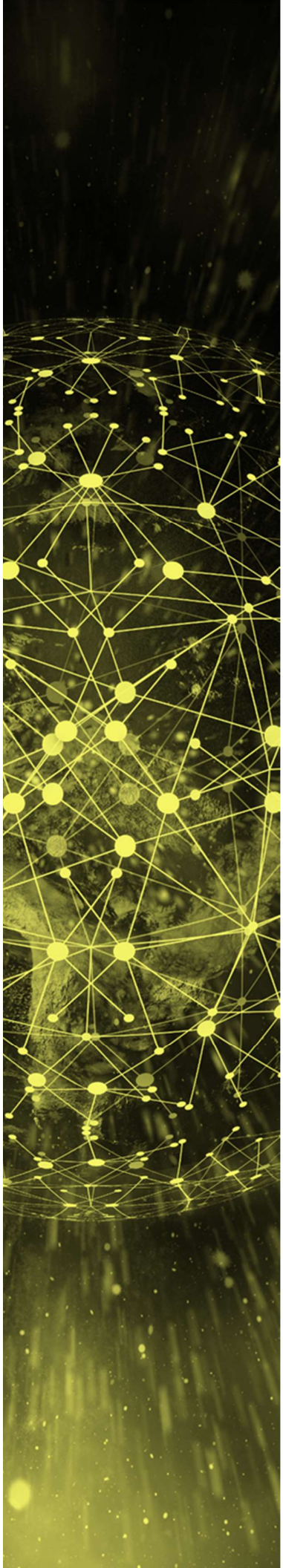


Strategic Pathway 5

Innovation

*This **strategic pathway** recognizes that innovation has the potential to stimulate, trigger and respond to rapid change, leapfrog outdated technologies and processes, and to bridge the geospatial digital divide. Technology is continually evolving, creating new opportunities for innovation and creativity.*

*The **objective** is to leverage the latest cost-effective technologies, innovations and process improvements so that governments, businesses and academia, no matter their current situation, may leapfrog to modern geospatial information management systems and practices.*

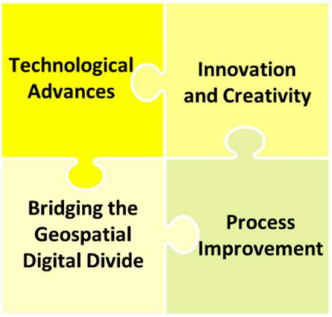
Summary

Digital transformation, emerging technologies and associated innovation and creativity are, at the same time, major industry disruptors and compelling enablers in the broader information sector. These same trends are significantly disrupting and influencing the geospatial information sector. The volume, size, speed, diversity and complexity in which geospatial information is being generated and disseminated is increasing exponentially across many industry sectors. For national governments, this brings a growing expectation that they are, by default, positioned to use these new and emerging digital technologies to leverage e-commerce, enhance service delivery, improve interactions with citizens, and generate visible organizational process efficiencies and savings.

Promoting and ensuring that innovation is being applied throughout the data ecosystem is critical. Innovation has the potential to have a significant impact on stimulating and embracing rapid change, to bridge the geospatial digital divide, and to reap the dividends of digital transformation. Yet in many countries, governments and national geospatial agencies, seeking to make digital transformation a reality, are often hampered by institutional processes, policies, skills and technology that are out of step with the available modern, agile technology and innovation that exists in advanced societies.

Arguably, for almost all countries, a major challenge is how national geospatial agencies, at the heart of digital transformation in government, leverage and stimulate the use of the latest enabling technologies and processes for evidence-based decisions and policy setting. For this very reason, 'Innovation' is at the centre of the nine strategic pathways of the Integrated Geospatial Information Framework (IGIF).

As a single strategic pathway, innovation has the potential to have the most significant single impact for countries in stimulating and triggering rapid change, to leapfrog outdated technologies, and to bridge the geospatial digital divide. The actions to create enhanced opportunities for innovation and creativity fall within four key elements that are common to all digitally maturing and innovative societies. The four elements are:



- **Technological Advances** – influenced by a new industrial paradigm to produce, share, analyze and deliver information to enrich knowledge economies.
- **Innovation and Creativity –** stimulates science and technology though digital transformation strategies, policy and legal instruments, innovation centers, and research and development to generate economic growth.
- **Process Improvement** – the proactive task of identifying, analyzing and improving upon existing processes to achieve efficiencies, productivity gains and new products and services.
- **Bridging the Geospatial Digital Divide** – enabled through a combination of technological developments, data, supportive policy and legal frameworks, financial commitment, stakeholder engagement, partnerships and capacity building.

These elements are underpinned by principles that can be adopted by each country to promote innovation and creativity. These principles are put into practice through strategic actions that stimulate the use of the latest cost-effective technologies, innovations, creativity and process improvements to deliver and strengthen participation and commitment to achieving the IGIF. Tools, such as matrices, examples and checklists, are provided in the appendices to assist countries to work through concepts and processes to successfully complete each action. The overall structure for innovation is illustrated in and anchored by Figure 5.1.

When implemented, the actions (and their interrelated actions) will enable the achievement of the four elements, which in turn will deliver significant and sustainable national outcomes and benefits for a country. These outcomes include attaining:

- Improved processes for the collection, management, distribution and analysis of geospatial information, leading to more effective evidenced-based decision-making;
- Increased productivity and efficiency achieved through an innovation-enabled environment;
- An innovative workforce that creates and executes new processes and develops new products and services; and
- The ability to bridge the geospatial digital divide through enabling technologies achieved through an innovation ecosystem.

Figure 5.1: *The overall structure for the Innovation Strategic Pathway – showing the four key elements, guiding principles, actions and interrelated actions, and the tools provided in the Appendices to support and achieve the outcomes.*

5.1 Introduction

The creation, development, diffusion and transfer of new innovations, technologies and associated know-how, are powerful drivers of economic growth and sustainable development.

The 2030 Agenda for Sustainable Development emphasizes the opportunity and potential that the spread of information and communications technology (ICT) and global interconnectedness provides to accelerate human progress, to bridge the digital divide, to develop knowledge and information societies, and scientific and technological innovation.

Within the context of developing countries, the Addis Abba Action Agenda recognizes that the creation, development and diffusion of new innovations and technologies and associated know-how, including the transfer of technology on mutually agreed terms, are powerful drivers of economic growth and sustainable development. However, the Action Agenda notes with concern the persistent 'digital divide' and the uneven innovative capacity, connectivity and access to technology, including ICTs, within and between countries. There is an urgent need to promote the development and use of ICT infrastructure, as well as capacity-building, particularly in countries in special situations, including rapid universal and affordable access to the Internet.

Promoting and ensuring that innovation is being applied throughout the data ecosystem is critical. Innovation has the potential to have a significant impact on stimulating and embracing rapid change, to bridge the geospatial digital divide and to reap the dividends of digital transformation.

Innovation is the application of knowledge and technology to change, or create more effective processes, products and ideas that deliver additional value. Innovation in 'nation building' is driven by the need to find solutions to problems; it can be incremental or transformational. As geography is at the heart of every major decision that organizations, businesses and individuals make each day, it can be argued that geospatial information is the most influential data underpinning innovation, creativity and intelligent data systems today.

Technology, end especially geospatial technology, is transforming almost every aspect of our lives - having a major impact on citizens, governments, and all sectors of industry and the economy - at an unprecedented pace and scale. However, all countries are at different stages and levels of development in their integrated geospatial information management journey – including with the many aspects of innovation.

All countries have different starting points depending on their individual circumstances, and what may be deemed as 'innovation' in one country may not be recognized as innovation in another. For this reason, this strategic pathway does not advocate a specific innovation or technology agenda; nor provide a 'future outlook'. The several UN-GGIM reports on 'Future Trends in geospatial

information management: the five to ten year vision'[1] now in its third edition, provides this outlook. Instead, this pathway describes a range of innovative practices that can be applied from different contexts and starting points.

While the Future Trends report[2] provides a global consensus view of the developments and future direction for geospatial information management over the next five to ten years, the 2020 iteration has been produced at this time to specifically complement the IGIF, helping to ensure that the Framework integrates and takes advantage of the latest innovation and trends, and to assist countries in bridging the geospatial digital divide.

As a valuable reference document to this strategic pathway, the Future Trends report cross-references, as an impact assessment, the top trends against the nine strategic pathways of the IGIF. It is notable that while all trends relate in some way to each of the individual pathways, the data and innovation pathways have the majority of direct 'touch points' with the Future Trends report.

With the advent of the Fourth Industrial Revolution (Schwab, 2016), digital transformation, and the disruptions that have come with them, have changed many business practices, provided new technological applications, and brought about a data revolution that is having a positive influence on social and economic systems. Ultimately, this is creating a world that is becoming increasingly interconnected and innovative.

Innovation is now enabling businesses, industry and governments to be far more agile in transforming and scaling-up capability than in the recent past. Technologies such as the Cloud, Big Data, drones and mobile innovations have become commonplace and are being replaced by emerging technologies that are starting to have a major impact on the geospatial industry. Big Data, Artificial Intelligence (AI), machine learning, cloud and edge computing, the Internet of Things (IoT), Blockchain, Building Information Modelling (BIM)[3], Smart Cities, and even autonomous vehicles, are playing increasing roles in expanding the geospatial industry and creating collaborative opportunities with mainstream ICT and engineering sectors (Geospatial Media, 2018).

Innovation is creating more convenient, secure and engaging touchpoints between businesses and their customers – providing situational awareness, and real-time insights. Nearly every aspect of commerce, from point of inspiration to delivery, is being reimagined using geospatial information – geotagging, routing, navigation, marketing, purchasing, delivery, and more.

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[1] Each edition of the UN-GGIM Future Trends Reports are available here: http://ggim.un.org/future-trends/

[2] http://ggim.un.org/documents/DRAFT_Future_Trends_report_3rd_edition.pdf

[3] Reference to be provided for the Integrated Geospatial and Building Information Modelling White Paper.

Emerging technologies – from mobile innovation to Big Data and Artificial Intelligence – are enabling more personalized experiences in new contexts. This is in line with today's consumers, who want more control over their way of life. They don't want to be boxed in; they value choice, and this demand is driving more personalized and more customizable location-based products and services.

This type of disruption not only creates new opportunities but also seismic shifts in consumer behaviour and expectations. The 'online' demographic profile is changing, increasing demands and expectations for high-quality digital experiences. These same 'millennial' customers are also driving innovation, pushing governments to reshape the delivery of integrated data and outcomes. These trends are gaining pace as technology creates new experiences and new experiences create new expectations.

The innovation migration to digital and mobile has created new opportunities for businesses to get closer to their customers. These developments offer significant innovation opportunities but also present challenges - both in terms of policy and in terms of law. Meeting these challenges and ensuring that the potential benefits can be realized by all countries will be important in ensuring that the full value of geospatial information can continue to be realized.

5.2 Context and Rationale

Technology, digital transformation, innovation, and the corresponding growth in the generation of data has meant that governments now realize the value of digital technologies and data as key strategic assets.

We are witnessing an exponential growth in the amount of data being generated and captured. Increases in the volume and variability of data, combined with rapid advances in digital acquisition and ICT, is changing – providing the opportunity for geospatial information to be leveraged as a viable transformative capability for governments to formulate better policy and to respond to national priorities. For example, sensors in autonomous vehicles are able to generate around a gigabyte of geospatially enabled data every second; satellites capture imagery of the whole world every day with volumes so large that data can only effectively be used in a cloud environment; and users of social media are creating an increasing amount of geospatially located information – just by sharing a picture or updating a profile of their location.

Technology, digital transformation, innovation, and the corresponding growth in the generation of data has meant that governments now realize the value of digital technologies and data as key strategic assets that lead to valuable and quantifiable results - growing economies and strengthening the wellbeing of societies around the globe. Yet, reaping the full benefits of the opportunities, afforded through the use of geospatial data and technologies, requires continuous reform and innovation to modernize and support new ways of working, particularly across the public sector (OECD, 2018).

Of the 9 IGIF strategic pathways, it is acknowledged that this pathway will be a particular challenge to implement for developing countries, and more so for the least developed countries. While more data, technology and innovation is available than ever before (for developed countries), many developing countries have yet to have the `opportunity' to interact with these rapidly emerging capabilities, as the democratization of ICT, geospatial information, and enabling technology and innovation is not yet being equally shared. Geospatial data, leadership, knowledge and innovation is primarily still limited to the developed countries. While technologies are evolving at a rapid rate, the commensurate capabilities, skills and opportunities in the developing countries are not (Scott and Rajabifard, 2019).

Why is this so? For developing countries, even those with a high-level of awareness and national support, realizing the benefits and efficiencies of digital transformation and innovation, is still out of reach. The reality is that many developing countries are yet to attain effective and sustained access to digital technology and the Internet, and lack the corresponding ICT and computer literacy skills needed to orchestrate transformational change towards an information society. Some countries also lack reliable electricity connectivity, posing a great challenge to information access. Further, there are institutional challenges related to coordination, leadership managing the value chain, fragmented implementation, diffused policy accountability, and then potentially the lack of skills, tools and mechanisms to properly manage the data supply chain and related technologies (Scott and Rajabifard, 2019).

Importantly, developing countries have a significant opportunity to learn from the experiences of developed countries in their transition to more sustainable and modern methods. Advances in computing power, connectivity, information mobility and data storage capacity, developed over the last few years, are now becoming more widely available to developing countries - but they pose a risk of higher inequality and dislocation of labor and capital (Productivity Commission, 2016).

As a consequence, it is necessary to stimulate the use of the latest technologies, processes and innovations in a way that leaves no one behind. Developed countries have tackled this by adding, strengthening, or removing regulations, investing in digital start-ups, and protecting the jobs of workers threatened by new ways of doing business through capacity development programs. This highlights that technological innovation in-itself is only one part of the broader innovation ecosystem – holistically it requires policy interventions, financial investment, and education and training programs, to be successful in leaving no one behind.

For example, through leapfrogging, millions of people in developing countries transitioned to mobile phones without having ever owned or used landline

telephones. Similarly, developing countries have the opportunity to leapfrog the traditional 'heavy architecture' NSDI implementation approaches with more agile and lighter technology enablers. Providing the guidance for countries to leapfrog with the latest cost-effective technologies, innovations and process improvements, provides the context and rationale for this strategic pathway. The objective is to guide countries towards developing a culture of innovation.

5.3 Approach

The approach to innovation is to find new ways to improve the lives of citizens; overcoming old structures and modes of thinking, and embracing new technologies and ideas.

The 2030 Agenda recognises the importance of promoting and fostering scientific and technological innovation in a number of the SDGs, including to develop policies that support productive activities, decent job creation, entrepreneurship, creativity and innovation to solve sustainable development challenges. Innovation builds strong collaborative industry clusters to stimulate location insights capabilities, enhancing geospatial capacity through knowledge networks, encouraging entrepreneurship and building social capital.

Close cooperation between government, the private and academic communities, and a focus on higher education and investment in science, are necessary ingredients for the process of nation building. Ultimately, innovation is about finding new ways to improve the lives of citizens; overcoming old structures and modes of thinking and embracing new technologies and ideas.

In this strategic pathway, the approach for stimulating the use of the latest cost-effective technologies, process improvements and innovations is presented in Figure 5.2. The approach aims to assist governments, no matter their current situation and national circumstances, to leapfrog to state-of-the-art geospatial information management systems and practices.

The approach includes four key elements that monitor the geospatial landscape, recognizing that technology and processes are continuously evolving; creating enhanced opportunities for innovation and creativity that enable governments to quickly bridge the geospatial digital divide. These elements (which are able to be considered sequentially) include a heightened awareness of the **technological advances** that are able to support and promote **innovation and creativity** in order to apply and optimize **process improvement** within and across organizations, so that countries are able to **bridge the geospatial digital divide**. These elements are explained in more detail in Section 5.4 below.

The approach includes strategic pathway actions that are recommended as a means to achieve the four key elements. The actions, which are underpinned by guiding principles, provide the step-by-step guidance to implement and achieve the desired outcomes. While most of these actions may be unique to this strategic pathway, there are several interrelated and/or prerequisite actions detailed in other strategic pathways that may also need to be completed.

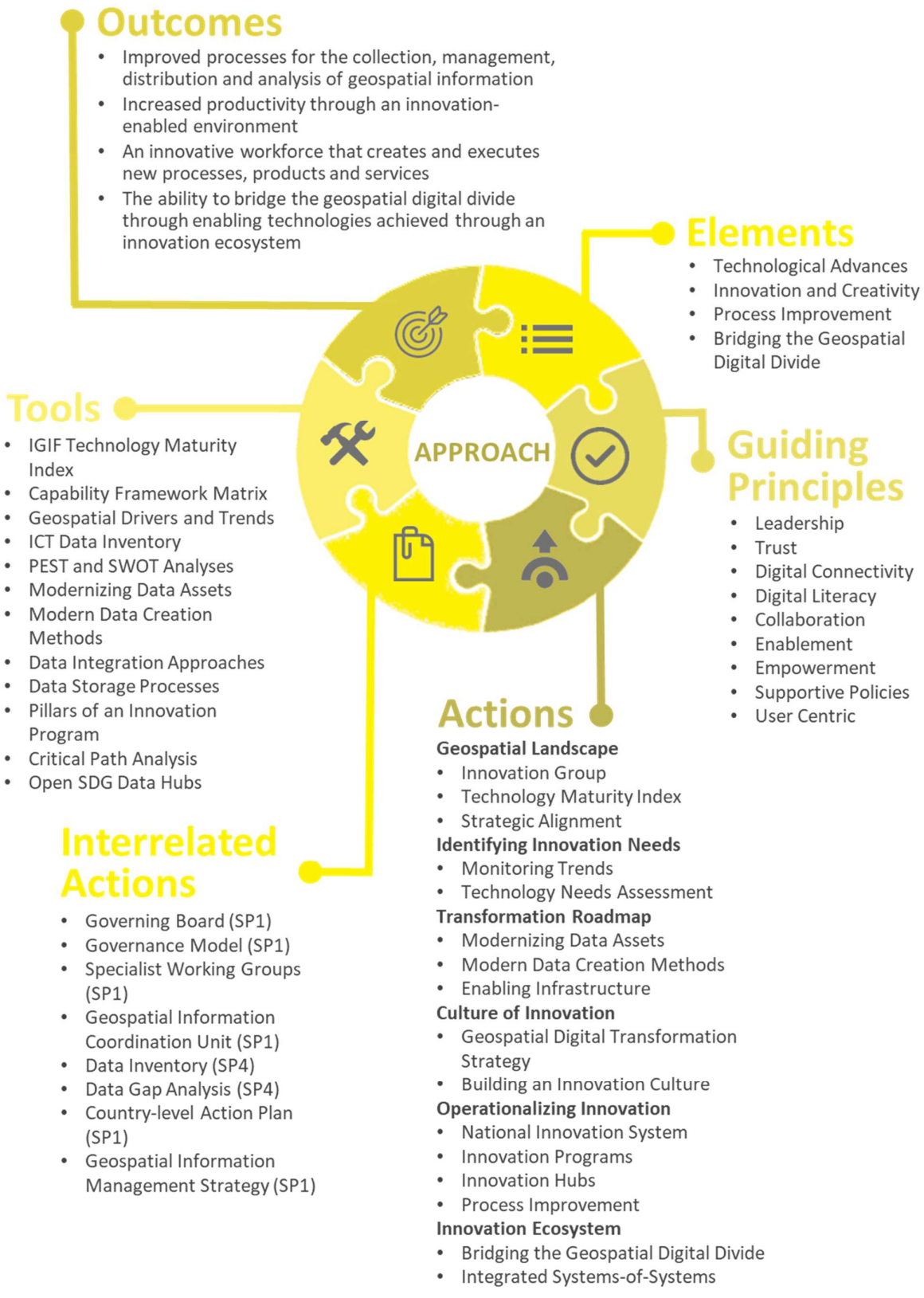

Figure 5.2: *The approach to innovation.*

Tools to assist in completing the actions are available in the appendices to the strategic pathway. The approach for Strategic Pathway 5: Innovation is illustrated in Figure 5.2 and explained in the following Sections.

The actual implementation approach of each strategic pathway action will depend on country-specific needs, which may be influenced by country priorities, existing capabilities, resourcing potential, culture and other practicalities. Whatever the implementation approach, each action should reference the guiding principles below (See Section 5.5) as these describe what is important for effective and efficient geospatial information management.

5.4 Elements

5.4.1 Technological Advances

Technological advances, both existing and emerging, present the best hope for bridging the geospatial digital divide and achieving broad-based sustainable development outcomes in developing countries.

Technological advances create new opportunities for economic growth and prosperity. Technologies, both existing and emerging, present the best hope for bridging the geospatial digital divide and achieving broad-based sustainable development outcomes in developing countries.

Technology plays a crucial role in leveraging the potential of the Fourth Industrial Revolution; where production, collaborative networks, and the digital integration of supply chains have emerged to create a new way of producing and distributing information products beyond a single enterprise. In addition, general purpose technology (communications, energy and transport) is fundamentally changing the way we manage, power and move economic activity across the value chain.

Given that geospatial information is utilized in communication technologies to power economic development and environmental sustainability, it is conceivable that geospatial information will be both impacted by, and have an influence on, future economic activity. For example, future autonomous transportation systems will impact data acquisition methods, by providing sensors to power 3-dimensional models of the environment. This information will in turn influence sustainable urban planning and infrastructure development.

The common themes arising from the result of several emerging technologies are data integration, real-time data and knowledge inferencing. These technologies include the Internet of Things (IoT), automation, sensors, data analytics, machine-learning, deep learning, robotics and quantum computing. These technologies are delivering data on demand, such as any IoT enabled device (vehicle sensors, appliances, satellites, phones, etc.). These new avenues for data collection are crucial, as many developing countries do not presently have good data. Yet, to benefit from these advances in data analytics, countries

require good data. This is because results from data analysis will only be useable if the data can be trusted, and machine-learning requires good training data, which in turn often requires new data.

5.4.2 Innovation and Creativity

Innovation and creativity is about finding new ways to improve the lives of citizens.

Innovation results from interdependencies among different technologies (Schwab, 2016). Innovation and creativity is about finding new ways to improve the lives of citizens, overcoming old structures and modes of thinking, and embracing new technologies and ideas.

While providing great opportunities, the challenges governments face in promoting innovation and creativity can be significant – requiring strategies to overcome bureaucratic barriers, harness the power of citizens', build trusted relationships and enable a culture that supports innovation, growth, productivity and competitiveness (OECD, 2017). In spite of these challenges, the potential of innovation in government is immense. There are many success stories that demonstrate how government can stimulate innovation and creativity – transforming the way work is done to generate economic growth and societal well-being. Approaches include digital transformation strategies, innovation hubs, research and development, and policy instruments that enable the management of data as an asset for many uses and users, and opening up access to data to fuel innovation so that societies may reap the benefits.

5.4.3 Process Improvement

Process improvement is the proactive task of identifying, analyzing and improving existing business processes, methods, and standards of quality.

Process improvement is the proactive task of identifying, analyzing and improving existing business processes, methods, and standards of quality through small achievable incremental steps, or through bold leaps forward to achieve productivity gains and new products and services. Process improvement applies to new developments as well as improvements to existing processes and systems.

When implementing business process improvement methodologies in the public sector, factors such as organisational readiness, success and new developments should be considered. In terms of organisational readiness, this includes elements such as having a process view, developing a culture focused on improvement and, an understanding of the customer and the 'value' within the organisation (Radnor, 2010).

In terms of new developments, it is not always easy nor straightforward to keep track of technology developments. Attending conferences, engaging with colleagues and seeking their advice, are strategies for keeping up to date. These elements of readiness are critical for process improvement, as they provide a basis which new tools and technologies can be applied. Key success factors are strong leadership and visible support from management. Other success factors

include an effective communication strategy, appropriate training and development, providing resources and time for the improvements to take place, and using external expertise and support when required (Radnor, 2010).

5.4.4 Bridging the Geospatial Digital Divide

Bridging the geospatial digital divide is a combination of technological development, innovation, ICT, data, supportive policy, financial commitment, stakeholder engagement, partnerships and capacity building.

Bridging the geospatial digital divide comprises a combination of technological development, innovation, ICT, data, supportive policy, financial commitment, stakeholder engagement, partnerships and capacity building – many elements of the strategic pathways of the IGIF.

The 'digital divide' refers to the 'gap' between those that have access to modern and innovative ICTs and those that do not. Criteria often used to distinguish the gaps between the 'haves' and the 'have nots' of the digital divide tend to focus on access to computers, ICT, access to the Internet, and details relating to all three categories. In developing countries, a major impediment to digital transformation is the lack of opportunity, literacy, digital workforce skills, and resources. While technologies are evolving at a rapid rate, the commensurate capabilities, skills and opportunities in developing countries are not keeping pace. Therefore, the digital divide has the potential to widen as a result of the increase in innovation and use of technologies in developed countries (Scott and Rajabifard, 2019).

The 'geospatial digital divide' is an extension of the digital divide, preventing access and opportunity for countries. The lack of access to mechanisms, such as ICT and Internet capabilities, are compounded and exponentially complicated by a lack of opportunity to interact with geospatial data and related enabling technology capability and capacity – not having the opportunity to connect to the vast amounts of data, including geospatial information, and scientific and technological innovation to make decisions and policy.

5.5 Guiding Principles

By applying these guiding principles, countries can stimulate the creative and innovative use of geospatial information and related technologies, and improve on current data management practices.

There are some specific guiding principles that can be applied by countries to stimulate the creative and innovative use of geospatial information and related technologies, and improve on current data management practices. These principles are mindful of both the potential of ICT as well as the dangers of marginalization of those without reliable access to ICT.

The actual approach to implementing these principles is likely to be different from country to country, and in some countries, approaches may not work in their entirety, as there are different priorities and levels of innovation development maturity and cultural aspects that need to be taken into account. That said, using good ideas and innovative thinking, adopting the following guiding principles is encouraged:

- **Leadership:** Communicate, encourage and foster innovation as a priority through a strong sense of mission and purpose, and with commensurate resources and investment.
- **Trust:** Foster an innovative and creative, experimental and developmental environment built on trust, transparency, responsiveness and freedom of expression.
- **Digital Connectivity**: Ensure organizations and people are able to connect to the Internet, digital infrastructure and networks, as necessary means for the digital transformation, transmission of digital data, and as the foundation for developing and mainstreaming innovative applications across organizations and sectors.
- **Digital Literacy:** Recognize and invest in digital and geospatial literacy, both for the young and the aged, as a basic skill for bridging the geospatial digital divide, foster greater participation in innovation and creativity by all.
- **Collaboration:** Enable collaboration across and beyond government, between the scientists, technologies, researchers and practitioners, with businesses and civil society.
- **Enablement:** Ensure digital transformation strategies equip all levels of government, all sectors and all people with enabling environment, tools and opportunities to foster innovativeness and creativity.
- **Empowerment:** Provide space for, and foster a culture and environment of experimentation and innovation, shared development and co-located research and development, to embolden innovation and creativity, and scale-up applications.
- **Supportive Policies:** A policy and legal framework that supports experimentation, innovation, creativity and application through polices that promote digital transformation, digital connectivity, and embrace the rapid pace of technological change.
- **User Centric:** Embrace user-centered approaches and application principles to innovate processes, products and services, promote readily accessible, re-purposing and re-use of public domain data and infrastructures.

5.6 Actions

The strategic pathway actions are recommended as a way to achieve the four key elements of innovation. They are a guide to assist countries in their efforts to leverage innovation, technology and process improvement to stimulate and trigger rapid change. Country-specific innovation needs may be influenced by factors such as country priorities, existing capabilities, resources, culture and other practicalities. These will influence approaches for implementing each strategic pathway and their related actions.

The strategic pathway actions are recommended as a means to achieve the four key elements.

For ease of use, particularly to assist countries in the early stages of developing and strengthening their national geospatial information management arrangements, the actions are presented in a sequential step-by-step structure. A road map illustrating this order and where the actions typically occur and are completed, is presented in Figure 5.3. However, it is acknowledged that countries, depending on existing national arrangements, may also wish to start their actions at different steps along the pathway, and in a different sequence. Therefore, a less structured road map is additionally presented in Figure 5.4.

Some actions may have interrelated and/or prerequisite actions that need to be achieved prior to, or in conjunction with, the strategic pathway actions. These interrelated actions are also illustrated in Figures 5.3 and 5.4, are referenced in the text, and detailed under other strategic pathways.

Whatever the implementation approach, each action should take into account the guiding principles in Section 5.5, as these describe drivers for attaining effective and efficient geospatial information management.

The actions for the Innovation Pathway are divided into six categories, which are:

1. Geospatial Landscape
2. Identifying Innovation Needs
3. Transformation Roadmap
4. Planning for Action
5. Operationalizing Innovation
6. Innovation Ecosystem

The following actions are typically used to address gaps in capability. They serve as a guide to building the necessary capacity to strengthen integrated geospatial information management processes and systems.

5.6.1 Innovation Group

Understanding and leveraging the latest cost-effective technologies, innovations and process improvements across the evolving geospatial landscape requires dedicated and ongoing monitoring and review – seeking efficiencies

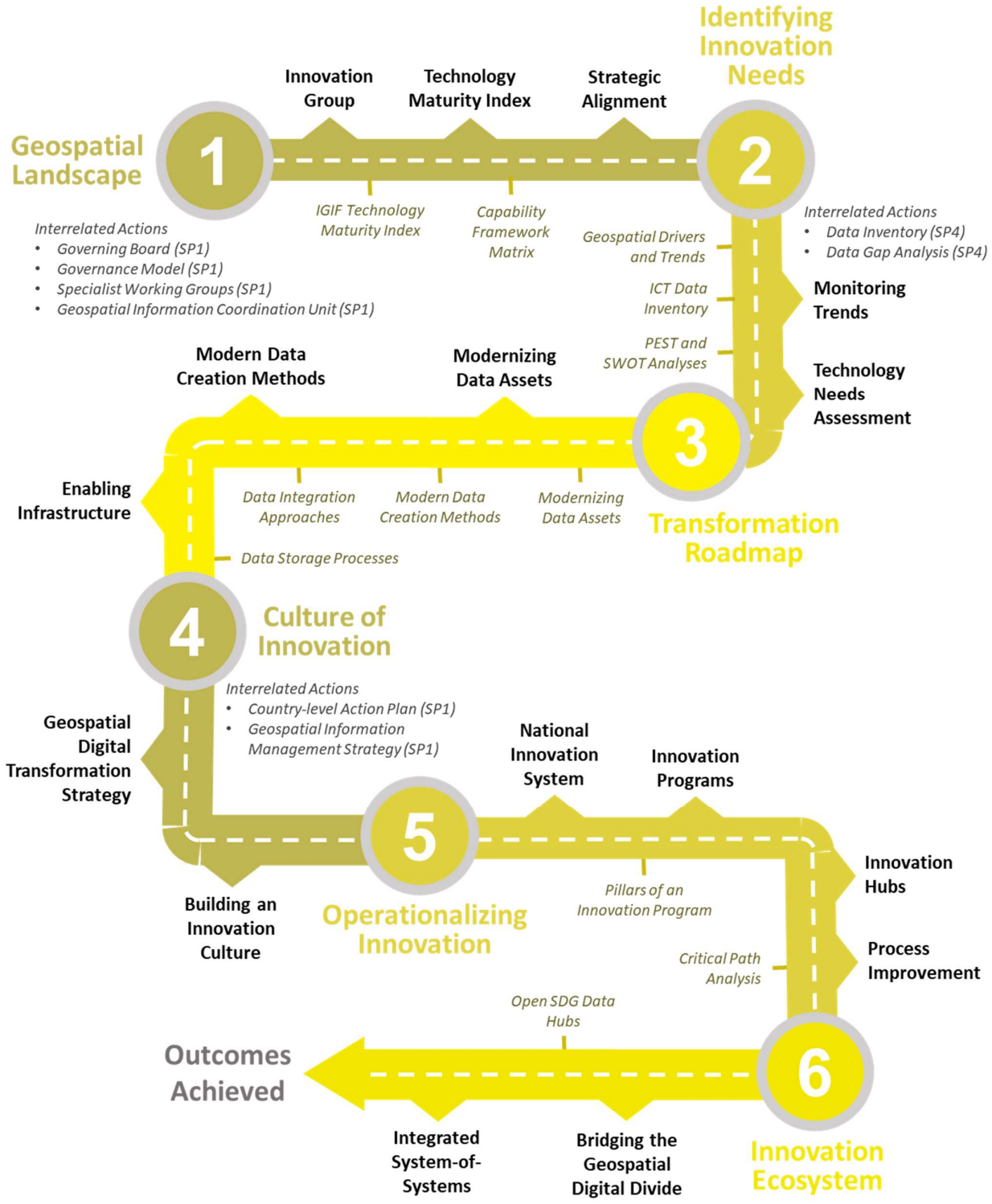

Figure 5.3: *Innovation includes several actions and tools designed to assist countries to stimulate the use of the latest cost-effective technologies, innovations and process improvements to deliver and strengthen integrated geospatial information management. The actions are divided into six categories and reflect the order with which these actions are typically completed.*

Figure 5.4: *Innovation includes several actions and tools designed to assist countries to stimulate the use of the latest cost-effective technologies, innovations and process improvements to deliver and strengthen integrated geospatial information management. The interrelated actions provide key linkages to other strategic pathway actions.*

and productivity benefits. This is becoming particularly relevant as national geospatial information agencies transition from traditional data supply models to more modern 'data on demand' and 'knowledge services' approaches.

The Innovation Group considers technologies and processes that improve the management and application of geospatial information.

The Governance Model for integrated geospatial information management (See SP1: Action 1.6.4) should typically include a Specialist Working Group (See SP1: Action 1.6.3), referred to here as the 'Innovation Group' to consider, propose and oversight the implementation of technologies and methods that improve the management, sharing and use of geospatial information across government.

The Innovation Group's ultimate aim is to strategically guide the implementation of information, products, applications and services that provide government, businesses and the general community with better decision-making tools. This includes consideration of modern practices and innovative technologies and methods.

The Innovation Group should report directly to the Geospatial Coordination Unit (See SP1: Action 1.6.2) and would typically have the following roles and responsibilities:

- Guide the development of the Geospatial Digital Transformation Strategy (See SP5: Action 5.6.9);
- Monitor and advise on the technology and innovation developments, trends, and future directions for geospatial information management;
- Ensure proposed process improvements and innovation efforts are in line with cross-government priorities, and are delivered in the national interest;
- Direct and monitor ongoing innovation programs and outcomes, and make further recommendations for improvement where necessary;
- Review any policy issues arising from the implementation of new technologies and methods, and make recommendations to the Geospatial Coordination Unit;
- Coordinate initiatives with other Specialist Working Groups (Data, Capacity and Education, Policy and Legal, Financial, etc.) that report directly to the Geospatial Coordination Unit to facilitate consistency, avoid redundant efforts, and manage program interdependencies, such as the need for capacity-building in new technologies;
- Guide the development of new policies, guidelines and reports related to technological innovation and digital transformation, as appropriate; and
- Engage with stakeholders on technology, process improvement and innovation opportunities so that programs are directed towards national priority needs.

The Geospatial Coordination Unit may appoint a senior official, with technology and digital reform expertise, to be responsible for the Geospatial Digital

Transformation Strategy. This senior official will typically chair the Innovation Group and report to the Governing Board on the development of the strategy and plan.

Once a Transformation Strategy and plan has been set, cross-functional teams can then be formed to implement the plan. It is a good idea to form teams from across relevant departments and agencies to steer geospatial digitalization projects. This will help ensure that the purpose of the project remains intact from the concept phase, through development, and to the launch.

See Interrelated Actions on Governing Board, Geospatial Coordination Unit, Specialist Working Groups, and Governance Model (SP1).

5.6.2 Technology Maturity Index

The IGIF Technology Maturity Index can be used as a guide to determine the starting point for the transition to new and innovative methods, processes and technologies.

Before embarking on a pathway of innovation and continual process improvement, the Innovation Group needs to first understand the country's level of maturity of the technology infrastructure to support a national geospatial information management program. The notion is to understand the current situation from a whole of government perspective, as well as the desired situation, in order to develop a roadmap for process improvement and technological innovation.

The IGIF Technology Maturity Index can be used as a guide to determine the starting point for the transition to new and innovative methods, processes and technologies. A detailed assessment is not necessary at this stage, as a review of the technologies and methods currently in use will typically be completed at a later stage (See SP5: Action 5.6.5).

The five levels (or stages) of the IGIF Technology Maturity Index are summarized in Figure 5.6 and detailed in Appendix 5.1. It is important to note that maturity levels may differ between organizations, and not all capabilities within a country will equate to a single level. For example, a country may associate with data storage as being at level 2 maturity, while data acquisition may have a maturity level 3.

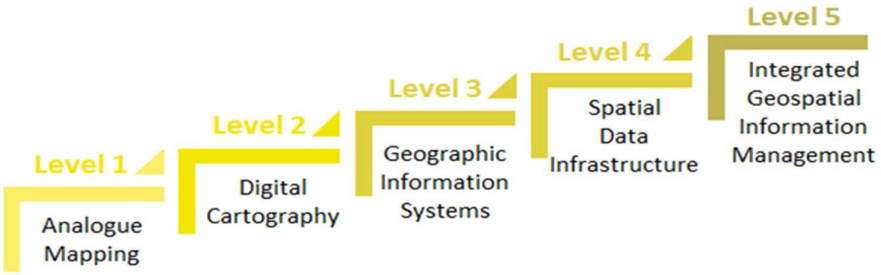

Figure 5.6: *The five levels of the IGIF Technology Maturity Index. Detailed further in Appendix 5.1.*

At this stage, the Maturity Index is used by the Innovation Group to form a consensus on the current deployment of information technology, to stimulate discussion towards a high-level roadmap, and to reach an agreement on the size of the innovation task ahead. The five levels of maturity are (Figure 5.6):

- **Level 1: Analogue Mapping** – Traditional 'manual' cartographic methods are used to prepare paper map products that are used for navigation, planning and visual analysis, and for recording boundaries such as planning schemes, land parcels and census districts etc. Maps and atlases are distributed over the counter.
- **Level 2: Digital Cartography** – Maps are produced using computer aided drawing/mapping packages that mimic traditional cartographic methods. For example, data is portrayed and presented according to map scale(s), as opposed to real world representations. Data is typically managed within institutional silos, and data and technology standards are likely to be ad hoc. Digital data files are shared via transportable storage devices, such as CD-ROM.
- **Level 3: Geographic Information Systems (GIS)** – Geographic data is managed within a GIS, typically based on service-oriented architectures and data clearinghouses that support web services and user-oriented functionality, such as the ability to retrieve and consume data directly onto applications. The geographic data is typically characterized by data harmonization through the adoption of national or international (ISO) standards.
- **Level 4: Spatial Data Infrastructures (SDI)** – Geographic data is delivered through an SDI – a data supply model characterized by enabling platforms and virtual globes that facilitate the sharing of data to meet domain-specific business goals, strategies, processes, and operations, as well as the creation of customized value-added products and services. The SDI employs common interoperable standards that enable information exchange and the delivery of e-services for government, industry and the public. Cloud storage and computing are often used to process and seamlessly analyze vast amounts of data.
- **Level 5: Integrated Geospatial Information Management** – An integrated geospatial information management environment, that enables cross-portfolio data and policy analysis, is achieved by consistently and reliably integrating all types of location-based data (i.e. different geographies) from across different domains of knowledge. Integrated information management involves multiple organizations providing numerous data inputs and advice. This brings versatility and responsiveness to complex decision-making and is the key enabler for

knowledge on-demand applications and global semantic networks of query-able Linked Data[4].

The IGIF Technology Maturity Index is provided in Appendix 5.1.

5.6.3 Strategic Alignment

Process improvements and innovations are strategically aligned to the priorities of government from an economic, social and environmental perspective.

The Innovation Group will be a key stakeholder in the development of the Geospatial Information Management Strategy (See SP1: Action 1.6.6). The Working Group advocates process improvements and innovations that are strategically aligned to the priorities of government from an economic, social and environmental perspective. These process improvements and technological innovations will form part of the Geospatial Information Management Strategy.

Geospatial innovation must also align with the country's digital transformation agenda (often referred to as the ICT strategy). There are two reasons why this is important. Firstly, innovation can be directed towards what matters most – this may be reforming land administration and valuation processes, enabling a common operating picture for disaster management, providing transparent governance through the ability to share government data efficiently and effectively, or it could simply be the need to reduce costs by eliminating data duplication. Secondly, by aligning innovation to national priorities, political support and buy-in is generally more likely, and there is greater potential for government investment.

Synergies between a digital transformation agenda (or ICT Strategy) and the Geospatial Information Management Strategy include the need to:

- Facilitate investment in enabling digital infrastructures;
- Improve access to, and use of, data while maintaining strong data safeguards;
- Improve trust, confidence and security around digital activities;
- Ensure regulatory frameworks are flexible, adaptable and fit-for-purpose;
- Deliver digital government services that are secure, fast and easy to use; and
- Champion an open, free and secure cyberspace.

[4] Linked Data is structured data which is interlinked with other data so it becomes more useful through semantic queries. It builds upon standard Web technologies such as HTTP, RDF and URIs, but rather than using them to serve web pages only for human readers, it extends them to share information in a way that can be read automatically by computers. (Bizer et al, 2009).

In contributing to the development of the Geospatial Information Management Strategy and influencing the country's digital transformation agenda, the Innovation Group will need to consider the following strategic alignment questions before embarking on a formal assessment (McKinsey, 2016):

- **Desired Situation:** If we are to strengthen geospatial information management, with no legacy structures or systems to start from, what would our systems look like, and what would be our top priorities?
- **Gaps in Capability:** What is the biggest difference between the vision (i.e. vision in the Geospatial Information Management Strategy) and where we are today with our geospatial information management practices?
- **Enablers:** What geospatial information program capabilities do government need to acquire to make up those differences, and what existing structures and systems would it have to abandon?
- **Current State:** How does government's current digital transformation efforts compare with the changes that are identified above?
- **Priorities:** What new priorities do we need to set for our geospatial digital transformation to bring it into line with the overall vision for improving government business?

By mapping the answers to these questions onto the framework of capabilities and enablers (Figure 5.7), the Innovation Group can set priorities for a powerful and lasting geospatial digital transformation agenda.

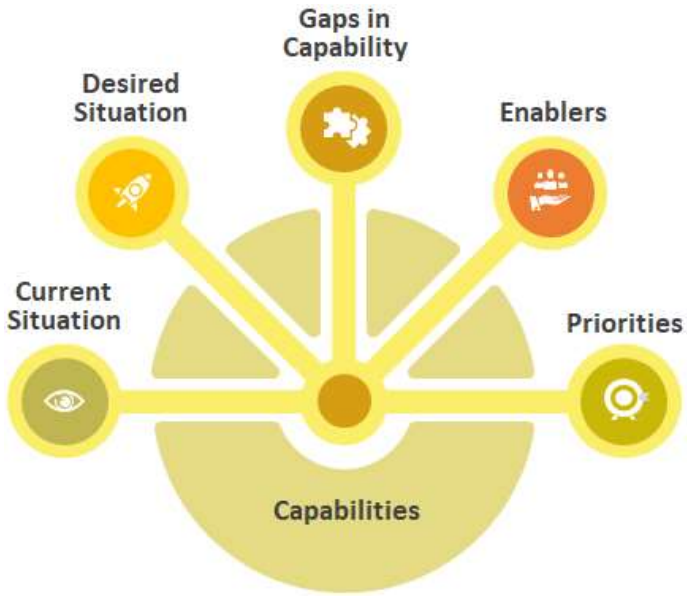

Figure 5.7: *Capability Framework*

An example of a Capability Framework Matrix is provided in Appendix 5.2.

5.6.4 Monitoring Trends

It will be valuable to continually review and monitor the drivers, trends, and future directions for geospatial information management; along with the technology and innovation developments.

In defining the Fourth Industrial Revolution, Klaus Schwab, on behalf of the World Economic Forum, noted that all new developments and technologies have one key feature in common; they leverage the pervasive power of digitization and information technology. Many innovations are made possible and are enhanced through digital power. Gene sequencing, for example, could not have happened without progress in computing power and data analytics. Similarly, advanced robots would not exist without artificial intelligence, which itself, largely depends on computing power (Schwab, 2016). These innovations change and embrace all aspects of life and living, including communication, education, employment, industry and its products, and government policies and services. Geospatial and location-based information is increasingly becoming a key part of this pervasive digital world of transformation and innovation trends.

The IGIF recognizes that geospatial information is a critical component of a national infrastructure and knowledge economy that provides a nation's blueprint of what happens where, and the means to integrate a wide variety of government services that contribute to economic growth, national security, sustainable social development, environmental sustainability and national prosperity.

The Future Trends Report has drawn on the global megatrends that convey the broad landscape of technological drivers of the Fourth Industrial Revolution, and analyzed those drivers and trends that are likely to have an impact on the geospatial industry over the coming decade. This high-level analysis shows that despite being driven by technological developments and the availability of new data sources and analytical methods, the geospatial industry is influenced by a much wider set of drivers. It appears certain that a data-driven society will fuel innovation which is central to growth within organisations and countries. Such innovation will be underpinned by developments in the areas of connectivity, sensor networks, data analytics, and cloud computing.

The Innovation Group will need to review and monitor these drivers and trends, along with the commensurate technology and innovation developments, and future directions for geospatial information management. This will inform and assist the Working Group in determining the level of technology maturity (See

SP5: Action 5.6.2) strategic alignment (See SP5: Action 5.6.3), and technology needs (See SP5: Action 5.6.5) necessary for a national geospatial information management program.

The Geospatial Drivers and Trends of the Third Future Trends Report are provided in Appendix 5.3.

5.6.5 Technology Needs Assessment

A Technology Needs Assessment determines where innovation is best directed to close the gaps in what a country desires in terms of their geospatial information management

A Technology Needs Assessment is typically undertaken to determine where innovation is best directed to close the gaps between what a country desires in terms of their geospatial information management capabilities and what they currently have. The assessment process typically includes five detailed steps. These are:

1. **Scoping Exercise** – to define clear goals and objective for the Technology Needs Assessment with respect to the desired future situation, the type of technology and processes to be considered, related studies (such as enabling policy and laws, and skills capacity assessment), and the extent of stakeholder consultations, such as the organizations and individuals.
2. **An Inventory** – to take stock of current technology used for collecting, managing, maintaining and sharing geospatial information. This inventory considers computing hardware (including mobile devices), software and applications (including SaaS and platforms), communication networks (including Internet connectivity and bandwidth), system interoperability, storage systems (including hardware and Cloud), equipment (such as data acquisition, surveying, geodetic, environmental sensors, etc.), data centers as well as any public facing open Internet portals and/or platforms.

   The inventory can be conducted as a high-level review that records government ICT capabilities, or it can be conducted as a 'deep dive' at an organization level – where in addition to understanding what ICT is available, the inventory is also used as a register to keep track of assets. As a minimum, the deep dive data inventory should record age/version, number and level of usage, as this information can be used to gauge technological innovation capacity.
3. **A Policy Review** – to be conducted in conjunction with the Technology Needs Assessment to understand the barriers to innovation. For example, some policies may stifle or explicitly prevent the development and adoption of innovative technologies and methods, such as data protections that restrict access to information.

4. **Data Needs Assessment** – understanding what data is required influences what technologies are needed. For this reason, it is best to conduct a Data Inventory (See SP4: Action 4.6.2) and Gap Analysis (See SP4: Action 4.6.4) at the same time as the Technology Needs Assessment.

5. **Risk Assessment** – to understand the risks associated with potentially disruptive technological change. For example, new technologies may have an implication on how governments undertake regulatory functions, while online (digital) services can make services less accessible or usable to a particular demographic. In addition, cultural norms may inhibit technological advancement. For example, some organizations may resist sharing their data, putting ICT projects, which aim to interconnect systems and data, at risk.

The Technology Needs Assessment will help the Innovation Group to better identify the things that are holding government back from achieving its geospatial information management goals. Knowing what is working well and what needs to change is crucial to progressing effectively towards geospatial information management strategic goals and making location-based services a success.

Gaps are likely to be identified in a number of areas including data, technology, knowledge, practices and skills, business intelligence, as well as data governance. Often, the best way to identify these needs is through PEST and SWOT Analyses. The PEST Analysis considers the **P**olitical, **E**conomic, **S**ocial, and **T**echnology issues that may have a positive or negative impact on achieving the geospatial goals with external stakeholders. The SWOT Analysis is used to identify **S**trengths, **W**eaknesses, **O**pportunities, and **T**hreats in relation to internal factors; namely the characteristics of government that are an advantage or disadvantage to geospatial information management, those aspects that can be exploited to advantage through IGIF implementation and those realities that are a threat to implementation.

The outcome of the Technology Needs Assessment is typically a report that identifies driving forces for change, what capabilities need to be strengthened and the barriers that are holding back change.

An example of an ICT Data Inventory is provided in Appendix 5.4.

An example of PEST and SWOT Analyses are provided in Appendix 5.5.

See Interrelated Actions on a Data Inventory (SP4); and Data Gap Analysis (SP4).

5.6.6 Modernizing Data Assets

For many countries, even before considering technological innovation, there is a need to digitally transform and modernize data assets. More efficient and effective methods are required to progressively update the accuracy, currency and coverage of a country's geospatial data holdings.

For many countries, even before considering technological innovation, there is a need to digitally transform and modernize data assets.

Geospatial information capture is time consuming and expensive, and even with the best efforts of government organizations, information can quickly become out-of-date, and/or there can be significant gaps in coverage. Incomplete and inaccurate data hinders business processes, may create administrative boundary disputes and cause delays in emergency response and evacuation.

When it comes to geospatial data capture and modernization, many countries, and developing countries in particular, typically have four starting points, or different opportunities to improve and potentially leapfrog to modern methods. As illustrated in Figure 5.8, the starting points include existing paper-based maps, limited or no geospatial datasets, partially completed geospatial datasets, or comprehensive geospatial datasets. These are described in Appendix 5.6.

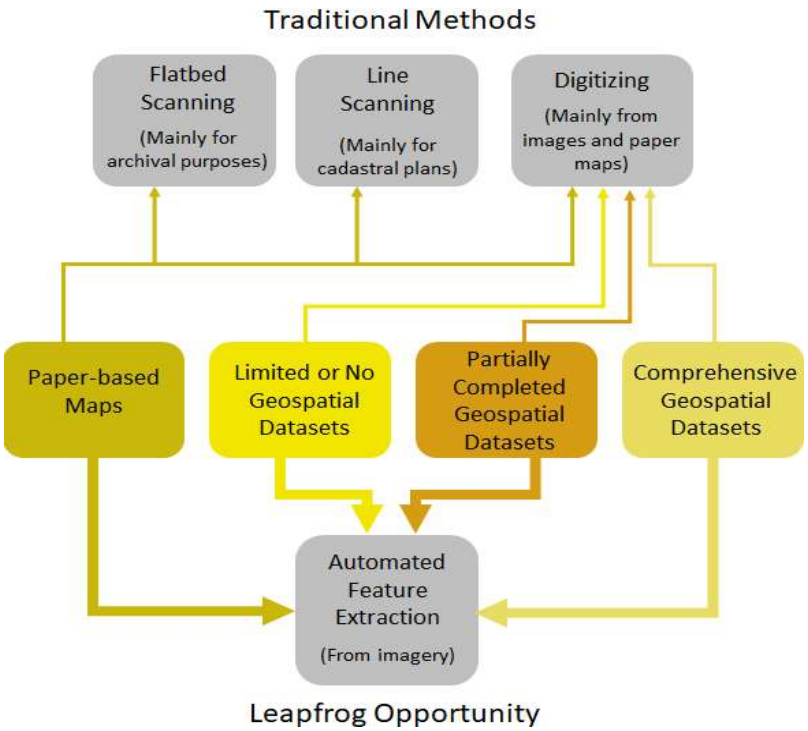

Figure 5.8: *Starting points and leapfrog opportunities for data capture and modernization.*

Examples of Modernizing Data Assets are provided in Appendix 5.6.

5.6.7 Modern Data Creation Methods

Modern data capture, creation and integration methods are being accelerated and improved through the emergence of new technological tools, innovation, and a greater variety of data sources.

Government policy and decision-makers are increasingly being called upon to use evidence-based research and integrated geospatial information to inform development decisions that will ultimately lead to the achievement of a nation's sustainable development goals.

However, while the objective of 'data analysis' is to enable decision-making, access to the right data is the first crucial step. Countries need access to fundamental and interoperable geospatial data, more rigorous modelling and analysis, and much better data dissemination and management. Linking different data – demographic, statistical, Earth observations, economic, environmental, Big Data, and other societal geospatial data – together with the one thing they have in common – geographic location – is critical.

For many countries, access to accurate and timely data, and associated analytics, remains problematic and undervalued. As a consequence, data-driven decision-making continues to be a major constraint to effective policy setting, and effective monitoring and evaluation of development programs. These problems are a very real impediment for many developing countries - those most affected by data challenges and need to achieve national development.

Fortunately, modern data capture, creation and integration methods are being accelerated and improved through the emergence of new technological tools, innovation, and a greater variety of data sources. The Future Trends Report highlights a number of these, including the following:

- Earth observation technology such as satellites, high altitude or vehicle-based sensors, which are providing a greater variety and volume of data about the Earth at a higher resolution, greater temporal frequency and at lower costs, than in previous years.
- Continued developments in image recognition and feature extraction, coupled with reduced storage costs, will provide opportunities for faster data capture and creation of geospatial information, and will come closer in quality and usability to that which can be achieved by traditional survey methods.
- The provision of mainstream web service infrastructures, making it easier to create new technology-based products quickly and more cheaply than before and to outsource costs.
- Applications of sensors, robotics, cameras, encryption, cloud computing and other software, and hardware intelligence, are converging to enable new ways for organizations to perceive and capture reality.

- Artificial Intelligence-driven solutions and machine-learning will drive cost efficiency, accuracy and speed in GNSS and positioning, spatial analytics and Earth observation.
- Satellites, unmanned aerial systems (UAS), and sensor technology are being invested in by leading tech giants that are existing providers of sensed imagery and governments.
- The integration of Linked Data and Spatial Data Infrastructures (SDIs) is a promising alternative to overcome issues concerning the discovery, access, exploration and use of spatial data through the Web that impair the full development of SDIs.
- The quality and quantity of crowd-sourced and volunteered geographic information (VGI) location-based content continues to grow. The willingness of 'crowds' to provide data or content for free, which is then monetized by the collectors of the data, continues largely unchallenged.

As countries undertake a Technology Needs Assessment, it is recommended that the Future Trends Report is used as a reference to trigger innovative and creative thinking to solve geospatial information management challenges and address gaps in data holdings.

Examples of Modern Data Creation Methods are provided in Appendix 5.7.

Examples of Data Integration Approaches are provided in Appendix 5.8.

5.6.8 Enabling Infrastructure

For some countries, the potential to capitalize on the true value of the nation's geospatial information assets can be limited because data storage and access is generally managed in closed systems of government. Storage, access to, and sharing of, data between government agencies remains one of the main challenges on a technical, policy and legal level. While, organizations across the government sector often recognize that current processes may be inefficient, there is often no technology available to readily store and share their geospatial data with others.

The potential to capitalize on the true value of geospatial information can be limited because access is generally managed in closed systems of government.

To resolve data storage issues, many countries are now implementing cloud-based storage systems as modern alternatives, and which provide scalable, cost-effective data storage and computing resources that can be used as and when required. These computing resources are anchored by third-party providers that offer a combination of physical hardware, networks, storage, services and interfaces that are needed to deliver computing as a service. Cloud computing and the internet have transformed the way in which organisations are able to manage data. An increasing amount of data is now being stored in cloud services. There are several advantages, including the opportunity to access,

adjust and share information more efficiently, thus increasing economies in data storage.

Internet-based geospatial information data hubs or portals (often referred to as geoportals) are able to provide access to geospatial information from a single location. The geoportal, with its underpinning enabling infrastructure, is an integrated environment where data and products from multiple agencies can be uploaded, discovered, viewed, queried and downloaded. These platforms, which are typically deployed within the framework of the National Spatial Data Infrastructure (NSDI) provide governments with a solid foundation towards transitioning to online citizen-centric whole-of-government services.

There are a number of off-the-shelf systems that provide capabilities to implement a geoportal and enabling Infrastructure, as well as an open source approach that combines OGC Reference Model architecture and Service Orientated Architecture (SOA) design concepts to provide standards-based integration between GIS and business applications, and data services. A typical conceptual model is shown in Figure 5.9.

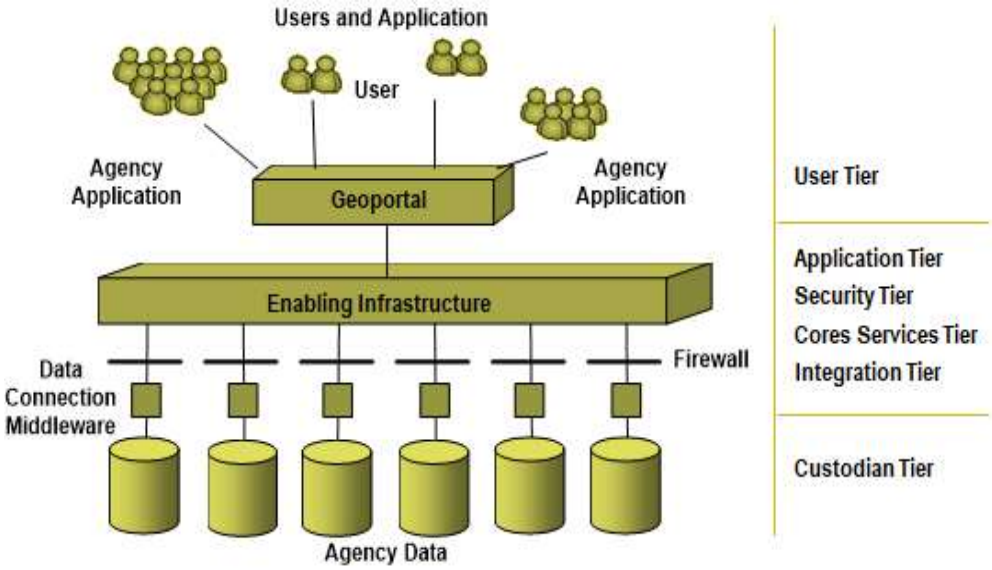

Figure 5.9: *Conceptual view of a geoportal and enabling infrastructure.*

There are typically six tiers to an enabling infrastructure:

- **User Tier:** Provides access to the data and geospatial services through a geoportal.
- **Application Tier:** Provides the tools to visualize, download and search for geospatial data.
- **Security Tier**: Provides data security and access authentication.
- **Core Services Tier**: Provides the data catalogue and metering services that manage usage and payment services.

- **Integration Tier:** Links the application tier to the virtual data stores.
- **Custodian Tier:** Enables custodians to upload data so that it is available to users.

A key consequence of adopting a shared approach is that agencies can build information systems which integrate geospatial information at a reduced cost when a shared foundation is in place. However, it is important to note that the geoportal and enabling infrastructure approach is a human-machine communication in that it requires a person to search a data catalog of metadata or manipulate a map view to locate information. Data mining[5] is typically not possible.

Current technology and innovation trends suggest that geoportals and NSDIs will transition towards 'spatial knowledge infrastructure'. A Spatial Knowledge Infrastructure (SKI) is a network of data, analytics, expertise and policies that assist individuals or organisations to integrate real-time geospatial knowledge into everyday decision-making and problem solving (CRCSI, 2017). The IGIF builds on the achievements in planning and implementing NSDIs, but focuses more on the collection of data and the implementation of technology.[6]

Examples of Data Storage Processes are provided in Appendix 5.9.

5.6.9 Geospatial Digital Transformation Strategy

The speed at which innovation occurs represents great opportunities and challenges to those trying to prioritise efforts. However, innovation does not occur with one single action, but rather through a series of many coordinated forward-looking steps. This is why a Geospatial Digital Transformation Strategy is so important. It helps to organize the important steps and keeps all stakeholder on the same path. It also considers the opportunities that digital technology and innovation creates, and sets transformation goals in line with overall government priorities.

The Geospatial Digital Transformation Strategy is important because Innovation does not occur with one single action, but rather through a series of many coordinated forward-looking steps.

A Geospatial Digital Transformation Plan is often a specific plan focusing on technology needs and process improvements. The plan complements the

[5] Data mining is the process of examining large databases to discover new patterns and generate new information.

[6] See 'Solving the Puzzle: Understanding the Implementation Guide; and the Future Trends Report.

Country-level Action Plan (See SP1: Action 1.6.8) and is strategically aligned to the Geospatial Information Management Strategy (See SP1: Action 1.6.6).

The reason for a Digital Transformation Plan is that technology is cross-cutting, and will have implications as well as benefits across a number of geospatial projects. The Digital Transformation Plan will make it easier to coordinate and visualize activities in terms of system interoperability, economies of scale, capacity needs, policy and regulatory needs, procurement efficiency and monitoring and evaluation. Illustrated in Figure 5.10, considerations include:

- **Interoperability:** How the different project-specific technologies align, particularly with regard to transferring information, as geospatial data supply chains will be technology interdependent and need to be considered holistically from an interoperability viewpoint;
- **Economies of Scale:** Whether one solution can be utilized for all projects e.g. whole of government, cybersecurity, and cloud computing for data storage and information processing etc.;

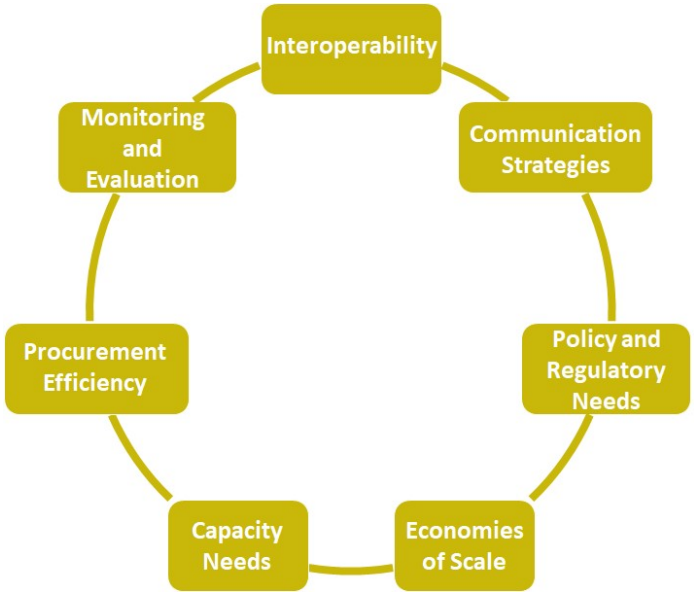

Figure 5.10: *The Geospatial Digital Transformation Plan coordinates and visualizes cross-cutting activities.*

- **Capacity Needs:** The impact that new technologies will have on human resources and the need for cross-cutting capacity-building programs in a number of skills and areas of innovation e.g. IoT platforms, machine-learning, data security and information classification;
- **Policy and Regulatory Needs:** Where existing policies and laws are a barrier to innovation and process improvement, so that new/revised policies can be implemented in a way that benefits all projects;
- **Procurement Efficiency:** Whether hardware and software procurement processes can be organized and rolled-out in way that delivers most cost

effective and efficient options when requirements are considered holistically;

- **Monitoring and Evaluation:** Whether digital programs are providing the benefits they were meant to provide, and whether those programs should be adjusted to reflect shifts in societal conditions or digital trends; and
- **Communication Strategies:** Whether similar communication approaches can be use across the broader range of projects, particularly if there are common stakeholder groups.

See Interrelated Actions on a Country-level Action Plan (SP1); and Geospatial Information Management Strategy (SP1).

5.6.10 Building an Innovation Culture

Constant change is the new normal. For government organizations in the ICT sector – including geospatial agencies – this is certainly the case. In organizations where agile and adaptive digital transformation and technology evolution prevail - people are now required to be just as agile, adaptive, and innovative in that change. After all, it is not organizations that change, it is their people.

Creating an innovation culture in an organization is as important as the latest cost-effective technologies, process improvements, and business practices being implemented.

Creating an innovation culture in an organization is as important as the latest cost-effective technologies, process improvements and business practices being implemented. Innovation is not a project or a task, unlike the research and development (R&D) concepts of the past. An innovation culture is a by-product of an organization's broader business decisions, and starts at the leadership level where the foundation for innovation is created. Leadership 'in embracing innovation' provides a critical role in building cultural change and encouraging that change to flourish over the long-term – relevant to the organization and its position.

This includes monitoring what is happening across the industry and in other sectors, as well as recognizing signals of change both within the organization and in the broader market. What is the business now, and what must the business be in the future in order to remain relevant? Only when an organization can answer this question will it become clear how the organization must think and behave in order to achieve its goals, and thus the cultural changes required in order to move forward. These factors and considerations form the 'people' side of the Geospatial Digital Transformation Plan (See SP5: Action 5.6.9), and the 'capacity needs' considerations in particular.

An innovation culture will encourage organizations to embrace new technologies, strive for knowledge, and remove barriers to creativity and opportunity. It will enable creative staff to pursue the organization's objectives,

key focus areas, core capabilities, and commitments to stakeholders. Communicating organizational goals and objectives is important.

Understanding and creating a culture of innovation are among the most difficult challenges faced by leaders and managers. Change is threatening – staff can feel threatened by digital or technological changes that may be perceived as making their roles redundant. To address these fears, leaders must explain that change is an opportunity, not just a disruption. As a guide, Figure 5.11 illustrates a conceptual approach and structure towards building a culture of innovation in an organization.

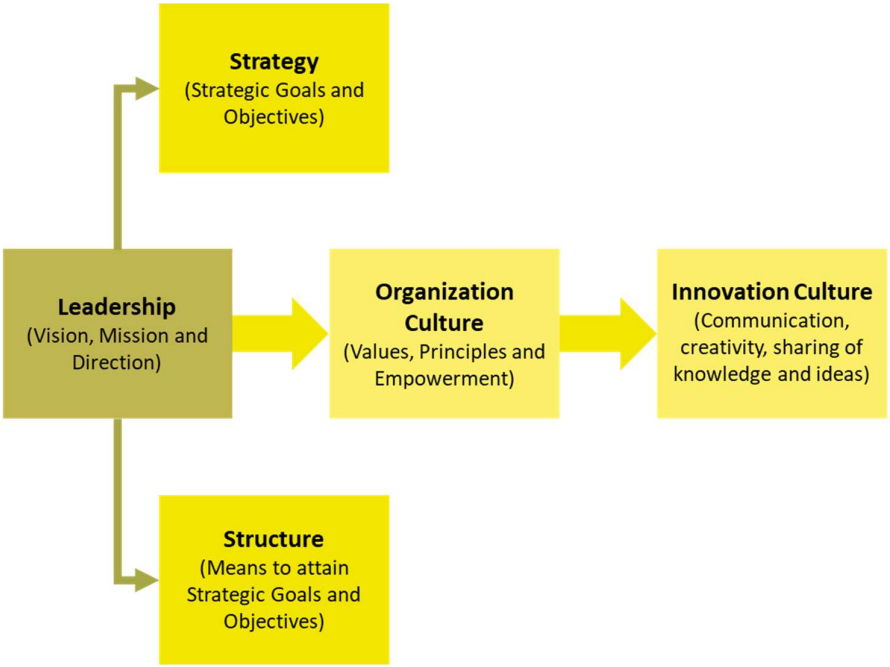

Figure 5.11: *Conceptual approach and structure towards building a culture of innovation in an organization.*

A culture of innovation is built on the following elements:

- **Leadership:** The central role of organizational leadership and vision in advocating the organizational changes vital to sustain innovation potential;
- **Strategy:** Provides the opportunities through strategic goals and objectives that can influence the path to create and sustain innovation culture;
- **Structure:** Represents the structural characteristics of the organization, methods of assigning responsibilities, the way the organization interacts, and the way staff communicate;
- **Organizational culture**: Source of the principal feature in nurturing culture i.e. the shared values, beliefs and behaviors. The organizational culture works as a mediator and is influenced by the leadership in order

to produce a culture of innovation. The emerging culture will determine how creativities are encouraged, how much risks are taken, and to what extend sharing of knowledge and ideas is the norm.

- **Innovation Culture:** This is the outcome of the previous interactions. An innovation culture includes flexibility, oriented visioning, empowering, appreciation of ideas, risk tolerance, communication and collaboration, cultivating external relationships, encouragement, and shared decision-making.

5.6.11 National Innovation System

National Innovation Systems are a key driver for economic growth and productivity improvement.

A key component of the innovation process is the flow of technology and information among people, enterprises, businesses and institutions. This flow is referred to as the National Innovation System (OECD, 1997). National Innovation Systems (NIS) are a key driver for economic growth and productivity improvement. They are influenced by, and are able to influence, financial, policy, governance and institutional frameworks. Economic activities are becoming more and more knowledge-intensive, as seen in the growth in high-technology industries and the increasing demand for highly skilled people. The NIS helps to enhance a country's innovative and technological capacity through these processes – and to enhance innovative performance in today's knowledge-based economy.

There are distinct differences between countries when it comes to innovation. Many are yet to achieve a culture of innovation to grow and prosper in competitive global environments. Building this culture requires a system that enables organizations to create a more agile, creative and competitive economy.

Where NIS exist, the approach to innovation is often ad hoc, and narrowly focused on academic research and development. In order to drive sustained economic growth, productivity improvement and innovation, a supportive and incentivized policy framework is required (OECD, 2017). This then has the potential to provide access to investment, subsidies and incentivized programs that support start-ups and larger companies to connect with global value and supply chains.

NIS are typically established at the national level and can be sectoral – focusing on a particular aspect of innovation, such as agriculture and industrial development. These systems typically set the priorities for innovation programs established at a sub-national, organizational and/or community level (See SP5: Action 5.6.12).

Elements of a NIS generally encompass infrastructure and knowledge, collaboration, education and skills, funding, regulation and policy, and culture. These are all equally important elements, and when considered together in a systematic and joined-up manner, they can address a country's long-term strategy in business innovation, and in collaboration between government, researchers and industry. As an example, the Australian Innovation System is illustrated in Figure 5.12. This innovation system can be adapted to suit a county's innovation culture where geospatial innovation is central to its core. Objectives are to:

- Support high-quality research that addresses national geospatial challenges and opens up new opportunities;
- Build a strong base of skilled researchers to support the national geospatial research effort in both the public and private sectors;
- Foster geospatial-related industries of the future, securing value from the commercialization of research and development;
- Enable more effective dissemination of new technologies, processes, and ideas;
- Increase innovation across the economy, with a particular focus on small and medium-sized enterprises;
- Encourage a culture of collaboration within the research sector and between researchers and industry;
- Assist researchers and businesses to be involved in more international collaborations on research and development; and
- Encourage the public and community sectors to work with others in the innovation system to improve policy development and service delivery.

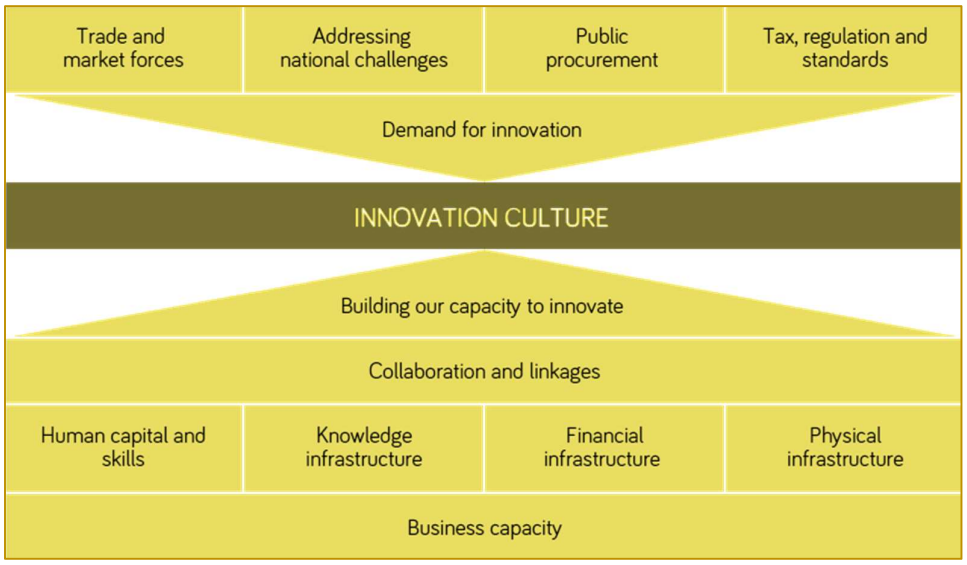

Figure 5.12: *Australia's Innovation System (BCA, 2014)*

5.6.12 Innovation Programs

Innovation programs are a subset of a National Innovation System - used to take new ideas or new ways of doing business and make them viable.

Innovation programs are a subset of a National Innovation System. The objective of an innovation program is to take new ideas or new ways of doing business and make them viable. Innovative change may be simple, incremental ideas that can be implemented immediately; or visionary ideas requiring research to ascertain their viability and long-term development.

Innovation programs are typically adopted to capture and fund new ideas; build research and development capacity and support an innovation culture across government and within organizations. Many governments have supported innovation programs within and across organizations to build their knowledge economy. There have been various degrees of success. The challenge has been to develop innovation programs that maintain the initial impetus for new ideas, methods, products and services, and enable success to continue in a repeatable and sustainable way.

Innovation programs are an investment in the future, and therefore require a long-term view to realize all of the benefits. Innovation programs that have achieved success are those that recognize innovation is a mindset that needs to be embedded within and across organizations. This means providing avenues for all staff to be involved in the innovation program – the notion being the greater the momentum, the higher the chance of success. Timeliness is a major factor. Innovation cannot become a part of an organizational culture if the lag between idea and production is too great.

Innovation programs typically include five pillars – innovation management, innovation infrastructure, the internal innovation community, open innovation community and monitoring and evaluation. These five pillars are elaborated in Appendix 5.8.

An Example of the Pillars of an Innovation Program is provided in Appendix 5.10.

5.6.13 Innovation Hubs

There are a growing number of success stories that demonstrate how countries can stimulate innovation and creativity – transforming the way work is done to generate economic growth and societal well-being. One such approach towards digital transformation strategies are innovation hubs. Geospatial innovation hubs and incubation centres are not a new concept but have seen a surge in interest in recent years. Sponsored by national geospatial agencies, geospatial innovation and entrepreneurship is being driven by the creation of innovation

Geospatial innovation and entrepreneurship is being driven by the creation of innovation hubs and programs aiming to support new and emerging start-ups in the geospatial sector.

hubs and programs[7] aiming to support new and emerging start-ups in the geospatial sector.

These innovation hubs are being established through seed funding, capacity development, public private partnerships, learning programs, and mentoring opportunities. Importantly, they leverage access to national geospatial datasets to solve real-world challenges. These programs are targeted at both early stage start-up companies and seasoned corporations that are looking to adopt geospatial technologies, processes, specifications and data to solve problems and build new applications. They create solutions and jobs, support national prosperity and bring together multiple disciplines from the private sector, academia and government agencies to drive geospatial innovation and data use.

More recently, private sector organisations have started to embrace the notion of innovation programs (See SP5: Action 5.6.12) providing tech-start-ups with access to industry-expertise in business management, marketing, product development, as well as mentorship.

Technology and innovation hubs are becoming part of enterprise innovation strategies, helping to self-disrupt the geospatial industry and ensure its continual evolution. To keep pace with the ever-increasing user expectations and technological advances, an increase in the number of geospatial innovation incubators is expected; run both by national geospatial agencies and private sector organisations.

This strategy is also being realized by the United Nations and UN-GGIM through the proposed establishment of a United Nations led Global Geospatial Knowledge and Innovation Centre in Deqing, China[8]. As a collaborative knowledge, technology and innovation hub for bringing contemporary methods in geospatial information together, the objective of the Centre is to provide a much-needed platform to strengthen and advance national geospatial information management, systems and capacities in countries. The Centre's overarching goal will be to work towards the ambitions of implementation of the IGIF set by countries, to develop capacity, promote and support the required innovation, leadership, coordination and standards to develop, strengthen, integrate and deliver national geospatial information policy, data, systems, tools, services and capabilities.

[7] National government examples include Geovation Hub in the United Kingdom: https://geovation.uk/; GeoHive in Ireland: https://geohive.ie/index.html; and GeoWorks in Singapore: https://geoworks.sg/.

[8] http://ggim.un.org/meetings/GGIM-committee/9th-Session/documents/E-C.20-2020-4-Add_1_Strengthening_Geospatial_Information_Report_31July2019.pdf

5.6.14 Process Improvement

Process improvement is the proactive task of identifying, analyzing and improving existing business processes, methods, and standards of quality. When implementing continuous process improvement in government, one of the key factors to consider is organisational readiness – elements such as having a process view, developing a culture focused on improvement, and an understanding of the customer (including the public) and the 'value' within the organisation (Radnor, 2010).

When implementing continuous process improvement in government, one of the key factors to consider is organisational readiness.

The key success factor is strong leadership and visible support from management. Other success factors include an effective communication strategy, appropriate training and development, providing resources and time for the improvements to take place and, using external expertise and support. Importantly, process improvement should be viewed and understood as a philosophy – more than just a policy and a set of tools.

Further, and in a similar vein, managers will need to view their organizations as a system and not a series of functional processes or activities. This means supporting a structure which is 'value facing' rather than 'management facing'. This may mean understanding processes not just across functional but organizational boundaries. This will bring about a better understanding of variety and variability of demand so that resources and capacity can be designed to respond around different types of 'customer' groups and demands.

By focusing on value, process and variation through viewing the organization as a system and understanding the data, it is possible to achieve impact in terms of improved time, cost savings, service quality as well as employee morale and satisfaction – all which support in achieving the requirements of the efficiency agenda. However, public sector leaders and managers need to fully understand what this means, commit and support it and not merely view it as another policy. They must view it not as set of tools but as part of an organizational strategy which can include rapid successes (which help in justifying its use particularly in a changing political environment) that fundamentally consists of a shift in culture, thinking and structure.

Critical path innovation is one way to progressively work towards process improvement. The process is to critically analyze existing, and often complex, geospatial information management workflows and procedures. This analysis is important for uncovering inefficiencies and barriers. Critical path innovation is not necessarily about being radical. In many cases, small incremental process improvement steps can be taken early to streamline data access. When connected, these steps will lead to improved business intelligence capabilities. Small innovative process improvements are often more effective than one large

project, particularly given financial constraints and difficulties associated with overcoming cultural barriers to change.

Examples of the Critical Path Analysis process are provided in Appendix 5.11.

5.6.15 Bridging the Geospatial Digital Divide

Although innovation and creativity have potential to significantly impact on, stimulate and embrace rapid change, and bridge the geospatial digital divide in developing countries, there is a general lack of capacity to do so.

An aspiration of the IGIF, and captured in its mission, is to assist developing countries to stimulate action towards bridging the geospatial digital divide. This is a major goal. However, a number of impediments beyond the control of national geospatial information agencies in many countries, ensure that some solutions will remain complex and difficult in their implementation.

At a basic level, addressing the gaps of the digital divide is a complex process that requires action on multiple fronts, including equitable access to computers, the Internet and other ICT resources; the opportunities to develop and adopt the knowledge and skills to increase computer literacy; and the value of inclusive understanding and use of the content, technology and uptake of digital continues to limit the ability for some developing countries to capitalize on many of the even basic geospatial capabilities that are heavily dependent on wireless and broadband Internet applications as the backbone of the digital ecosystem.

Additionally, the dynamic nature of technology change and innovation is difficult for developing countries to keep pace with. Although innovation and creativity has the potential to have a significant impact on stimulating and embracing rapid change, leapfrogging[9], and to bridge the geospatial digital divide in developing countries, there is a general lack of capacity to do so without considerable industry and financial support, including in the establishment of geospatial technology centres of excellence and innovation networks.

The digital divide not only limits the exploitation of data itself. When viewed through a geospatial lens, the digital divide extends to, and is compounded by, the gaps in the geospatial digital divide. Breaking the six 'gaps' in Figure 5.13 down to the most basic levels, there are several fundamental impediments that

[9] Leapfrogging generally refers to the adoption of advanced or state-of-the-art technology in developing countries in an application area where immediate prior technology has not yet been adopted.

are persistent and must be overcome to bridge the geospatial digital divide (Scott and Rajabifard, 2019). These include:

- **Digital Access:** Is core to bridging the digital divide and geospatial digital divide. Bringing people online in the first instance is both the greatest challenge and success. Many developing countries are in a special situation. Having access to reliable electricity and the Internet are the greatest impediments. Without these basic commodities, access to ICT, computers and technology becomes irrelevant;
- **Digital Adoption:** While stemming from lack of skills, literacy and knowledge, it is lack of 'opportunity' to participate in the information society that is the greatest impediment. Bringing people online will increase skills and literacy at a rapid rate, particularly with the younger generations;
- **Digital Value:** Inclusion (or exclusion), demographics (gender, race, ethnicity, age, education, social status) and geography (urban versus rural) are the main impediments, are almost entirely socio-economic in nature, and require medium to long-term strategies to be implemented by governments to overcome them. The solutions to these problems reside outside of the realm of technology, but are critical for innovation;
- **Data Ecosystem:** The impediment is lack of data. More geospatial data, including fundamental data, information and resources need to be created, accessible, sharable and online. Countries should be able to access and derive national benefits from this wealth of data – but this is not the case. Nor are they leveraging value from data contributors from local and regional governments, private companies, academia, civil society, and citizens including crowdsourced and volunteer geographic information;
- **Geospatial Technology:** The enabling, and increasingly growing, technology innovations and digital transformation is growing every day. The impediment is access and literacy to use it. Harnessing and using technology, and with the appropriate skills and bandwidth (including high-end or low-end options), is the challenge. While technology opportunities remain unevenly distributed, they are solvable, and industry is leading in this area. Further, leapfrogging with technology provides new opportunities; and
- **Geospatial Policy:** The lack of integrated and interoperable frameworks and guides has been the major impediment until now, but can be rectified through the IGIF. The leadership and role of government and institutions as facilitators, is critical to ensuing that no one is left behind, and should not be underestimated.

Many developing countries face similar digital divide and geospatial digital divide challenges, yet are addressing and prioritising them slightly differently, depending on context and national priorities. There is no doubt that the combined momentum of the 2030 Agenda and digital transformation, including

the Fourth Industrial Revolution, is having an impact, building digital capacities as an accelerator for SDG implementation. But there are still concerns that they are not yet inclusive enough and that (growing) disparities still exist. Unlocking the potential of creative innovation and digital technology offers opportunities to increase the effectiveness, efficiency and coverage of development, but national policy, laws and regulation will need to provide better direction and an enabling environment for innovation and technological progress.

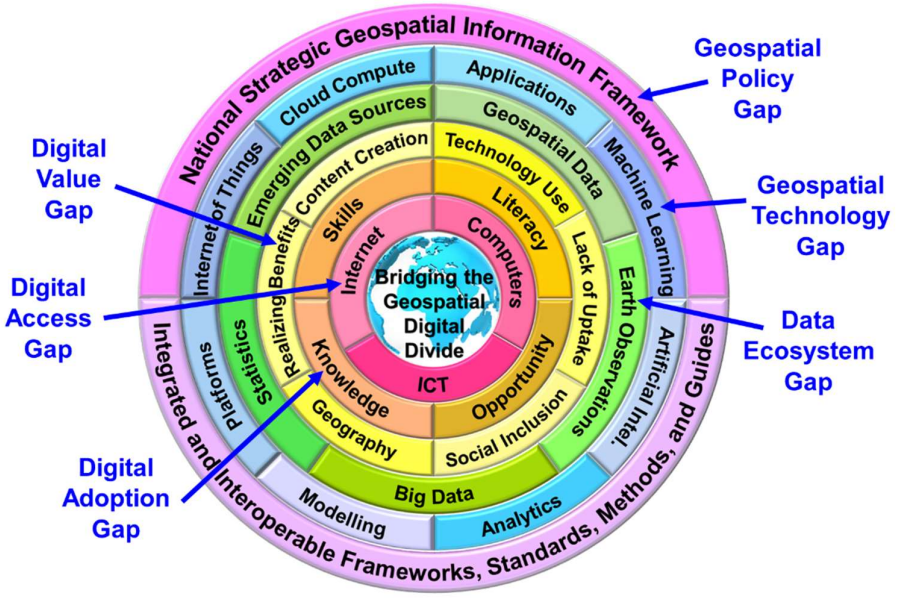

Figure 5.14: *The gaps of the geospatial digital divide (Scott and Rajabifard, 2019).*

5.6.16 Integrated System-of-Systems

The implementation of a system-of-systems approach, with reliable, secure and scalable platforms and data hubs, will assist countries in their efforts to address national priorities and monitor and report on the SDGs.

As detailed in this strategic pathway, and referenced in several others, technology and innovation trends are shifting away from the traditional pattern of agencies storing and maintaining data in silos to the development of an integrated, or federated, system-of-systems approach.

A 'system-of-systems' can be viewed as multiple, often dispersed, independent systems as part of a larger, more complex system. A system can be viewed as a group of interrelated and interdependent components, including resources and capabilities, which interact to form a complex and unified whole – offering more integrated functionality and performance. GIS, in itself, is a 'system'. The aspects of geospatial information mentioned throughout the IGIF – data, software, algorithms, analytics, devices, tools and services – are what make up the systems and their capabilities.

Utilizing integrative technologies for implementation of a system-of-systems approach, with reliable, secure and scalable platforms and data hubs, will assist countries in their efforts to address national priorities and monitor and report

on the SDGs. In a geospatial context, this means bypassing the heavy legacy geospatial technology, infrastructure and practices adopted in past years, and leaping with technology to more agile and flexible geospatial solutions that leverage technology, cloud services, the semantic web, and analytics.

An example of such a federated system-of-systems approach has been the implementation of a Federated Information System for the SDGs (FIS4SDGs). This initiative focuses on the development of a scalable global network of interoperable and country-led SDG Data Hubs that are able to connect to a global Open SDG Data Hub[10]

The FIS4SDGs enables the implementation of a system-of-systems approach to securely collect, store, access, analyze, manage and share policy-relevant, actionable SDG data and information at the global, national and sub-national levels in an integrated and scalable environment. The strategy is to develop an open, interoperable, standards-based, and federated system that leverages web and GIS technologies as an integration framework for data analysis, collaboration, user engagement, and communication.

As the Fourth Industrial Revolution evolves, and with growing expectation for a future 'knowledge on demand' within society and the knowledge economy, geospatial knowledge infrastructure (GKI) concepts are also rapidly evolving. GKI is being seen as enabling trusted understanding, knowledge, decisions and automation through integrating location, geospatial technologies, geospatial information, analytics and visualisation into the knowledge and automation environments of our cooperative digital future.[11]

Driven through a geospatial industry perspective, GKI aims to move the geospatial sector closer to the wider Fourth Industrial Revolution data ecosystem, focussing on delivering knowledge to support human and machine decision-making. In parallel, GKI will increase the use of geospatial data, information and knowledge across business and government, setting the conditions for better evidence-based decisions. In this regard, the GKI will build upon the IGIF as coherent set of elements that will contribute to bringing geospatial cognition to the heart of the data, knowledge and decision-support ecosystem.

An example of Open SDG Data Hubs is provided in Appendix 5.12.

[10] https://unstats-undesa.opendata.arcgis.com/

[11] Insert the reference to the GKI White Paper here.

5.7 Deliverables

The list of deliverables below are the outcomes typically created as a result of completing the actions in this strategic pathway. They are key success indicators in realizing an Integrated Geospatial Information Framework. Examples include:

- Innovation Group
- Technology Maturity Matrix
- Strategic Alignment Study
- Monitoring Trends and Technology Needs
- Modernizing Data Assets and Data Creation Methods
- Enabling Infrastructure
- Geospatial Digital Transformation Strategy
- Building an Innovation Culture
- Innovation System and Program
- Innovation Hubs
- Process Improvement
- Bridging the Geospatial Digital Divide
- Integrated Systems-of-Systems

6.8 Outcomes

The following outcomes result from stimulating the use of the latest cost-effective technologies, innovations and process improvements:

- Improved processes for the collection, management, distribution and analysis of geospatial information, leading to more effective evidenced-based decision-making.
- Increased productivity and efficiency achieved through an innovation-enabled environment.
- An innovative workforce that creates and executes new processes and develops new products and services.
- The ability to bridge the geospatial digital divide through enabling technologies achieved through an innovation ecosystem.

6.9 Resources

As part of the work programme of UN-GGIM, there are a number of related initiatives and activities, including by the Subcommittee, Expert and Working Groups of the Committee of Experts. These initiatives and activities are multi-stakeholder when arriving at outcomes and outputs. This inclusive and

participatory nature of work has allowed the preparation of a number of resource documents/publications that are helpful and useful when addressing the complexities of implementing innovation programs, especially in developing countries.

This includes specifically the work and contributions of the following reports:

- Future Trends in Geospatial Information Management: The five to ten year vision. Third Edition;[12]
- The value of Integrated Geospatial and Building Information Modelling (BIM) solutions to advance the United Nations Sustainable Development Goals (Agenda 2030) with specific focus on resilient infrastructure;[13] and
- Advancing Role of Geospatial Knowledge Infrastructure in World Economy, Society and Environment: A Discussion Paper.[14]

6.10 References

Bizer, C., Heath, T., and Berners-Lee, T. 2009. Linked Data – The Story So Far. International Journal on Semantic Web and Information Systems. 5 (3). doi:10.4018/jswis.2009081901.

CRCSI 2017. Towards a Spatial Knowledge Infrastructure. Australia and New Zealand CRC for Spatial Information. https://www.crcsi.com.au/assets/Program-3/CRCSI-Towards-Spatial-Knowledge-Whitepaper-web-May2017.pdf

Geospatial Media 2018. 2018 Geospatial Industry Outlook and Readiness Index.

McKinsey Center for Government. 2016. Digital by Default: A Guide to transforming Government. https://www.mckinsey.com/~/media/mckinsey/industries/public%20sector/our%20insights/transforming%20government%20through%20digitization/digital-by-default-a-guide-to-transforming-government-final.ashx

OECD 1997. National Innovation Systems. https://www.oecd.org/science/inno/2101733.pdf

OECD 2017. Embracing Innovation in Government,: Global Trends. https://www.oecd.org/gov/innovative-government/embracing-innovation-in-government.pdf

[12] http://ggim.un.org/documents/DRAFT_Future_Trends_report_3rd_edition.pdf

[13] Reference to the White Paper to be provided.

[14] Reference to the GKI Discussion Paper to be provided.

OECD 2018. Open Government Data Report: Enhancing Policy Maturity for Sustainable Impact, OECD Digital Government Studies, OECD Publishing, Paris. https://doi.org/10.1787/9789264305847-en

Productivity Commission. 2016. Digital Disruption: What do governments need to do? Commission Research Paper, Canberra. https://www.pc.gov.au/research/completed/digital-disruption/digital-disruption-research-paper.pdf

Radnor, Z. 2010. *Review of Business Process Improvement Methodologies in Public Services*, Advanced Institute of Management Research, United Kingdom.

Schwab, Klaus. 2016. The Fourth Industrial Revolution. World Economic Forum, Geneva. https://luminariaz.files.wordpress.com/2017/11/the-fourth-industrial-revolution-2016-21.pdf

Scott, G. and Rajabifard, A. 2019. SDGs Roadmap, *Sustainable Development Goals Connectivity Dilemma: Land and Geospatial Information for Urban and Rural Resilience,* pp. 13-44, CRC Press, Taylor and Francis Group.