project motivations and evaluations. However, it is not structured for comparative evaluations or project prioritisation due to inconsistent application of measurement bases and weightings across projects. The WCG and DoI need a robust model for comparative decision-making that accurately reflects provincial objectives.

Existing Treasury approaches need expansion to enable equitable comparative evaluations, requiring consistent criteria application, measurement, and analysis. Additionally, many infrastructure decisions span multiple disciplines and government spheres, necessitating a meta-level selection process before budget allocation.

4. Leading Identification and Prioritisation Approaches

An MCDA approach that is increasingly being applied in the context of assessment is the Infrastructure Prioritisation Framework (IPF). The IPF is a multi-criteria decision support tool that considers project outcomes across two important dimensions: social-environmental and financial-economic. It is based on applying differentiable criteria in a consistent, systemic fashion, while at the same time being

pragmatic and feasible for environments with basic project appraisal elements, using attainable information until more extensive economic appraisals are feasible. Typically, provisional assessments justify project identification, followed by detailed appraisals for final prioritisation decisions.

The IPF differs from other multi-criteria decision tools in several important ways:

- It systemically incorporates policy goals, social and environmental sustainability considerations, and long-term development aims alongside traditional financial factors.
- It is predicated on parsimony and pragmatism.
- Results are displayed graphically on an intuitive graphical interface by which decision-makers can compare alternative investment scenarios.
- It facilitates active deliberation of key decision criteria and priorities for improving project appraisal going forward. This means that the IPF process is as important as its outputs.

Many infrastructure decisions are made in environments where only basic elements of project appraisal are available. In this context, the challenge is to develop a pragmatic approach that utilises reasonably attainable information in the immediate term. This provisional framing device serves until capacity and resources are sufficient to generate more extensive economic appraisals across full project sets, supporting prioritisation decisions. Typically, the provisional assessment justifies project identification, while more detailed appraisals are applied in the final prioritisation decisions. Marcelo et al proposed a stepping stone approach to project identification and prioritisation.¹³

The approach followed in IPF evaluations is designed to promote transparency and accessibility through clear decision criteria, weighting, and sensitivity analysis, all of which are made transparent before selection. In determining the criteria, weightings, and ratings, the views and preferences of all stakeholders are considered. Additionally, good practice involves conducting the process and analysis transparently, making reports publicly available and subject to third-party review.

Two-Dimensional IPF Approach¹³: This approach combines selection criteria into social-environmental and financial-economic indices, plotting projects on a Cartesian plane. Projects are positioned based on

these indices, aiding comparative analysis without providing absolute SCBA values.

5. Three-Dimensional IPF Approach¹³

This approach expands on the two-dimensional model, incorporating the triple bottom line (economic efficiency, social justice, and ecological integrity). It uses primary criteria groups weighted by importance, secondary measurable objectives rated on importance, and consistent criteria application for all projects. The results are displayed in a 3D bubble chart, visualising economic, social, and environmental indices along with project size and risk.

TWO-STAGE EVALUATION PROCESS

A two-stage evaluation process is often applied to avoid unnecessary cost and effort for projects that do not make the final cut. The first stage involves a meta-level evaluation for initial "go or no-go" decisions and budget allocation. The second stage involves a detailed analysis for projects that pass the initial threshold, guiding final prioritisation and implementation planning.

In environments where there are a variety of project owners or implementation bodies, there is often a need to make an early decision to enable the appropriate allocation of resources between the project owners and/or implementers. Commonly this meta (first cut) decision-making step enables appropriate and timely resourcing through equitable budget allocations between competing project owners. In the case of the provincial context this would be the departments, programme owners, and project implementers requiring a decision to be made prior to the allocation of budgets at a Provincial Treasury level. This would also apply to the need for comparing proposals that provide alternative ways to address the core objective(s) and/or need at an early stage to ensure the appropriate allocation of resources. For example, alternative projects competing for resources with similar objectives of improving transport efficiencies, one being a road widening project compared to an alternative investment in public transport, NMT, and spatial nudging. In this case both would improve transport efficiencies, but differ in terms of factors such as economic efficiencies and benefits in terms of social and environmental costs.

APPLICATION OF PANOPTIC PRINCIPLES

It is critical that the approach to the prioritisation of projects is also based on the Panoptic Principles embedded in the WCIF 2050. The more consistently these principles are applied, the greater the alignment from framework to strategy to planning and implementation of WC infrastructure. Each of the Panoptic Principles outlined reflects upon various global and local economic growth, development, equality, and ecological aspects. These principles will guide the development of the proposed prioritisation of infrastructure for the Western Cape.

Applying the proposed principles authentically will ensure the WCIF 2050 evaluation model will incorporate metrics such as:

- Prioritisation context** – framing spatial justice by reflecting upon the past and present, also engendered in King IV principles, and various other core national, provincial, and local policy contexts that call for spatial equality.
- Consider** – innovations by rewarding project prioritisation metrics that speak directly to innovations across the life-cycle of infrastructure.
- Coherence** – prioritisation models must contain sustainable forms of infrastructure currently emerging coupled with alternative partnerships that extend beyond only funding.
- Comprehensive** – prioritisation models or approaches comprehensively reveal how they satisfy the Panoptic Principles.
- Compelling** – the Panoptic Principles hold dearly the sustainability aspects of the evaluation process.

The above examples are indicative of what ideal alignment the prioritisation model must ensure as central to its design and algorithms. It proposes that the DoI develop a tightly aligned and multi-criteria basis for its project prioritisation model. Models that currently exist include the IPF approach applied in two stage provincial decision-making structures, as follows: (a) a meta level (first stage) selection and prioritisation evaluation to facilitate resourcing allocations prior to funding being allocated to votes; and (b) a second stage more detailed project and/or programme analysis applying the full range of criteria to confirm the project benefits.

These models should be grounded in the principles of the “Triple Bottom Line” model, which emphasise the three pillars of sustainability being social (People), environmental (Planet), and financial sustainability (Economic). On a more practical level, the model must also be aligned with the Municipal Evaluation Model to ensure integration and collaborative partnerships are not minimised.

CONCLUSION

In conclusion, the Panoptic Principles must be central to project prioritisation, as they are fundamentally linked to the UN’s Sustainable Development Goals (SDGs), South Africa’s National Development Plan (NDP), and the Western Cape’s Provincial Spatial Development Framework (PSDF).

KEY FEATURES OF A PUBLIC INVESTMENT PROCESS

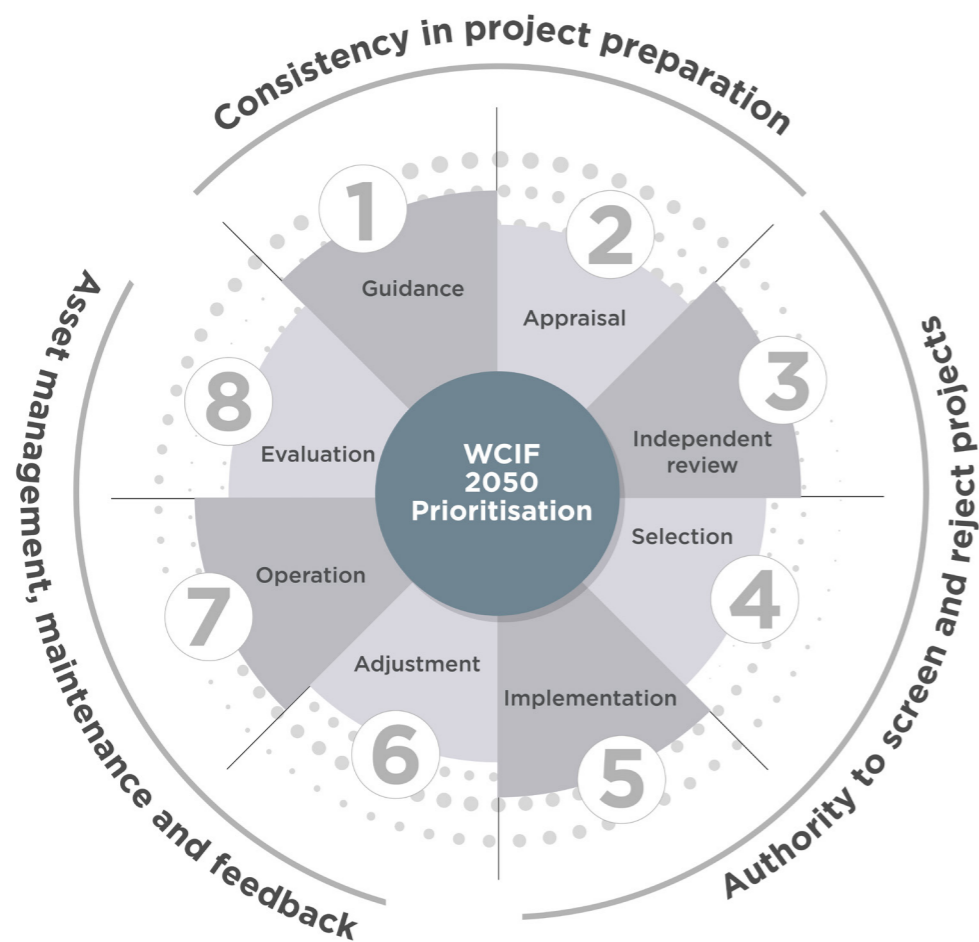


Figure 1: Key Features of a Public Investment Process¹³



SOUND GOVERNANCE FOR INFRASTRUCTURE

Chapter 12

INTRODUCTION

This governance chapter builds upon the preceding chapters in the WCIF 2050, and provides clear connections to the framework's guiding principles, focus areas, and strategic objectives. It addresses governance through the following two distinct yet interrelated layers, highlighting the significance of each while exploring their interconnection:

- a. **DoI's governing rules and regulations** as it relates to its infrastructure mandate.
- b. **WCIF 2050 governance** as it relates to the broader governance approach required for the long-term success of the WCIF 2050.

It emphasises the necessity of cross-agency coordination and the integration of efforts across different stages of infrastructure development, including conception, design, planning, delivery, maintenance, and repurposing.

The DoI's governance role as the custodian of immovable assets with a focus on a primary broad infrastructure mandate, provides for:

- a. Infrastructure planning, delivery, and coordination.
- b. Provincial roads,
- c. Public works, including the provision of general office accommodation, health, and education infrastructure; as well as the Expanded Public Works Programme (EPWP).
- d. Human settlements, as a concurrent function with National Government, in the provision of sustainable integrated human settlements.

The WCIF 2050's institutional framework and governance requirements for effective infrastructure growth and development:

- a. A robust institutional framework is essential for effective infrastructure planning, implementation, and oversight.
- b. Several measures are recommended to align infrastructure provision with key objectives, such as addressing spatial inequality and strengthening the foundations for social and economic growth.
- c. The roles, responsibilities, and relationships among institutions must be clearly defined and integrated.

- d. Successful infrastructure execution requires effective and collaborative institutional arrangements.
- e. Key governance elements include infrastructure stewardship, asset management, planning, regulatory compliance, PPPs, the role of local government, financial management, project implementation agencies, monitoring and evaluation, capacity-building efforts, and comprehensive stakeholder engagement, including public participation and communication strategies.

An institutional model is needed that builds on the existing architecture, addressing gaps in governance that are crucial to achieving the outcomes of WCIF 2050. The governance framework for the DoI must focus directly on its core mandate, incorporating intergovernmental structures and mechanisms to ensure seamless coordination, collaboration, and integration across the sub-sectors of infrastructure. By doing so, the model will clearly define roles, responsibilities, and mandates while outlining the intergovernmental and institutional governance structures necessary to implement the WCIF 2050.

The institutional model needs to be designed to ensure that the WCIF 2050 addresses governance and accountability challenges in infrastructure planning, delivery, and management. The WCIF 2050 emphasises citizen-centric governance, setting policy priorities, and identifying governance requirements. It should also aim to streamline operations by identifying areas of governance duplication and creating opportunities for efficiency. Furthermore, the WCIF 2050 calls for clarity on the roles and responsibilities of the various committees and structures involved in infrastructure planning and management. The sections that follow elaborate on these concerns and outline specific recommendations of how the WCIF 2050 can address them effectively.

The current governance arrangements must adapt to support the implementation of the Western Cape Infrastructure Delivery Management System (WCIDMS), which is to be applied alongside the Framework for Infrastructure Delivery and Procurement Management (FIDPM). The FIDPM, effective from 1 October 2019, replaced the Standard for Infrastructure Procurement and Delivery Management (SIPDM), making it mandatory for all levels of government to follow this framework for

infrastructure procurement.

It is recommended that legislative and policy instruments aligned with the proposed Stakeholder and Partnership Model incorporate advisory panels across various levels of governance. The model should consider the establishment of Communities of Practice (COPs) to engage in innovation, planning, execution, and implementation stages. These COPs can work in conjunction with advisory panels focused on specific areas such as financing, investment, and partnerships, which would operate at higher levels within the governance framework. This multi-layered approach ensures collaborative input across all stages of infrastructure development, from conceptualisation to execution.

GOVERNANCE AND MANAGEMENT ARRANGEMENTS

In considering governance for infrastructure, factors such as poor planning and inadequate project selection prioritisation can contribute to infrastructure failure.

These factors include:

- a. **Misalignment with needs:** If infrastructure projects are not selected based on a thorough assessment of current and future needs (such as population growth, economic development, or environmental changes), they may not effectively address the demands placed on them. This can lead to inefficiencies, inadequate capacity, and ultimately, failure to meet user expectations.
- b. **Budgetary constraints:** Inadequate prioritisation can result in insufficient funding being allocated to critical infrastructure projects. This may lead to shortcuts in design, construction, or maintenance, compromising the quality and longevity of the infrastructure.
- c. **Lack of coordination:** Poor planning can result in fragmented development where different components of the infrastructure system are not properly integrated. For example, roads, public transport, and utilities may not work cohesively, leading to inefficiencies and increased operational costs.

Governance arrangements should distinguish between portfolios, programmes, and projects and address the understanding of distinctions between these descriptions. An infrastructure pipeline

description as a combination of municipal, provincial, and national projects is required.

Prioritising basic maintenance is vital to prevent infrastructure deterioration, and maintenance teams should be fully capacitated. Maintenance of existing infrastructure should be given equal attention to building new assets. Annual reviews of the state of infrastructure may not be feasible but should be considered.

Governance arrangements should also be responsive to **managing the institutional inter-relationships** as provided for in GIAMA. Management arrangements should account for the distinct roles of portfolio and project management, including quality assurance, appraisal functions, and interface with FIPDM.

Longer-term opportunities, financial implications of the WCIF 2050, and resource availability/challenges should be addressed. A “System Description”

is recommended to provide information on the legitimacy, mandate, outputs, deliverables, timelines, sources, and controlled environment of the WCIF 2050.

Reliance is placed on PPP mechanisms to finance and deliver key infrastructure. In order to further enhance the utilisation of such mechanisms, the key determinants of success thus far in South Africa need to be identified in designing strategies to further strengthen the ability of the DoI to roll out PPP infrastructure.

Risk management responses need to be part of a governance system. There are instances of infrastructure failure because of local circumstances and instability resulting in damage or destruction of infrastructure. Managing the risks related to infrastructure damage by beneficiary communities involves a combination of proactive measures, community engagement, and effective governance.

Key strategies include:

- a. Stakeholder engagement and consultation:** Involve the beneficiary communities early in the planning and decision-making process. This helps in understanding their needs, concerns, and potential impacts of the infrastructure project on their surroundings.
- b. Education and awareness:** Raise awareness among community members about the importance of the infrastructure project, its benefits, and the potential consequences of damaging or interfering with it. Clear communication about project timelines, safety measures, and expectations can help mitigate misunderstandings.
- c. Community participation:** Encourage community participation in the project, where feasible. This could involve employment opportunities, skills training, or local procurement, fostering a sense of ownership and responsibility towards the infrastructure.
- d. Legal and regulatory frameworks:** Establish clear legal frameworks and regulations governing infrastructure protection and community responsibilities. Outline consequences for damaging infrastructure and ensure enforcement mechanisms are in place.
- e. Physical protection measures:** Implement physical measures to protect infrastructure from damage, such as fencing, signage, barriers, or security patrols where necessary. These measures should be designed to be effective without overly restricting community access or activities.
- f. Monitoring and surveillance:** Employ monitoring systems, such as CCTV cameras or sensors, to detect and deter potential damage or interference with infrastructure. Regular inspections and maintenance also help to identify vulnerabilities early.
- g. Conflict resolution mechanisms:** Develop effective mechanisms for resolving disputes or grievances related to the infrastructure project. Establish channels for community feedback and complaints, ensuring prompt response and resolution.
- h. Capacity building:** Build capacity within the community to understand and manage their interactions with the infrastructure. This can include training on safety protocols, environmental stewardship, and responsible use of public resources.
- i. Incentives and rewards:** Consider providing

incentives or rewards for positive community behaviours towards infrastructure protection. Recognition programmes or community benefits tied to infrastructure integrity can foster a sense of pride and responsibility.

- j. Continued engagement:** Maintain ongoing dialogue and engagement with the community throughout the project lifecycle and beyond. This helps build trust, address evolving concerns, and sustain positive relationships.

The establishment of an Infrastructure Ministerial Committee has been identified as a critical requirement for effective governance, with the need for coordination at three distinct levels:

- 1. Overall Coordination of Planning and Long-Term Pipeline:** This involves driving key transitions related to spatial alignment, coordination, and integration. It also focuses on addressing climate change adaptation and resilience, promoting labour-intensive practices, and encouraging technological and social innovation.
- 2. Facilitation of Programme Implementation:** This level is responsible for system improvements and reforms, facilitating knowledge transfer, monitoring programme progress, and prioritising key initiatives.
- 3. Individual Project Implementation:** This level emphasises the monitoring and evaluation of specific projects to ensure their successful delivery.

Monitoring and evaluation are essential components of this governance structure, providing oversight and ensuring accountability throughout the infrastructure development process. The governance structure recognises the need for comprehensive oversight of infrastructure provision, and integrating accountability mechanisms into the transversal management system of the WCG. Currently, infrastructure provision is reported within this system, and it is crucial to establish a mechanism that accommodates the WCIF 2050 and its intended outcomes.

This governance structure must account for all key elements of infrastructure provision, including:

- Infrastructure stewardship
- Asset custodianship
- Infrastructure planning
- Regulatory compliance
- PPPs

INNOVATION CURVE FROM DESTRUCTIVE INFRASTRUCTURE TOWARD REGENERATIVE INFRASTRUCTURE



Figure 1: Innovation curve from destructive infrastructure toward regenerative infrastructure

- Local government roles
- Financial management
- Project implementation agencies
- Monitoring and evaluation
- Capacity-building initiatives
- Stakeholder engagement, public participation, and communication strategies

The establishment of an appropriate governance structure serves as a foundation for informed decision-making to support the successful execution of the WCIF 2050.

TRANSVERSAL INFRASTRUCTURE GOVERNANCE AND THE WCIF 2050

The fragmented design and evolution of infrastructural systems, be it for finance, food, water, energy, or buildings were all originally developed as isolated pieces of infrastructure and specialised areas of engineering. Today, engineering practitioners and managers, as well as our lived experiences, reveal infrastructure to require greater integrated resilience to endure a multiplicity of current and future systemic shocks. This fact has compelled multilateral institutions (UNDRR, IPCC, etc.) to intently study the drivers of systemic risk, its governance, and increasing manifestations.⁴⁸ These and other agencies commissioned research on systemic risks and their interactions between individual risk.⁴⁹ Typical case studies include addressing global and systemic risk with local climate planning in Mexico⁵² and anticipatory action before tipping point event by OCHA and UNRCO in Bangladesh.⁴⁶

Research detailing features of systemic risk,^{49,50,51} all consider the scale of the system, system understanding, system component relationships, and transboundary effects. They recognise the need for transversal governance since these risks transcend spatial and sectoral boundaries, while also generating cascading effects. On this basis, the preamble to the 2030 Agenda states that SDGs are integrated and indivisible and require balancing the economic, social, and environmental dimensions of sustainable development.⁴⁰

In this context, our modern, populous, networked, and globalised society increases the scale of risk, surpassing established risk management and institutional approaches. This directive necessitates transversal governance to emphasise the interaction among physical, technological, social, and environmental hazards, and to address

“anthropogenic metabolism”, which is the systemic interaction between humans and the environment brought about by non-linear changes in hazard intensity and frequency.⁴³

The COVID-19 pandemic is a recent example of a systemic risk, threatening basic services and critical functions across societies. Subjects such as spatial inequality, water, and food security leading to forced migrations, all have potentialities of systemic risk. On this basis, the OECD recognised this and formally introduced the category of “systemic risk”.² Systemic risk refers to networked risk that arise from nested or inter-linked infrastructural systems¹⁰ characterised by high complexity, multiple uncertainties, and major ambiguities, which combined produces transgressive effects on other systems outside of the system of origin.²¹

The characteristics of systemic risks exceed traditional risk management since they create new, unsolved challenges for policymaking and governance from their pervasive negative effects that impact fields beyond obvious primary areas of harm. Global warming is another example of a systemic risk since it flows from multiple root causalities that require urgent governance and remediation. Systemic risks endanger the functionality of multiple critical systems of society. Systemic risks can also arise from a diversity of causalities having a range of impacts extending beyond the system of origin to affect other systems and functions. These dynamic causalities have several distinct properties that distinguish them from the conventional risks. For example, they involve multiple scales, multiple levels, and multiple systems,⁴⁶⁻⁵⁰ all of which have multiple interacting elements that generate unknown, emergent effects.

When reviewing the history of risks regarding infrastructure planning, research cites challenges of systemic risks to arise from traditions of different disciplines, sectors, niches, and specialised perspectives acting in isolation from one another. This siloed model was a norm based upon specialisation of fields. Today however, all specialists agree to have deliberate efforts to synthesise perspectives and approaches for interdisciplinary understanding of infrastructure systems and their related cascading risks. In this way, it mitigates isolated niche engineering efforts to produce unintended negative consequences across infrastructure conception, design, planning, implementing, and repurposing/ decommissioning, this means, integration and

governance across the infrastructure value chain or life cycle model. A thematic argument across all the research calls for improved governance that is able to integrate novel tools from complexity sciences with empirical (cold) data as well as experiential (warm) data of socio-cultural response patterns. Together these reveal quantitative and qualitative participatory appraisals.

Due to this complexity, systemic risks arise from multiple sources or numerical estimations, best mapped and visualised using multiple indicators having several critical dynamic gradients to offer coherence.²¹

Importantly, the governance of systemic risks requires:

- **Interdisciplinary and cross-sectoral cooperation.**
- **A scanning tool or system.**
- **Engagement of key stakeholders** like departments, private sector, communities of practice, regulators, and other such stakeholders.

This historical context must be juxtaposed to modern day “systemic risk that refers to the risk of breakdowns of entire systems, as opposed to breakdowns in individual parts or components of the system, as evidenced by co-movements (correlation) among most or all parts”.³ Systemic risk is very different to the classic treatment of risks of the 1940s grounded upon mechanistic orientations called risk management, which was adopted by the OECD.²

All management at this time was based upon Taylorism which also then directly influenced risk management as a discipline. Taylorism is premised upon atomism that studies isolated parts of a system, thus producing niched or siloed risk models allowing its processes to be well-described and documented. These distinctions or categories offer risk mitigation in strictly specified contexts (boundaries). For example, European reductions in occupational accidents in the construction sector; German reduction of deaths from fatal occupational accidents decreased from 5,000 in 1960 to less than 400 in 2014; its traffic accidents from 22,000 to 3,700 over the same period; and more recently strokes decreased from 109 cases per 100,000 to 62 between 1992 and 2002.

Today, systemic risks describe phenomena of infrastructural functionality losses at the macro-level involving multiple agents at the micro-level that may each contribute in varying degrees to

its causality. In practice and in a technical sense, agents and agencies operating in any system may be part of technical infrastructure, like energy generation, water, sanitation, or roads, of which each infrastructure type may trigger the systemic risk. For example, expressed in an ecological sense, agents and agencies may introduce harmful chemicals that interact with ecosystems, which can produce systemic risks having irreversible destruction to the socio-ecological systems. An adequate analysis of systemic risks and their governance still remains a serious challenge.

Another key infrastructure insight comes from behavioural sciences on risk, seen to broaden the scope beyond the usual components of severity and probability of harm. It extends risk horizons to include “individually perceived”, “socially constructed”, and/or “socially mediated” realities.²⁰ In other words, it flows from individual risk perceptions that are often biased,²¹⁻²³ and that produce risk assessments that do not correspond with technical aspects assumed to be inherent to risk assessments. Appreciating the potential of human bias to both risk perception and assessment requires us to design more effective measures for risk management, since human biases may enhance negative outcomes relating to “measures or causality of the risk itself”.²⁴

Because of this and other multi-dimensional aspects across the infrastructure value chain, it suggests we review the underlying narratives of Infrastructure governance and it’s associated systemic risk, this means we cannot “tame infrastructural challenges by suppressing complexity and seeking simplicity”, instead we require capacities to deal with contradictions and paradoxes since such challenges are trans-contextual⁵⁰ and transdisciplinary.⁴⁶⁻⁵⁰

PROPERTIES OF SYSTEMIC RISK

Systemic risk relates to cascading impacts that spread across infrastructural systems and sectors such as health, food, and water sectors, via the movements of people, goods, and capital within and across regions, countries, and continents.⁴⁶ Understanding and managing systemic risk is central to managing concurrent global challenges that arise from varied sources having connectivity to multi-agent and multi-agency dynamics, be it from food, health, water, energy, or other forms of infrastructure.⁴⁷

Systemic risks encompass multiple risk areas like economic, social, technological, and policy across regional, national, and international levels. It introduces endangering potentials having wide-ranging, cross-sectoral, even transnational impacts that are insufficiently covered by conventional risk management.

There are key characteristics to be considered in developing a comprehensive understanding of such risks:⁵⁻⁷

1. **Complexity:** referring to the difficulty of identifying and quantifying causal links between a multitude of potential elements coupled to feedback loops, requiring sophisticated models to unravel non-linear causal relations.
2. **Emergent uncertainty:** evolving random interaction of components producing statistical variation, measurement errors, ignorance, and in-determinacy. It reduces confidence estimates and their causalities for governments, insurers, funders, and respondents to systemic risk eventualities.
3. **Ambiguity:** the variability of interpretations, despite having identical observations and data, that tend to arise from different worldviews interpreting factual statements about the world.
4. **Networked effects:** also called trans-boundary or ripple-effects beyond the source of risk and refers to negative physical impacts, be it immediate or latent, yet having the potential to trigger severe effects outside the domain where the risk is located.
5. **Nonlinearity:** relations between systems have unknown tipping points (sensitivity to initial conditions). It produces stochastic causality that can only offer impossible or weak statistical confidence.

Examples of systemic risks are climate change, food insecurity, poverty, migrations, police violence, etc. Using food security as an example of producing turbulences, was when more than one core crop-producing region suffered from losses simultaneously – a term called multiple breadbasket failure (MBBF)⁴¹ as depicted in Figure 2. Academics, industry, and policy experts warn that a better understanding of the risks of MBBF are needed to manage such risks. Systemic risks inherently deal with information gaps and ambiguity of random patterns in disaster vulnerability of infrastructure and human activities.

Typically risks to urban infrastructural spaces references the global assessment reports (GARs) that divide risk in three classes:⁴⁰

- a. **Everyday risk** like food insecurity, disease, crime, accidents, pollution, and lack of sanitation and clean water.
- b. **Extensive risk** like death, injury, illness, and poverty of smaller intensity.
- c. **Intensive risk** like major disasters with deaths between 25 to 600 people or the destruction of homes.

The Paris Agreement of 2015, required signatories to ensure a hybrid of legally binding and non-binding provisions, requiring governance to include alternative political aspects like market entrepreneurship, lifestyle changes encompassing more flexible and participatory approaches, “climate-friendly food” or eco-driving and car-sharing.⁴¹

META-GOVERNANCE FOR INTEGRATED AND MEDIATED PARTNERSHIPS

The features of systemic risk require panarchic governance for its potential mitigation and must be understood from the classic Build and Engineering (infrastructure) space. Since engineering deals with closed systems or highly defined problem statements (e.g., a bridge, road, clinic, building), they must contain boundaries so as to define their purpose and function. The stated boundaries of the specifications thus make it fairly simple to design, construct, and maintain infrastructure, from a closed systems view.

However, systemic risks do not have clear boundaries especially in terms of scope, time, and space, since the different infrastructural systems are linked, networked, and effected by forces outside of its original engineering specifications. For example, say a limitation in public transport occurs, it puts immediate pressure on road traffic; or when port inefficiencies cause road network decline due to heavy freight use; or when Covid health risks extend across economic, socio-political domains.⁵

From a transversal governance perspective, the WCIF 2050 offers the following key considerations based upon systemic risk profiling:

- a. The complexity of infrastructure within the WCG challenges traditional human intuition, which tends to rely on linear or mechanistic assumptions, where cause and effect are expected to be closely linked in time and space.⁹ This is contrasted with

GLOBAL CASCADING EFFECTS OF MULTIPLE BREADBASKET FAILURES

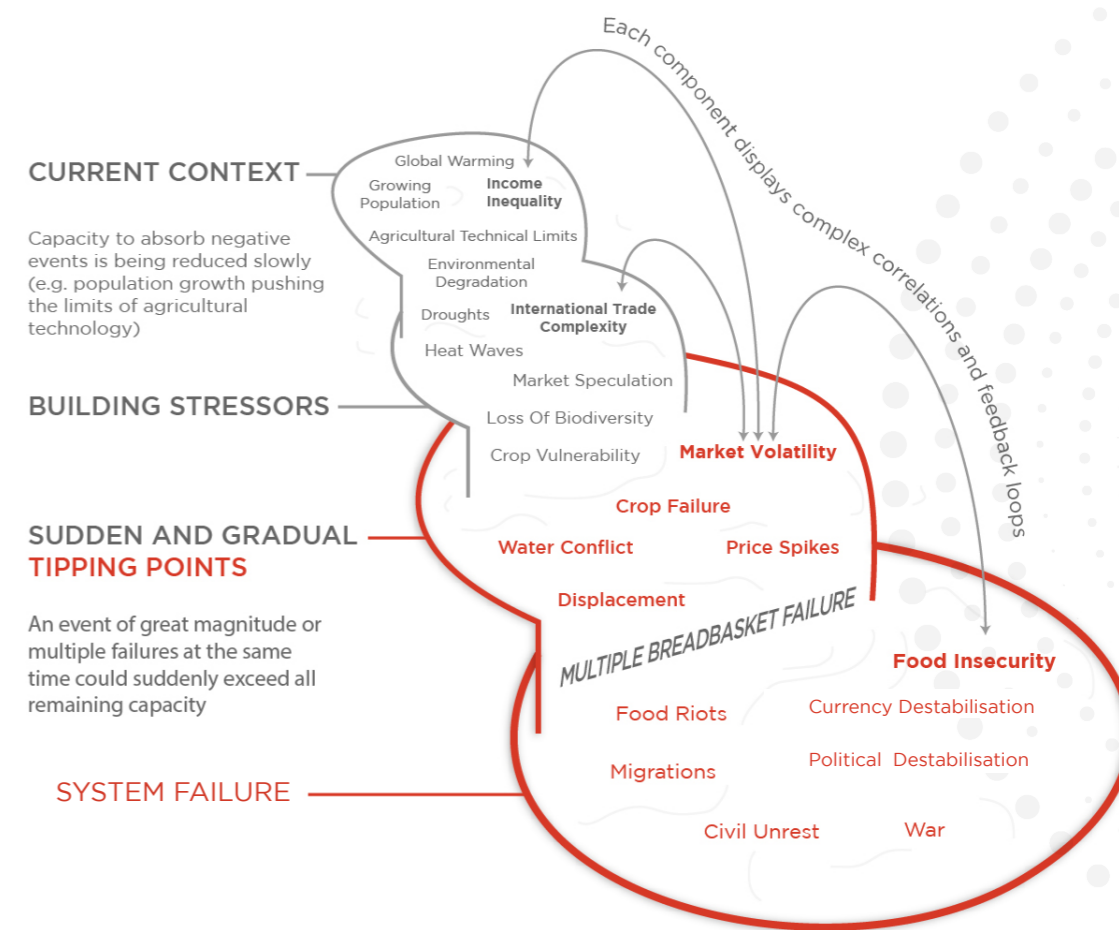


Figure 2: Key Features of a Public Investment Process¹³

inter-locked infrastructure types and forms that increase complexity since it holds far-fetched and distant changes having catastrophic impacts on WCG infrastructure systems.

- b. Classic management holds that humans have been codified to expect predictability and are educated to react using predetermined responses (playbook or norms and standards). However, humans are exceedingly good at learning by trial and error, also called reflexive-action.¹⁰ When faced with nonlinear infrastructure tipping point failures, people are encouraged through their subconscious bias to repeat the errors contained in their education and norms and standards.

Taken together, these features suggest that a transversal form of WCIF 2050 infrastructure governance, based on the concept of panarchy, could enable the WCG to better interpret and respond to systemic tipping points. This approach would move beyond fragmented and ineffective

responses, promoting an integrated pooling of contributions from various actors. By incentivising collective behavioural change and fostering greater responsiveness, such a governance model could create a more cohesive and adaptable infrastructure management system.

CRITICAL INFRASTRUCTURE SYSTEMS (CIS)

Further analysis of systemic risk and governance insights from an engineering and built environment (EBE) perspective sees infrastructural linkages and their relational patterns yielding dynamic structures and evolutionary emergence from the components of complex infrastructure systems. In particular, this is called critical infrastructure systems (CIS), also studied as panarchic structures and relationships.^{12,46-50} The functionality of CIS depends on the ability of human control systems to cope effectively with complex relationships in a dynamic environment.¹³ Critical infrastructure risks

impact the basic infrastructure that society relies on and have the potential to trigger a collapse of interconnected systems. Due to the networked nature of infrastructure, failures in one component can cascade, threatening the stability of the entire system. This very real view sees infrastructure to “form complex relationships among themselves, but particularly with their environments”.¹⁴

Transport systems, energy systems, water systems, and technological systems are expressly noted in both the WCIF 2050’s five sectors and five focus areas. This directly links the WCIF 2050 to all infrastructure typologies, agencies, departments, and policies that combine to represent a CIS formation for the WCG, with the DoI already being responsible for guiding integrative infrastructure. The interactions of the WCIF 2050 sectors and focus areas form sets of conditions that provide systemic risk management protocols (designs, responses, integration, stakeholder formations, communities of practice, etc.). The aim of the WCIF 2050 is to offer uniquely integrative value, guidance, and potential response options to all its stakeholders.

Individual departmental conception, design, planning, and delivery of their infrastructure may indeed involve traditional risk plans for their segmented parts or components, but they still need to speak to a meta-level governance that all can support and benefit from. Since most CIS are composed of a plethora of heterogeneous elements of various physical and functional diversity, they inherently interact in multiple ways via networked interdependencies. The WCIF 2050 recognises that potential stressors are often unknown or may come as unintended effects, but do still require adaptive management and reflexive-action.⁴⁶⁻⁵⁰

In this manner, systemic risk management seeks to understand patterns of variability of performance and does not seek to focus only on single error scenarios or fault trees of traditional risk management.¹⁵ The WCIF 2050 is deeply embedded in multi-faceted contexts of social, political, economic, and natural systems, which automatically contain different actors, partners, and stakeholders, often having opposing or different objectives and viewpoints. The WCIF 2050 requires transversality in governance (panarchy). This is closely aligned with the Panoptic Principles, designed to ensure utility across all infrastructure types by providing resilient value to both safety and

security. These elements are interconnected within CIS¹⁶ systems, which are typically geographically dispersed yet spatially connected, emphasising the need for integrated, holistic approaches to infrastructure governance.

CIS face risks from a wide range of sources, including mechanical, electrical, and material failures, as well as issues related to design, planning, and maintenance. Natural hazards such as earthquakes, tsunamis, floods, landslides, and extreme weather also pose significant threats. In addition, software and hardware malfunctions, along with human error, contribute to the risk landscape. Notable examples of CIS failures include the California electricity crisis of 2000-2002; the disruptive shift from analogue to digital data processing¹⁸; and the social crisis triggered by economic and political surveillance through social media.¹⁹ Collective intelligence, warm data (contextual), and collaborative AI are direct link to the research regarding the abuse of social media as a tool of surveillance.¹⁹

The effects of interdependent, globally connected systems and vulnerabilities are clear and noted in complexity science, which recognises limits of human computation and logic.⁴⁶⁻⁵⁰ Complexity science requires a migration from the mechanistic paradigm to a systemic paradigm in order to become comfortable when confronted with what is called “novel-practice” or reflexive-action that allow society to live with the inherent uncertainty and complexities of life. Developing these capacities for contextual understanding and decision-making is most effective since human decision-making is biased and non-rational, and often emotional. It sees every individual, organisation or group being tied to resilience building and a thriving planet if they choose to embrace the “bigger mind” of collective intelligence.

The vitality of warm or contextual data remains highly underestimated with regard to AI innovations and collaboration since it demands empathetic design and large doses of transdisciplinarity and interdisciplinarity. Closed systems scientific research and methodologies require “subjects” to be isolated from their contexts in order to derive detailed, specialised, quantifiable information, i.e., the classic flaws of mechanistic thought and action.⁴⁶⁻⁵⁰ This view requires transdisciplinarity to offer societies the best of authentic science in order to allow the bridging of all sorts of divisions and specialisms.

A related area to an open science ontology is that of “warm data”, which is a specific kind of information about the way parts of a complex system (e.g., members of a family, organisms in the oceans, institutions in a society or departments of an organisation) come together to give vitality to that system. By contrast, the usual “cold data” describes only parts of the system, while warm data describes the interplay of the parts in context of its effects or lived experience. Systemic consequences are easily disconnected from their networked causality and their relations among contextual factors are easily lost (e.g., the cause of the increase in asylum seekers from Central America in 2018 was stated as violence and poverty when in fact it was the drought conditions over multiple years). These and many other examples suggest that local capacity can be increased using collective intelligence and mutual learning.

GOVERNANCE IMPLICATIONS FOR THE WCIF 2050

The insights from the various disciplines and perspectives illuminate systemic risks and its inherent complexity. As such, it requires the WCIF 2050 stakeholders to build mental methods and Gigamaps able to explore possible “critical-futures settings” that combines scenarios with judgments, bias, and decision-making. This would require a meta-governance that: (a) acknowledges the complex dynamics of such risks; and (b) formally design early warning systems using faint signals and scenarios, constructing robust strategies to deal with uncertainties arising from variations, disturbances, disruptions, and surprises.²⁵

Panarchic or meta-governance manages the meta-risks by discerning them from idiosyncratic behavioural patterns that may only be peripherally correlated to the seriousness of the risk at hand. Much work has been done across the sciences that offer insights regarding how to manage emergence of order despite the dynamics of nonlinear individual interactions producing circular causalities.^{26,53}

The dynamic nature of systemic risk cannot be handled by reductionist tools and stepwise protocols. This is explicated in the following case study examples: The World Health Organisation (WHO) securing co-operation of all agents in the Colorado virus outbreak^{27,28}; the rise in police brutality

foreshadowing revolutions²⁹; the size of the economy and its private debt before the onset of a financial crisis³⁰; and the dominance of conflict-related news used by officials to prepare for the outbreak of war.³¹ All these examples illustrate how classic physical and mathematical assumptions of stability are unable to analyse systemic risks, because signals preceding system-tipping points tend to be non-dimensional in natural systems and in social systems. Based on these examples, the WCIF 2050 governance structure should use its collective stakeholder intelligence to build routines that take into account the cascading and transgressive nature of systemic risks in order to appreciate its consequential networked effects beyond their domains of origin.^{32,33}

These insights require systemic risk governance to cope with these new challenges, paying particular attention to the unique Western Cape contextual features and knowledge to ensure that we construct socially just risk reduction policies,^{34,18} also noted under inclusive governance from complexity research. Having stakeholders involved brings attention to a multitude of early warning signal irregularities that may be outside of the mental models of official risk observers.³² Assigning responsibility, power, and accountability to stakeholder representatives is another way to reduce counterintuitive threat scenarios seen in climate change and biodiversity loss.³⁵ As such, inclusive governance requires additional features beyond current guidelines for traditional “good governance”³⁶ which is really to curb financial wastefulness in the private sector.

CONCLUSION

Transversal governance, rooted in the concept of panarchy, involves creating meta-rules that equitably govern systemic risks.

This approach inherently requires integrative tools, approaches, and policies to manage complex, interconnected systems. Addressing systemic risks recognises the shortcomings of viewing infrastructure or its failures as isolated incidents. Traditional methods often fall short in anticipating the cascading effects of multiple infrastructure failures, especially when such failures propagate beyond their immediate origins, threatening society on a larger scale.

In this context, the WCIF 2050 proposes a form of meta-governance that spans all types of infrastructure. Importantly, this meta-governance must be collectively owned by all infrastructure stakeholders. The WCIF 2050 provides for integrative value by fostering synthesis, consistency, transparency, and auditability, in alignment with the NDP's commitments.

The Western Cape has relied on the DoI in recent real-life risk mitigation efforts, such as during the Covid-19 pandemic, severe weather events, fires, floods, and displacements. These experiences highlight the need for further critical discussions with stakeholder communities to establish a democratic infrastructure regime³⁸ that values plurality and collective input³⁹.

The growing importance of collective wisdom and intelligence is exemplified by the increasing use of decentralised AI in infrastructure, combining both cold and warm data to empower citizens through contextual engagements. This model of Infrastructure as a Service (IAAS) ties every individual, organisation, or group to resilience-building and planetary well-being, embracing the concept of “collective intelligence” as a driver for perpetual renewal and resilience.

In terms of systemic agency and governance, research suggests the following key points^{44,49}:

1. Governing systemic risks requires interdisciplinary and cross-sectoral cooperation between public and private sectors, scientists, regulators, and other stakeholders, while incorporating intergenerational and poly-cultural perspectives.
2. Communication and knowledge sharing with stakeholders are essential for risk governance, facilitated by processes that enhance problem-solving abilities and systemic practices.
3. While many stakeholders have developed basic systems-thinking capabilities, future governance requires a more formal framework to build and expand this competence.

This approach underscores the necessity of collective intelligence, which, through collaborative governance, will strengthen infrastructure resilience and adaptability for the future. ●

Complexity science requires a migration from the mechanistic paradigm to a systemic paradigm in order to become comfortable when confronted with what is called “novel-practice” or reflexive-action that allow society to live with the inherent uncertainty and complexities of life.

DEVELOPING AN ALIGNED, CAPABLE AND CAPACITATED INFRASTRUCTURE SYSTEM

Chapter 13

Chapter 1 outlined the historical impact of infrastructure on economic growth and job creation, highlighting its pivotal role in shaping South Africa's development. It also emphasised the need for the WCIF 2050 to serve as an inclusive instrument of transformation, driving spatial and social development, and promoting equitable economic growth that benefits all sectors of society. It further highlighted the need for the WCIF 2050 to deliver on these key priorities:

1. Aligning with the Government of National Unity's objectives to drive inclusive growth, reduce poverty, tackle the high cost of living, and build a capable, ethical state (President Ramaphosa, July 2024).¹
2. Supporting the Western Cape Government's focus on creating an inclusive, infrastructure-led economy that creates jobs, improving energy and water security, enhancing safety, and strengthening education and healthcare (Premier Winde, July 2024).
3. Implementing Ministerial priorities to accelerate infrastructure delivery through innovation, adopting advanced technologies and practices to meet growing challenges (Minister Simmers, August 2024).

The WCIF 2050 fully embraces the priorities of the Government of National Unity, the Western Cape Government, and the Ministerial directives, by ensuring that infrastructure growth and development is aligned with key national and provincial objectives:

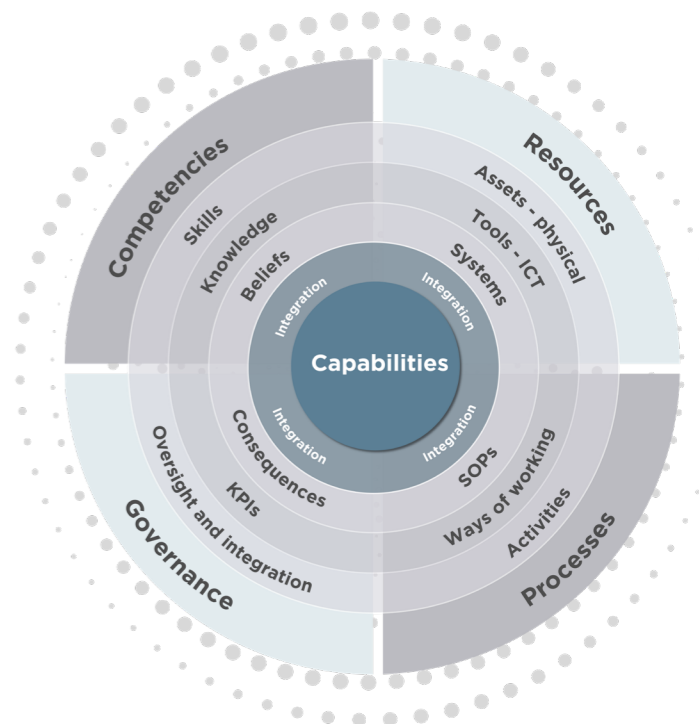
- a. Infrastructure growth and job creation:** Aligned with the national and provincial priorities of driving inclusive growth and creating jobs, the WCIF 2050 ensures that infrastructure projects stimulate employment across various sectors. During the construction phase, infrastructure provides jobs for skilled professionals, technicians, and semi-skilled labour, particularly using labour-intensive methods. This supports job creation, directly contributing to economic growth and reducing poverty, in line with President Ramaphosa's focus on reducing poverty and addressing the cost of living.
- b. Operational and maintenance roles:** The

WCIF 2050 recognises that infrastructure must contribute to long-term employment during its operational life. For example, airports, transport hubs, and utility networks require staff to operate and maintain these assets, driving inclusive job creation across sectors like technical, retail, and services. This, in turn, addresses high living costs by creating more efficient systems, such as shifting from road to rail for commuting and goods distribution, which helps lower costs for citizens, in line with the inclusive economic growth priorities.

- c. Strategic value of infrastructure:** The WCIF 2050 ensures that infrastructure growth and development serve as a direct enabler of societal and economic benefits. Water infrastructure, for example, channels water to homes and businesses, demonstrating how key infrastructure serves the needs of citizens and enterprises. By ensuring alignment with Premier Winde's priorities of energy and water security, the WCIF 2050 addresses crucial infrastructure needs that are essential for sustainable growth and long-term development.
- d. Accelerating the delivery of essential infrastructure and embracing innovation:** A core element of the WCIF 2050 is to establish the infrastructure necessary to enhance service delivery through innovative, efficient, and sustainable solutions. Without effective infrastructure, key government services cannot be delivered at the scale required. By aligning infrastructure growth with the need for rapid, forward-thinking development, the WCIF 2050 ensures that essential services are supported by modern infrastructure that meets citizens' needs. This approach echoes Minister Simmers' call for embracing new technologies and methodologies to address contemporary challenges.

In the development of the WCIF 2050 we have emphasised the need to view infrastructure from a complex adaptive systems perspective and have demonstrated the importance of mapping the needs and dynamic interactions of stakeholders within the infrastructure ecosystem. This provides an important foundation for understanding how to **build capable organisations** and people, at all levels of the infrastructure ecosystem, in order to ensure that it optimally delivers the benefits originally intended through the provision of infrastructure.

In addition to being capable, an infrastructure ecosystem also needs to have the necessary capacity.



- Competencies**
How people get work done, including their skills, knowledge, experience and beliefs.
- Resources**
What work gets done, including physical assets such as buildings, vehicles and machines, ICT, architecture and systems.
- Processes**
How work gets done, including activities, ways of working, rules and Standard Operating Procedures.
- Governance**
Oversight for work to ensure that it is carried out ethically, with integrity and in accordance with legislation and regulations.

Figure 1: Capability Development Features

In other words, it needs to have sufficient resources with the right capability to deliver and maintain the infrastructure it delivers. The amount of water in a bucket is an indication of a bucket's capacity. A bucket with a hole in the bottom, is not capable of performing the task for which it was designed because it is not able to hold the water as intended.

What does "capable" mean within the context of infrastructure?

A capability is simply having the ability to do something. In the context of infrastructure, being able to do something also implies being able to do it efficiently, effectively, and safely. A capability consists of several different elements as set out in Figure 1. It requires people to be competent, for the right resources to be in place, the most efficient

and effective processes to be employed, and the appropriate governance to be applied. All of these contribute to a well-rounded, efficient, and effective capability. A fundamental truth is that “form follows function”. It will be necessary, therefore, to develop the WCIF 2050 Strategy to be able to understand exactly what capabilities are required at different levels of the infrastructure ecosystem, as well as what capacity is required to deliver on the Implementation Plan.

As outlined in Chapter 8, the WCIF 2050, and its Strategy and Implementation Plan, must specify the actions required at each level and component of the ecosystem to achieve successful outcomes. It is evident that South Africa, and the public sector in particular, has struggled for some time to attract and retain the skilled and competent people required for effective and efficient infrastructure delivery.

There are several important traditional clusters of competencies required, including:

- a. Skills for infrastructure planning.
- b. Skills for infrastructure delivery and maintenance across the asset lifecycle. A comprehensive assessment of these skills is to be found in the CIDB’s report “Skills for Infrastructure delivery in South Africa, 2007”.²
- c. “Green” skills to support the transition to a sustainable future.
- d. Social and community engagement skills.
- e. Effective management and leadership skills.
- f. Systems and design thinking skills to ensure that empathetic design drives the design of infrastructure as opposed to simple technical analysis and specifications.

Going forward, the WCIF 2050, and its Strategy and Implementation Plan, will need to identify ways of building these skills and competencies “at scale”, harnessing technical institutions, industry associations, universities as well as the indigenous and the lived skills and knowledge of communities. All these skills may also be supplemented in our current digitally enabled world through the judicious application of AI.

In addition to skills and competencies, behavioural and mindset changes will also be required to effect desirable system-wide changes. For example, attitudes towards car ownership will need to shift

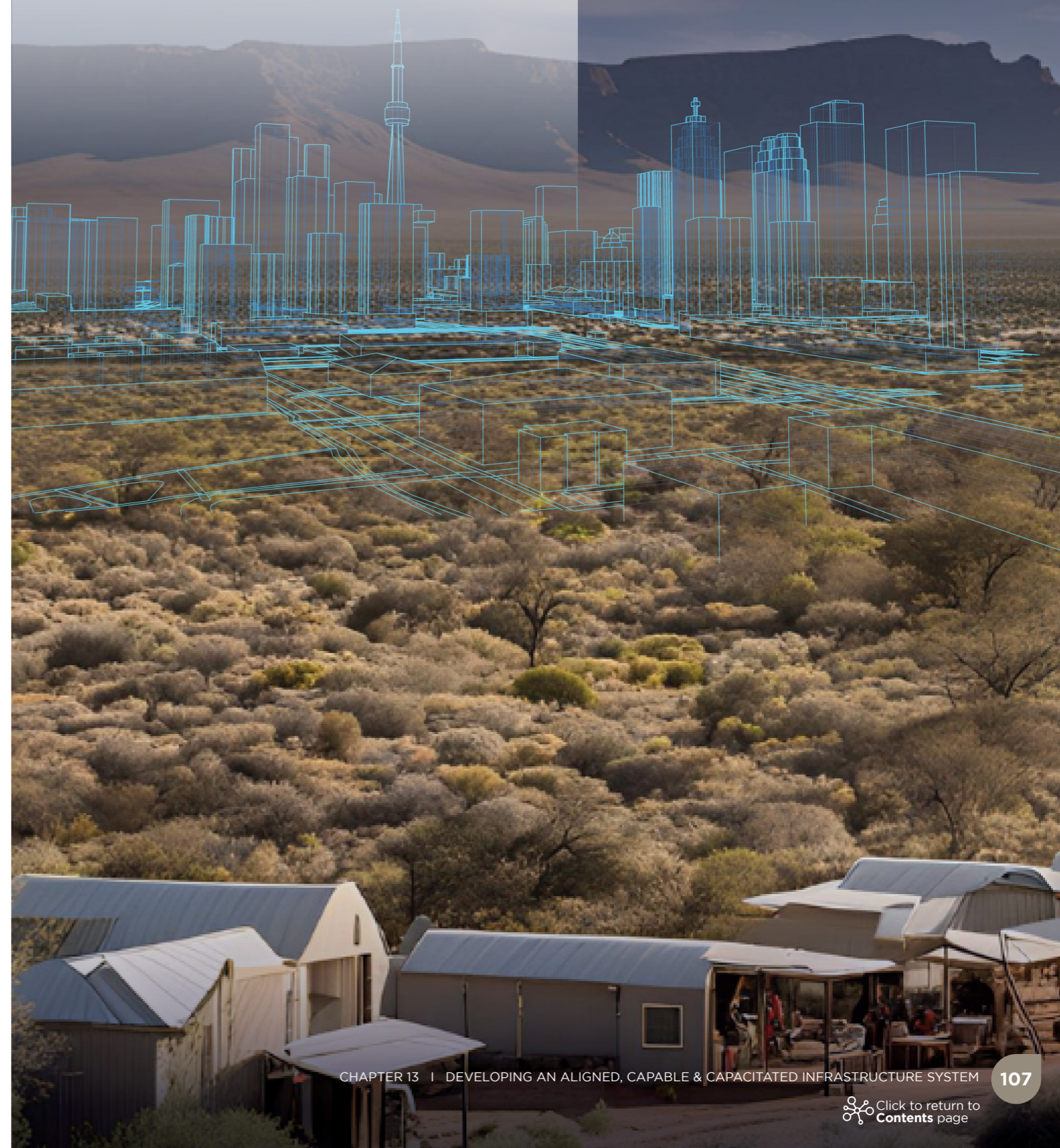
to support a transition where more people choose to use public transport infrastructure. This means that the WCIF 2050 will need to engage social psychologists and behavioural economists to identify and accelerate the necessary “nudges” to bring about the desired behavioural changes, in line with the aspirations of its strategy.

All the capabilities, competencies, and behavioural changes discussed are necessary but not sufficient for the complex task of enabling the WCIF 2050.

A mission-oriented approach necessitates a broader set of capabilities beyond those typically required for traditional infrastructure:

- 1. Institutional entrepreneurship:** Missions require strong political and managerial leadership to galvanise support and ensure the implementation of complex policy processes, e.g., political contestation practices open to new political leaders or means to purposefully create new public organisations to break institutional inertia or bring new skills into the public sector.
- 2. Investment:** Mission-oriented innovation often relies on long-term financial planning and capabilities around devising a portfolio of investments and other financial instruments (e.g., financial regulations and grants) to fund public, private, and third-sector actors. Such capabilities are relevant for public financial institutions (e.g., investment banks) and research and innovation funding agencies. Typically, these agencies are independent of the central government and succeed under circumstances of relatively strong operational autonomy.
- 3. Market shaping:** These capabilities involve facilitating the development and adaptation of market structures through supportive policy frameworks, regulations, and procurement practices.
- 4. Coordination and engagement:** These capabilities refer to new ways to design policies and engage with stakeholders and citizens, such as through innovation labs. The capabilities are typical for new types of public organisations such as digital agencies but are also applicable to welfare services and across the public sector.
- 5. Anticipation and stress testing:** These capabilities describe the ability to anticipate different avenues to solve a mission or use foresight to stress-test the relevance of a mission in the future.

- 6. Evaluation:** Equally important are evaluation capabilities that do not simply rely on market-failure-based approaches (e.g., cost-benefit analysis), but can also integrate user research, social experiments, and system-level reflections (e.g., dynamic efficiencies) as well as help govern portfolio approaches to investment and co-ordination and engagement processes. ●



WAY FORWARD TO CRAFTING THE WESTERN CAPE INFRASTRUCTURE STRATEGY AND IMPLEMENTATION PLAN

Chapter 14

To advance the strategic objectives of the WCIF 2050, the next phases are divided into two interdependent segments, namely **Phase 2: Strategy** and **Phase 3: Implementation Plan**. This process is illustrated in Figure 1 below.

PHASE 2: FORMULATING THE STRATEGY

This phase involves developing a comprehensive strategy for the WCIF 2050, and includes several critical components:

- a. Development of a prioritisation model:** This model will systematically assess and prioritise infrastructure projects based on predetermined criteria, ensuring that the most critical and impactful projects are addressed first.
- b. Creation of a robust communication plan:** An effective communication plan will be developed to disseminate information, engage stakeholders, and foster public awareness and support for WCIF 2050 initiatives.
- c. Stakeholder engagement and partnership model:** This model will facilitate collaboration and alignment among government agencies, private sector entities, development partners, and community organisations. Ensuring inclusivity and stakeholder participation throughout the implementation process is key to the success of the WCIF 2050.

PHASE 3: TRANSLATING STRATEGY INTO ACTIONABLE IMPLEMENTATION PLANS

This phase focuses on:

- a. Comprehensive infrastructure implementation plan:** Formulating a thorough infrastructure implementation plan that integrates all sector-specific plans and aligns with the vision and overall objectives of the WCIF 2050.
- b. Sector-specific plans:** Developing detailed actionable plans for each infrastructure sector to address immediate needs and challenges within the Western

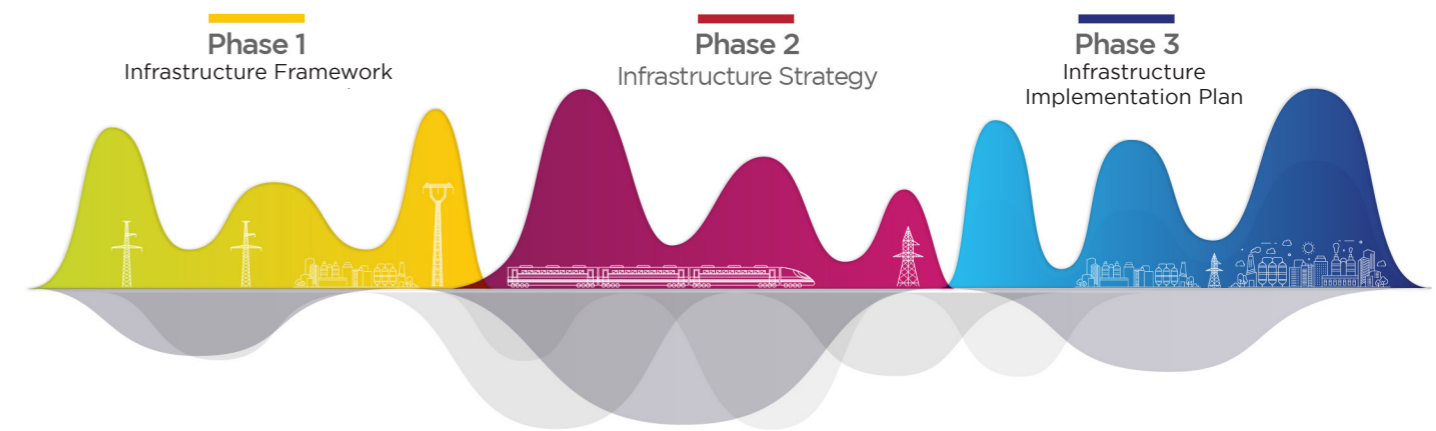


Figure 1: WCIF 2050 phases

Cape.

THE EVOLVING NATURE OF THE WCIF 2050

The DoI views the WCIF 2050 as an evolving artefact, requiring constant updating and feedback to ensure that strategies are measured and evaluated against their intended purposes.

This positions the WCIF 2050 as an “artefact-of-action”, a form of innovation necessitating perpetual improvements and continuous learning, similar to evolutionary fitness.

Continuous improvement through reflexive-action: The DoI will employ reflexive-action, building capacities to critically reflect-and-act in continuous loops or iterations over different time periods (e.g., every 6 months, every 5 years). This approach ensures that the WCIF 2050 remains adaptive and responsive to emerging challenges and opportunities.

By following these phases and embracing the concept of reflexive-action, the WCIF 2050 aims to create a resilient, inclusive, and forward-looking infrastructure framework for the Western Cape.

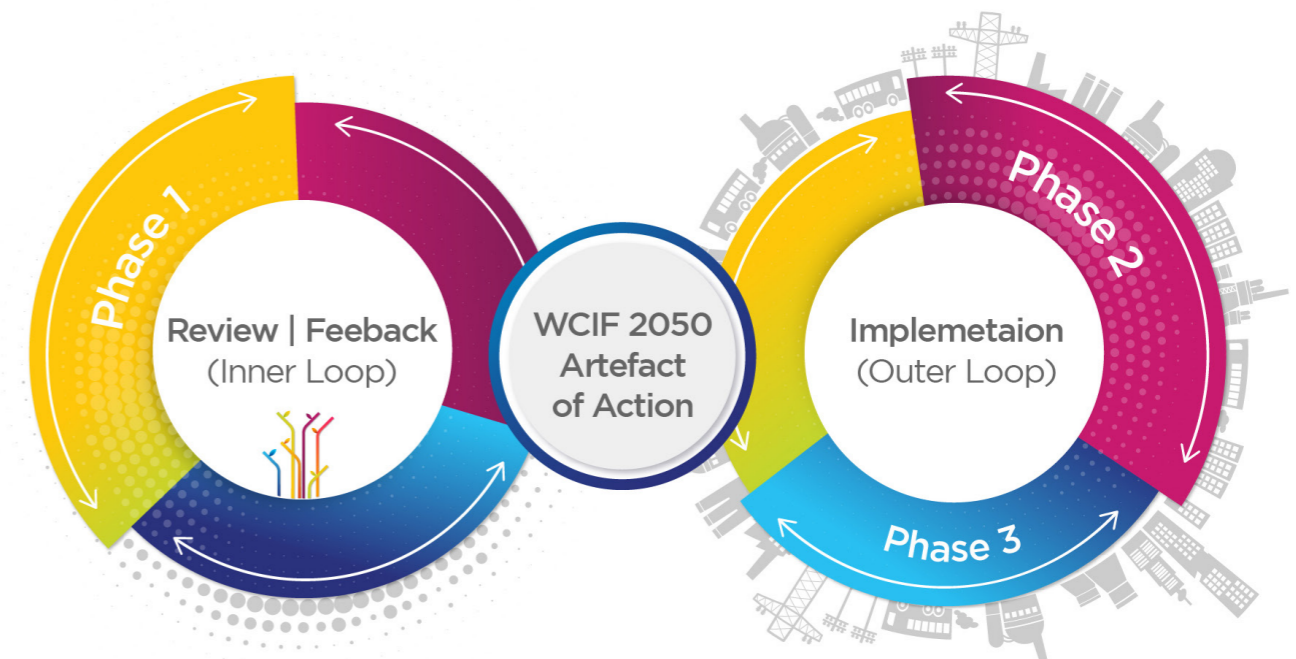


Figure 2: Reflexive action as expressed through the WCIF 2050 as artefact-of-action

Glossary, acronyms and abbreviations

Adaptation

Any adjustment in natural or human systems in response to actual or expected environmental (including climatic) stimuli that moderates harm or exploits beneficial opportunities.

Adaptive System

A system capable of adjusting and evolving in response to changes in its environment, recognising the interconnected and dynamic nature of infrastructure.

African Union Agenda 2063

A strategic framework for the socio-economic transformation of Africa over the next 50 years, aiming to create a conducive environment for Public-Private Partnerships (PPPs) and Foreign Direct Investments (FDIs) by addressing high project failure rates and unfair risk perceptions.

Bankable Infrastructure

Infrastructure projects that are financially viable and attractive to investors due to their compliance with recognised standards and minimal ESG risks.

Benefits-Realization Analysis

The process of assessing whether the anticipated benefits of a project or programme are achieved.

Best Practice

Established methods and techniques that have been proven to achieve desired results efficiently and effectively, typically applied in stable and predictable contexts.

Biophilia

Biophilia, which literally translates to “love of life,” is the idea that this fascination and communion with nature stem from an innate, biologically-driven need to interact with other forms of life such as animals and plants.

Biophilic Design

The concept of integrating natural elements into infrastructure design to enhance the well-being and health of communities.

Biosphere

The region of the earth including soil, water and air where life exists.

Blended Finance

A financial approach that combine public and private funds to support infrastructure projects, often including concessional funding to attract private investment.

Broadband Infrastructure

High-speed internet infrastructure that provides fast, affordable, and reliable internet connectivity, crucial for digital inclusion and the functioning of modern societies.

Budget Facility for Infrastructure (BFI)

A funding mechanism that supports infrastructure projects through grants and allocations, specifically targeting improvements in infrastructure across provinces.

Capacity Building

Initiatives aimed at developing skills, competencies, and capabilities of individuals and institutions involved in infrastructure governance.

Capital Expenditure

Spending on long-term assets, such as infrastructure projects, which provides future benefits and is recorded separately from operational expenditures.

Carbon Dioxide Equivalent (CO₂eq)

A metric measure used to compare the emissions from various greenhouse gases on the basis of their Global Warming Potential (GWP), by converting amounts of other gases to the equivalent amount of carbon dioxide with the same GWP.

Chaotic Contexts

Situations with numerous interlocked and dynamic interactions leading to unpredictable outcomes, necessitating emergent and novel practices.

Circular Economy

An economic system aimed at eliminating waste and the continual use of resources through reusing, remanufacturing, and recycling based on closed-loop systems.

Citizen-Centric

Ensuring that citizens and their communities are at the center of design and solution processes for infrastructure projects.

Glossary, acronyms and abbreviations

Climate Change Act

Legislation approved in July 2024 (Act No. 22 of 2024) aiming to foster a long-term, just transition to a low-carbon, climate-resilient economy and society, mandating national sectoral emissions targets and requiring provinces and municipalities to plan for climate risks and vulnerabilities.

Collaborative Infrastructure Planning

A strategic approach that involves multiple stakeholders in the planning and decision-making process for infrastructure projects.

Communities of Practice (COPs)

Groups of people who share a concern or a passion for something they do and learn how to do it better through regular interaction.

Complex Adaptive Systems (CAS)

Infrastructure systems characterised by numerous interacting components that adapt and evolve over time, similar to natural ecosystems.

Conflict Resolution Mechanisms

Processes and methods used to resolve disagreements or disputes, particularly in the context of infrastructure projects.

Corporate Social Investment (CSI)

Initiatives where businesses invest in community or social development projects. The practice of companies contributing to improve the quality of life, create social capital and support sustainable social development of communities.

Criteria-Based Methods

Approaches that use predefined criteria to evaluate and prioritise projects based on their ability to meet objectives.

Crowd-in Investment

Attracting private sector investment and co-investment into public infrastructure projects, ensuring broad-based economic and social benefits.

Cybersecurity

Measures and practices designed to protect networks, devices, programs, and data from attack, damage, or unauthorised access. It is crucial for safeguarding information systems and ensuring the security and privacy of data.

Data Governance

The management of data availability, usability, integrity, and security within an organisation. It involves setting policies, procedures, and standards to ensure data quality and compliance with regulations.

Department of Infrastructure (DoI)

The Western Cape Government department responsible for planning, delivering, and maintaining infrastructure, as well as managing provincial roads, public works, and human settlements. Formerly known as the Department of Transport and Public Works (DTPW) and the Department of Human Settlements (DHS).

Development Bank of South Africa (DBSA)

A development finance institution focused on large-scale infrastructure projects in South Africa and the broader Southern African region.

Digital Economy

An economy that is based on digital computing technologies. It encompasses all economic activities that use digital information and knowledge as key factors of production.

Digital Inclusion

Efforts to ensure all individuals and communities, including the most disadvantaged, have access to and can effectively use information and communication technologies (ICTs).

Digital Public Infrastructure (DPI)

A set of shared digital systems designed as minimal digital building blocks that can be used by governments, businesses, academia, and civil society to enable society-wide development. These systems are critical infrastructure and must be regulated, created, and governed for the common good.

Digital Public Value

The value created for the public by leveraging digital technologies in government operations and public services. It includes benefits like improved efficiency, transparency, citizen engagement, and community participation.

Digital Transformation

The process of integrating digital technologies into all areas of a business or organisation, fundamentally changing how they operate and deliver value to customers.

Glossary, acronyms and abbreviations

Doughnut Economics

A framework for sustainable development that combines ecological limits of the planetary boundaries with a set of social boundaries above which humanity will thrive in the form of a doughnut.

Ecosystem

The physical environment of and the community of living organisms living in a particular area.

Ecological Infrastructure

Naturally functioning ecosystems that deliver valuable services to people, such as water and climate regulation, soil formation, and disaster risk reduction. Examples include healthy mountain catchments, rivers, wetlands, coastal dunes, and nodes and corridors of natural habitat.

Emergent Practice

Approaches that evolve in response to changing circumstances and complex problems, requiring flexibility and rapid adaptation.

Environmental Impact Assessment (EIA)

Analysing the potential environmental effects of a project to ensure sustainability and compliance with regulations.

Environmental, Social and Governance (ESG)

ESG is a set of aspects, including environmental issues, social issues and corporate governance that can be considered in investing.

Environmental, Social and Governance Risks

Environmental, Social, and Governance risks associated with infrastructure projects, which standards aim to minimise to ensure sustainable and responsible development.

Expanded Public Works Programme (EPWP)

A South African government initiative aimed at job creation through public infrastructure projects.

Feedback Mechanism

Processes through which stakeholder engagement provides continuous input, allowing the infrastructure system to learn, adapt, and improve.

Fiscal Transfers

Funds provided by one level of government to another to support various services and projects, including infrastructure.

Fourth Industrial Revolution (4IR)

The current era of technological advancement characterised by a fusion of technologies blurring the lines between the physical, digital, and biological spheres. This includes advancements in connectivity, data storage, cloud computing, and artificial intelligence. The ongoing transformation in the way societies operate, driven by advancements in technologies like AI, IoT, and robotics, leading to significant changes in industry, economy, and daily life.

Framework for Infrastructure Delivery and Procurement Management (FIDPM)

A 2019 framework focused on governance to support infrastructure delivery, replacing the Standard for Infrastructure Procurement and Delivery Management, guiding infrastructure procurement by various government tiers.

Gigamap

A comprehensive visual representation of the process and information that informed the development and summarises the WCIF 2050 in an infographic.

Global Warming Potential (GWP)

The relative potency, molecule for molecule, of a greenhouse gas, taking account of how long it remains active in the atmosphere. The Global Warming Potentials (GWPs) currently used are those calculated over 100 years. Carbon dioxide is taken as the gas of reference and given a 100-year GWP of 1.

Governance

The framework of rules, relationships, systems, and processes within and by which authority is exercised and controlled in infrastructure projects.

Government Immovable Asset Management Act (GIAMA)

South African legislation (Act No. 19 of 2007) outlining the responsibilities of custodians and users of immovable assets, emphasising efficient asset

Glossary, acronyms and abbreviations

management and alignment with service delivery and social development objectives.

Government-as-a-Platform (GaaP)

A vision for government structures where digital platforms are used to streamline and enhance the delivery of public services, making them more efficient, transparent, and citizen-centric.

Green Building

A building that, in its design, construction, or operation, reduces or eliminates negative impacts on the climate and natural environment, preserving natural resources and improving quality of life.

Green Building Council of South Africa (GBCSA) Certification

An internationally recognised certification for both existing and new buildings, promoting green building practices and providing a comprehensive support program to achieve varying levels of sustainable certification.

Greenhouse Gas (GHG)

Atmospheric gas(es) that raise the surface temperature of planets such as the Earth through absorbing radiation emitted by the planet, including Carbon Dioxide (CO₂), Methane (CH₄) amongst others.

Greenhouse gas emissions

A term used to describe human-induced GHG emissions.

Growth for Jobs (G4J) Strategy

A strategy focusing on infrastructure and connected economy to support job creation and economic growth in the Western Cape.

Growth Through Inclusion

An approach aimed at ensuring economic growth benefits all segments of society, particularly marginalised and disadvantaged groups, to reduce inequality and enhance social and economic opportunities.

Heatwave

Defined by the South African Weather Service as three consecutive days when the maximum temperature is 5°C above the mean maximum for the hottest month.

Human Settlements

Infrastructure projects aimed at developing residential areas with adequate access to services such as transportation, economic, and social facilities.

Impact Investment

Investments made with the intention of generating positive social or environmental impacts alongside financial returns.

Inequality

The unequal distribution of wealth, income, opportunities, and resources within a society. In South Africa, this often reflects the enduring effects of apartheid-era policies.

InfraGov

The Infrastructure Governance Assessment Framework introduced by the World Bank to assist countries in optimising infrastructure investments and achieving better outcomes.

Infrastructure

The fundamental facilities and systems serving a country, city, or area, including transportation, communication, power plants, and schools. It is crucial for economic growth, development, and quality of life.

Infrastructure Delivery Management System (IDMS)

A framework for managing the planning, procurement, and delivery of infrastructure projects to ensure efficiency and compliance.

Infrastructure System

The complex network of interacting stakeholders, processes, and systems involved in infrastructure development and management.

Infrastructure Life-cycle Asset Management

Managing infrastructure assets throughout their entire life cycle, from planning and construction to maintenance and decommissioning.

Infrastructure Standards

Set guidelines and norms that dictate the design, construction, and operation of infrastructure projects, aimed at ensuring safety, efficiency, and sustainability.

Glossary, acronyms and abbreviations

Infrastructure Value Chain

The sequence of activities involved in the development, management, and maintenance of infrastructure projects, from planning to execution.

Infrastructure-as-a-Service (IaaS)

A model where infrastructure is provided as a service, allowing organisations to outsource their infrastructure needs to a third-party provider, which manages and maintains it.

Innovation across Engineering and Built Environment (EBE)

Investing in new methodologies, techniques, and tools to build capacity for innovation and prepare leadership for dealing with uncertainty, diversity, complexity, and conflicting requirements.

Integrated Urban Development Framework (IUDF)

A policy instrument guiding urban development and infrastructure planning in South Africa.

Intelligent Infrastructure

Utilising advanced technologies and innovative solutions to create smart, efficient, and resilient infrastructure systems.

Intergovernmental Panel on Climate Change (IPCC)

The formal United Nations body for assessing the science related to climate change and giving guidance on the requirements to address it. The Sixth Assessment Review (AR6) recognises the interdependence of climate, ecosystems and biodiversity, and human societies.

International Organisation for Standardisation (ISO)

An international body that develops and publishes standards to ensure quality, safety, efficiency, and interoperability of products and services across the globe.

International Telecommunication Union (ITU)

A specialised agency of the United Nations responsible for many matters related to information and communication technologies. It provides important technology roadmaps and regulates global spectrum arrangements.

International Telecommunication Union Radiocommunication Sector (ITU-R)

One of the three sectors of the ITU and is responsible for radio communications. Its role is to manage the international radio-frequency spectrum and satellite orbit resources and to develop standards for radiocommunication systems with the objective of ensuring the effective use of the spectrum.

Just Transition

The shift towards a low-carbon, climate-resilient economy and society, and ecologically sustainable economies and societies which contribute toward the creation of decent work for all, social inclusion, and the eradication of poverty.

Just Transition Framework

A framework outlining policy measures and commitments from various social partners to minimise the social and economic impacts of the climate transition, aiming to improve the livelihoods of those most vulnerable to climate change.

Kunming-Montreal Global Biodiversity Framework (GBF)

A framework supporting the achievement of the Sustainable Development Goals and the global vision of humanity living in harmony with nature, with goals and targets for biodiversity conservation, restoration, and sustainable use.

Legacy Systems

Outdated computer systems, software, or technologies that are still in use, often because they still perform essential functions, but they are limited in their capacity to meet modern demands and innovations.

Low-Carbon Economies

Economies that prioritize reducing carbon emissions through sustainable practices and technologies, supported by infrastructure standards that promote environmental sustainability.

Maintenance

The preventative, reactive and predictive upkeep necessary to keep infrastructure in good working order and extend its useful life.

Glossary, acronyms and abbreviations

Meta-Governing Structure

A higher-level governance framework designed to integrate and coordinate various stakeholders and processes involved in infrastructure planning and delivery.

Meta-Level Evaluation

An initial evaluation stage used to make broad decisions about project viability and resource allocation.

Meta-Standards

High-level standards that provide a framework for the development and alignment of more specific standards across various sectors and regions.

Metric Tons of Carbon Dioxide Equivalent (MtCO₂Eq)

A metric measure used to compare the emissions from different GHGs based on their Global Warming Potential (GWP).

Monitoring and Evaluation (M&E)

The systematic process of tracking the performance of infrastructure projects and assessing their outcomes against the set objectives and goals.

Multi-Criteria Decision Analysis (MCDA)

A method for evaluating and prioritising projects based on multiple criteria, providing a comparative basis for decision-making.

Municipal Finance Management Act (MFMA)

South African legislation (Act No. 56 of 2003) that regulates financial practices and accountability at the municipal level.

Municipal Systems Act

South African legislation (Act No. 32 of 2000) providing mechanisms for service delivery partnerships, including Public-Private Partnerships (PPPs).

National Development Plan (NDP)

South Africa's long-term plan aiming to eliminate poverty and reduce inequality by 2030, with infrastructure investment as a critical enabler for inclusive and sustainable economic growth.

National Environmental Management Act (NEMA)

Legislation (Act No. 107 of 1998) aiming to prevent

pollution and ecological degradation, promoting sustainable development and establishing air quality measures, norms, and standards managed by all levels of government.

National Infrastructure Plan 2050 (NIP 2050)

A strategic framework aimed at boosting investment and coordinating infrastructure development in South Africa.

National Spatial Development Framework (NSDF)

A framework guiding spatial development planning in South Africa to address past inequities and support economic growth and development.

Nationally Determined Contribution (NDC)

South Africa's pledge to reduce greenhouse gas emissions, contributing to global efforts to keep temperatures well below 2°C, with aspirations to limit the increase to 1.5°C above pre-industrial levels.

Net Zero

A situation where carbon emissions have been reduced to a level of residual emissions that can be absorbed and durably stored by nature and other carbon dioxide removal measures, leaving zero in the atmosphere.

Novel Practice

Innovative methods used in complex and contested situations where traditional best practices may not apply, particularly useful for addressing unique local needs.

Panarchic Governance

A governance model that emphasizes adaptability, interconnectedness, and resilience across different levels of governance. It aims to harness the public good potential of digital technologies and ensure sustainable infrastructure development.

Panarchy

A framework for transversal governance ensuring data-driven practices while guarding against false methodological superiority.

Panoptic Principles

The foundational principles guiding the Western Cape

Glossary, acronyms and abbreviations

Infrastructure Framework (WCIF) 2050 to ensure inclusive, innovative, and resilient infrastructure development.

Phygital Infrastructure

The integrated framework that combines physical and digital factors and features to create seamless interactions between the physical and digital worlds. This infrastructure includes physical assets like sensors, devices, and network hardware, along with digital technologies such as software platforms, cloud computing, and data analytics, working together to enable connected, intelligent environments.

Planetary Boundaries

A set of nine boundaries that define the safe operating space for humanity to continue to develop and thrive. Exceeding these boundaries increases the risk of large-scale abrupt or irreversible environmental changes.

Portfolio Approach

A strategy that considers the collective impact of a group of projects rather than evaluating each project in isolation.

Portfolio Prioritisation

The process of ranking and selecting projects within a portfolio to align with strategic objectives and optimise resource allocation.

Presidential Climate Commission (PCC)

An independent, statutory, multi-stakeholder body established to oversee and facilitate a just and equitable transition towards a low-emissions and climate-resilient economy.

Prioritisation Models

Frameworks or tools used to rank projects based on various criteria, such as benefits, costs, and risks.

Project Scoping

Defining the objectives, deliverables, and constraints of a project to determine its feasibility and scope.

Project Support Facilities

Structures or institutions designed to assist with the preparation, planning, and management of infrastructure projects to ensure effective use of funds and resources.

Promotion of Administrative Justice Act (PAJA)

South African legislation (Act No. 3 of 2000) ensuring fair administrative action by the government, including adequate public participation processes.

Provincial Equitable Share

A portion of national revenue allocated to provincial governments to fund their operational needs, including infrastructure.

Provincial Strategic Plan 2023 – 2027

The Western Cape Government Department of Infrastructure's plan outlining its vision and objectives for infrastructure development over a five-year period.

Public Finance Management Act (PFMA)

South African legislation (Act No. 1 of 1999) ensuring fiscal accountability and compliance with financial management practices in government departments and entities.

Public-Community Partnerships

Collaborations between government entities and local communities or civil society organisations to address local development needs.

Public Private Partnership (PPP)

A contractual arrangement between a public authority and a private sector entity for providing public infrastructure or services, where both parties share risks and responsibilities.

Public Value Creation

The process of generating value that benefits the public through government policies, services, and infrastructure projects. It emphasizes the importance of inclusivity, sustainability, and meeting the needs of the community.

Quadruple-Helix Model

An extension of the Triple-Helix model that includes civil society as a key player in the innovation process, emphasising the role of societal involvement in research and development.

Regenerative Economy

An economic system focusing on holistic sustainability, restoring natural resources, and promoting social well-being. Infrastructure contributes to ecosystem restoration while improving social well-being.

Glossary, acronyms and abbreviations

Regenerative Infrastructure

Infrastructure that aims to restore and enhance natural ecosystems, going beyond sustainability to actively improve environmental health.

Resilience

The capacity of social, economic (human), and environmental systems to cope with a hazardous event, trend, or disturbance, maintaining their essential function, identity, and structure, and adapting, learning, and transforming in response.

Resilient Infrastructure

Infrastructure designed to withstand and adapt to extreme weather events, climate change, and other disruptions.

Resilient Infrastructure Value Chains

Infrastructure systems harmonised with ecological imperatives to build resilience and sustainability.

Return on Investment (ROI)

A measure of the profitability or financial return of a project relative to its costs.

Risk Assessment

Evaluating potential risks and their impact on a project or programme to inform decision-making.

Risk Management

The identification, assessment, and prioritisation of risks followed by coordinated efforts to minimise, monitor, and control the probability or impact of unfortunate events.

Risk Transfer

In PPPs, the allocation of project risks to the party best able to manage them, which can lead to more efficient risk management.

Silver Dividend

The economic contributions of an ageing population, particularly affluent retirees, who can support economic growth through their spending and investments.

Six Capitals

A framework incorporating financial, manufactured, intellectual, human, social and relationship, and natural capitals to ensure comprehensive value creation, including value for money as defined by the

International Development Association (IDA).

Social Cost Benefit Analysis (SCBA)

A method of evaluating projects by comparing the total social benefits with the total social costs.

Social Cost Effectiveness Analysis (CEA)

An evaluation method that measures the cost-effectiveness of a project in terms of its benefits, often using natural units like life years saved.

Social Cost Utility Analysis (CUA)

An evaluation technique that assesses a project's impact using both quantitative and qualitative measures, commonly used in health-related contexts.

South African Bureau of Standards (SABS)

The national body responsible for developing, maintaining, and promoting standards in South Africa, ensuring quality and safety in various sectors.

Spatial and Economic Transformation

Efforts to restructure the spatial distribution of people and economic activities to promote more equitable access to opportunities and resources.

Spatial Exclusion

The phenomenon where certain geographic areas or communities are excluded from economic opportunities, often due to historical, social, or policy-driven factors.

Spatial Justice

The principle of equitable distribution of infrastructure and resources to address past spatial imbalances and improve access for all communities.

Spatial Planning and Land Use Management Act (SPLUMA)

South African legislation (Act No. 16 of 2013) setting principles and procedures for infrastructure investment in priority areas, ensuring coordinated and sustainable development.

Spatial Transformation

The process of changing the physical and social landscape of a region to achieve more equitable distribution of resources and services.

Stakeholder Engagement

The process of involving individuals or groups who have an interest in or are affected by infrastructure

Glossary, acronyms and abbreviations

State Owned Enterprises (SOEs)

Entities owned or controlled by the government, providing public goods or services.

Strategic Environmental Assessment

The process to assess the environmental implications of a proposed strategic decision, policy, programme, piece of legislation or major plan and integrates the concept of sustainability into strategic decision-making.

Sustainable Development Goals (SDGs)

A collection of 17 global goals set by the United Nations to address global challenges and achieve a better and more sustainable future for all by 2030.

Sustainable Infrastructure

Infrastructure designed and operated in a way that ensures economic, social, and environmental sustainability, aiming to meet the needs of the present without compromising future generations.

Sustainable Infrastructure Development and Finance Facility (SIDAFF)

A facility focused on providing technical support and expertise to cities in the Western Cape for accessing funding and developing infrastructure projects.

Systems View

An approach that considers the interconnectedness and interdependence of various components within an infrastructure system.

Three-Dimensional IPF Approach

An extension of the two-dimensional model that includes economic efficiency, social justice, and ecological integrity, visualised using a 3D bubble chart.

Transversal Governance

Integrated, cross-disciplinary planning and management of infrastructure projects to ensure comprehensive and effective governance.

Triple Bottom Line

The inclusion of an organisation's contribution to / impact on social wellbeing, environmental health and a just economy in its reporting framework. Also known as the "Three Ps" – People, Planet and Profit or Prosperity.

Triple-Helix Model

A framework for innovation involving collaboration between the public sector, private sector, and academia.

Two-Dimensional IPF Approach

An approach using two indices (social-environmental and financial-economic) to prioritize projects, plotted on a Cartesian plane.

Value-for-Money

The optimization of the return on investment (RoI) in respect of a project or group of projects across their life cycle in relation to functional, financial, economic, environmental sustainability and social return. (Infrastructure Development Act of 2014, as amended: IDA Regulations 2022)

Volatile, Uncertain, Complex, and Ambiguous (VUCA)

Describes the challenging and unpredictable nature of infrastructure planning and decision-making.

Western Cape Climate Change Response Strategy (WCCRS)

A strategy updated in 2023 to address the global climate emergency, providing policy direction for a green, low-carbon economic recovery and mitigating climate-related risks in the Western Cape.

Western Cape Ecological Investment Infrastructure Framework (EIIIF)

A framework guiding public and private sector decision-makers on investing to promote the resilience of the Western Cape's ecological infrastructure, addressing risks such as water security threats and rangeland degradation.

Western Cape Government (WCG)

The provincial government of the Western Cape, South Africa, responsible for regional governance and development.

Western Cape Government Project Preparation Facility (WCG PPF)

A facility that helps develop and prepare investment-ready infrastructure projects in the Western Cape, aiming to build a credible project pipeline.

Glossary, acronyms and abbreviations

Western Cape Infrastructure Delivery Management System (WCIDMS)

A system that integrates with FIDPM, guiding infrastructure delivery and procurement processes within the Western Cape.

Western Cape Infrastructure Framework 2050 (WCIF 2050)

A strategic framework outlining the principles, priorities, and objectives for infrastructure provision in the Western Cape region by the year 2050.

Youth Dividend

The economic benefit that can arise from having a large, youthful population, provided there are adequate opportunities for employment, education, and development.

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