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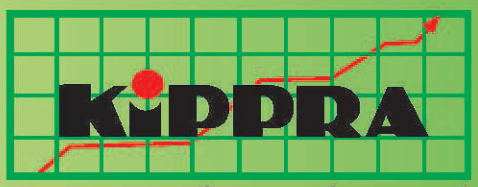


The KENYA INSTITUTE for PUBLIC POLICY RESEARCH and ANALYSIS

# Pivoting Digital Inclusion to Unlock Kenya's Arid and Semi-Arid Lands: An ICT Composite Index Approach

Austin Odera and Alex Matiy

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

YOUNG PROFESSIONALS (YPs) TRAINING PROGRAMME

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*KIPPRA Discussion Paper No. 314*
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## Abstract

*Digital inclusion is an essential aspect of the development of any country. Digital inclusion means ensuring that all individuals and communities who may be marginalized or underserved have access to and can effectively use digital technologies and the Internet. The primary objective of this study was to investigate the role of digital inclusion in unlocking the potential of Kenya's Arid and Semi-Arid Lands (ASALs) by utilizing an ICT index. The specific objectives were to assess the current status of digital access within Kenya's ASALs and to identify the challenges and opportunities associated with digital inclusion in the ASAL regions of Kenya. The study employed the use of an ICT composite index in the methodology. Creating an ICT composite index involved combining multiple indicators into a single measure representing the overall ICT development level. The study used data from the Communication Authority(CA) yearly reports, KNBS 2022 ICT Analytical report, KNBS 2019 Kenya Population and Housing Census, ICT Authority Digital Literacy Programme, and Ajira Digital. The findings showed that counties in the arid areas (84-100%) scored rather dismally in the ICT index, which reflected that there is still a need to put concerted efforts into improving aspects of the digital economy to ensure that the ASALs of Kenya are not left behind in taking up the massive opportunities offered in the digital spectrum. Despite the potential benefits of digital inclusion in unlocking Kenya's Arid and Semi-Arid Lands (ASALs), there is a lack of comprehensive understanding of its role and impact. Limited access to digital resources and infrastructure and challenges such as low digital literacy and technological barriers hinder realizing the ASALs' potential. Additionally, the absence of a tailored ICT index framework for assessing digital inclusion in the ASALs further limits the ability to measure progress and identify targeted interventions. The study recommended that stakeholders, the private sector, and the government may need to expand fiber optic networks and explore satellite-based internet solutions. Another key takeaway from the study was that mobile network expansion efforts could prioritize coverage in remote areas and introduce affordable data plans. Mobile money services can also be further encouraged to facilitate financial inclusion.*

## Abbreviations and Acronyms

CA Communication Authority

DAI Digital Access Index

DLP Digital Literacy Programme

DOI Digital Opportunity Index

ICT Information Communication Technologies

IDI ICT Development Index

NOBFI

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# 1. Introduction

Digital inclusion is an important aspect in the development of any country, but the question is always that what if this digital inclusion leaves excluded groups worse off? Digital inclusion means ensuring that all individuals and communities who may be marginalized or underserved have access to and can effectively use digital technologies and the Internet (Aker et al., 2012; Donner, 2015; Heeks, 2008). Digital inclusion aims to bridge the digital divide, which is the gap between people who have access to and can benefit from digital technologies and those who do not.

A nexus has been identified between ICT and overall economic growth with an exploration of how ICT can contribute to social and economic development, especially in developing countries (Awad & Albaity, 2022; Donou-Adonsou, 2019; Myovella et al., 2020; Stanley et al., 2018; Tchamyou et al., 2019). Some highlight the direct effects, while others highlight the indirect. Information and Communication Technology (ICT) is pivotal in fostering economic and social growth, particularly in developing countries. ICT enhances innovation, entrepreneurship, and financial inclusion by providing access to education, healthcare, and economic opportunities (Adeleye et al., 2021). It also facilitates efficient governance, promotes social connectivity, and enables data-driven decision-making. Through internet expansion and skills development, ICT bridges gaps and encourages international collaboration, driving economic progress. However, challenges like the digital divide and cybersecurity must be addressed to ensure equitable access and maximize ICT's potential for sustainable development.

Arid Semi-Arid Lands (ASALs) comprise 89 per cent of the country with approximately 38 per cent of Kenya's Population, covering 29 counties and about 16 million people within country borders (Kenya National Bureau of Statistics, 2019). The ASALs counties in Kenya have ICT Infrastructure present to some extent (Communications Authority of Kenya, 2020). However, they may not experience the growth, development, and benefits of using ICT since the percentage of ICT infrastructure installed is relatively inadequate.

Furthermore, some ICTs cannot be effectively operated without technical knowledge that often comes with certain levels of education. The implication means that where illiteracy levels are high, other factors notwithstanding, access to ICTs can be problematic. These studies collectively highlight the multifaceted impact of ICT on various aspects of development, including well-being, economic growth, and trade dynamics in Africa. They underscore the importance of digital technologies and infrastructure in fostering positive change across diverse domains.

Despite the potential benefits of digital inclusion in unlocking Kenya's Arid and Semi-Arid Lands (ASALs), there is a lack of comprehensive understanding of its role and impact. Limited access to digital resources and infrastructure and challenges such as low digital literacy and technological barriers hinder realizing the ASALs' potential. Additionally, the absence of a tailored ICT index framework

for assessing digital inclusion in the ASALs further limits the ability to measure progress and identify targeted interventions. Therefore, there is a need to address these gaps and explore the challenges and opportunities of digital inclusion in the ASALs while proposing an ICT index framework to guide the assessment and improvement of digital inclusion efforts. By highlighting the unique challenges ASAL communities face and underscoring the significance of digital inclusion, we have established the need to examine the ICT landscape in these regions.

The primary objective of this study is to investigate the role of digital inclusion in unlocking the potential of Kenya's Arid and Semi-Arid Lands (ASALs) by utilizing an ICT index. The specific objectives of this study are to assess the current status of digital access within Kenya's ASALs and identify the challenges and opportunities associated with digital inclusion in the ASAL regions of Kenya.

The rest of the sections are organised as follows: Section 2 presents the literature review, section 3 discusses the methodological approaches, findings and discussions are presented in section 4 while section 5 concludes.

## 2. Digital Economy in Kenya

The digital economy in Kenya is still a nascent sector and is primarily measured through the ICT sector It witnessed a growth rate from 7.9 percent in 2018 to 8.8 percent in 2021(KIPPRA, 2022). An annual Digital Quality of Life (DQL) study revealed that Kenya is ranked 78th out of 122 countries. The DQL index is calculated by combining five core pillars: internet affordability, internet quality, e-infrastructure, e-security, and e-government. In Kenya, the pillars of the digital economy, however, provide a clearer picture to highlight the areas under which progress has been made(Surfshark, 2022).

### 2.1 Digital Infrastructure

In terms of digital infrastructure, significant progress has been made overall in Kenya. Concerning the National Optic Fibre Backbone Infrastructure, as of 2021, we have more than 7000 kilometres of optic cable installed across all 47 counties of Kenya(Ministry of Information, Communications and The Digital Economy, 2023). This translates to the total number of mobile data/Internet subscriptions, which stood at 47.7 million as of December 2022. Up to 66.8 percent of these connections are mobile broadband in the 3G,4G, and 5G connectivity bands. There has been a steady increase in connections to the faster bands, such as 4G and the newly piloted 5G, as users prefer faster internet speeds(Communications Authority of Kenya, 2022). However, in the ASAL regions of Kenya, there is still relatively low internet usage. The arid and semi-arid counties have between zero to 12 percent of the total population with access to the Internet (Kenya National Bureau of Statistics, 2022). Most households in the ASALs use feature(kabambe) phones. These are basic phones or dumb phones which offer limited functionalities, unlike smartphones. They offer basic communication features like calling and sending text messages. Apart from being inexpensive, the main advantage of these phones in the ASAL regions is their long battery life. This is an advantage because these areas have fewer households connected to the electricity grid.

### 2.2 Digital Government

Concerning the digital government, the government has an E-Government Portal, an eCitizen portal (www.ecitizen.go.ke), and its mobile app, Gava Mkononi, which provides citizens easy access to over 5,000 government services. Through this platform, citizens can conveniently apply for essential documents like passports and driver's licenses and make payments for various government services. The aim is to enhance revenue collection efficiency and reduce leaks by digitizing tax payments. The app covers various services from different government entities, including Kenya Ports Authority, Kenya Revenue Authority, Hustler Fund, NTSA, and HELB. It also facilitates business registration, police clearance, civil registration, foreign nationals' registration, and immigration services. This digitization initiative is a significant milestone, with 5,000 services out of 7,000 now accessible online. The government is streamlining payment channels by

shutting down over 1,000 pay bills and introducing a single pay bill number, 222222, for all government transactions(MOICT, 2022).

## 2.3 Digital Skills and Values

The SDG target for Internet and broadband aims that by 2025, 60 per cent of youth and adults should have achieved at least a minimum level of proficiency in sustainable digital skills. Digital skills have been defined as skills that enable people to access, use, and benefit from the Internet, enhance Internet penetration, and access to employment and entrepreneur opportunities. It is estimated that by 2030, digital skills will be required in most of the jobs in Kenya(International Finance Corporation, 2021). Limited knowledge and skills in ICT in the ASALs of Kenya are a significant barrier to households' Internet use, which prevents them from exploiting its benefits even during emergencies or disasters. Digital skills are measured from basic to intermediate to advanced levels. Basic skills, including hardware, software, and basic online tasks, form the foundation for functioning in society. Intermediate skills go further, allowing critical technology use and content creation, particularly for work-related tasks like digital marketing. Advanced skills are specialized, including programming, AI, big data, and cybersecurity, often requiring advanced education and leading to higher-paying roles, particularly in ICT professions(KIPPRA, 2022). The national government introduced a mandatory digital literacy program to ensure every pupil is ready and equipped for this digital environment. As of 2022, the average percentage of schools with the DLP program is 98.67 per cent. The Ajira Digital Programme is another national government initiative to empower over one million young individuals to access digital employment opportunities. An important aspect of this initiative is emphasizing education and skill development tailored for the constantly changing landscape of online jobs. The program has achieved notable success by granting Kenyans access to various online digital job opportunities and fostering partnerships and collaborations that have proven beneficial for the country. It collaborates with 56 established digital platforms, offering various services, from business development to ensuring efficient technology access(MOICT, 2023).

## 2.4 Digital Business

Access to and capability to use ICT is important for business continuity and resilience in times of adversity. Integrating ICT in business processes has proven to be a critical solution to the survival of enterprises when risk events occur. For this to happen, businesses need to remain interconnected among themselves (B2B), with their customers (B2C), and with government (B2G). Globally, the target is to overcome the unconnectedness of Micro, Small, and Medium-sized Enterprises (MSMEs) by 50 per cent by sector by 2025. It is also targeted that 40 per cent of the world's population should be using digital financial services by 2025. In Kenya, enterprises have made progress in accessing and using ICT in their activities. 90 per cent of enterprises interviewed used computers, all enterprises across all sectors recorded high usage of computers in their work

environment. Similarly, 84 per cent of enterprises had Internet on their premises, of which most firms, 81 per cent, used fixed broadband for their connectivity. Fibre to the office was dominant, with 50.7 per cent of firms using it. Firms that did not have Internet on their premises accessed it elsewhere. Enterprises mainly used the Internet for communication by sending and receiving emails (88.7%). Delivery of products was the activity least carried out using the Internet (16.6%) (Enterprise ICT Survey, 2016).

Similarly, the level of e-commerce nationally is low and below optimal levels. Data from the Kenya Population and Housing Census 2019 revealed that only 4.3 per cent of those aged 15 years and above searched and bought goods/services online. The UNCTAD B2C E-commerce Index of 2020 ranked Kenya at position 88 out of 152 countries worldwide, further highlighting the gap in e-commerce in Kenya. This will likely have improved during the COVID-19 pandemic, where lockdown measures pushed enterprises to e-commerce. Contrastingly, most of the informal enterprises do not use Internet-enabled platforms to enhance their business. The ISSOS 2020 revealed that about 80.4 per cent of informal enterprises were not using the available platforms. The National Payments Strategy (NPS) 2022-2025 by CBK recognizes the importance of emerging digital technologies in the payments ecosystem, such as cryptocurrencies, stablecoins, central bank digital currencies (CBDC), blockchain, and distributed ledger technology (DLT).

## 2.5 Innovation-Driven Entrepreneurship

The innovation-driven entrepreneurship pillar aims to create a supportive ecosystem for local firms, enabling them to produce world-class products and services, thereby advancing digital economic transformation. Key indicators of progress include the adoption of new digital technologies, enhancing operational efficiency, customer experience, and profitability. In Kenya, the digital economy exhibited positive growth, with combined revenue from Internet service providers and the telecommunications industry increasing from Ksh 320 billion in 2019 to Ksh 366 billion in 2021, maintaining a 7.4 ratio of revenue to investments in 2021(KIPPRA,2022).

# 3. Literature Review

## 3.1 Theoretical Literature

### Digital Divide Theory

The study borrows from the digital Divide theory, which supposes that unequal access to and use of digital technologies can exacerbate existing social and economic inequalities, leading to a division between those with access to digital resources and those without (Dutton & Dutton, 1999). This divide can manifest in multiple dimensions. The Digital Divide theory does not have a single original author, as it has evolved through the contributions of various researchers and scholars. The term digital divide was coined to describe the gap between those with access to digital technology and those without access (Cai, 2008). In recent years, the idea of the digital divide has been further elaborated to differentiate between physical access and practical use (Alam & Imran, 2015; Kabbar et al., 2008; van Deursen & van Dijk, 2014) posit that specific groups, such as women, older people, and less educated, may be disadvantaged in ICT adoption and use. This may be deemed valid in Kenya's ASAL counties since The Kenya National Bureau of Statistics census of 2019 highlights men having more access to ICT infrastructure like mobile Internet, which is a critical factor in measuring digital inclusion.

### Information Poverty Theory

The information poverty theory posits that lack of access to information and communication technologies (ICTs) leads to information poverty, limiting individuals' ability to participate in society and the economy. It considers the multifaceted nature of the digital divide, encompassing access, skills, and usage dimensions. Chatman and Pendleton (1995) conducted three studies that worked with low-income populations of janitors, older women in retirement communities, and women participating in the CETA (Comprehensive Employment and Training Act) program. Chatman conducted her studies using ethnographic and sociological methods and theories, including social network theory, gratification theory, diffusion theory, opinion leadership theory, and alienation theory. When information practices are understood to be shaped by social context, privilege and marginalization alternately impact access to and the use of information resources. In the context of information, privilege, and community, politics of marginalization drive stigmatized groups to develop collective norms for locating, sharing, and hiding information. One may want to understand the nexus between the information model and the digital divide, and studies have shown that information poverty is one of the consequences of the digital divide. As people without access to digital technologies cannot engage in online information exchange, communication, and knowledge sharing, they experience a lack of information essential for personal, educational, and economic development.

For this study, it was decided that a composite index would be adequate for measurement purposes. An ICT index combines multiple indicators into a single measure representing the overall level of ICT development. Here is our suggested disposition to create this index.

## 3.2 Empirical Literature

The development of ICT development indices can be categorized into two distinct phases. In the early 2000s, the focus was on ICT access and use (International Telecommunication Union, 2003). The Digital Access Index (DAI) weighted eight indicators based on expert opinion, including fixed telephone subscribers, mobile cellular subscribers, internet access price, school enrolment, literacy, international internet bandwidth, broadband subscribers, and usage. The ICT Opportunity Index (ICT-OI) measured access to and usage of ICT by individuals and households, assigning equal weighting to indicators. The Digital Opportunity Index (DOI) equally weighted 11 indicators across three categories: opportunity, infrastructure, and utilization. These indices assessed 181 countries based on their respective DOI scores (International Telecommunication Union, 2005).

The second phase introduced the ICT Development Index (IDI) in 2009, a composite index comprising 11 comparable indicators grouped into three sub-indices: ICT access, use, and skills. The IDI differs from previous indices by including skills alongside access and use. This recognition of ICT skills is crucial, as they are necessary for meaningful social and economic outcomes resulting from ICT access and use (International Telecommunication Union, 2009).

Numerous subsequent studies to construct indices have employed various weighting approaches to enhance the precision of sub-indices and indicators. For instance, certain studies determined indicator and sub-index weights through expert opinion. Others utilized weighted summation methods (Billon et al., 2010; Bruno et al., 2011; Kirkman et al., 2002). However, most empirical studies calculated weights by simply averaging or summing individual indicator values (Hair et al. 2012).

Attributing equal weights to all indicators is inappropriate, as it essentially assumes, without valid reasoning, that all indicators hold equal significance (Wallsten 2008). Furthermore, specific indices, such as the Networked Readiness Index (NRI), strongly emphasize perception-based data, constituting about half of the total indicators. However, this data may not necessarily reflect the actual state of ICT development (Baller, Dutta, and Lanvin 2016). Moreover, none of the abovementioned methods are tailored to capture the socio-economic outcomes that ICT development aims to foster.

Various studies have been carried out, to show the influence of ICT on development(Abubakre & Mkansi, 2022; Adeleye et al., 2021; Njoh, 2018). Through an interpretive, qualitative study, Abubakre and Mkansi( 2022) identified three fundamental mechanisms (emotional connectedness, user-centred technologies, and symbiotic relations) through which digital technologists work to improve the well-being of disadvantaged members of society. Adeleye et al. (2021) conducted a study exploring the relationship between ICT, trade, and economic growth in 53 African countries from 2005 to 2015, using mobile and fixed telephone subscriptions as ICT indicators. Their findings revealed that trade positively impacts growth, but this impact varies across African sub-regions.

Furthermore, Njoh (2018) also investigated the relationship between ICT consumption and development in Africa, measuring development using the Human Development Index (HDI). Their index included mobile phones, fixed phones, broadband, and wireless Internet as utility services. Their results showed a strong positive link between ICT usage and development, supported by regression analysis. In their study, Bahrini and Qaffas (2019) found that ICT positively impacts the economic growth of developing countries. They allude that economic growth is better in countries with a higher ICT infrastructure than those with lower levels. The International Telecommunications Union (ITU) (2009) and Pena-Lopez (2009) postulate that access to ICTs and their availability within the home while its use is referred to operationalization by at least one individual in the household. Further, access is "not only to the physical proximity and accessibility of ICT infrastructure, tools, and services but also to their affordability" (George et al., 2011). Many remote areas have limited access to ICTs due to impediments such as a lack of electricity or recharging facilities (ITU, 2017).

# 4. Methodology

## 4.1 Theoretical Framework

Creating an ICT composite index involved combining multiple indicators into a single measure representing the overall ICT development level. The following approach was used in our study:

Indicator Selection: Determining the specific indicators to include in the index. Data Collection: Collecting of reliable data for each indicator for the countries in Sub-Saharan Africa. Normalization: Normalizing the data for each indicator to bring them to a standard scale. Weighting: Assigning weights to each indicator based on their relative importance in capturing ICT development. The weights can be determined through expert judgment, stakeholder consultation, or statistical analysis, such as principal component analysis. Aggregation: Combine the normalized indicators using the assigned weights. Scaling: Scale the aggregated index to a desired range, 0 to 100, for more straightforward interpretation and comparison.

## 4.2 Analytical Framework

The widespread emergence of digital technologies in an ever-interconnected, youthful world has given rise to conceptualizing the term 'digital economy.' Kenya's Digital Economy Blueprint (2019) defines the digital economy as all the different areas that use technology like the Internet and mobile devices to communicate and work, despite the field they are in. The digital economy also includes companies offering things and services online for regular people or other businesses. This blueprint highlights five pillars of the digital economy: Digital Government, Digital Business, Digital Infrastructure, Innovation- Driven Entrepreneurship, and Digital Skills and Values. Table 1 below shows the Digital Economy Pillars, their subsequent components, and how they are measured.

**Table 1: Pillars of the digital economy**

| Pillar | Components |
|---|---|
| Digital Infrastructure | • Broadband Infrastructure |
| | • Broadband Connectivity |
| | • Logistics Infrastructure |
| | • Digital Assets |
| | • Payment systems |
| | • Data Centres |

| | |
|---|---|
| Digital Government | • E-government services |
| | • Integrated Financial Management System (IFMIS). |
| | • Constituency Innovation Hubs. |
| | • National Addressing System of Kenya (NASK) |
| Digital Skills and Values | • Digital skills (Digital Literacy, Ajira Digital) |
| | • Employees in the ICT Sector |
| Digital Business | • Enterprises using ICT |
| | • Digital technologies in the payment's ecosystem |
| | • E-commerce (buying, selling goods/services online) |
| Innovation-driven entrepreneurship | • Products and services offered to the public by innovation driven-entrepreneurs |
| | • Products and services that are brought to market by innovation-driven entrepreneurs |
| | • Revenues from entrepreneurs invested in the information economy |

*Source: KIPPRA (2022)*

## 4.3 Indicator Selection

The following specific indicators were included in our index. The factors were selected carefully after considering the five pillars of the digital economy in Kenya. These factors are aggregated per county in Kenya, hence the selection as shown in table 2.

(i) Internet penetration represents the digital government as well as the digital infrastructure.

(ii) Fibre optic coverage represents the digital infrastructure.

(iii) Mobile phone ownership represents the digital infrastructure as well as digital skills and values.

(iv) Digital Literacy Levels represent digital skills and values as well as the digital government.

(v) E-commerce usage represents digital business.

It is key to note that for the innovation-driven entrepreneurship pillar, data obtained from (Musamali et al., 2019) paper showed that an MSE innovation index exists, but it is not aggregated for all 47 counties; hence, it was deemed not representative and was not consider not the study's index.

**Table 2: Indicators used in the ICT composite index**

| Indicator | Measurement Methodology | Sources | Digital Economy Pillar Represented |
|---|---|---|---|
| Internet penetration | Percentage of the population with access to the Internet, either through fixed or mobile connections. | Communications Authority (CA) reports, mobile network operators, or surveys. | Digital government and Digital infrastructure. |
| Fibre optic coverage | The extent of fibre optic infrastructure coverage across the country, measured in kilometres/ percentage of geographic coverage. | MOICT (NOFBI Project)<br>Communications Authority (CA) reports | Digital infrastructure |
| Mobile phone ownership | Percentage of households or individuals owning at least one mobile phone. | KNBS 2019 Kenya Population and Housing Census | Digital infrastructure and Digital skills and values |
| Digital Literacy Levels | Percentage of schools with a digital literacy programme<br>Ownership of a computer/ tablet<br>Use of Internet | ICT Authority DLP Report<br>KNBS 2019 Kenya Population and Housing Census | Digital skills and values as well and the digital government. |
| E-commerce usage | Percentage of households engaged in e-commerce activities. | KNBS 2019 Kenya Population and Housing Census, KNBS 2022 ICT Analytical report | Digital business. |

### 4.3.1 Data Collection

Through desktop research, we collected reliable data for each indicator for the counties in Kenya. The data was obtained from Communication Authority (CA) yearly reports, KNBS 2022 ICT Analytical report, KNBS 2019 Kenya Population and Housing Census, ICT Authority Digital Literacy Programme, Ajira Digital.

### 4.3.2 Normalization

We normalized the data for each indicator to bring them to a standard scale (min-max normalization or z-score normalization). For each indicator X, we calculate the normalized value X_norm using the formula:

$$X\_norm = (X - X\_min) / (X\_max - X\_min)$$

## 4.4 Weighting

Weighting indicators in an index often involves a combination of empirical evidence, expert judgment, and stakeholder input. This study identified the Analytic Hierarchy Process (AHP) as the most appropriate weighting method. AHP is a structured decision-making technique that helps assign relative weights to criteria or indicators based on pairwise comparisons (Saaty, 2005). The process of assigning weights is as follows:

(i) Create the Pairwise Comparison Matrix (C), where c_ij represents the relative importance of criterion i compared to criterion j.

(ii) Calculate the Weighted Average of Each Row (W_i) as follows:

$Wi = (ci1 + ci2 + ...+ cin) / n$

(iii) Calculate the Relative Weights (Priority Vector, P) by taking the geometric mean of the weighted averages:

$Pi = (Wi)^{(1/n)}$

(iv) Normalize the Priority Vector (P) to ensure that the sum of the weights equals 1:

(v) Normalized Weight

$(wi) = Pi / \sum P$

The final normalized weights (w_i) represent each criterion or alternative's relative importance or priority in decision-making. These weights can be used to make informed decisions or prioritize the evaluated indicators. In this study, the following scale of relative importance ranging from 1 to 5, with the following interpretations, was used:

1: Equal importance

2: Slightly more important

3: Moderately more important

4: Significantly more important

5: Extremely more important

## 4.5 Final Index Calculation

We combine the normalized indicators using the assigned weights. We suggest using a weighted average, where each indicator's value is multiplied by its weight and then summed as follows:

$$ICT\ Index = (W1 * Indicator1\_norm + W2 * Indicator2\_norm + ...+ WN *$$

*IndicatorN_norm) / Total_Weights*

Where: W1,W2,...,WN are the weights assigned to the respective indicators.

Indicator1_norm,Indicator2_norm,...,and IndicatorN_norm are the normalized values of the indicators.

Total_Weights is the sum of all the weights.

The aggregated ICT Composite Index was scaled to a desired range, typically 0 to 100, for more straightforward interpretation and comparison:

S.Index= (ICT Index - Min_Index) * (100 / (Max_Index - Min_Index)

# 5. Findings and Discussion

## 5.1 Internet Penetration

Low Internet Usage Counties (6.9% - 9.7%): Turkana, Wajir, Samburu, and Mandera fall within this range. These countries face challenges regarding internet access, which may impact education and economic opportunities. Infrastructure development and digital literacy programs are crucial to improving connectivity.

Moderate Internet Usage Counties (15% - 30%): Lamu, Narok, Homabay, Kitui, Makueni, and Tharaka-Nithi fall within this range. They have moderate internet usage, with opportunities for improvement. Investment in digital literacy programs, digital infrastructure, and partnerships with internet service providers can increase access and improve digital skills.

Medium to High Internet Usage Counties (Above 30%): Kiambu, Migori, Nakuru, and Nyeri continue to have medium to high Internet usage percentages, indicating a rather suitable environment for digital inclusion. These counties may focus on further digital innovation, cybersecurity, and e-government services to enhance their digital ecosystems.

## 5.2 Fibre Optic Coverage

### *High Coverage Counties*

***Kiambu (61%):*** Kiambu boasts the highest fibre optic coverage at 61%, making it a significant digital centre in Kenya. This high coverage level suggests a strong digital presence, which can drive the region's economic growth, innovation, and education.

***Nakuru (39%):*** Nakuru is a high-coverage county with 39% fibre optic coverage. This indicates a robust digital infrastructure, making it a hub for digital activities. The county is well-positioned to attract businesses, support innovation, and provide access to advanced digital services.

### Moderate Coverage Counties

Moderate coverage counties have coverage percentages ranging from 4% to 28%. These counties are progressing in expanding digital infrastructure but may benefit from further investment and development initiatives.

***Meru (19%):*** Meru's 19% fibre optic coverage indicates a moderate level of digital infrastructure. This can facilitate better access to online resources, supporting education and e-commerce.

***Embu (12%):*** Embu has a 12% fibre optic coverage, suggesting a moderate level of connectivity. The county and national government may explore initiatives to increase access and promote digital inclusion.

***Machakos (28%):*** With 28% fibre optic coverage, Machakos is well-positioned for digital growth. The county and national government may leverage its infrastructure to boost its digital economy, education, and e-government services.

***Taita-Taveta (8%) and Tharaka-Nithi (8%):*** These counties share an 8% fiber optic coverage, indicating progress in improving digital infrastructure. Continuing to expand coverage and enhancing digital literacy can further benefit these regions.

**Low Coverage Counties**

Low-coverage counties have coverage percentages ranging from 2% to 9%. These counties face challenges regarding fiber optic infrastructure development and digital access.

***Tana River (2%) and Isiolo (2%):*** These counties have the lowest coverage at 2%, indicating limited access to fiber optic networks. Improving infrastructure and digital literacy are crucial to enhancing connectivity.

***Kwale (2%) and Lamu (2%):*** Kwale and Lamu have 2% coverage, suggesting a significant investment in digital infrastructure to bridge the digital divide.

**Table 3: Internet penetration, fibre optic coverage and mobile phone ownership in the 29 ASAL counties of Kenya**

| County | % of Internet Penetration | % of Fibre Optic Coverage | % of Mobile Phone Ownership |
|---|---|---|---|
| Tana-River | 8.9 | 2 | 31.6 |
| Isiolo | 14.2 | 2 | 38.2 |
| Garissa | 12.2 | 4 | 30.3 |
| Wajir | 8.3 | 3 | 30.3 |
| Samburu | 9.7 | 4 | 27.9 |
| Mandera | 7.8 | 4 | 25.3 |
| Marsabit | 8.3 | 4 | 29.0 |
| Turkana | 6.9 | 4 | 16.6 |
| Kwale | 12.4 | 2 | 36.7 |
| Kilifi | 15.1 | 17 | 39.4 |
| Taita-Taveta | 23.9 | 8 | 54.9 |
| Kajiado | 33.1 | 2 | 54.6 |
| Makueni | 16.1 | 5 | 49.0 |
| Kitui | 13.6 | 8 | 42.9 |
| Machakos | 25.8 | 28 | 56.4 |
| Embu | 22.1 | 12 | 57.0 |
| Tharaka-Nithi | 18.8 | 8 | 51.3 |
| Meru | 19.3 | 19 | 50.3 |

| | | | |
|---|---|---|---|
| Laikipia | 22.6 | 14 | 51.5 |
| West Pokot | 8.1 | 9 | 21.1 |
| Baringo | 15.3 | 8 | 35.0 |
| Narok | 12 | 8 | 34.3 |
| Nakuru | 27 | 39 | 52.7 |
| Migori | 33 | 6 | 37.5 |
| Homabay | 15 | 8 | 41.1 |
| Nyeri | 30 | 22 | 64.1 |
| Kiambu | 43 | 61 | 66.0 |
| Lamu | 19 | 2 | 45.2 |
| Elgeyo Marakwet | 14 | 7 | 37.6 |

## 5.3 Mobile Phone Ownership

***High Mobile Phone Ownership Counties (Above 50%):***

Kiambu (66%) and Nyeri (64.1%): These counties have high mobile phone ownership rates, indicating widespread access to mobile communication. High ownership rates can positively influence digital inclusion, as mobile phones are a gateway to the Internet and digital services. Residents in these counties are more likely to access online education, e-commerce, and government services.

Machakos (56.4%) and Taita-Taveta (54.9%): With ownership rates above 50%, these counties also have significant mobile phone access. This facilitates communication and digital engagement, potentially improving access to information and services.

Tharaka-Nithi (51.3%) and Meru (50.3%): These counties have crossed the 50% threshold for mobile phone ownership. This ownership can be leveraged for improved access to digital resources, benefiting education and economic activities.

Narok (52.7%) and Lamu (45.2%): While not as high as some other counties, these regions still have substantial mobile phone ownership. Mobile phones can serve as tools for communication and accessing online services, contributing to digital inclusion effort.

***Moderate Mobile Phone Ownership Counties (Between 30% and 50%):***

Kilifi (39.4%) and Homabay (41.1%): These counties fall within the moderate ownership range. Improving mobile infrastructure and digital literacy can further enhance digital inclusion in these regions.

Isiolo (38.2%) and Embu (37.6%): These counties also have moderate ownership rates. Promoting mobile-based education and digital skills training can help bridge the digital divide.

***Low Mobile Phone Ownership Counties (Below 30%):***

Turkana (16.6%) and West Pokot (21.1%): These counties have relatively low mobile phone ownership rates. Expanding mobile network coverage and implementing awareness campaigns on the benefits of mobile phones for education and healthcare can be vital in these areas.

Garissa (30.3%) and Mandera (25.3%): While ownership rates are not extremely low, these counties still face challenges in mobile phone access. Infrastructure development and affordability are key factors in improving digital inclusion.

Mobile phone ownership is critical in digital inclusion, especially in remote or underserved areas like ASAL counties. Mobile phones enable access to the Internet, online education, and government services, which can improve healthcare, education, and economic opportunities. Higher ownership rates in counties like Kiambu, Nyeri, and Machakos suggest that residents are more likely to benefit from these digital resources. However, counties with lower ownership rates may need targeted efforts to improve access, such as expanding network coverage and providing affordable smartphones.

## 5.4 Digital Literacy

***Low Digital Literacy Cluster (DL Scores Below 30%):***

Samburu is the sole member of the low digital literacy cluster, characterized by DL scores below 30%. With a DL score of 27.56%, Samburu faces challenges in digital literacy, especially regarding computer/tablet usage, internet access, and the presence of a Digital Learning Program (DLP).

Moderate to low digital Literacy Cluster (DL Scores Between 30% and 40%):

The moderate digital literacy cluster encompasses seven counties, each scoring between 30% and 40% in DL. Garissa, Wajir, Mandera, Turkana, West Pokot, and Isiolo form this cluster. While these counties exhibit moderate digital literacy levels, there is room for improvement in computer/tablet usage, internet access, and DLP presence.

***Moderate to High Digital Literacy Cluster (DL Scores Above 40%):***

The high digital literacy cluster comprises 21 counties, all boasting DL scores exceeding 40%. Marsabit, Kwale, Kilifi, Taita Taveta, Kajiado, Makueni, Kitui, Machakos, Embu, Tharaka Nithi, Meru, Laikipia, Baringo, Narok, Nakuru, Migori, Nyeri, Kiambu, and Elgeyo Marakwet belong to this cluster. These counties exhibit strong digital literacy levels, with scores reflecting proficiency in computer/tablet usage, internet access, and DLP presence.

Within this high digital literacy cluster, Kiambu stands out with the highest DL score of 51.00%, indicating exceptional digital literacy. Nyeri follows closely with a DL score of 44.29%, while other counties in this cluster display varying degrees of digital proficiency.

**Table 4: Percentage of Internet usage, tablet/computer use and schools with DLP**

| County | % of the Population Age 3 Years and Above Using Internet | % of Population Age 3 Years and Above Using a Computer/ Laptop/Tablet | % of Schools with Digital Literacy Programme | Digital literacy score(%) |
|---|---|---|---|---|
| Tana River | 8.9 | 3.2 | 100.0 | 35.0 |
| Isiolo | 14.2 | 5.3 | 83.0 | 31.3 |
| Garissa | 12.2 | 4.6 | 93.9 | 33.7 |
| Wajir | 8.3 | 2.9 | 100.0 | 33.7 |
| Samburu | 9.7 | 4.1 | 76.7 | 27.6 |
| Mandera | 7.8 | 2.7 | 100.0 | 33.4 |
| Marsabit | 8.3 | 3.0 | 100.0 | 33.7 |
| Turkana | 6.9 | 2.4 | 98.9 | 32.7 |
| Kwale | 12.4 | 4.6 | 99.5 | 35.4 |
| Kilifi | 15.1 | 6.6 | 100.0 | 37.2 |
| Taita Taveta | 23.9 | 9.6 | 100.0 | 40.0 |
| Kajiado | 33.1 | 16.2 | 99.8 | 46.4 |
| Makueni | 16.1 | 6.1 | 100.0 | 37.3 |
| Kitui | 13.6 | 4.9 | 99.6 | 35.9 |
| Machakos | 25.8 | 11.8 | 99.8 | 42.4 |
| Embu | 22.1 | 9.4 | 100.0 | 40.4 |
| Tharaka Nithi | 18.8 | 8.2 | 99.5 | 38.8 |
| Meru | 19.3 | 7.1 | 99.7 | 38.5 |
| Laikipia | 22.6 | 9.5 | 99.0 | 40.3 |
| West Pokot | 8.1 | 3.0 | 100.0 | 33.6 |
| Baringo | 15.3 | 6.2 | 99.7 | 38.0 |
| Narok | 12.0 | 4.1 | 99.8 | 35.2 |
| Nakuru | 26.8 | 11.6 | 99.7 | 42.6 |
| Migori | 14.3 | 6.1 | 99.7 | 36.6 |
| Homabay | 15.2 | 6.8 | 100.0 | 38.1 |
| Nyeri | 29.9 | 13.7 | 99.5 | 44.3 |
| Kiambu | 42.7 | 21.8 | 98.3 | 51.0 |
| Lamu | 19.4 | 6.2 | 97.9 | 40.0 |
| Elgeyo Marakwet | 14.2 | 5.5 | 100.0 | 36.5 |

## 5.5 E-commerce Usage

### *High E-commerce Adoption (7.2% to 9.2%)*

Kiambu and Kajiado counties have shown high levels of e-commerce adoption at 9.2% and 7.2%, respectively as shown in table 4.5.1. These countries serve as examples of how e-commerce can significantly enhance digital inclusion. In these regions, residents may access a wide range of online services, educational resources, and job opportunities. E-commerce facilitates access to markets, job platforms, and online education, levelling the playing field for individuals in both urban and rural areas.

### *Moderate E-commerce Adoption (2% to 4.6%)*

Counties like Machakos, Nakuru, Nyeri, Laikipia, and others with moderate e-commerce adoption rates between 2% and 4.6% indicate a growing digital presence. E-commerce enables small and medium-sized enterprises (SMEs) to reach a broader customer base. This is particularly relevant for ASAL counties as it can empower local businesses, create jobs, and improve economic prospects for residents.

### *Low E-commerce Adoption (0.8% to 1.6%)*

Several ASAL counties, including Mandera, Marsabit, and West Pokot, exhibit lower e-commerce adoption rates, ranging from 0.8% to 1.6%. These regions can benefit significantly from increased digital inclusion through e-commerce. E-commerce can offer remote communities access to a wider array of goods and services, online learning opportunities, and financial services, thereby reducing geographical disparities in digital access.

Regardless of their current adoption levels, E-commerce's universal benefits extend to ASAL counties. It can bridge the digital divide by providing access to markets, job opportunities, and education for residents in remote and underdeveloped areas. Additionally, e-commerce can facilitate the flow of information, improve healthcare services through telemedicine, and support agriculture through online marketplaces for agricultural products.

**Table 5 E-commerce usage in the ASALs**

| County | % of E-commerce usage |
|---|---|
| Tana-River | 1.0 |
| Isiolo | 2.0 |
| Garissa | 1.6 |
| Wajir | 1.1 |
| Samburu | 1.3 |
| Mandera | 0.9 |
| Marsabit | 0.8 |

| | |
|---|---|
| Turkana | 1.0 |
| Kwale | 1.5 |
| Kilifi | 2.2 |
| Taita-Taveta | 3.4 |
| Kajiado | 7.2 |
| Makueni | 2.0 |
| Kitui | 1.7 |
| Machakos | 4.6 |
| Embu | 2.5 |
| Tharaka-Nithi | 2.1 |
| Meru | 2.1 |
| Laikipia | 3.2 |
| West Pokot | 0.8 |
| Baringo | 2.0 |
| Narok | 1.5 |
| Nakuru | 4.4 |
| Migori | 2.4 |
| Homabay | 2.6 |
| Nyeri | 4.2 |
| Kiambu | 9.2 |
| Lamu | 3.1 |
| Elgeyo Marakwet | 1.7 |

## 5.6 Final Index Calculation

### 5.6.1 Weighting

Internet Penetration (Weight: 0.30): Internet penetration was considered the most essential criterion in that analysis, as indicated by the highest weight of 0.30. This suggested that internet penetration was the highest priority among the indicators when assessing digital inclusion. It was deemed critical because it directly reflected access to the Internet, which was a foundational component of digital inclusion.

Fibre Optic Coverage (Weight: 0.15): Fibre optic coverage was assigned a weight of 0.15, indicating that it was less critical than internet penetration but still significant. This suggested that while it contributed to digital infrastructure, it was not as critical as actual internet access in measuring digital inclusion.

Mobile Phone Ownership (Weight: 0.25): Mobile phone ownership received a weight of 0.25, making it the second most important criterion. This suggested that it was highly relevant in assessing digital inclusion because mobile phones were

widespread and accessible digital devices, even though they may not have directly represented internet access.

Digital Literacy (Weight: 0.10): Digital literacy was given a weight of 0.10, indicating that it was relatively less important in that analysis than the other indicators. This suggested that while digital literacy was valuable, it was not as critical as the availability of digital infrastructure or access to digital devices.

E-commerce Usage (Weight: 0.20): E-commerce usage was assigned a weight of 0.20, indicating its significance in assessing digital inclusion. This suggested that the level of engagement in online economic activities was considered important but not as critical as internet penetration and mobile phone ownership.

**Table 6:Weighting for the indicators selected**

| Indicator | Internet Penetration | Fibre Optic Coverage | Mobile Phone Ownership | Digital Literacy | E-commerce usage | Weight |
|---|---|---|---|---|---|---|
| Internet Penetration | 1 | 3 | 4 | 3 | 4 | 0.30 |
| Fibre Optic Coverage | 1/3 | 1 | 3 | 2 | 3 | 0.15 |
| Mobile Phone Ownership | 1/4 | 1/3 | 1 | 2 | 3 | 0.25 |
| Digital Literacy | 1/3 | 1/2 | 2 | 1 | 3 | 0.10 |
| E-commerce usage | 1/4 | 1/3 | 1/2 | 1/3 | 1 | 0.20 |

**Table 7 ICT Index Score for the ASALs of Kenya**

| County | Internet Penetration | Fibre Optic Coverage | Mobile Phone Ownership | Digital Literacy | E-commerce | ICT Index Score |
|---|---|---|---|---|---|---|
| Tana-River | 8.9 | 2.0 | 31.6 | 35.0 | 1.0 | 14.2 |
| Isiolo | 14.2 | 2.0 | 38.2 | 31.3 | 2.0 | 17.7 |
| Garissa | 12.2 | 4.0 | 30.3 | 33.7 | 1.6 | 15.5 |
| Wajir | 8.3 | 3.0 | 30.3 | 33.7 | 1.1 | 13.1 |
| Samburu | 9.7 | 4.0 | 27.9 | 27.6 | 1.3 | 13.9 |
| Mandera | 7.8 | 4.0 | 25.3 | 33.4 | 0.9 | 12.8 |
| Marsabit | 8.3 | 4.0 | 29.0 | 33.7 | 0.8 | 14.8 |
| Turkana | 6.9 | 4.0 | 16.6 | 32.7 | 1.0 | 9.7 |
| Kwale | 12.4 | 2.0 | 36.7 | 35.4 | 1.5 | 18.0 |
| Kilifi | 15.1 | 17.0 | 39.4 | 37.2 | 2.2 | 21.1 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Taita-Taveta | 23.9 | 8.0 | 54.9 | 40.0 | 3.4 | 26.8 |
| Kajiado | 33.1 | 2.0 | 54.6 | 46.4 | 7.2 | 30.0 |
| Makueni | 16.1 | 5.0 | 49.0 | 37.2 | 2.0 | 21.3 |
| Kitui | 13.6 | 8.0 | 42.9 | 35.9 | 1.7 | 18.8 |
| Machakos | 25.8 | 28.0 | 56.4 | 42.4 | 4.6 | 31.2 |
| Embu | 22.1 | 12.0 | 57.0 | 40.4 | 2.5 | 27.3 |
| | | | | | | |
| Tharaka-Nithi | 18.8 | 8.0 | 51.3 | 38.8 | 2.1 | 24.3 |
| Meru | 19.3 | 19.0 | 50.3 | 38.5 | 2.1 | 25.6 |
| Laikipia | 22.6 | 14.0 | 51.5 | 40.3 | 3.2 | 26.4 |
| West Pokot | 8.1 | 9.0 | 21.1 | 33.6 | 0.8 | 12.6 |
| Baringo | 15.3 | 8.0 | 35.0 | 38.0 | 2.0 | 17.5 |
| Narok | 12.0 | 8.0 | 34.3 | 35.2 | 1.5 | 16.0 |
| Nakuru | 27.0 | 39.0 | 52.7 | 42.6 | 4.4 | 32.3 |
| Migori | 33.0 | 6.0 | 37.5 | 36.6 | 2.4 | 23.4 |
| Homabay | 15.0 | 8.0 | 41.1 | 38.1 | 2.6 | 20.4 |
| Nyeri | 30.0 | 22.0 | 64.1 | 44.3 | 4.2 | 33.6 |
| Kiambu | 43.0 | 61.0 | 66.0 | 51.0 | 9.2 | 45.5 |
| Lamu | 19.0 | 2.0 | 45.2 | 40.0 | 3.1 | 21.9 |
| Elgeyo Marakwet | 14.0 | 7.0 | 37.6 | 36.5 | 1.7 | 17.6 |

# 6. Conclusions and Recommendations

## 6.1 Conclusion

Based on the ICT index scores calculated for the listed Kenyan counties, several key conclusions can be drawn, focusing on assessing the current status of digital access within Kenya's ASALs and identifying counties that may require additional efforts to enhance digital inclusion. These conclusions underscore both the diversity and the disparities in digital inclusion across Kenya's counties and emphasize the urgent need for comprehensive actions to bridge the digital divide:

(i) Diverse Range of Scores and the Digital Divide: The ICT index scores vary significantly across the counties, indicating a diverse digital inclusion landscape in Kenya. This diversity underscores the need for tailored strategies to address specific regional challenges and opportunities. Notably, the digital divide between urban and rural areas is evident, with relatively urban counties such as Kiambu, Machakos, and Kajiado performing better in digital inclusion. Bridging this divide can be considered a priority to ensure equitable access to digital resources.

(ii) High-Performing Counties as Models: Several counties, such as Machakos, Kajiado and Kiambu, have relatively high ICT index scores, suggesting strong digital inclusion in these regions. These counties serve as potential models for others. However, the economic and social implications of these disparities are substantial, with counties having lower digital inclusion scores potentially facing challenges in harnessing the full potential of digital technologies for economic growth, education, healthcare, and government services.

(iii) Counties in Need of Improvement and Infrastructure Gaps: Conversely, some counties have lower ICT index scores, indicating a need for more significant efforts to enhance digital inclusion. Notable examples include Turkana, Marsabit, and Mandera. The presence of low fiber optic coverage in these areas highlights significant infrastructure gaps in providing high-speed internet access to the population, which can hinder the adoption of advanced digital technologies.

(iii) Collaboration and Knowledge Sharing and E-commerce Potential: High-performing counties can share best practices and collaborate with lower-performing counties to accelerate digital inclusion efforts. Simultaneously, the level of e-commerce usage can provide insights into the country's readiness for online business and trade. A low score may suggest untapped potential for growth in the digital economy.

## 6.2 Recommendations

To enhance Kenya's digital inclusion, the following is recommended:

(i) Since ASAL counties often have limited infrastructure, expanding broadband in these areas becomes even more critical. The focus can be on expanding

fiber optic networks and exploring satellite-based internet solutions, which may be more feasible in remote regions. Special attention can be given to nomadic communities and pastoralists who move across vast areas. Public-private partnerships may play a vital role in infrastructure development in ASAL counties. Private sector companies can be encouraged to invest in these regions by providing incentives, such as tax breaks or access to government-owned land for infrastructure projects.

(ii) In ASAL counties, digital literacy programs may be designed with an understanding of the specific needs of the population. Training can encompass practical skills relevant to livelihoods in these regions, such as digital marketing for agricultural products or accessing healthcare services online. Community leaders and elders can be actively involved in promoting digital literacy.

(iii) Recognizing the challenges in deploying fixed-line infrastructure, mobile connectivity becomes a lifeline for ASAL counties. Mobile network expansion efforts can prioritize coverage in remote areas and introduce affordable data plans. Mobile money services can also be further encouraged to facilitate financial inclusion.

(iv) E-commerce incentives can target ASAL counties' unique products, such as handicrafts and traditional goods. Supporting local artisans and small-scale entrepreneurs in going digital can boost their income and promote the preservation of cultural heritage.

(v) As ASAL counties embrace digital technologies, they become susceptible to cybersecurity threats. Awareness campaigns about online safety, may be tailored to the local context, and local cybersecurity experts may be trained to protect critical infrastructure.

(vi) The digital divide is often more pronounced in ASAL countries. Special initiatives can be launched to provide digital access to marginalized communities. The Universal Service Fund whose purpose (USF)is to support widespread access to ICT services and promote capacity building and innovation in ICT services in the country may prioritize projects in the ASALs of Kenya due to the significant ICT challenges they face. Mobile libraries or community centres equipped with digital resources can be established to serve remote areas.

(vii) Monitoring and Data Collection Given the distinctive challenges prevalent in ASAL counties, a robust system for monitoring progress is imperative. The scope of data collection needs to encompass a diverse array of region-specific indicators. This includes, but is not limited to, measuring the accessibility of digital services in local languages, evaluating the transformative impact of ICT on traditional livelihoods, and assessing the overall digital literacy levels within these communities. The comprehensive data collected will serve as a cornerstone for informed decision-making and policy formulation tailored to the unique needs of these regions.

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