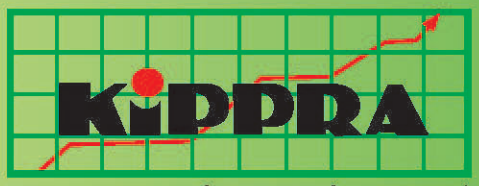
Discussion Paper Series



The KENYA INSTITUTE for PUBLIC POLICY RESEARCH and ANALYSIS

The Role of Infrastructure Utilization and Connectivity on Economic Performance in Kenya

Victor Mose

DP/258/2022

THE KENYA INSTITUTE FOR PUBLIC POLICY RESEARCH AND ANALYSIS (KIPPRA)

The Role of Infrastructure Utilization and Connectivity on Economic Performance in Kenya

Victor Mose

Kenya Institute for Public Policy
Research and Analysis

KIPPRA Discussion Paper No. 258
2022

KIPPRA in Brief

The Kenya Institute for Public Policy Research and Analysis (KIPPRA) is an autonomous institute whose primary mission is to conduct public policy research leading to policy advice. KIPPRA's mission is to produce consistently high-quality analysis of key issues of public policy and to contribute to the achievement of national long-term development objectives by positively influencing the decision-making process. These goals are met through effective dissemination of recommendations resulting from analysis and by training policy analysts in the public sector. KIPPRA therefore produces a body of well-researched and documented information on public policy, and in the process assists in formulating long-term strategic perspectives. KIPPRA serves as a centralized source from which the Government and the private sector may obtain information and advice on public policy issues.

Published 2022

Bishops Garden Towers, Bishops Road
PO Box 56445-00200 Nairobi, Kenya
tel: +254 20 2719933/4; fax: +254 20 2719951
email: admin@kippra.or.ke
website: http://www.kippra.org

ISBN 978 9966 817 95 2

The Discussion Paper Series disseminates results and reflections from ongoing research activities of the Institute's programmes. The papers are internally refereed and are disseminated to inform and invoke debate on policy issues. Opinions expressed in the papers are entirely those of the authors and do not necessarily reflect the views of the Institute.

Abstract

The study investigates infrastructure inadequacies in Kenya, which slows down economic performance, by assessing the linkages between the sub-regional economic performance and infrastructure connectivity and services. It uses infrastructure-led theory to lay the foundation for the nexus between economic performance and infrastructure. The study fills a major gap in the country and literature, since there are no studies that have assessed the effects of connectivity and utilization of infrastructure network to economic growth in Kenya, and the studies that have made such attempts in other jurisdictions have various limitations, including choice of variables and scope of infrastructure. Regression analysis is applied using cross-sectional data obtained from the Kenya National Bureau of Statistics, Kenya Roads Board and Water Services Regulatory Board. The study finds evidence that utilization or quality of water infrastructure was significant in boosting the performance of agriculture, manufacturing and accommodation. However, water infrastructure connectivity was not significant in promoting the performance of agriculture, manufacturing, and accommodation. There were missing links on the effect of utilization of transport infrastructure in support of agriculture and manufacturing, besides connectivity showing that transport infrastructure was significantly associated with growth in agriculture and manufacturing outputs. Besides, trade and accommodation showed positive responsiveness to transport infrastructure utilization, even though they had significant coefficients under connectivity. Kenya is yet to establish adequate electricity infrastructure and environment to support the economy. Besides connectivity of electricity having significant influence on manufacturing, utilization of electricity was not significant in explaining the performance of manufacturing. Utilization of information communication technology infrastructure is only significant in explaining the performance of the accommodation sector, besides its connectivity being associated with increase in agriculture outputs. Utilization of housing infrastructure is associated with increase in agriculture and manufacturing. However, connectivity is negatively associated with agriculture, and was not significant for manufacturing, trade and accommodation. The main weakness in transport logistics is in the quantity and quality of infrastructure and timeliness in service delivery. The country needs to improve on the number of days it takes to get connected to electricity and associated costs. There is evidence of positive correlation between economic performance and Internet use through observation of the overall patterns of per capita GDP and Internet use and mobile-cellular penetration. There are weaknesses in registration of property and issuance of construction permits, especially on number of procedures, time taken, and costs incurred. There is weak positive correlation between economic performance and water availability across the globe, given the pattern of per capita GDP and freshwater availability per capita, and the responsiveness of sectoral outputs to changes in water availability. It is recommended that the country should review property registration and construction requirement and processes with a view to reducing the number, time and cost of processes; invest in ground water mapping and dam construction, and address issues making dam construction period lengthy, and costly; upgrade transport infrastructure by increasing the network, improving the quality of the networks and scale down cost of transportation; and reduce the cost of electricity and enhance the quality of power.

Abbreviations and Acronyms

GCP	Gross County Product
GDP	Gross Domestic Product
GFCF	Gross Fixed Capital Formation
ICT	Information and Communication Technology
ITU	International Telecommunication Union
KAM	Kenya Association of Manufacturers
KIHBS	Kenya Integrated Household Budget Survey
KNBS	Kenya National Bureau of Statistics
MTP	Medium-Term Plan
NOFBI	National Optic Fibre Backbone Infrastructure
SDGs	Sustainable Development Goals
WASREB	Water Services Regulatory Board

Table of Contents

List of Tables

List of Figures

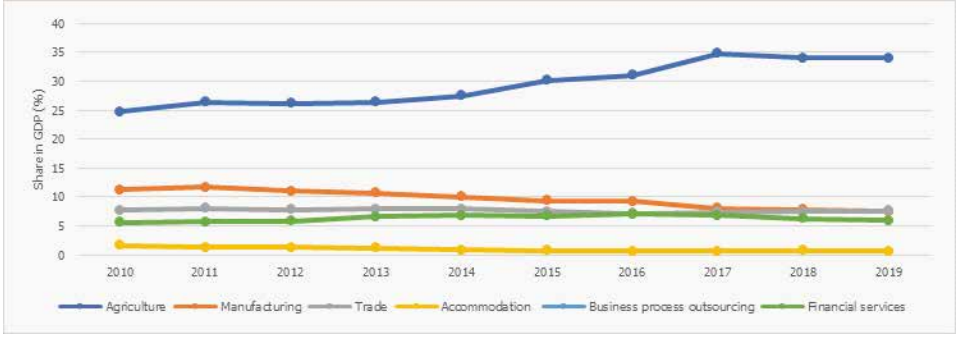
1. Introduction

Infrastructure comprises physical facilities that enhance connectivity to utilities of transport, energy, information and communication, water and sanitation, and housing as stipulated in the infrastructure sector plan 2013-2017 (Government of Kenya, 2013). Transport infrastructure supports accessibility and usability of roads, railway, air, and water transport services. Some of the energy infrastructure includes electrification and pipeline network and installed facilities for generation or supply of energy. Information and communication infrastructure encompasses connectivity to Internet and mobile telephony services, while water and sanitation infrastructure includes water and sewer pipelines, water storage facilities such as water dams and water pans. Housing infrastructure includes the buildings for domestic and commercial use. These set of infrastructure support the economy by contributing directly through their production but also indirectly by facilitating the political, social, and economic sectors.

In Kenya's Vision 2030, infrastructure is identified as an enabler for the growth and development of the political, economic and social pillars. The economic pillar of the Vision encompasses six (6) sectors, namely agriculture, manufacturing, tourism, trade, business process outsourcing, and financial services. Two more sectors, namely oil, gas and minerals and the blue economy were added in the third Medium-Term Plan (MTP III) of the Vision. These sectors define the scope of this study with respect to assessing the role of infrastructure in economic growth within the context of the Vision, and by identifying infrastructure inadequacies that impede such growth.

One of the measures of economic growth is Gross Domestic Product (GDP), which is an aggregation of the value of economic activities undertaken within the country, and by extension, therefore, an aggregation of value of sectoral outputs in the economy. The sectoral outputs form their contributions to the economy. In terms of contribution to overall Gross Domestic Product in Kenya, the cumulative share of agriculture, manufacturing, trade, accommodation, and financial sectors rose from 51 per cent in 2010 to 55 per cent in 2019 (Figure 1.1). Agriculture commands the largest share followed by manufacturing, trade, financial services and accommodation and food services. The share of agriculture in contribution to GDP rose from 24.8 per cent to 34.1 per cent in the period 2010-2019, while manufacturing and accommodation dropped from 11.3 per cent to 7.5 per cent and 1.6 per cent to 0.7 per cent, respectively, over the same period. The contribution of trade and financial services remained relatively stable in the period, with an average of 7.5 and 5.5 per cent, respectively. There is no data for Business Process Outsourcing.

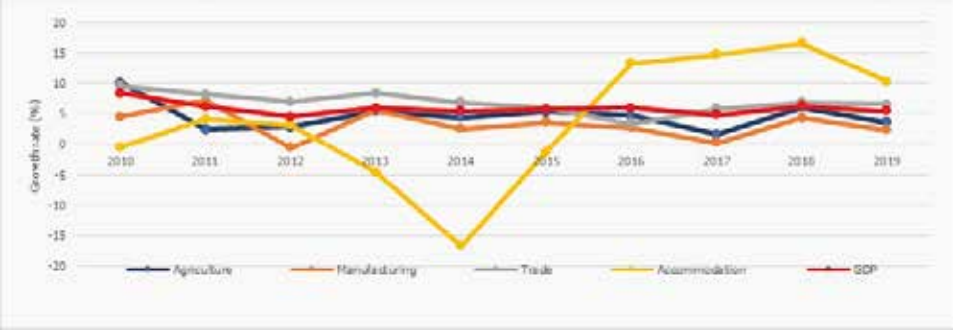
Figure 1.1: Contribution of economic sectors to Gross Domestic Product in Kenya



Source of Data: KNBS (Various 2010-2019), Statistical Abstracts, and Economic Surveys

The growth rates of the outputs of these economic sectors have shown mixed trends and patterns over time (Figure 1.2). Trade grows faster and above the average growth compared to the rest of the economic sectors. The growth in agriculture is slightly below the average growth, followed by manufacturing and accommodation. Accommodation and food services emerged in 2015 as a growth pacesetter besides having struggled since 2010, with even declines in 2013-2015. The overall trend in growth of these sectors is deceleration, which becomes a macroeconomic policy concern for this is a symptom of deceleration in either investment, consumption, or government spending in these sectors.

Figure 1.2: Annual growth rates for value of output in economic sectors



Source of Data: KNBS (Various 2010-2019), Statistical Abstracts, and Economic Surveys

Infrastructure networks provide various services required in the economy, including transportation, communication, energy/power, water, waste disposal, and housing. Like the economic sectors, the output of infrastructure services experience varied growth rates, swinging between stagnation and deceleration.

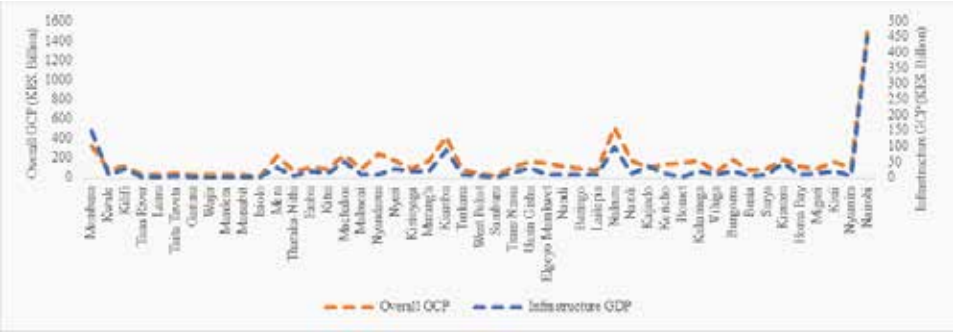
These trends are likely to result in inhibitive effect on economic growth. For instance, deceleration in the growth of electricity, transport, water, ICT, and real estate have direct negative effect specifically on economic sectors including manufacturing, trade, agriculture and financial services. The infrastructure services growth rate was below 10 per cent, on average, in the period 2010-2019. The ICT sector is growing the fastest over the years 2010-2019, followed by electricity in the same period. Whereas growth in transport infrastructure services decelerated between 2010 and 2013, the sector bounced back in 2014 and experienced sustained growth path through 2019. Real estate sector has experienced sustained growth over the period 2010-2019, though not growing as fast as ICT and electricity; this demonstrated catch-up effect over the period which was realized in 2019 in terms of growth path.

Figure 1.3: Annual growth rates for value of output in infrastructure services

Source of Data: KNBS (Various 2010-2019), Statistical Abstracts, and Economic Surveys

At sub-regional level, the economic performance of the counties in overall gross county product is highly correlated with value of output in infrastructure (Figure 1.4), showing that the share of infrastructure services in the economy is substantial. The infrastructure sector comprises of transport, water, electricity, ICT and real estate both in infrastructure capital formation, infrastructure services and incidental services. On average, infrastructure industries across the counties contribute approximately 16 per cent of the Gross County Product, with a lowest of 4 per cent and highest of 45 per cent. These may be largely associated with the level of connectivity to infrastructure and the quality of infrastructure across the counties. The share of infrastructure services in the economy reflects the level of infrastructure inputs and the quality of such infrastructure, as expounded later in section 2.4. Changes in infrastructure outlay and accessibility have potential to determine the level of overall economic performance of the economy, given the dependence of the economic sectors on infrastructure services.

Figure 1.4: Comparing value of infrastructure output with overall Gross County Product (GCP in 2017)



- Correlation between overall GCP and infrastructure GCP = 0.9668
- Lowest share of value of infrastructure output in GCP = 4%
- Average share of value of infrastructure output in GCP = 16%
- Highest share of value of infrastructure output in GCP = 45%

Source of Data: KNBS (2019), Gross County Report

The public policy problem under investigation is that inadequate infrastructure has an impeding effect on the economic sectors of the economy. For instance, Kenya's Vision 2030 anticipated that the economy grows by 10 per cent. However, over time, the growth has been sporadic and below this projection, with a high of 6.3 in 2018 (KNBS, 2020). This is partly associated with the slow growth in the output of infrastructure sector, which had been either stagnating or decelerating. If these trends in infrastructure performance persist, it will be difficult for the economy to achieve the target of the Vision 2030, which will translate to missed targets in growth, investment, employment, consumption, and infrastructure development. It is therefore imperative to assess and address the infrastructure inadequacies towards maximum contribution of infrastructure in economic growth.

The government has continued to fund infrastructure development in Kenya, but the quality of infrastructure is still a problem. For instance, some areas of the country experience bad roads, power outages, bad communication connectivity, and low access to quality water. However, there is no study that has investigated the economic effects of infrastructure in Kenya, especially by using the sectoral approach while seeking to establish the missing links that may be associated with low quality infrastructure. The studies have not investigated the connectivity and utilization of infrastructure network in Kenya, and the studies that have made such attempts in other jurisdictions have various limitations, including choice of variables and scope of infrastructure. For instance, Mburu (2012) linked gross domestic product with capital investment transport and by breaking down transport into air, rail, marine and road. Mwaniki (2019) investigated the relationship between gross domestic product with government investment in transport, communication water and energy, where capital investment in road and rail had a positive effect on GDP while air had a negative effect, but marine investments were not significant. Njiru, Simiyu and Bunde (2020) investigated the

effect of public expenditure on economic infrastructure and social infrastructure on GDP, which were found to have positive and negative effects, respectively. The nexus between bad infrastructure and economic performance can be explained using sub-sectors of infrastructure by looking at the infrastructure services and connectivity.

For instance, bad roads are often blamed for post-harvest losses in agriculture and business losses due to delayed deliveries, and this is common during the rainy season. Bad road networks also cause congestion in urban areas, which cause business losses and low worker productivity due to delays and time spent on roads. For instance, the Kenya Association of Manufacturers (2021) identifies costs of transport and logistics as a major challenge, and reducing such costs would enhance their production and productivity.

In addition, access to water is low in Kenya, and this limits agriculture, hospitality industry and manufacturing due to the role of water in their core processes. For instance, the proportion of households with piped water connections declined between 2015 and 2019 from 44.3 per cent to 34.1 per cent using the 2015/16 KIHBS (KNBS, 2016) and 2019 Kenya population census (KNBS, 2019c). These KIHBS and population census reports show that this decline was consistent even among rural households, from 24.8 per cent to 19.3 per cent, and among urban households declining from 69.4 per cent to 57.6 per cent. By extension, such level of access to water affects food production. In the 2015/16 survey, food poverty (32%) was higher than overall poverty (27.4%), comparing as 35.8 per cent against 32.6 per cent, 28.9 per cent against 20.6 per cent, 24.4 per cent against 21.1 per cent, for rural, peri-urban and core urban, respectively. Such a decline may be attributed to slow development of infrastructure amid increasing population.

Further, according to the 2015/16 KIHBS and 2019 population census reports, connectivity of households to mains electricity increased over the period 2015-2019, from 41.4 per cent to 50.4 per cent, disaggregating to 17.1 per cent to 26.3 per cent in rural areas and 73 per cent to 88.4 per cent in urban areas. However, quality of electricity and high tariffs have been blamed for slow growth in manufacturing. For instance, the Kenya Association of Manufacturers (KAM) identifies access to quality, affordable and reliable energy as one of the challenges facing manufacturers (KAM, 2021; 2018) and indicates that electricity accounts for 40-50 per cent of total conversion cost in some sub-sectors such as metal and allied sector, while frequent blackouts or power outages and low voltage have a huge impact on the cost and competitiveness of this sector's products in the market (KAM, 2018). The effect of this is reduction in manufacturing and business due to increased cost of doing business, which compound the slow growth of the economy.

While Kenya has made strides in ICT penetration, some regions are still experiencing low connectivity and poor quality of mobile and Internet networks. According to KNBS 2016 and 2019, the population with 3 years and above using Internet is low, although it increased (16.6% to 22.6%) over the period 2015-2019, being 8.6 per cent to 13.7 per cent in rural areas and 30.9 per cent to 42.5 per cent in urban areas. However, ownership of mobile phone declined over the same

period from 68.2 per cent to 47.3 per cent, being 62 per cent to 40.5 per cent in rural areas and 79.4 per cent to 62.6 per cent in urban areas. This hinders use of online services in trade, which reduces the contribution of the digital economy to the country's economic growth.

The construction of markets, premises and industrial parks infrastructure is critical especially in the growth of manufacturing and trade. However, the increasing cost of construction has been associated with slow growth in construction activities and high rental prices, which limit hiring of premises for businesses, and development of markets infrastructure especially for start-ups. For instance, the cost of construction input has been consistently increasing, having increased by 0.9 percent, 1.8 percent, 3.0 percent, 3.1 per cent and 5.7 per cent over the period 2015-2019, respectively (KNBS, 2020).

This situational analysis presents the significance of this study to investigate the inadequacies in infrastructure that slow down economic growth in Kenya. To achieve this, the study seeks to examine the link between infrastructure and economic growth, and the extent to which Kenya's infrastructure varies from the optimal expectations or targets. This is geared towards informing the required capacity to enhance the role of infrastructure in economic development. Specifically, the paper seeks to assess the responsiveness of Kenya's economic performance to changes in various infrastructure, and to assess the variation of various infrastructure from the set standards based on the level of competitiveness or set norms, where norms are either targets, benchmarks, set standards or best practices.

This is based on the recognition that infrastructure is an enabler in the economy, with inherent potential of catalysing performance of the economic, social, and political pillars of the Kenya Vision 2030. In addition, all county governments, through the county integrated development plans, have also identified the significance of infrastructure services in these sub-regional economies. The study seeks to establish the missing link between infrastructure and the performance of the economic sectors with a view to recommending policy interventions to enhance the catalytic role infrastructure plays in the economy. This will be in response to two critical questions that are of interest to policy makers: How do various types of infrastructure associate with growth of the economic sectors in Kenya? and to what extent do such infrastructure fall below the requisite capacity?

2. Policy Environment and Development of Infrastructure in Kenya

2.1 Infrastructure Policy

The Constitution of Kenya (2010) allocates infrastructure and economic development functions as concurrent functions of National and County governments, since both governments have respective functions stipulated in Schedule IV of the Constitution. For instance, whereas the national government is charged with national infrastructure works, County governments have specific infrastructure county works to execute across the infrastructure sectors, including transport, water, energy, housing and information and communication technology. Similarly, whereas the National government has the function of national economic planning, which cut across all sectors, the County governments have specific roles in agriculture, manufacturing, trade, accommodation and business processing and offshoring. Therefore, this requires well-coordinated and integrated planning to avoid duplication of efforts and wastage of resources and building on intergovernmental synergies. Besides, integrated planning reinforces complementarity between infrastructure output and infrastructure services.

The infrastructure sector in Kenya is governed by various policy frameworks that are largely based on the respective sub-sectors. The overall infrastructure framework can be traced in the Constitution of Kenya and vision documents, such as the Kenya Vision 2030 and its medium-term plans. For instance, the Vision provides for programmes geared towards creating an interconnected country through a network of roads, railways, ports, airports, and water ways, and telecommunications, and which provide efficient and effective infrastructure for the energy, water and housing sectors. In the Constitution of Kenya infrastructure works are shared between the National and County governments. Whereas the National government coordinates infrastructure works through State-owned institutions across the sub-sectors, County governments have established departments in charge across the sub-sectors. The National government and County governments provide for budgets for infrastructure development, and also seek for the participation of the private sector under the public private partnership framework.

The transport policy (Ministry of Transport, 2010) maps the transport sector as a composition of roads, railway, air, pipeline, maritime and inland water transport sub-sectors. One of the objectives of this transport policy is to develop and maintain an integrated and coordinated transport infrastructure for efficient movement of passengers and freight support disaster management efforts. The policy seeks to integrate the transport sector, increase investment, respond to market needs and enhance participation of the private sector towards improved infrastructure development and maintenance. The policy targets to improve the quality of transport services, safety and security. It recognizes the distinct but dependent nature of National and County governments in infrastructure development by appreciating their respective roles as guided by the Constitution of Kenya.

The National Information, Communications and Technology Policy (Ministry of Information, Communications and Technology, 2019) seeks to create the infrastructure conditions for use of always-on, high speed, wireless, Internet across the country and provide an enabling infrastructure and framework that supports the growth of data centres, Internet, machine learning and local manufacturing while fostering a secure innovation ecosystem. Such infrastructure is expected to enhance the contribution of ICT to 10 per cent of GDP by 2030. The policy anchors the mandate and function of the National government in broadcasting, postal and telecommunications, in accordance with the Constitution of Kenya, which establishes a devolved system of government and provides that the County governments will provide ICT infrastructure that can tap on the national infrastructure, including the National Optic Fibre Backbone Infrastructure (NOFBI).

The Water Act 2016 (Government of Kenya, 2016a) seeks to enhance infrastructure development for water storage and distribution by establishing the national public water works, which develop infrastructure for water storage, bulk distribution and inter-basin water transfer. Accordingly, the Act has established various institutions as water works agencies that are basin-based and charged with responsibility of shared and inter-basin water infrastructure, and the Water Sector Trust Fund, which funds pro-poor infrastructure development for communities. Water is a devolved and concurrent function, with County governments establishing departments for county waterworks, which include water supply network and storm water management.

The Energy Act (2019) and the National Energy Policy (Ministry of Energy, 2018) seek to promote infrastructure development for electricity generation, distribution, and transmission. In accordance with the Constitution, County governments are mandated to provide land and rights of way for energy infrastructure. The policy advocates for provision of adequate fiscal incentives for energy resource and infrastructure development which, among other things, is expected to attract investment in energy infrastructure across the country. In addition, the policy envisages the participation of the private sector through the Public Private Partnership framework to enhance financing, construction, development, operation and maintenance of energy resource or infrastructure projects, including development of infrastructure for strategic petroleum reserves and power generation projects.

The National Housing Policy for Kenya (Government of Kenya, 2016b) identifies various infrastructure for housing. These infrastructure include access roads, water-supply, sanitation, ICT connectivity, electricity and waste-management facilities. The policy reiterates that the rate of urbanization and population growth in Kenya is unmatched with planning for housing development. Consequently, it sets strategies for expansion and improvement of infrastructural facilities and services, which include integration of infrastructural services in housing developments, encouraging private developers to participate in development of infrastructure, and establishment of institutions charged with the responsibility of developing houses and housing financing. According to the Constitution of Kenya, housing is a devolved function, and counties are expected to play a key role in this

with the support of the National government. The counties are also charged with the mandate of setting aside space for industrial parks and market centres, which are critical in trade development.

These policy frameworks provide evidence that the country recognizes the role of infrastructure in socio-economic development. The framework underscores the country's strategy in promoting investment in development of infrastructure through public financing and public-private partnerships. It also provides an enabling environment for intergovernmental relations. However, Kenya does not have an integrated infrastructure policy that links all infrastructure sectors. Instead, each sub-sector has a policy, but their interconnectedness is limited, which in turn weakens the inter-sector synergies. Lack of such a pivot policy instrument may pose a challenge in planning and coordination of the development of infrastructure projects. As a result, challenges of communication, disruptive and uncoordinated construction, and waste of resources arise.

2.2 Economic Policy Framework on Demand for Infrastructure

At global level, various Sustainable Development Goals (SDGs) recognize the role of infrastructure to the economic and social growth of economies. For instance, the SDG 9 seeks to build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation (United Nations General Assembly, 2015). The SDG 9 seeks to develop quality, reliable, sustainable, and resilient infrastructure, including regional and transborder infrastructure, which support economic development and human well-being, with a focus on affordable and equitable access for all. It also targets to increase the proportion of the rural population who live within 2 km of an all-season road and the passenger and freight volumes by mode of transport. The SDG also seeks to realize universal access to affordable, reliable, sustainable and modern energy services; sustainable transport systems; and quality and resilient infrastructure. In SDG 2, the role of rural infrastructure in enhancing agricultural productive capacity in developing and least developed countries is recognized. The SDG 7 seeks to promote investment in energy infrastructure and clean energy technology, among others.

At regional level, the Africa Agenda 2063 (African Union, 2015) seeks to create integrated infrastructure network connecting all African capitals and commercial centres. This is to facilitate movement of goods, factor services and people and reduce transport congestion of existing and future systems. It also seeks to expand and improve access to water, sanitation, electricity, transport and Internet connectivity. The Agenda also aims at transforming Africa energy to ensure access by all Africans to clean and affordable electricity, and help make the continental regional power pools.

In the Kenya Vision 2030 and its medium-term plans, infrastructure is one of the foundations of socio-economic development. The Vision of the infrastructure sector is to provide cost-effective world-class infrastructure facilities and services in support of the Kenya Vision 2030. The vision aspires to establish an infrastructure network that will interconnect the country and provide efficient

and effective infrastructure facilities. The Vision plans to have Kenya producing sufficient power and connecting the energy-surplus to the region. It is appreciated in the Vision that poor infrastructure is a major constraint to doing business and in improving the livelihoods of people. Infrastructure is important in improving security and connectivity of people and firms in wealth-creation through infrastructure services such as transport, telecommunications, energy, water, sewerage and sanitation and meteorological services. In addition, at county level, the County Integrated Development Plans provide for the role of infrastructure in enhancing the sub-regional economies. Various counties have established public works departments in charge of infrastructure development.

2.3 Kenya's Infrastructure Competitiveness in Africa

Competitiveness is the level of achievement based on some norm(s). Norms are benchmarks established to guide the adequacy or milestone of any product or process by quality and quantity. Norms can be derived from set standards, targets or achievements of pacesetters. The comparative analysis on infrastructure varies across infrastructure service, using indices provided by at least one regional or global sector player who provides an index using a uniform criterion. For instance, ease of doing business, which is developed by the World Bank, captures various infrastructure indicators such as transport logistics performance index, electricity connectivity, property registration and construction, water availability and access indicators. The ICT penetration indicators such as mobile-cellular subscription and proportion of population using Internet services, among others, are monitored by the International Telecommunication Union (ITU).

2.3.1 Competitiveness in transport logistics

Kenya ranks 4th in Africa and 68 globally in terms of transport logistics performance index, which assesses the level of infrastructure customs processes, timeliness of services, quality and competence of logistics systems, tracking and tracing and international shipment linkages (Table 2.1). The main weakness for Kenya in transport logistics is the state of infrastructure, timeliness and international shipment which globally rank 79, 79 and 99, respectively. However, the country is making progress in ensuring seamless connectivity by upgrading and integrating roads, airports/airstrips, railway and seaways transport (Ministry of Transport, 2016). Further, the country is enhancing the approval systems through automation, regulation of professional services in transport, such as clearing and forwarding, use of ICT to enhance tracking and tracing and reducing turn-around time in service delivery. For instance, the country is funding local roads upgrading and major roads designs, upgrading facilities in airports and seaports, and increasing the network of both standard and meter gauge railways, including commuter railways. Such initiatives are expected to enhance Kenya's competitiveness in transport and enhance ease of doing business to attract investment to promote economic growth.

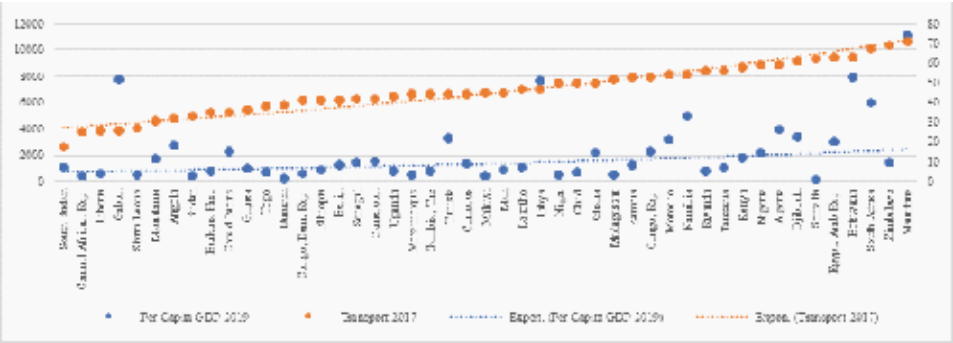
Table 2.1: Kenya's competitiveness in Africa on transport logistics, 2019

		Overall LPI score		Customs		Infrastructure		International shipments		Logistics quality and competence		Tracking and tracing		Timeliness	
	Country	score	rank	score	rank	score	rank	score	rank	score	rank	score	rank	score	rank
1	Côted'Ivoire	3.08	50	2.78	51	2.89	56	3.21	45	3.23	37	3.14	49	3.23	71
2	Rwanda	2.97	57	2.67	64	2.76	65	3.39	29	2.85	60	2.75	86	3.35	61
3	Egypt	2.82	67	2.60	77	2.82	58	2.79	73	2.82	63	2.72	89	3.19	74
4	Kenya	2.81	68	2.65	67	2.55	79	2.62	99	2.81	64	3.07	56	3.18	79
5	Benin	2.75	76	2.56	82	2.50	83	2.73	83	2.50	98	2.75	87	3.42	57
6	Mauritius	2.73	78	2.71	59	2.80	59	2.12	151	2.86	59	3.00	63	3.00	99
7	Djibouti	2.63	90	2.35	113	2.79	60	2.45	118	2.25	135	2.85	72	3.15	85
8	Burkina Faso	2.62	91	2.41	100	2.43	95	2.92	60	2.46	106	2.40	124	3.04	95
9	Cameroon	2.60	95	2.46	90	2.57	76	2.87	63	2.60	87	2.47	118	2.57	142
10	Mali	2.59	96	2.15	133	2.30	109	2.70	88	2.45	107	3.08	54	2.83	119

Source of data: World Bank (2019; 2020)

However, in terms of population accessing quality public transport facilities and services, Kenya ranks 10th in Africa (Figure 2.1). There is a weak correlation between access to public transport and economic performance across Africa. This corroborates with the state of infrastructure, where most of them are in bad state, and the logistics in public transport where most players flout transport rules. For instance, on average, the state of roads in good condition is approximately 18.2 per cent while fair condition is 43.7 per cent (Kenya Roads Board, 2018).

Figure 2.1: Kenya's competitiveness in Africa on public transport satisfaction and GDP, 2017-2019



Source of data: The World Bank (2019; 2020)

2.3.2 Electricity connectivity

Kenya also ranks 4th in Africa and 70 globally on the ease of getting connected to electricity. The country ranks higher in Africa if it improves on the number of days it takes to get connected and deal with the issue of high cost of electricity. For instance, the country's estimated average time it takes to obtain electricity was rated at almost 100 days in 2019 against Rwanda with best performance of 30 days (Table 2.2). The cost of acquiring electricity connection was rated at over 600 per cent of income per capita against Mauritius, which had approximately 140 per cent. However, the country is making progress in connectivity, having increased the number of customers from 2.2 million in 2018 to over 7.7 million in 2019. The country is also shifting to renewable and affordable energy sources such as wind and geothermal, away from hydro- and diesel-based, which are likely to reduce the cost and improve quality of power, thus improve Kenya's competitiveness.

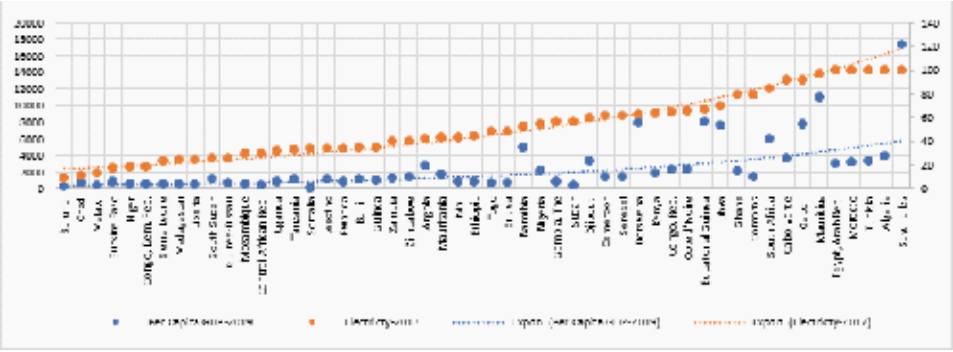
Table 2.2: Kenya's competitiveness in Africa on ease of obtaining electricity, 2019

	Location	Rank	Score	Procedures (number)	Time (days)	Cost (% of income per capita)	Reliability of supply and transparency of tariff index (0-8)
1	Mauritius	28	88.0	3	67	143.6	6
2	Morocco	34	87.3	4	31	1308.8	7
3	Rwanda	59	82.3	4	30	1923.1	6
4	Kenya	70	80.1	3	97	615.4	5
5	Namibia	76	78.3	6	37	272.2	6
6	Egypt	77	77.9	5	53	180.2	5
7	Ghana	79	77.4	4	55	632.0	4
8	Tanzania	85	74.9	4	105	690.8	5
9	Togo	99	72.6	3	66	2120.4	3
10	Algeria	102	72.1	5	84	967.0	5

Source of data: World Bank (2019; 2020)

Kenya ranks 16th in Africa in terms of the population accessing electricity (Figure 2.2). This downgrades Kenya's competitiveness as a business destination, since though it is easy to obtain electricity, its actual access is lower than in countries such as Seychelles, Algeria, Tunisia, Morocco, and Egypt which are top in Africa. This can be attributed to limited infrastructure network across the country, and cost of access, which need to be addressed. This is besides the trend in electricity showing strong positive correlation with the trend in performance of the economy.

Figure 2.2: Kenya's competitiveness in Africa on access to electricity and GDP, 2017-2019



Source of data: World Bank (2019; 2020)

2.3.3 ICT penetration

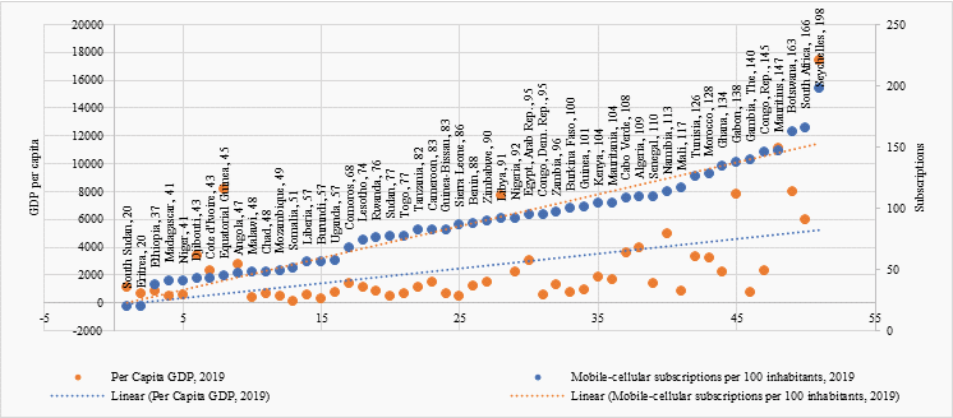
Kenya ranks 28th in Africa on proportion of population using Internet services, which is estimated at approximately 22.2 per cent of the population in 2019. There is evidence of positive correlation between economic performance and Internet use through observation of the overall patterns of per capita GDP and Internet use (Figure 2.3). Thus, the country should endeavour to catch up with countries such as Morocco, Tunisia, and Mauritius, which have attained over 60 per cent of the population using Internet services. The country is on track with roll out of broadband Internet services and mobile-cellular connectivity across the country, high Internet tariffs and limited awareness on integrated online government and private sector activities. The country had 22.6 million broadband subscriptions in 2020, up from 20.5 million in 2018 for both fixed and mobile broadband. There were 41 million data/Internet subscriptions in 2020, which remained relatively the same since 2018. The continued automation of government and private sector services, and emergence of increasing need for online services in education, meetings and business processing will influence the use of Internet going froward, and this requires reforms on costing of Internet services.

Figure 2.3: Kenya's competitiveness in Africa on Internet use and GDP, 2019

Source of data: World Bank (2020); International Telecommunication Union (2019)

Kenya ranks 12th in Africa on mobile-cellular subscriptions per 100 inhabitants, which is estimated by the International Telecommunication Union (ITU) at approximately 104 in 2019. There is also evidence of a positive correlation between economic performance and mobile-cellular penetration, based on the overall patterns of per capital GDP and mobile-cellular subscriptions (Figure 2.4). Countries with highest subscriptions such as Seychelles, South Africa, Botswana, Mauritius, and Cote d'Ivoire have higher Internet usage, which is a pointer to the role mobile phone connectivity can play in enhancing Internet business. The country had reached 57 million mobile-cellular subscriptions for both prepaid and post-paid across all operators in 2020, up from 52 million and 45 million in 2019 and 2018, respectively, which shows annual incremental rate of 5 million.

Figure 2.4: Kenya's competitiveness in Africa on mobile-cellular connectivity and GDP, 2019



Source of Data: World Bank (2020), International Telecommunication Union (2019)

2.3.4 Housing project processing

Two of the key areas in assessment of ease of doing business in housing is dealing with construction and registration of property. The country ranks 18th in Africa and 105 globally on dealing with construction permits, having had 16 procedures, 159 days, and costing almost 3 per cent of property value in processing costs (Table 2.3). Though registering such competitiveness, there are various reforms that have potential to let the country catch up with pace setting countries such as Mauritius, Morocco, Tunisia, and Botswana. For instance, the country should enhance issuance of construction permits, reduce number of procedures and time taken to obtain the permits, and reduce the cost of all the processes. The country had suspended construction and environmental levies, but there are other charges within the county governments and professional services in the approval process, which make construction expensive. These charges and fees need to be regulated, or the government should establish subsidized or free service stations within the Huduma centres for approvals that require professional services, including legal, architect, planner, environment impact assessment, among others.

Table 2.3: Kenya's competitiveness in Africa on ease of construction, 2019

	Location	Dealing with Construction Permits rank	Dealing with Construction Permits score	Procedures (number)	Time (days)	Cost (% of warehouse value)	Building quality control index (0-15)
1	Mauritius	8	85.8	12	95.5	0.4	14.0
2	Morocco	16	83.2	12	58	3.3	13.0
3	Tunisia	32	77.4	14	133	3.4	14.0
4	Botswana	44	75.6	16	102	0.4	10.5
5	Cabo Verde	50	74.6	17	101	1.0	11.0
6	Nigeria	55	73.6	15	105	4.0	11.8
7	Mozambique	61	73.2	11	118	6.0	11.0
8	Zambia	67	72.1	10	188	2.3	10.0
9	Egypt	74	71.2	20	173	1.3	14.0
10	Rwanda	81	70.6	15	97	11.4	15.0
18	Kenya	105	67.6	16	159	2.8	10.0

Source of data: World Bank (2019; 2020)

However, the country ranks 27th in Africa and 134 globally on registration of property. This requires reducing number of procedures of registering property from 10 to 3, number of days from 44 to 7, and cost of registration from 5.9 per cent of property value to 0.1 per cent of property value and improving quality of land administration from 15 to 28, which are best scores that make Rwanda the best country in Africa and 3rd globally on property registration (Table 2.4). The country is making progress in automation of property registration, but there is need to improve on cost efficiency and time efficiency and cutting down red tape.

Table 2.4: Kenya's competitiveness in Africa on registering property, 2019

	Location	Registering Property rank	Registering Property score	Proce-dures (number)	Time (days)	Cost (% of property value)	Quality land administration index (0-30)
1	Rwanda	3	93.7	3	7	0.1	28.5
2	Mauritius	23	82.5	5	17	0.6	22.5
3	Togo	56	72.0	3	35	1.6	9.5
4	Seychelles	65	70.8	4	33	7.0	21.0
5	Cabo Verde	69	68.8	6	19	2.2	12.0
6	Morocco	81	65.8	6	20	6.4	17.0
7	Botswana	82	65.8	4	27	5.1	10.5

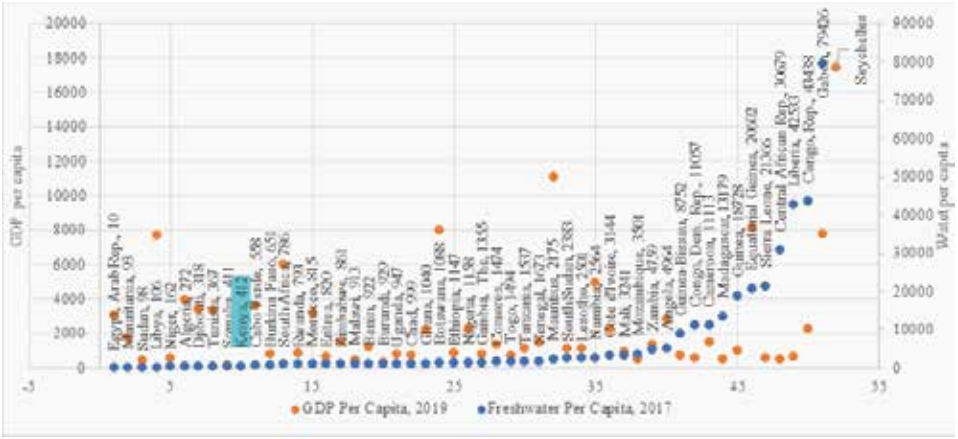
8	Malawi	90	64.9	6	47	1.7	10.5
9	Tunisia	94	63.7	5	35	6.1	13.5
10	Sudan	95	63.7	6	11	2.6	5.5
27	Kenya	134	53.8	10	43.5	5.9	15.0

Source of data: World Bank (2019; 2020)

2.3.5 Water availability

The country ranks 42 in Africa on availability of water, with freshwater per capita of 412 M^3, which makes the country be under absolute scarcity of water under United Nations classification (World Bank, 2020). Water is key especially in the growth of the agriculture sector. However, there seems to be a weak positive correlation between economic performance and water availability across the globe, given the pattern of per capita GDP and freshwater availability per capita (Figure 2.5). Nevertheless, together with the elasticity results obtained in the previous section, the country needs to invest in rainwater harvesting and ground water exploration and mapping as a means of increasing water availability. The country would require policy shift on dam construction since the processes involved have slowed down project lead time or escalated project costs. For instance, project planning and procurement processes are cumbersome, and emergence of conflicting interests on contracting, land compensation and resettlement plan during project execution yield to corruption, all of which lead to project delays and over-costing.

Figure 2.5: Kenya's competitiveness in Africa on water availability, 2017



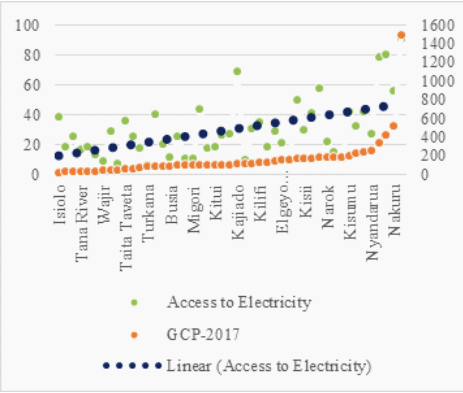
Source of data: World Bank (2020)

2.4 County Infrastructure Outlay in Kenya

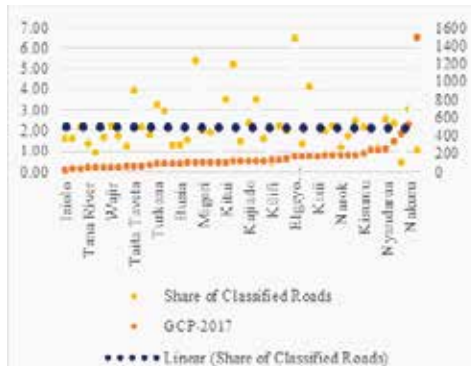
The level of connectivity across the counties shows high variability, which is reflective of differentials in infrastructure services. The patterns emerging from the trends in scatter diagrams shown in Figure 2.6 present scenarios that the economic performance across counties increase with increase in coverage of electricity, mobile phone, Internet, housing, and water services. This provides early evidence of the role played by infrastructure to changes in economic performance. However, we need to ascertain the extent to which these variations influence the performance. However, the level of access to the infrastructure services is still low in the country. The roads connectivity shows that counties with higher classified road network have lower economic performance, which points to either quality of the roads not being adequate, or such areas are vast in terms of surface area and do not have strong economic foundation (Figures 2.6a-2.6f). Dense road networks are likely to have more paved roads than vast road networks due to different human settlement behaviour and revealed economic potentials in such areas. Unpaved roads affect the effectiveness and efficiency of the infrastructure in supporting economic activities. Bad roads increase post-harvest losses and delay inputs, while poor communication networks hinder information exchange for business, and poor electricity reduces production and increases cost of production.

Figure 2.6: Infrastructure connectivity across counties

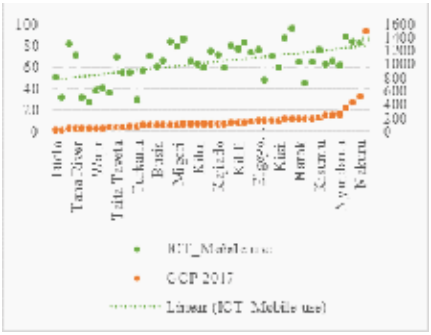
(a) Access to electricity by households (%)



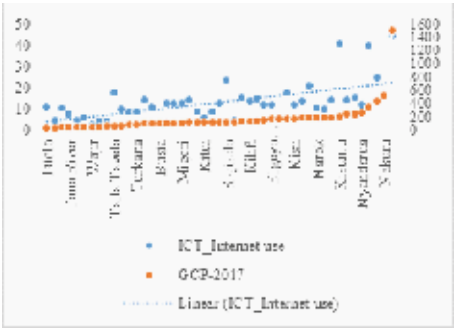
(b) Share of classified roads (%)



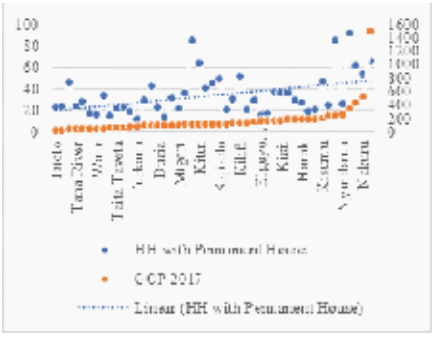
(c) Population using mobile phones (%)



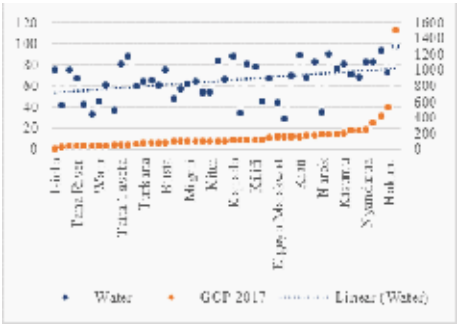
(d) Population using Internet (%)



(e) Households with permanent housing (%)



(f) Access to safe water by households (%)



Source of Data: KNBS (2016), KIHBS 2015/16

It is therefore important to focus on analyzing the role of infrastructure in boosting economic growth. There are many dimensions to infrastructure, including connectivity and level of infrastructure services. The linkages can be derived from theoretical underpinnings and empirical evidence.

3. Literature Review

3.1 Theoretical Literature

Infrastructure-led development

The theoretical underpinnings on infrastructure-led development are the central nerve that links performance of the economy and the state of infrastructure services. The theory proposes that infrastructure plays a pivotal role in economic growth and development (Carlsson, Otto and Hall, 2013; Agenor, 2010; Snieska and Simkunaite, 2009). For instance, the theory presupposes that public infrastructure is the engine of growth (Agenor, 2010), and that availability and quality of infrastructure inform decisions on investment, migration and business location, thus have direct effect on business productivity and growth (Snieska and Simkunaite, 2009). In addition, inadequate infrastructure can limit economic growth (Carlsson, Otto and Hall, 2013).

There are some infrastructure that are critical in improving the productivity of agriculture. Some of these infrastructure include roads, water irrigation technology and post-harvest handling facilities (Gajigo and Lukoma, 2011; Goswami and Chatterjee, 2009) and electricity and information communication and technology (Edeme et al., 2020; Goswami and Chatterjee, 2009). Public infrastructure has potential to reduce the cost of agricultural production and increase output, thus promoting economic growth (Gajigo and Lukoma, 2011). For instance, roads link farmers not only with their input markets but also with their product markets, while lack of efficient transportation links and substandard roads decrease farmers' margins by increasing the cost of inputs and reducing accessibility to the product Market (Edeme et al., 2020; Gajigo and Lukoma, 2011).

Further, in support of agriculture, rural roads provide connectivity, with markets and lower input and transaction costs for rural producers and consumers, while access to low-cost electricity opens options for production, processing, marketing and distribution (Edeme et al., 2020; Llanto, 2012). Water infrastructure for irrigation is the most effective means of driving a country from rainfed agriculture, which is vulnerable to climate change effects such as droughts. Investment in irrigation infrastructure has a major positive effect in output per unit of land and per worker (Gajigo and Lukoma, 2011; Goswami and Chatterjee, 2009). Storage technology infrastructure reduces post-harvest losses (Gajigo and Lukoma, 2011). Further, access to electricity creates various support opportunities for rural farmers (Gajigo and Lukoma, 2011; Goswami and Chatterjee, 2009).

The cost of manufacturing is a significant component in the competitiveness of a firm, and this can be compromised by high cost of power and transport. Transport and electricity are the main infrastructure services in manufacturing productivity (Soneta et al., 2019) while Andreas (1997) considered road transport as being key. It is therefore clear why governments are motivated to develop energy and transport infrastructure more significantly, since the costs of power and transport are a critical contributor to the overall cost of manufacturing and prices of final products.

Infrastructure such as energy, markets, transport and ICT are the bedrock of ease of doing business in trade and tourism sectors. For instance, transport and digital communications infrastructure play a role in reducing the cost of trade, thereby facilitating economies of scale and knowledge accumulation (Carlson and Otto, 2013). Information and Communication Technology (ICT) is expected to increase growth by improving market functioning and increasing trade (Chatterjee and Anand, 2017). Business process outsourcing is largely dependent on ICT infrastructure. This, therefore, depends on the extent to which businesses are automated and interconnected through Internet platforms. Conducive markets provide an enabling environment for buyers and sellers across all scales, whether micro, small medium or large enterprises. Market infrastructure comprises of premises, warehousing, and utilities such as water, energy, security, and garbage collection. Transport infrastructure on land, air and water become a necessity in domestic, regional and global trade. This is the basis for developing roads, railways, seaports/inland ports, airports/airstrips and pipelines. Information and communication infrastructure facilitate flow of information and establishment of transactions. Lack of such infrastructure raises barriers to trade and tourism, just like taxes and tariffs. Rehman, Noman and Digo (2020) assert that transport infrastructure connect remote areas for business, while energy promotes capital-intensive industrialization and telecommunications enhances product marketing.

Financial services are undergoing a revolution in the 21st century in terms of scope of service, financial inclusion, and ease of transaction due to ICT-enabled financial solutions. This has ranged from Internet to cellular phone-based financial transactions, which have enhanced financial deepening and ease of transacting (Alshubiri, Jamil and Elheddad, 2019; Chatterjee and Anand, 2017). Though ICT can raise the efficiency level for banking sector by being cost effective and improve accessibility of finance by the people through branchless banking and mobile banking, it can also impose negative impact on employment and labour market (Chatterjee and Anand, 2017). In their works, Alshubiri, Jamil and Elheddad (2019) argue that ICT-based applications such as mobile and Internet financial services are essential in promoting financial integration and economic growth, thus their accessibility would reduce cost of financial intermediation. ICT developments such as mobile penetration promotes financial inclusion (Andrianaivo and Kpodar, 2011).

Production and technological progress

Production theory also provides a host through which we can explain the role of infrastructure in economic growth. In production, applicable technology within the country combines capital, labour and materials to produce various goods and services whose collective value forms the country's gross domestic product. Technological progress could shift the production function, and infrastructure is a potential trigger of such a shift. Capital-augmenting technological progress increases the share of capital in the contribution to production as opposed to labour-augmenting. For instance, in capital augmenting, infrastructure is a subset of capital, and this can be derived from the understanding that investments in

development of infrastructure contribute to gross fixed capital formation. This is evidenced by various authors who have asserted that gross fixed capital formation comprises of both infrastructure and non-infrastructure assets (Han, Su and Thia, 2020; Joshi, Lazatin and Flaminiano, 2017; Agenor and Moreno-Dodson, 2006). Capital formation through infrastructure development is a technological change that enhances the capital intensity and rate at which capital contributes to economic growth, thus it changes the ratio of capital-labour in favour of capital.

The capital augmenting technology defines technological change that favours productivity of capital, thus the accumulation and quality of capital can be associated with changes in economic performance across sectors. This assumes that variations in labour across economic entities may not significantly vary over some given period, and this may stagnate their contribution to variation in economic performance in the short-run. It takes time to change skills set across economic entities due to various labour market dynamics, including duration taken for development of skills, limitations in skills matching, and labour immobility factors that lag the effect of labour on economic growth in the short-run. The converse of these assertions is labour-augmenting technology, which enhances labour intensity and productivity, thus assume that variation in capital may have less significant contribution to variations in economic growth across regions.

3.2 Empirical Literature

Various studies have undertaken empirical analysis on the association between infrastructure services and economic and sectoral growth. Infrastructure accelerates economic growth by ensuring movement of goods, labour and services. Some studies have focused on the role of electricity (Edeme et al., 2020; Llanto 2012; Soneto et al., 2019), transport and roads (Edeme et al., 2020; Soneto et al., 2019; Llanto 2012; Prabir, 2006; Andreas, 1997), ICT (Edeme et al., 2020; Chatterjee and Anand, 2017; Alshubiri, Jamil and Elheddad, 2019) and others on either the overall economic performance or specific sectors such as agriculture, manufacturing, trade, among others.

For instance, on macroeconomic growth, Lenz, Skender and Mirković (2018) found gross fixed capital formation (GFCF), rail and road network as significant infrastructure in growth of gross domestic product. Though GFCF and road network were positive, railway was negative related to economic growth. However, this left out key infrastructure services such as water, housing, information communication and technology, because it used only roads and railway.

In agriculture, electricity was found to be a significant determinant of agricultural productivity in the Philippines (Llanto 2012). In the study, a one percentage point increase in the number of households with electricity was associated with an increase in agriculture productivity by about 22 million Pesos per agricultural worker. Edeme et al. (2020) found the elasticity of agriculture output to electricity connectivity to be 0.33 among the ECOWAS countries, although this was insignificant. In addition, the change of one per cent in electrified villages would

lead to 0.16 q/ha increase in agricultural productivity (Goswami and Chatterjee, 2009).

The quality of transport network influenced the performance of agriculture in the Philippines (Llanto, 2012). The study showed that a 1 percentage point increase in the length of paved roads as a ratio to total length of roads accounted for increased agriculture productivity by about 285,000 Pesos per agricultural worker (Llanto, 2012). However, Edeme et al. (2020) found a negative relationship between agriculture output and transport (roads network), with a negative elasticity of 2.93 but not significant. Edeme et al. (2020) also found that a percentage increase in access to information communication and technology increases agriculture output by 0.27 per cent.

In manufacturing, the effects of infrastructure on manufacturing output vary across regions. For instance, road infrastructure in the US had a positive effect on total factor productivity of manufacturing, with elasticities ranging between 0.3 and 1.1 (Andreas, 1997). However, Soneto et al (2019) found that investment in transport and electricity infrastructure were inversely proportional to productivity and growth of manufacturing in Pakistan, accounting for negative 23 per cent, but acknowledged that many other studies in literature had positive effect.

In trade, most studies focus on infrastructure and international trade as opposed to domestic trade. However, we borrow on the common results that indicate the influence of infrastructure on the volume of trade. For instance, Rehman, Noman and Ding (2020) investigated the effect of transport, communication and energy infrastructure on exports and trade deficits, which they found to be positive and negative, respectively. This showed that infrastructure enhanced export processing industries and domestic consumption, which in turn reduced the deficit, including reduction in importation. Further, Ismail and Mahyideen (2015) found significant positive long-run impact of transport, telecommunication, and energy on exports. In addition, Prabir (2006) found that variations in trade mobility infrastructure across countries had significant influence on regional trade flows in Asia where the country's transport infrastructure produced a significant positive effect on bilateral trade, with the highest elasticity reaching a 1 per cent level.

In the financial services sector, Chatterjee and Anand (2017) show that the ICT penetration variables such as mobile phones and Internet have positive and significant impact on financial services with multiplier effects being Internet (6.7 units), mobile access lagged 2 years (4 units) and mobile phone with Internet (0.038 units). In the works of Alshubiri, Jamil and Elheddad (2019), which involved six countries in the Gulf Cooperation Council, a 1 per cent increase in fixed broadband led to about 2 per cent increase in financial development, but the Internet user variable resulted in about a 0.09 per cent increase. The other money supply proxy increased by 0.40 per cent when ICT increased by 1 per cent. Additionally, money supply increased by 0.11 per cent when the Internet user ratio increased by 1 per cent.

Whereas a complimentary role of housing infrastructure is expected in economic development, its adverse effect to some sectors such as agriculture have gained focus. This is largely due to urban sprawl causing land use changes where

agricultural land is converted to real estate, thereby reducing the agricultural economic activities. Some authors have argued that farmers may continue to conduct farming even with rising demand for land and land prices for real estate development, but empirical evidence shows that housing demand significantly influenced farmer's choice to reallocate agricultural acreage to the non-farming sector, especially due to off-farm incomes and absence of government incentives to hold land for agriculture (Yagi and Garrod, 2018; Bekkerman, 2007). The competition between housing and agriculture is seen to be an urban problem than it is a rural problem. For instance, Rohndi et al. (2018) found that agricultural land yielded relatively higher economic benefit than housing in the rural areas unlike in urban areas.

Whereas there is consensus on the potential in infrastructure to boost economic development, there is no consensus on the indicators that represent infrastructure in empirical literature. It is observed that the choice of variables relies on the objective of the study and availability of data; besides, there is a mix in using sectors or sub-sector indicators (Appendix 1). For instance, some authors have used overall transport infrastructure (Soneta et al., 2019; Rehman Norman Ding, 2020) while others have used its sub-sector indicators such as road network, rail, air and water network (Edeme et al., 2020; Goswami and Chatterjee, 2009; Llanto, 2012) as representative variable for transport while others use value added by transport. Energy infrastructure has been represented by electricity connectivity in terms of the number of connections or proportion of population with access to electricity. For information communication and technology, the population with Internet use, or telephone connection or mobile connections is used. Further, water connectivity, rainfall and irrigation network have been used to represent water infrastructure. However, these studies have failed to differentiate between infrastructure utilization and network connectivity. Whereas infrastructure utilization can be captured using the value of infrastructure service or output, connectivity will represent the network characterization including length, number of connections and even quality of infrastructure.

Further, the type of data and objective of the studies have also determined the method used in the analysis, whether time series, panel data or cross-sectional analysis. In terms of methodology, time series analysis, panel data analysis, cross sectional analysis have been adopted by various authors (Appendix 1).

3.3 Overview of Literature

There is unanimous agreement that infrastructure is key in economic growth and development. However, empirical evidence shows that various infrastructure are yet to play their role in accelerating growth across the various economic sectors. Infrastructure areas such as transport, energy, information and communication, water and real estate are some of the key sub-components that have featured in the literature.

Authors continue to use different variable and methodology, which result in various results and interpretations. This study will endeavour to make the contribution

towards this by introducing other indicators that are more inclusive, such as value of infrastructure services to represent utilization, and choose indicators that are more relevant to the economic sectors.

4. Methodology

4.1 Theoretical Framework

Following various authors (Han, Su and Thia, 2020; Agenor, 2010; Agenor and Moreno-Dodson, 2006; Canning, 1999), a Cobb Douglass production function is assumed and simplified, such that the value of the economic sector output (Q) is linked with Capital (K) and Labour (L) as shown in equation 3.1, with α and β being parameters linking output with capital and labour, respectively.

$$Q=AK^{\alpha}L^{\beta} \quad 3.1$$

In Agenor (2010) and Agenor and Moreno-Dodson (2006), capital *(K)* infrastructure is broken down into the stock of physical capital *(KI)* and private capital *(KP)* in infrastructure (equation 3.2) while in equation 3.3, Han, Su and Thia (2020), capital is broken down into infrastructure *(K)* and non-infrastructure *(N)*, although in all cases labour-augmenting technology is used by modifying labour (L) into effective labour by multiplying it with productivity index (A).

$$Q=KI^{\alpha}\, L^{\beta}\, K_{P}^{1-\alpha-\beta} \quad 3.2$$

$$Q=K^{\alpha}\, L^{\beta}\, N^{1-\alpha-\beta} \quad 3.3$$

The gap is that most authors do not break down infrastructure into its sub-sectors, which Edeme et al. (2020) do, but separate capital from infrastructure, which is erroneous in this study following Han, Su and Thia (2020) assertion that capital can be broken into infrastructure and non-infrastructure. The study will fill these gaps by using a more comprehensive description of infrastructure using the sub-sector approach because infrastructure works in a seamless manner. These sub-sectors include transport, electricity, water, information communication and technology and housing.

4.1 Analytical Framework

The study modifies the framework of Agenor (2010), and Agenor and Moreno-Dodson (2006) who break down capital into public and private capital in infrastructure, but in this case, we disaggregate the capital into sub-sectors of infrastructure. Therefore, changes in capital investment *(ΔK)* across the regions are assumed to be depending on changes in the various infrastructure investments, including transport *(T)*, electricity *(E)*, water *(W)*, information communication and technology *(C)*, and housing *(H)*, among others. Transforming equation 3.1 into log form and by further modification, the model specifications to assess the effect of infrastructure on economic growth is presented in equation 3.4. The component $a_o logA_i$ is a constant, which accounts for the contribution of non-infrastructure. This approach is also in line with Edeme et al. (2020), who for example regress agriculture output against transport, electricity, and ICT, among other variables such as land.

$$logQ_i=a_o logA_i+a_1 logT_i+a_2 logE_i+a_3 logW_i+a_4 logC_i+a_5 logH_i+a_6 logL_i+\varepsilon \quad 3.4$$

It is also assumed that infrastructure development affects different sectors differently. This assumption is used to associate infrastructure inadequacies to the performance in various sectors across the economy. Thus, variations in sector performance due to variations in infrastructure services helps in investing in targeted infrastructure, which has higher impact on the respective sectors and ascertaining the sectors that require intensive investment for them to play the expected role. Some of the priority economic sectors in Kenya's economy include agriculture, manufacturing, finance, trade and accommodation, whose output can be analyzed against utilization of infrastructure services and connectivity to infrastructure networks.

4.2 Data Description and Sources

Secondary data was used from the Kenya National Bureau of Statistics, including statistical abstracts and economic surveys (KNBS, 2010-2019), the gross county product report (KNBS, 2019d) and household budget surveys (KNBS, 2016). The other local sources data were Kenya Roads Board, and Water Services Regulatory Board. Data on infrastructure index was obtained from the Africa Development Bank reports on Africa Infrastructure Development Index (2016; 2018), which provides credible regional data. Additional data was sourced from the World Bank (2019; 2020) and International Telecommunication Union (ITU, 2019), which provide credible global data.

The dependent variables include value of outputs of five economic sectors, which are agriculture, manufacturing, trade, accommodation, and financial services, obtained from KNBS (2019d). The independent variables include values of outputs and levels of connectivity for five types of infrastructure services and network variables, including water, transport, electricity, information communication technology and housing sub-sectors. The value of output refers to economic value that the sector contributes to the gross county product, which is a sub-regional economic performance, akin to gross domestic product for the country at large. Most of the data was sourced from KNBS, with additional data for roads and water connections being obtained from Kenya Roads Board (2018; 2019) and Water Services Regulatory Board (WASREB, 2020), respectively. The description of the variables and the hypothesis are provided in Table 4.1.

Table 4.1: Description and measurement of variables

	Variable	Description/Measurement	Hypothesis: Output effect
Dependent variables	lagri	Log of the value of agriculture output in the county output	NA
	lmanuf	Log of the value of manufacturing output in the county output	NA
	ltrade	Log of the value of wholesale and retail output in the county output	NA
	laccom	Log of the value of accommodation and food services output in the county output	NA
Independent variables on infrastructure value	lwatvalue	Log of the value of water services in the county	+
	ltransvalue	Log of the value of transport services in the county	+
	lelectvalue	Log of the value of electricity services in the county	+
	lictvalue	Log of the value of ICT services in the county output	+
	lhsevalue	Log of the value of real estate services in the county	+/-
	llabour	Log of the value of professional and public administration services at counties	+
Independent variables on infrastructure connectivity	lwatconn	Log of the number of water connections across counties	+
	ltransconn	Log of the length of roads in km across counties	+
	lelectconn	Log of the number of electricity connections across counties	+
	lictconn	Log of the number of Internet connections across counties	+
	lhseconn	Log of the number of structurally stable wall across counties	+/-
	llabour	Log of value of professional & public administration services at counties	+

The value of the economic and infrastructure services sectors varies across the counties (Table 4.2). The contribution of agriculture to gross county product of the county is the highest, followed by finance given their high mean value. However, there is evidence that the variation across counties in terms of manufacturing is significant following higher standard deviation, and the wide range in values represented by the min. and max. values.

The contribution of infrastructure services is dominated by real estate and transport services, whose average contribution was about 12 billion followed by electricity, water, and ICT, respectively. However, the absolute contribution of infrastructure services varies across the counties (Table 4.2). It is also observed that housing and transport infrastructure services have high contributions to the gross county products, but transport has wider distributional bias given the high standard deviation and the wide ranges represented by the min. and max. values, together with electricity (Table 4.2).

Table 4.2: Descriptive statistics

	Variable	Obs	Mean	Std. Dev.	Min	Max
Economic sectors value	lagri	47	10.60	1.03	7.29	12.62
	lmanuf	47	6.83	2.60	2.40	12.83
	ltrade	47	8.66	0.92	7.14	12.59
	laccom	47	6.03	1.30	3.81	9.55
Infrastructure value	lwatvalue	47	6.58	0.94	4.50	9.29
	ltransvalue	47	8.61	1.21	5.55	12.13
	lelectvalue	47	6.63	1.51	3.09	10.52
	lictvalue	47	6.81	1.07	4.96	10.88
	lhsevalue	47	8.71	1.07	6.62	12.08
	llabvalue	47	8.77	0.65	7.67	12.00
Infrastructure connectivity	lwatconn	47	9.47	1.45	5.73	13.25
	ltransconn	47	8.40	0.60	6.94	9.67
	lelectconn	47	10.72	1.16	8.70	14.13
	lictconn	47	11.65	0.92	9.74	14.07
	lhseconn	47	10.93	1.06	8.92	13.80

Source of data: KNBS, KRB, WASREB

5. Analysis and Findings

5.1 Responsiveness of Economic Performance to Changes in Infrastructure

5.1.1 Correlations between infrastructure and economic performance across counties

Except for agriculture, other economic sectors such as manufacturing, trade, and accommodation show that their contribution to the economy depends on infrastructure, given that the contribution of the infrastructure sectors have very high correlations with the performance of the economic sectors of the counties (Table 5.1a and 5.1b). However, there is no significant correlation between all forms of infrastructure with agriculture, yet agriculture is the backbone of the economy. This is a pointer to failure by the infrastructure sector to create an enabling environment for agriculture. However, the status of connectivity to access and use infrastructure services by the population indicates that transport infrastructure represented by roads connectivity has low correlation with all economic sectors (Table 5.1b). Once again, agriculture shows no significant correlation with infrastructure services.

Table 5.1: Correlations in economic performance and infrastructure services, 2017

5.1a	Economic sectors performance				
	lagri	lmanuf	ltrade	laccom	
Infrastructure value	lwatvalue	0.227	0.706	0.680	0.446
	ltransvalue	0.114	0.810	0.851	0.741
	lelectvalue	0.050	0.772	0.760	0.719
	lictvalue	0.073	0.814	0.848	0.766
	lhsevalue	0.134	0.862	0.830	0.747
5.1b	Economic sectors performance				
	lagri	lmanuf	ltrade	laccom	
Infrastructure connectivity	lwatconn	0.088	0.793	0.782	0.681
	ltransconn	0.393	0.157	0.114	0.097
	lelectconn	0.129	0.877	0.838	0.719
	lictconn	0.340	0.857	0.757	0.652
	lhseconn	0.157	0.846	0.780	0.673

Source of Data: KNBS (2019), Gross County Product

5.1.2 Elasticity of economic performance to value of infrastructure services in Kenya

The significance of changes in infrastructure services varies across the economic sectors of the economy (Table 5.2), and this demonstrates the differences in

utilization of infrastructure network. For instance, the value of water infrastructure services has significant and positive influence on the output of agriculture, and manufacturing, but shows negative association with accommodation (tourism), and no significance in explaining variations in trade across the counties. The elasticity of agriculture and manufacturing to changes in value of water infrastructure services were all approximately 0.5. The elasticity of the value of accommodation to the value of water infrastructure services was approximately -0.5. This shows that counties that rely on accommodation as one of the critical economic sectors are either deprived of adequate water or they have low utilization.

The output of transport infrastructure services was positively associated with output growth in trade, and accommodation (tourism), whose value had elasticity approximated as 0.3 and 0.4, respectively. However, the insignificance of value of transport services to agriculture and manufacturing may show that transport infrastructure services such as roads are not adequate or are under-utilized. Such situation exposes farmers to low agricultural productivity and post-harvest losses while manufacturers incur high transportation costs besides the delays in delivery of firm inputs and transportation of products.

The ICT infrastructure showed significance in variation of accommodation sector only, whose elasticity was 0.9. This was against expectation that utilization of ICT service has a positive effect especially on trade, since they are service-oriented as opposed to primary or secondary production.

The electricity infrastructure also showed no significance in variation of all economic sectors. This finding reiterates the appeals by the manufacturing sector that electricity is not playing its supportive role to make the sector grow. This may be a reflection that most of electricity connections are largely for domestic use as opposed to business.

Further, the value of real estate infrastructure services had significant and positive association with the values of outputs in agriculture and manufacturing, whose elasticity was 0.8 and 1.7, respectively. However, real estate infrastructure services had no effect on trade and accommodation, showing that such infrastructure are yet to integrate with the economic activities in trade and accommodation.

Therefore, there some missing links in infrastructure services, starting with expected effect of transport infrastructure in explaining variation of output in agriculture and manufacturing. There is also evidence from this analysis that the country is yet to establish adequate electricity systems to support all sectors of the economic pillar. Real estate infrastructure would have also shown significance in supporting the trade sector, but this corroborates with market structures that show that most of the business in Kenya is largely micro to small scale, and often carried out in open markets. The negative coefficients of water in accommodation points to water deprivation of counties, with accommodation sector potential. On its part, ICT is yet to be integrated in supporting agriculture, manufacturing, trade, and accommodation.

Table 5.2: Elasticity of economic performance to changes in infrastructure services, 2017

Independent variables	Eq1		Eq2		Eq3		Eq4	
	Dependent variable lagri		Dependent variable lmanuf		Dependent variable ltrade		Dependent variable laccom	
	Coef.	Prob (Sig.)	Coef.	Prob (Sig.)	Coef.	Prob (Sig.)	Coef.	Prob (Sig.)
Lwatvalue	0.557	0.099**	0.555	0.062**	-0.048	0.647	-0.557	0.001*
Ltransvalue	0.132	0.658	0.362	0.304	0.293	0.009*	0.352	0.069**
Lelectvalue	-0.215	0.398	0.089	0.741	0.024	0.757	0.122	0.325
Lictvalue	-0.478	0.261	-0.311	0.422	0.165	0.449	0.875	0.012*
Lhsevalue	0.888	0.078**	1.691	0.002*	-0.041	0.805	-0.080	0.787
Llabvalue	-1.066	0.020*	-0.241	0.651	0.634	0.001*	0.038	0.857
_cons	12.093	0.000	-11.02	0.000	-0.034	0.975	0.268	0.845
R-squared	0.25		0.77		0.83		0.68	
Hetero: Breusch-Pagan; Prob>chi2	0.35		0.07		0.61		0.29	
Multicollinearity	Variance inflation factors; lreal (10.42), lict (10.38), ltransport (5.88), lelect (4.64), labor (3.66), lwater (2.69), Average (6.28): rule of thumb of VIF>10 points to traces of multicollinearity thus robust regression							

* and ** stands for significant at 95% and 90% confidence interval, respectively

Variations in infrastructure services contribute a minimal 25 per cent in variations in performance of agriculture across counties, where water and real estates are significant infrastructure services while transport, electricity and ICT are insignificant (Table 5.2). Variations in agricultural output depend on changes in water infrastructure services, where an increase of value of water output by 10 per cent can account for an increase in the value of agricultural output by 5.6 per cent. This indicates that water is a critical input in agriculture, thus the need to continue increasing water infrastructure that supports agriculture, including bulk water storage and distribution networks. In addition, there is a positive relationship between agriculture and real estate development, where an increase in real estate services by 10 per cent is associated with growth in value of agriculture output by 8.8 per cent. This may be explained by human settlements, which are attracted to economic activities, and the over-reliance of agriculture on labour, thus attracting development of the housing sector. However, there is need to enhance development of some sectors such as transport, electricity and ICT to enable them play a supportive role to the growth of agriculture. In particular, the non-responsiveness of transport services may be arising from the investment concentration on major roads, thus denying the minor roads the impetus to transport farm inputs and outputs effectively. This results in sub-optimal production and post-harvest losses.

Changes in the value of manufacturing are significantly associated with variations in infrastructure services for water and real estate, unlike transport, electricity, and

ICT (Table 5.2). An increase in value of water infrastructure services by 1 per cent is associated with 0.5 per cent increase in value of manufacturing. The relationship between the two would be explained by the need for water in manufacturing processes, either as a reagent or within the cooling system, and in discharge of waste. The value of manufacturing also increases by 1.7 per cent with 1.0 per cent increase in real estate services. This confirms the symbiotic relationship between manufacturing and housing, since workers and manufacturing allied businesses require residential and commercial houses around industrial areas. This elevates the significance of the twin initiative of the government on affordable housing and manufacturing. However, lack of significance in electricity and transport, besides their importance in manufacturing, is a pointer to limited quality of electricity and transport network to support manufacturing. This calls for spirited efforts in scaling up connectivity of electricity to industrial areas, reduction of electricity tariffs, improved quality of electricity without outages, and improved network and quality of transport infrastructure. This will also translate to lower cost of manufacture, thus boosting production.

The analysis shows that trade is more dependent on transport infrastructure than water, electricity, ICT, and real estate infrastructure (Table 5.2). It is also largely driven by labour services, which include professional and public administration services. For instance, an increase in transport services by 1.0 per cent increases value of trade output by 0.3 per cent across counties. However, the insignificance of ICT in promoting trade is of policy concern, since there is huge potential in ICT that can promote business if entrepreneurs could market their products through such media. E-commerce is entirely dependent on ICT infrastructure services, yet this is not significant. The e-commerce platforms promote business marketing, billing, payment, and receipting. They also help in customer intelligence by mapping Internet search behaviour to products, which enables matching of needs and products, thus increasing sales.

The accommodation sector seems to be significantly benefitting from transport and ICT infrastructure, but it is deprived of water infrastructure (Table 5.2). For instance, an increase in infrastructure services of transport and ICT by 1.0 per cent each results in an increase in output of accommodation by 0.4 per cent and 0.9 per cent, respectively. Counties depending on accommodation services or hospitality industry seem to have better transport facilities. The significance of transport shows that customers in the hospitality industry make decisions on destinations based on ease of transport. The significance of ICT shows that the hospitality industry exploits ICT opportunities for e-business, e-marketing, e-billing and e-sporting, among other relevant ICT applications.

5.1.3 Elasticity of economic performance to infrastructure connectivity in Kenya

There is a difference between having the infrastructure and receiving the infrastructure services. Though infrastructure network is expected to increase the value of infrastructure services in an economy, it is possible to have an elaborate

network with minimal linkages with the economic sectors, and unsupportive logistics and pricing. This will limit the contribution of infrastructure to the economic performance of the country or region. To assess this, the key indicators of infrastructure, including number of water connections, length of roads, number of electricity connections, number of Internet connections and the number of structurally stable houses are used. The analysis shows that the significance of changes in infrastructure network varies across the economic sectors of the economy (Table 5.3).

Table 5.3: Elasticity of economic performance to changes in infrastructure connectivity, 2017

Independent variables	Eq1		Eq2		Eq3		Eq4	
	Dependent variable lagri		Dependent variable lmanuf		Dependent variable ltrade		Dependent variable laccom	
	Coef.	Prob (Sig.)	Coef.	Prob (Sig.)	Coef.	Prob (Sig.)	Coef.	Prob (Sig.)
lwatconn	-0.071	0.637	0.156	0.551	0.151	0.070	0.195	0.307
ltransconn	0.633	0.003	-0.510	0.073	-0.153	0.133	-0.218	0.385
lelectconn	-0.084	0.770	0.975	0.058	0.208	0.131	0.365	0.316
lictconn	1.616	0.000	0.858	0.157	-0.086	0.671	-0.053	0.891
lhseconn	-0.621	0.042	0.509	0.308	0.051	0.753	0.186	0.619
llabvalue	-0.968	0.002	-0.280	0.453	0.750	0.000	0.319	0.396
_cons	3.312	0.140	-13.912	0.000	0.145	0.906	-2.114	0.449
R-squared	0.556		0.818		0.822		0.5532	
Hetero: Breusch-Pagan; Prob>chi2	0.539		0..4038		0.767		0.6153	
Multicollinearity	Variance inflation factors; lreal (10.42), lict (10.38), ltransport (5.88), lelect (4.64), labor (3.66), lwater (2.69), Average (6.28): rule of thumb of VIF>10 points to traces of multicollinearity thus robust regression.							

The agriculture sector had positive elasticity to the length of road network and Internet connections but decreases with increase in number of structurally stable houses. The value of agriculture sector output had an elasticity of 0.6 and 1.6 to road network and Internet connections, respectively (Table 5.3), besides having had transport and ICT services being insignificant (Table 5.2). This indicates that utilization of the road and ICT networks is still low to support agriculture. The value of agriculture output had negative elasticity of 0.6 to development of houses (Table 5.3), besides having had positive elasticity with the value of real estate service (5.2). This is evidence that areas with high housing development are more likely to encroach into agricultural land and reduce the productivity of agriculture by diverting labour.

The manufacturing sector seems to increase with increase in electricity and Internet connectivity but decreases with increase in length of road network.

The elasticity of the value of manufacturing output to electricity and Internet connectivity was 1.0 and 0.9, respectively (Table 5.3), besides the value of electricity and ICT having had no significance in explaining it (Table 5.2). This again shows that besides efforts to increase connectivity to electricity and Internet, the economy is yet to structurally integrate these in manufacturing. For instance, utilization of electricity and Internet can be inhibited by the cost of access and skills set, together with prevailing technology in manufacturing and operations. The negative elasticity to road network was approximately 0.5 (Table 5.3), besides transport services having had no significance as earlier established (Table 5.2). This is an indication that although the length of road network is important, its quality and other logistic services are pertinent in supporting manufacturing.

The trade sector seems to increase with increase in water and electricity connectivity but decreases with increase in length of road network. The value of trade sector output had elasticity of 0.2 to water and electricity connectivity for each (Table 5.3). This was again besides the insignificance of their respective value in infrastructural services (Table 5.2). This is an indication that there is concerted effort to increase connectivity to water and electricity, but again there is limited linkages, or most of the trade transactions do not necessarily require water or electricity as a critical input. The value of trade sector output had a negative elasticity of 0.2 with the road network, besides the value of transport services having had positive influence on the performance of the trade sector (Table 5.3 and 5.2). It is therefore understood that trade may be concentrated in areas with small surface area with shorter road length. Besides, for trade, it is the quality of road that matters most and not necessarily vastness of the road network.

6. Conclusion and Recommendations

Countries and regions with advanced infrastructure have demonstrated higher potential for economic performance. Therefore, differentials in infrastructure networks have potential to determine the rate of economic performance in gross domestic product or sub-regional domestic products such as gross county products, in case of counties being sub-regional economies. It is observed that the level of connectivity and utilization of infrastructure services affects the competitiveness of Kenya's economy regionally and globally.

The difference in significance of infrastructure utilization and connectivity across the various economic sectors provides evidence of infrastructure inadequacies, and that such level of infrastructure effectiveness hampers the role of infrastructure in economic performance. The insignificance in the role of infrastructure in economic performance is a strong pointer that quality of infrastructure across and within countries is critical in an economy. Therefore, there is need to enhance connectivity and utilization of infrastructure network.

The study finds utilization of water infrastructure to be supporting economic sectors such as agriculture and manufacturing, whose elasticity ranges within 0.3-0.5, unlike accommodation with significant negative elasticity of -0.6 and trade which had insignificant coefficient. However, connectivity to water infrastructure was only significant for trade with 0.2 elasticity, and not agriculture, manufacturing, and accommodation. Utilization of transport infrastructure had significant influence on performance of trade and accommodation, with elasticity ranging within 0.2 and 0.4 showing inadequacies in supporting agriculture and manufacturing. This was against connectivity to transport infrastructure showing significance for agriculture and manufacturing, with elasticity of 0.6 and -0.5, respectively. Electricity connectivity influences the manufacturing sector significantly, with elasticity of 1.0, although electricity utilization had negative elasticity on -0.2 on utilization. Infrastructure in information communication technology shows significance in supporting financial and agriculture sectors, whose elasticity was 1.2 and 1.6 in connectivity, and only accommodation in utilization which has 0.9 elasticity. The utilization of real estate infrastructure has significant and positive influence in agriculture and manufacturing, whose elasticity was 0.9 and 1.7, respectively.

Kenya's competitiveness in infrastructure shows mixed potential. The country is performing well on ease of connectivity to electricity and transport logistics, but needs to improve on water availability, ICT utilization and housing indicators such as property registration and construction permits. There is need to enhance the effectiveness of infrastructure in economic growth and development, thus it is recommended that:

(i) Review property registration and construction requirement and processes with a view to reducing the number, time, and cost of processes. The analysis has shown that Kenya lags in its competitiveness on these indicators of ease of doing business. This will enhance the development, access and quality of housing infrastructure.

(ii) The country invests more in enhancing water infrastructure network, ground water mapping and dam construction, and address issues making dam construction lengthy and costly. The analysis has shown that output in economic sectors such as agriculture are non-responsive to value of water and connectivity across the country. This will enhance the connectivity and freshwater availability, to enable water to boost productivity in agriculture, manufacturing, and accommodation sectors.

(iii) Upgrade transport infrastructure by improving the quality of the road networks through road maintenance and upgrading and scaling down cost of transportation and enhancing transport logistics. The analysis shows that areas with increased road network still have low performance in manufacturing and trade, a trend which needs to be reversed for the manufacturing and trade to reap the dividends of increased road network. This points to inadequacies in terms of quality of the roads and ease of using the roads. This will enhance the country's regional competitiveness and make transport connectivity and utilization more productive in the agriculture, trade, and manufacturing sectors.

(iv) The country should increase connectivity, reduce the cost of electricity, and enhance quality of power. Electricity showed weak linkages with agriculture, manufacturing, trade, and accommodation in utilization of the connectivity, which implies that besides connectivity, accessibility ad utilization is hindered by other factors such as cost and quality of power.

(v) Continue promoting automation of government and private sector activities while reducing the cost of Internet use and increasing coverage of mobile telephony with Internet use capability. The analysis shows that the value and connectivity to ICT infrastructure is weak linkages with trade, manufacturing, and accommodation, although utilization was significantly impactful for the accommodation sector.

References

Africa Union (2015), Africa Agenda 2063. *The Africa We Want*. Africa Union.

African Development Bank–AfDB (2013), *The Africa Infrastructure Development Index (Aidi)*. AfDB.

African Development Bank–AfDB (2016), *The Africa Infrastructure Development Index (Aidi)*. AfDB.

African Development Bank–AfDB (2018), *Africa Infrastructure Development Index*. AfDB.

Agenor, P.R. (2010), "A theory of infrastructure-led development". *Journal of Economic Dynamics and Control*, Vol. 34: 932-950.

Agenor, P.R. and Moreno-Dodso, B. (2006), *Public infrastructure and growth: New Channels and Policy Implications*. Washington DC: World Bank.

Alshubiri, F., Jamil, S.A. and Elheddad, M. (2019), "The impact of ICT on financial development: Empirical evidence from the Gulf Cooperation Council countries". *International Journal of Engineering Business Management*, Vol 11: 1-14.

Andreas, S. (1997), *The impact of road infrastructure on productivity and growth: Some preliminary results for the German manufacturing sector*. Wissenschaftszentrum Berlin für Sozialforschung (WZB), Berlin: WZB Berlin Social Science Research Center.

Andrianaivo, M. nd Kpodar, K. (2011), *ICT, financial inclusion, and growth: Evidence from African countries*. Washington DC: International Monetary Fund.

Canning, D. (1999), *The contribution of infrastructure to aggregate output*. Washington DC: World Bank.

Carlsson, R., Otto, A. and Hall, J.W. (2013), "The role of infrastructure in macroeconomic growth theories". *Civil Engineering and Environmental Systems*, Vol. 30: 263-273.

Chatterjee, A. and Anand, N. (2017), Financial inclusion, information and communication technology diffusion and economic growth: A panel data analysis. Research Gate.

Edeme, R.K., Nkalu, N.C., Idenyi, J.C. and Arazu, W.O. (2020), "Infrastructural development, sustainable agricultural output and employment in ECOWAS countries". *Sustainable Futures*.

Gajigo, O. and Lukoma, A. (2011), Infrastructure and agricultural productivity in Africa. African Development Bank.

Government of Kenya (2007), *The Kenya Vision 2030*. Nairobi: Government Printer.

Government of Kenya. (2010), The Constitution of Kenya. Nairobi: Government Printer.

Government of Kenya (2016), National Housing Policy for Kenya. Nairobi: Government Printer.

Government of Kenya (2016), Water Act, 2016. Nairobi: Government Printer.

Government of Kenya (2018), Third Medium-Term Plan 2018-2022: Transforming Lives: Advancing socio-economic development through the "Big Four". Nairobi: The National Treasury and Planning.

Government of Kenya (2013), Sector plan for infrastructure 2013-2017. Nairobi: Government Printer.

Goswami, P.K. and Chatterjee, B. (2009), "Impact of infrastructure and technology on agricultural productivity in Uttar Pradesh". *Agricultural Economics Research Review*, Vol. 22: 61-70.

Han, X., Su, J. nd Thia, J.P. (2020), Impact of infrastructure investment on developed and developing economies. Asian Infrastructure Investment Bank.

International Telecommunication Union – ITU (2019), Statistics: Percentage of individuals using Internet and mobile cellular subscriptions. ITU.

Ismail, N.W. and Mahyideen, J.M. (2015), The impact of infrastructure on trade and economic growth in selected economies in Asia. Asian Development Bank Institute.

Joshi, K., Lazatin, J.E. nd Flaminiano, J.P. (2017), Can we measure infrastructure investments more accurately? African Development Bank.

Kenya Association of Manufacturers–KAM (2018a), Manufacturing in Kenya under the 'Big 4 Agenda': A sector deep-dive report. Nairobi: Kenya Association of Manufacturers.

Kenya Association of Manufacturers–KAM (2018b), Manufacturing priority agenda 2018. Nairobi: Kenya Association of Manufacturers.

Kenya Association of Manufacturers–KAM (2021). Manufacturing priority agenda 2021. Nairobi: Kenya Association of Manufacturers.

Kenya National Bureau of Statistics–KNBS (2010-2019), Statistical Abstracts. Nairobi: Kenya National Bureau of Statistics.

Kenya National Bureau of Statistics–KNBS. (2016), Kenya Integrated Household Budget Survey 2015/16. Nairobi: Kenya National Bureau of Statistics.

Kenya National Bureau of Statistics–KNBS (2019a), Statistical Abstract 2019. Nairobi: Kenya National Bureau of Statistics.

Kenya National Bureau of Statistics–KNBS (2019b), Economic Survey 2019. Nairobi: Kenya National Bureau of Statistics.

Kenya National Bureau of Statistics–KNBS (2019c), 2019 Kenya Population and Housing Census. Nairobi: Kenya National Bureau of Statistics.

Kenya National Bureau of Statistics–KNBS (2019d), Gross County Product 2019. Nairobi: Kenya National Bureau of Statistics.

Kenya National Bureau of Statistics–KNBS (2020), Economic Survey 2020. Nairobi: Kenya National Bureau of Statistics.

Kenya Roads Board–KRB (2018), Road Inventory and Condition Survey - Road Register Report Volumes I II and III. KRB.

Kenya Roads Board–KRB (2019), Annual Public Roads Programme 2020-2021. Nairobi: Kenya Roads Board.

Lenz, N.V., Skender, H.P. and Mirkovic, P.A. (2018), "The macroeconomic effects of transport infrastructure on economic growth: The case of Central and Eastern EU member states". *Economic Research*, 1848-9664.

Llanto, G.M. (2012), The impact of infrastructure on agricultural productivity. Philippine Institute for Development Studies.

Mburu, M.J. (2013), The relationship between government investment in infrastructure and economic growth in Kenya. University of Nairobi.

Ministry of Energy (2018), National Energy Policy. Ministry of Energy.

Ministry of Information, Communications and Technology (2019), National Information, Communications and Technology Policy. Ministry of Information, Communications and Technology.

Ministry of Transport (2010), Integrated National Transport Policy. Nairobi: Ministry of Transport.

Mwaniki, P.M. (2019), Transport infrastructure investment on economic growth in Kenya. University of Nairobi.

Njiru, E.W., Simiyu, J.M. and Bunde, A.O. (2020), "Effect of government infrastructure investment on economic growth in Kenya". *Journal of Economics and Sustainable Development*, Vol. 11(4).

Prabir, D. (2006), "Trade, infrastructure and transaction costs: The imperatives for Asian economic cooperation". *Journal of Economic Integration*, 21(4): 708-735.

Rehman, F.U. and Noman, A.A. and Ding, Y. (2020), "Does infrastructure increase exports and reduce trade defcit? Evidence from selected South Asian countries using a new Global Infrastructure Index". *Journal of Economic Structures*, Vol. 10(9).

Rondhi, M., Pratiwi, P.A., Handini, V.T., Sunartomo, A.F. and Budiman, S.A. (2018), "Agricultural land conversion, land economic value, and sustainable agriculture: A case study in East Java, Indonesia". *Land*, Vol. 7(148). MDPI.

Snieska, V. and Simkunaite, I. (2009), "Socio-economic impact of infrastructure investments". Inzinerine Ekonomika-Engineering Economics, 16-25.

Soneta, K., Bhutto, N.A., Butt, F., Mahar, N. and Sheikh, S.A. (2019), Impact of infrastructure on manufacturing sector of Pakistan. Sukkur Institute of Business Administration, Sukkur.

United Nations General Assembly (2015). Transforming our world: The 2030 Agenda for Sustainable Development. United Nations General Assembly Resolutions, A/RES/70(1).

Water Service Regulatory Board – WASREB (2020), Impact report: A performance review of Kenya's water services sector 2018/19. Nairobi: WASREB.

World Bank (2019), *Ease of Doing Business*. Washington DC: World Bank.

World Bank (2020), *World Development Indicators*. Washington DC: World Bank.

Yagi, H. and Garrod, G. (2018), "The future of agriculture in the shrinking suburbs: The impact of real estate income and housing costs". *Land Use Policy*, Vol. 76: 812-822.

Appendix

Appendix 1: Matrix of literature review

Author	Sector	Methodology for analysis	Dependent variable	Independent variable
Gajigo and Alan Lukoma, (2011)	Agriculture	Correlation	Value added per worker	Land under irrigation
Edeme et al., (2020)	Agriculture	Pooled regression: augmented mean group estimator	Value added as % to GDP	Rural electricity (% of pop) Transport (rural roads) ICT (internet, mobile, computer, % of HH) (% of employed population in agriculture (% of total land area GDP growth, % annual growth
Goswami and Chatterjee (2009)	Agriculture	OLS	Agricultural productivity (q/ha),	Proportion of rural roads, Fertilizer consumption, Proportion of area under irrigation, Proportion of electrification villages
Llanto (2021)	Agriculture	Panel: fixed effect	agricultural labour productivity	Wages, irrigation area, energy (electricity access), paved road, rainfall
Chatterjee and Anand (2017)	Finance	Panel: FE	Usage indicators of F.I - Domestic Credit to private sector (percent of GDP), Outstanding Deposit (percent of GDP)	Usage indicators of F.I - Domestic Credit to private sector (percent of GDP), Outstanding Deposit (percent of GDP) ICT variables – Mobile phone users, internet users, fixed telephone line users, ICT imports (percent of total imports) Control variables GDP, education, value added of industry (percent of GDP)
Alshubiri Jamil Elheddad (2019)	Finance	Panel Fixed effects	financial development (domestic credit/GDP) or FD (broad money supply/GDP)	ICT (Internet users), ICT (fixed broadband), GDP growth, Trade openness ratio, Oil rent ratio, Urbanization
Andrianaivo and Kpodar, (2011)	Finance	System Generalized Method of Moment	number of deposits and loans per head	Mobile telephone subscribers, Number of deposits, Number of loans, Private Credit/GDP, Education, Government consumption, inflation
Canning (1999)	General	Panel Fixed effects	GDP per worker	capital per worker, human capital per worker, telephones per worker, electricity generating capacity per worker, transportation routes per worker
Han Su Thia, (2020)	General	Panel RE and FE	Output Per Worker	Infrastructure gross fixed capital formation, Non-infrastructure gross fixed capital formation
Snieska and Simkunaite (2009)	General	OLS and Correlations	GDP, per capita	Roads, Telecoms, Sanitation
Lenz, Skender and Mirković (2018)	General	Panel; Pooled OLS, FE and RE.	GDP	Roads, railway, gross fixed capital formation and population
Yagi Garrod (2018)	Agriculture and housing	Logit	Agriculture yes/no	Real estate income, Land price, agriculture productivity, land area, pop density, agricultural sales per area, diversification, area farmed
Bekkerman (2007)	Agriculture and housing	Panel GMM	Agriculture production	Farm income expected, Land value, unemployment rate, Government expenditure, expected non-farm income, housing permit value, relocation distance, Home value after relocation, Farm Income, Farm Acres
Rohndi (2018)	Agriculture and housing	OLS	Land Economic Value	Building area, road, no. of rooms, location,
Soneta et al., (2019)	Manufacturing	Time series; Cointegration	growth of manufacturing sector	transportation and communication, electricity and gas distribution, per capita income
Prabir (2006)	Trade	Panel fixed effects Indices Linear and quadratic regression	Trade volumes	Exporting and importing countries GDP, population, duties, exchange rate, distance, FTA. Agriculture infrastructure (access to fertilizer consumption, irrigated land and agricultural machinery), economic infrastructure (access to electricity, telephones, personal computer, banking facility, and internet), social infrastructure (access to health facility, media, education, drinking water), and transport infrastructure (access to roadways, railways, airways and ports).
Rehman Norman Ding (2020)	Trade	Cointegration	export and trade deficit.	Transport, telecommunication, energy and financial sector; Exchange rate, human capital, per capita GDP and institutional quality;
Ismail and Mahyideen, (2015)	Trade	autoregressive distributed lag	Exports Exports in agriculture Exports in manufacturing Real GDP	Air transport, roads transport, rail transport, container port facilities, Telephone lines, mobile phones, broadband, internet use, Road total network, paved road, air passengers, air freight,

ISBN 978 9966 817 95 2

Kenya Institute for Public Policy Research and Analysis
Bishops Garden Towers, Bishops Road
PO Box 56445, Nairobi, Kenya
tel: +254 20 2719933/4, 2714714/5, 2721654, 2721110
fax: +254 20 2719951
email: admin@kippra.or.ke
website: http://www.kippra.org