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Digital Infrastructure: A Mini Review

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ABSTRACT
The digitization of almost every aspect of our lives implies that we now depend on the infrastructure that enables this connectivity. Digital infrastructure refers to the "bridges and roads" that support the global economy, in particular the digital economy. This includes data centers, fiber optic cable, and mobile phone. It is now indispensable necessity since it constitutes the foundation of the digital economy and enables the connectivity that we all enjoy. This is why national governments prioritize digital connectivity for their citizens. This paper introduces the reader to digital infrastructure.

KEYWORDS: *digitalization, digital technology, digital infrastructure*

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INTRODUCTION
Digital technologies came to the fore during the pandemic, with millions of people successfully working from home. The pandemic has demonstrated the importance of digital infrastructure assets. As the Covid-19 pandemic has introduced social distancing and lockdown orders across the world, the need for digital connectivity has become evident and pressing. There is no denying that the Covid-19 pandemic has pushed digital adoption forward.

WHAT IS DIGITAL INFRASTRUTURE?
Infrastructure has always been important to nations' economic growth and success. The infrastructure of any nation is the major driver for any country's competitiveness.

Nations have gradually improved their infrastructures for traffic, communication, and energy. However, the use of technology in traditional infrastructure sectors is lagging behind. Recent developments indicate the need to engage with digitization and critical infrastructure, as illustrated in Figure 1 [1]. There is a need for targeted implementation of the digital infrastructure to prevent a nation from losing its competitiveness.

Digital infrastructure refers to the interconnection of physical and virtual technologies (such as compute, storage, network, applications, and IaaS, PaaS and SaaS platforms) to provide the foundation of a company's operations. It serves as the basis for "Industry 4.0" innovations, digital activities, and significant productivity improvement. Connectivity, information and communications technology (ICT), and transport are the major building blocks of digital infrastructure. The physical assets include data centers, macro towers, small cells, fiber optic cables, sub sea cables, and satellites. Figure 2 shows a typical digital infrastructure [2].

Digital infrastructure has become more of an indispensable necessity today. It is the building block of a modern economy. As shown Figure 3, examples of digital infrastructure include [3]:

- *Internet Backbone:* Computer networks have become critical infrastructure for nations around

the world. Continents, nations, and regions connect networks to form the Internet, includes communications cables and facilities. Roughly 60% of the world's population uses the Internet mainly for shopping.

- *Mobile Telecommunications:* This consists of cellular networks that provide wireless broadband Internet and communication services.
- *Virtual Technologies:* These include compute, storage, network, applications, and IaaS, PaaS, and SaaS platforms.
- *Fiber Optics Cable:* This connects data center to a macro tower to enable transmission of data to our mobile devices.
- *Communications Satellite:* Satellites cover continents and provide information services across regions of the world.
- *Data Centers*: These refer to facilities that manage computing, data storage and network services.
- *APIs & Integration Services:* These services permit various platforms, systems and applications to work together and share information. It has become so popular in recent years that it is an indispensable part of the economy.
- *User Devices:* Devices such as mobile phones, laptops, IoT Robots, machines, sensors, and facilities fall under this category.

This is by no means a comprehensive list. Figure 4 shows the key elements of digital infrastructure [4]. Each element is necessary to create robust, scalable, sustainable, and equitable infrastructure for the society. Each element defines a component of infrastructure that must be addressed.

APPLICATIONS OF DIGITAL INFRASTRUCTURE

Digital infrastructures can be regarded as shared, heterogeneous, open, and evolving sociotechnical systems comprising an installed base of diverse information technology capabilities and their user. Every organization must ensure that it is future-ready with a digital infrastructure. Every sector is digitizing due to the efficiencies that can be realized. Some common applications of digital infrastructure include the following.

- *Healthcare:* Just like other industries, healthcare is increasingly turning to digital technologies to thrive and meet customer demands. Digitized healthcare will enable efficiency through seamless communication between hospitals, pharmacies, and patients. Connected devices will help doctors to monitor patients remotely.
- *Economy:* We live in a winner-takes-all digital economy, where power is concentrated in the hands of a few actors who control what we read and what we see, leaving citizens with little or no choice. Digital economy requires digital infrastructure to thrive. The impact of digital infrastructure on economy cannot be underestimated. It provides people with the ability to access services such as education, healthcare, ecommerce, and banking. An increasingly digital economy will require a reliable and accessible digital infrastructure and major investments in sophisticated networks, cybersecurity, and electronics.
- *Business:* Digital transformation is driving the business world. In order for brick and mortar businesses to have a digital presence in the current marketplace, they have changed to the digital platform. Big retailers such as Walmart, Target, Best Buy, and Amazon have stepped up their digital game. The business's digital infrastructure is the operating system of the business. The business cannot function without a digital infrastructure. Businesses use digital infrastructure to re-architect their services for global digital delivery. Digital infrastructure helps a business become smarter and enable it to meet customer demands and employee productivity. Consumers are using the Internet and mobile apps to purchase products and services. The successful operation of any business now largely depends on a combination of user experience, appealing business models, and business agility. Sustainable business practices must apply triple bottom line-people, profit, and planet.

BENEFITS

Businesses around the world are now taking advantage of digital infrastructure in order to get ahead of their competition. Digital infrastructure enhances and contributes to the economy and quality of life. Organizations are now embracing the change in digital infrastructure in order to solve complex business problems and to improve customer retention. Every nation around the world now has a specific digital strategy to ensure that the country can compete in the global economy and to ensure citizens have access to connectivity. It has been estimated that the digital infrastructure industry has eliminated 80% of energy losses over the last 15 years. It is evident that access to digital connectivity will help to close the "digital divide" [2].

Transforming traditional infrastructure into digital infrastructures will also provide significant benefits. Successfully development of digital infrastructure will unlock new economic opportunities, create jobs, and improve the quality of life. Nations stand to benefit from digital infrastructure in the following ways [5]:

- *Capacity expansion*: increased use of both existing and new infrastructures;
- *Time savings and convenience*: reduce congestion, simplify operations, and enable more informed decision making;
- *Cost savings:* minimize waste, boost efficiency, and create more flexibility in the provision of key services;
- *Improved reliability*: reduce unpredictability and interruptions in the provision of key services; and
- *Enhanced safety*: improve resiliency to threats and interruptions.

CHALLENGES

There are numerous barriers to realizing the full benefits of digital infrastructure. These include costly and outdated regulatory policies, a lack of public funding for investment, a scarce talent pool of individuals trained in ICT skills, and fears about the privacy and security of data. These issues cannot be addressed by individuals, companies, organizations, or nations. National governments and the private sector should work together to develop rapid deployment of digital infrastructures.

Policymakers often call for increased spending on digital infrastructure that will expand access to high-speed broadband. They will need to address privacy concerns from slowing progress [5]. Individuals and governments are increasingly concerned about how some digital infrastructure could be used by espionage to threaten national security.

Although digitization can create new pathways out of poverty and empower people in new ways, it could exacerbate inequalities, undermine trust in critical institutions, and erode social norms. The acceleration of digital transformation tend to threaten and challenge companies. As countries around the world return to various forms of lockdown, the pandemic led to the shortage of both goods and human resources.

Some critics have argued that there is little innovation in infrastructure because cars still drive on roads; planes fly in the air; and trains run on tracks just like 50 years ago. Fragmented universe of digital indicators create an uncertain and complex relationship between digital infrastructure and development outcomes.

CONCLUSION

Digital infrastructure may be regarded as a collection of data center locations that deliver services to devices and people. It will build and support the coming decade of the nation's development. It will change our lives in the future. Digital infrastructure networks underpin how societies and industries function.

The future is digital. Traditional infrastructure around the world is undergoing a significant digital transformation to meet the growing demands of existing individual and corporate users for faster and more reliable services. Only governments have the mandate shape the direction of digital infrastructure. More information on digital infrastructure can be found in the books in [6-12].

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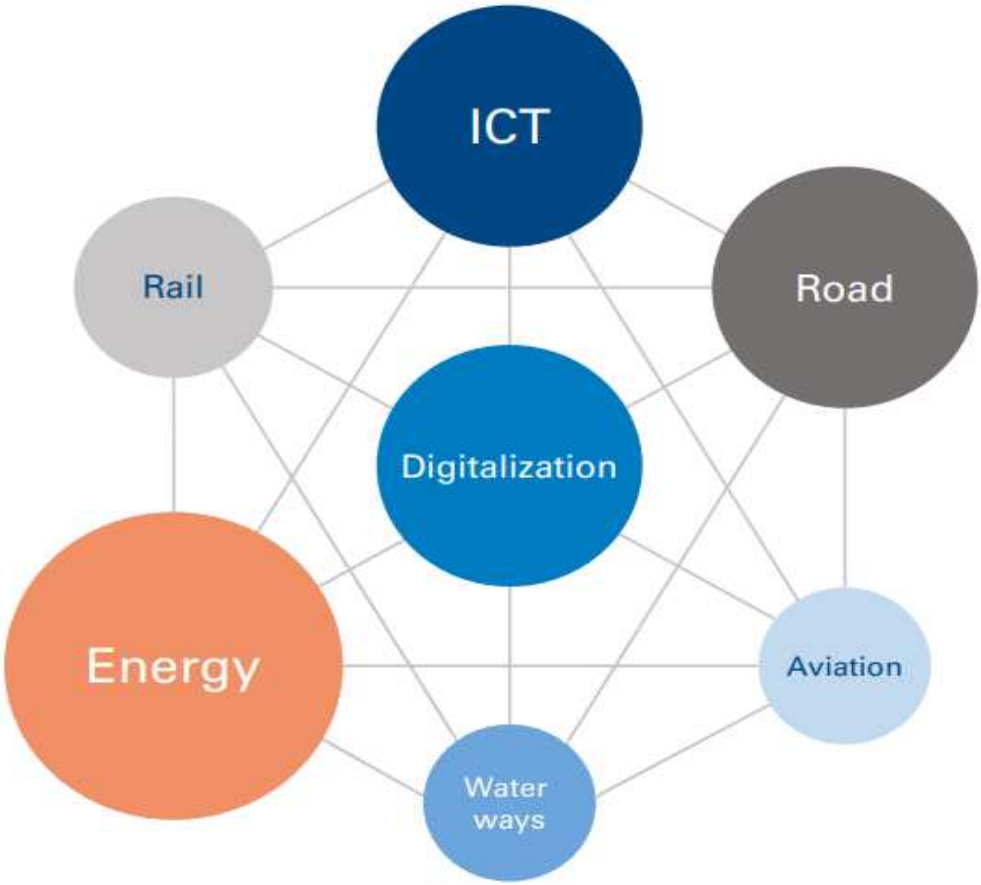

Figure 1 Engaging digitization and critical infrastructure [1].

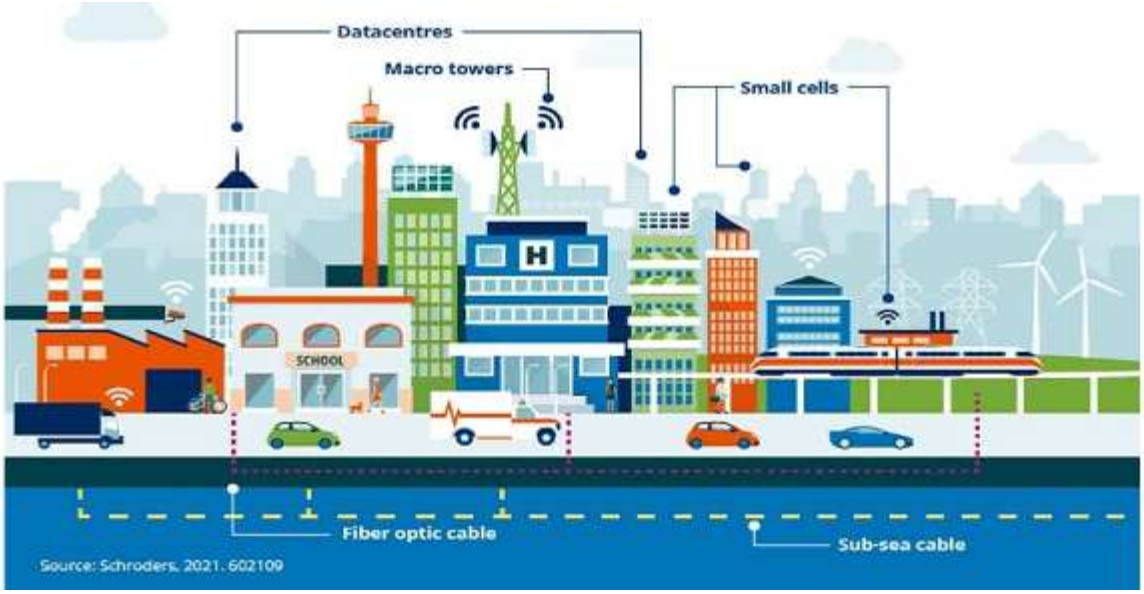

Figure 2 A typical digital infrastructure [2].

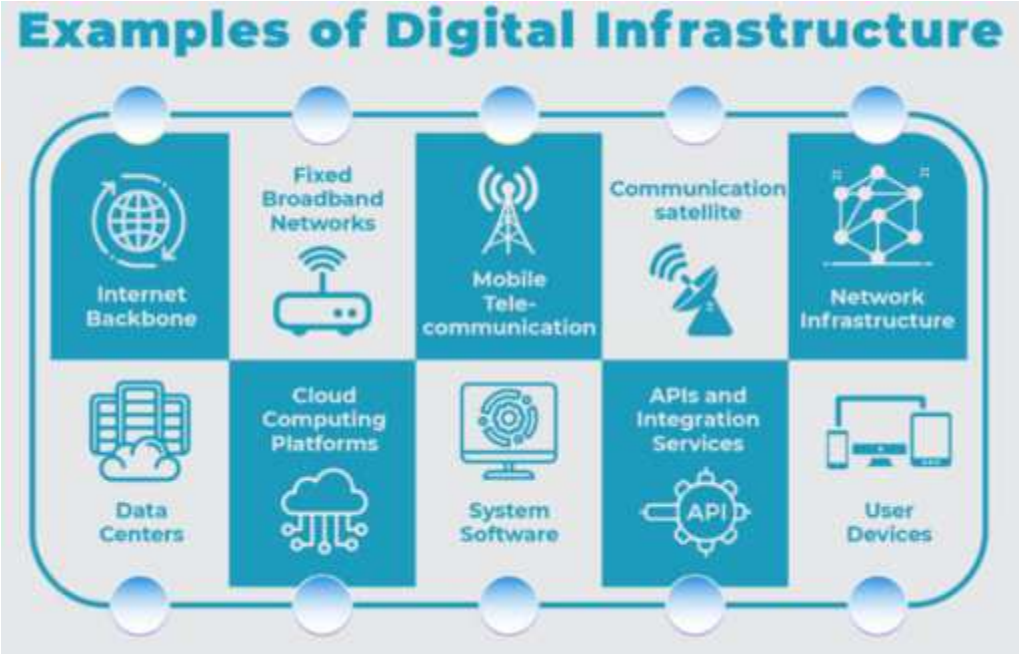

Figure 3 Examples of digital infrastructure [3].

Figure 4 The key elements of digital infrastructure [4].