GSMA

Digital Africa Index
Methodology

GSMA

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Representing mobile operators and organisations across the mobile ecosystem and adjacent industries, the GSMA delivers for its members across three broad pillars: Connectivity for Good, Industry Services and Solutions, and Outreach. This activity includes advancing policy, tackling today's biggest societal challenges, underpinning the technology and interoperability that make mobile work, and providing the world's largest platform to convene the mobile ecosystem at the MWC and M360 series of events.

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Introduction

About the Digital Africa Index

While the transformative socioeconomic impacts of digital technologies are well established, a digital divide persists in Africa, where around two thirds of the population do not currently use mobile internet.[1] Achieving digital transformation requires more than internet connectivity alone; it involves consumers having access to the applications they need and being able to use these services as much as they need to. Beyond the consumer segment, digital transformation also means the adoption of technology by businesses across sectors, allowing them to realise commercial and productivity gains. The benefits of digitalisation can extend to government too by improving service delivery to citizens and improving efficiency, transparency and accountability.

It is only by achieving digitalisation across all three economic actors (consumers, businesses and governments) that the full benefits of mobile technology can be realised, driving economic growth, social development and environmental sustainability.

For countries not achieving the level of digitalisation they would like, or for those not seeing the desired level of digital growth, a key question is what policymakers can do to move the needle. Governments and regulators can benefit from an index that benchmarks the extent to which policies and regulations are enabling investment in – and adoption and usage of – mobile technologies. It is in this context that the GSMA has launched two composite indices: the Digital Nations and Society Index (DNSI) and the Digital Policy and Regulatory Index (DPRI).

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1   The State of Mobile Internet Connectivity Report 2024, GSMA, 2024

Why an index is necessary

To assess the level of digital integration among countries in Africa, we need to go beyond measuring network coverage and counting connections, and aim for a comprehensive assessment of digital adoption and use by consumers, businesses and government. As there are many elements to achieving digitalisation, an index is required to reflect the multiple outcomes. Similarly, there is no single measure of enabling policy and regulation, so an index is required to benchmark and assess the different aspects of regulation important to achieving governments' digital objectives.

In constructing both the DNSI and DPRI, we have considered the fact that a number of indices already exist in the digital and ICT sectors.[2] It is important that the new indices are designed in a manner that does not replicate others; they should offer unique and relevant insights. In particular, when considering the DNSI and DPRI alongside the GSMA Mobile Connectivity Index[3] and the Mobile Money Regulatory Index,[4] the four benchmarks provide a comprehensive assessment for countries in Africa to understand how advanced they are in terms of integrating digital technologies in their societies, and a guide to the interventions required to accelerate growth in each country.

The objectives of each index can be understood based on the key questions they aim to address:

— **Digital Nations and Society Index** – To what extent are consumers, businesses and governments in Africa effectively leveraging mobile technologies to accelerate socioeconomic development? What is the level of digital development in each country?

— **Mobile Connectivity Index (MCI)** – Why are people and businesses unable or unwilling to adopt mobile broadband technologies?

— **Digital Policy and Regulatory Index** – To what extent are public policies and regulations facilitating the development of a digital society? What are the bottlenecks policymakers need to address to accelerate the deployment and adoption of new mobile technologies?

— **Mobile Money Regulatory Index (MMRI)** – To what extent do mobile money regulations and policies enable the widespread adoption of digital financial services? What are the bottlenecks policymakers need to address to accelerate the deployment and adoption of mobile money and digital financial services more generally?

While we could theoretically combine the four indices into a single, larger index, it would conflate multiple inputs and outcomes, which represents poor practice when building indices. By keeping them separate, the DNSI can reflect the relevant digitalisation outcomes, while the MCI reflects mostly non-policy inputs, and the DPRI and MMRI reflect policy inputs for mobile technology and mobile money respectively.

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2 See for example the GSMA Mobile Connectivity Index, the GSMA Mobile Money Regulatory Index, the ITU's ICT Development Index, the ITU Benchmark of collaborative digital regulation, the Portulans Institute Network Readiness Index and the UNCDF Inclusive Digital Economy Scorecard.
3 https://www.mobileconnectivityindex.com/index.html
4 https://www.gsma.com/mobilemoneymetrics/#regulatory-index

How the pillars are measured

The DNSI is constructed around three main pillars, which in turn comprise the selected indicators for the index:

— **Digital Consumer** – Use of mobile technologies and digital platforms to access services, make purchases, and engage with content and communities.

— **Digital Business** – The integration, investment and adoption of digital technologies by enterprises.

— **Digital Government** – The implementation of digital tools, platforms and services by national governments to enhance public service delivery and create more efficient and responsive governance.

The DPRI is constructed around five pillars:

— **Licensing and Spectrum** examines whether sufficient and affordable spectrum has been assigned in a timely and efficient manner for both access and mobile backhaul, as well as whether there is a unified licensing framework and spectrum roadmap.

— **Consumer Protection** examines whether there are comprehensive consumer and data protection frameworks that strengthen consumer confidence, safety and trust but do not disincentivise investment.

— **Taxation** examines whether or not there are distortive sector-specific taxes on consumers and operators that can hinder investment and make mobile services less affordable.

— **Network Deployment and Management** examines whether there are harmonised deployment regulations, enabling regulation for fibre rollout, options to share infrastructure, and whether or not coverage and quality-of-service obligations are implemented in a manner that distorts or reduces investment.

— **Public Policy** examines whether countries have digital or broadband policies (or strategies) that address barriers related to affordability and digital skills, and policies that address connectivity gaps for women and rural populations. This pillar also assesses whether universal service funds (USFs) are efficient, transparent and effective, and whether there is competition policy and regulation to promote tech start-ups.

02
Data selection

Selection criteria

The following criteria have been developed for selecting indicators, based on guidance from the JRC and OECD:

— **Relevance** – An indicator in the DNSI should measure the adoption or use of relevant digital technologies by consumers, governments and enterprises. In the case of the DPRI, the indicator should measure a regulatory barrier (or regulatory enabler) of investment or of mobile use.

— **Accuracy** – The indicator should correctly estimate or describe the quantities or characteristics it is designed to measure.

— **Coverage** – In this first edition of the index, most countries have comprehensive data for each indicator. The data should cover as many countries as possible, as the DNSI and DPRI are intended to be Africa-wide, allowing for consistent country comparisons.

— **Timeliness** – The data should be collected consistently over time.

There are several areas related to digitalisation that we have not been able to measure in the first version of the DNSI, due to a lack of data across countries. These include adoption of mobile technology by businesses of different sizes (micro, small and medium) and sector; the different services used by firms (e.g. private networks, cloud computing, AI); and the different applications consumers use (e.g. mobile health, mobile education). Going forward, we will regularly assess the indicators and make improvements as data becomes available. Three indicators – mobile and mobile internet adoption by businesses, and the proportion of schools with internet access – are included in the DAI web tool[5] but are not incorporated in the DNSI scores due to the lack of updated and complete data. As more data on these is gathered in the future, they will be fully incorporated into the index.

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5   https://www.gsma.com/digital-africa-index

DNSI indicators

Table 1 details the DNSI indicators. The DNSI comprises three main pillars, constructed by aggregating five indicators.

Digital Nations and Society Index pillars and indicators

Source: GSMA Intelligence

Pillar	Indicator	Description	Source
Digital Consumer	**Mobile penetration**	Unique mobile subscriber penetration	GSMA Intelligence
	Mobile internet penetration	Unique mobile internet user penetration	GSMA Intelligence
	4G/5G smartphone adoption	Penetration of 4G/5G smartphone mobile internet subscribers	GSMA Intelligence
	Mobile data usage	Mobile data consumption (traffic per connection, per month)	GSMA Intelligence
	Digital financial services	Proportion of adults using digital financial services	Global Findex Database 2021/2022, World Bank
Digital Business	**Tech start-ups**	Measure of tech and digital start-ups	Africa: The Big Deal Startup Deals Database
	IoT penetration	Number of IoT connections, normalised by total population	GSMA Intelligence
	Digital patents per capita	Number of patents granted in the ICT sector, normalised per 1 million people	World Intellectual Property Organization
	Mobile commerce	The use of mobile technologies for digital transactions	Global Findex Database 2021/2022, World Bank
	Firms with a website	Proportion of firms in the country with a website	World Bank Enterprise Surveys and Network Readiness Index 2023
Digital Government	**Digital ID**	Availability and adoption of digital identification systems	ID4D Global Dataset, World Bank
	E-government participation	E-participation mechanisms deployed by the government	E-Government Index, United Nations
	Govtech maturity	Measure of digital transformation in the public sector	GovTech Maturity Index, World Bank
	Digital health	Metric that evaluates the use of digital technology for health	Global Digital Health Monitor
	G2P/P2G	Metric that measures the adoption of government-to-person (G2P) transactions and person-to-government (P2G) transactions	Global Findex Database 2021/2022, World Bank

Indicators constructed from other sub-indicators

Several DNSI indicators are built on various sub-indicators. The following definitions clarify how each main indicator is derived from its respective sub-indicators:

— **Digital financial services:** Includes an equally-weighted average of two sub-indicators:

 • the proportion of people using mobile technologies for financial purposes, measured by the maximum proportion in each country of those who either have a mobile money account (aged 15+), use a mobile phone or the internet to check their account balance (aged 15+), or use a mobile phone or the internet to make payments, purchase goods, or send/receive money using a financial institution account (aged 15+)

 • the proportion of people who have made or received a digital payment (aged 15+).

— **Tech start-ups:** Includes an equally-weighted average of two normalised sub-indicators: the number of start-ups per 1 million people in each country, and the total amount raised by start-ups in $ million.

— **Mobile commerce:** Considers the maximum value among the following sub-indicators in each country:

 • the proportion of people (aged 15+) who used a mobile phone or the internet to make an online purchase

 • the proportion of people (aged 15+) who made a digital in-store merchant payment

 • the proportion of people (aged 15+) who made a digital merchant payment.

— **Digital ID:** Considers an equally-weighted average of two sub-indicators:

 • a composite metric on 'Availability of digital ID' scored out of 3, which includes the following components (each country earns 1 point for each capability they have included):

  ◦ digital data – this involves countries that store identity records in a digital format

  ◦ digital verification – identities and/or identity information (e.g. name, date of birth, etc.) can be verified or authenticated using digital mechanisms

  ◦ online digital identity – digital credentials provide the ability to securely authenticate identities remotely to access online services and transactions

 • the adoption rate of ID among adults.

— **Govtech maturity:** Corresponds to the average of the GovTech Maturity Index (GTMI) in its first three components, as measured by the World Bank: Core Government Systems Index, Public Service Delivery Index and Digital Citizen Engagement Index. The fourth component of GTMI, the GovTech Enablers Index, which captures strategy, institutions, laws and regulations, digital skills, and innovation policies and programmes, was excluded because these are already captured by some indicators in the DNSI and the main components of the DPRI.

— **G2P/P2G:** Corresponds to the maximum value observed among the following sub-indicators:

 • the percentage of public sector wage recipients, government transfer or pension recipients

 • government payment recipients (aged 15+) who received these payments via a mobile phone.

DPRI indicators

Table 2 presents the DPRI indicators. These have been constructed based on research that demonstrates which policies have been most effective in driving higher investment in and adoption of mobile technologies.[6]

Table 2

Digital Policy and Regulatory Index pillars and indicators

Source: GSMA Intelligence

Licensing and Spectrum

Indicator	Sub-indicators	Score	Criteria
Licensing framework	n/a	0	There is no unified licensing framework in the country
		50	There exists a unified licensing framework in the country but not all mobile operators hold a unified licence
		100	There exists a unified licensing framework in the country and all mobile operators hold a unified licence
Spectrum roadmap	n/a	0	There is not a published document setting out a spectrum roadmap for the country
		100	There is a published document setting out a spectrum roadmap for the country
Spectrum assignments	Low-band spectrum assignments	0–100	A maximum score is achieved if 190 MHz has been assigned to mobile operators for IMT in bands below 1 GHz, including: 700 MHz (n28), 800 MHz (n20) or 900 MHz (n8)
	Lower mid-band spectrum assignments	0–100	A maximum score is achieved if 560 MHz has been assigned to mobile operators for IMT in bands between 1 GHz and 3 GHz, including: 1800 MHz (n3); 2100 MHz (n1); 2300 MHz (n40); 2600 MHz (n7 and n38)
	Upper mid-band spectrum assignments	0–100	A maximum score is achieved if at least 300 MHz has been assigned to mobile operators for IMT in the 3.5 GHz range (n77)
	mmWave band spectrum assignments	0	No mmWave band spectrum has been assigned
		100	At least one mmWave band has been assigned

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6   See for example Mobile Tax Policy and Digital Development. A study of markets in Sub-Saharan Africa, GSMA, 2023; Modernising quality of service regulations in Sub-Saharan Africa, GSMA, 2020; Effective Spectrum Pricing in Africa. How successful awards can help drive mobile connectivity, GSMA. 2020; Technology neutrality and Legacy Network Sunsets. The Evolution of Connectivity in Africa, GSMA 2023; Universal service funds in Africa. Policy reforms to enhance effectiveness, GSMA, 2023.

Indicator	Sub-indicators	Score	Criteria
Mobile backhaul	Mobile backhaul spectrum available	0	No backhaul frequencies are available to use by operators
		50	Frequencies between 6 GHz and 42 GHz (traditional microwave) are available for mobile backhaul
		100	Frequencies between 6 GHz and 42 GHz (traditional microwave) as well as frequencies between 57 GHz and 174.8 GHz (V, E, W and/or D bands) are available for mobile backhaul
	Mobile backhaul process	0	The process to utilise microwave bands for mobile backhaul follows an individual assignment process – for example, an auction
		33	The process to utilise microwave bands for mobile backhaul follows a lengthy administrative process – for example, via application forms
		67	The process to utilise microwave bands for mobile backhaul follows a system registration with automated verification of link or block availability
		100	The process to utilise microwave bands for mobile backhaul follows a first come, first served approach, with a simplified administrative approval given by the regulator
	Mobile backhaul payments	0	Operators are required to make payments to utilise bands for mobile backhaul
		100	Operators are not required to make payments to utilise bands for mobile backhaul
Technology neutrality	n/a	0	One or more spectrum licences are not fully or partially technology neutral
		50	One or more spectrum licences are partially technology neutral
		100	All spectrum licences are fully technology neutral
Spectrum fees	n/a	0	Annual spectrum fees are more than 2% of operator revenues
		50	Annual spectrum fees are between 1–2% of operator revenues
		100	Annual spectrum fees are less than 1% of operator revenues
Licence duration	n/a	0	One or more spectrum licences are currently up to 10 years long
		50	One or more spectrum licences are currently up to 20 years long
		100	All spectrum licences are currently at least 20 years long
Spectrum leasing and trading	Spectrum leasing	0	Spectrum leasing is not permitted by regulation
		100	Spectrum leasing is permitted by regulation
	Spectrum trading	0	Spectrum trading is not permitted by regulation
		100	Spectrum trading is permitted by regulation

🛡 Consumer Protection

Indicator	Sub-indicators	Score	Criteria
Consumer protection framework	n/a	0–100	25 points are awarded for EACH of the following that apply: (i) There are consumer protection rules that apply to mobile services. (ii) Regulation provides for the disclosure of customer terms and conditions, fees and charges. (iii) Regulation provides for customer complaint redress mechanisms. (iv) There is a consumer protection agency, commission, authority or tribunal to address consumer complaints.
Data protection framework	n/a	0	There are no horizontal data privacy legislative frameworks governing data processing (including but not limited to collection, correction, quality, accuracy, integrity, deletion and retention)
		25	There are horizontal data privacy legislative frameworks governing data processing (including but not limited to collection, correction, quality, accuracy, integrity, deletion and retention), and/or any relevant sector-specific legislation
		50	There are harmonised policy and/or regulatory enforcement frameworks between data privacy legislation and any relevant sector-specific legislation
		75	There is a designated function and/or supervisory authority enforcing data privacy legislation
		100	There is an independent and/or resourced supervisory authority for data privacy enhancing enforcement activities and coordinating with other supervisory and relevant authorities both within and outside the region
Cybersecurity	n/a	0–100	ITU Cybersecurity Index score
Cross-border data flow	n/a	0	There is no policy and regulatory guidance on cross-border data flows
		25	There is policy and regulatory guidance on cross-border data flows
		50	There are a range of data transfer mechanisms on cross-border data flows, and/or adequacy requirements
		75	There are a range of data transfer mechanisms on cross-border data flows, and/or adequacy requirements. There is very limited or no data localisation (sovereignty) requirements in data privacy legislation and/or any relevant sector-specific legislation, and there is harmonised regulatory and policy engagement with other supervisory authorities both within and outside the region
		100	There are a range of data transfer mechanisms on cross-border data flows, and/or adequacy requirements. There are no data localisation (sovereignty) requirements in data privacy legislation and/or any relevant sector-specific legislation, and there is harmonised and implemented data privacy legislative frameworks both within and outside the region
SIM registration	n/a	0	There is a mandatory SIM registration policy and there is no KYC verification provided by governments
		100	There is a mandatory SIM registration policy and operators verify a customer's ID via access to a government ID database

Taxation

Indicator	Sub-indicators	Score	Criteria
Consumer mobile taxes	Consumer taxes on mobile data	0	A sector-specific tax (e.g. excise duty) is imposed on mobile data and is set at 10% or higher
		50	A sector-specific tax (e.g. excise duty) is imposed on mobile data and is set below 10%
		100	No sector-specific taxes are imposed on mobile data (for example, excise duties)
	Consumer taxes on mobile money	0	Sector-specific taxes are imposed on mobile money consumption
		100	No sector-specific taxes are imposed on mobile money consumption
Consumer handset taxes	Consumer taxes on handsets	0	Sector-specific taxes or customs duties are imposed on handsets and are set higher than 10%
		50	Sector-specific taxes or customs duties are imposed on handsets and range between 1–10%
		100	No sector-specific taxes or customs duties are imposed on handsets
	VAT exemption on handsets	0	There is no VAT exemption on the purchase of handsets
		100	There is a VAT exemption on the purchase of handsets
Operator taxes	n/a	0	Sector-specific taxes on operators account for more than 5% of operator revenues
		50	Sector-specific taxes on operators account for 2–5% of operator revenues
		100	Sector-specific taxes on operators account for less than 2% of operator revenues
Fiscal incentives	n/a	0	Operators do not receive tax rebates or credits or other fiscal incentives for network investments
		100	Operators receive tax rebates or credits or other fiscal incentives for network investments
Tax stability	n/a	0	Taxes on consumers or operators have increased in the past three years (2021–2023)
		100	Taxes on consumers or operators have not increased in the past three years (2021–2023)

Network Regulation

Indicator	Sub-indicators	Score	Criteria
Harmonised deployment	n/a	0	There is no national policy that harmonises mobile deployment regulations
		100	There is a national policy that harmonises mobile deployment regulations
Small cell deployment	n/a	0	There are no exemptions from planning permissions or faster review processes for small cell installations
		100	There are exemptions from planning permissions or faster review processes for small cell installations
Fibre regulation	Rights of way	0	RoW charges are applied
		100	RoW charges are not applied
	Fibre regulation	0–100	33.33 points are awarded for EACH of the following that apply: (i) There is more than one provider of fibre infrastructure in the country. (ii) Operators can lay their own fibre infrastructure for mobile backhaul. (iii) Mobile operators can access dark fibre from other providers.
Infrastructure sharing	n/a	0–100	20 points are awarded for EACH of the following that apply: (i) Operators are permitted to engage in passive sharing agreements. (ii) Operators are permitted to engage in active RAN sharing agreements. (iii) Operators are permitted to engage in core sharing agreements. (iv) Operators are permitted to engage in spectrum sharing agreements. (v) Mobile operators can utilise other (non-telecoms) infrastructure assets for deployment.
Coverage obligations	n/a	0–100	50 points are awarded for EACH of the following that apply: (i) There are no geographic coverage obligations that apply to any spectrum licences. (ii) There are no population coverage obligations OR coverage obligations are set for rural populations and supporting policies or resources have been enabled (excluding USF support or access).
Quality of service	n/a	0	There are QoS obligations imposed on operators that are applied uniformly throughout the country
		50	There are QoS obligations imposed on operators but requirements are not uniform throughout the country
		100	The regulator applies a consumer-empowerment approach to improving QoS
Commercial flexibility	n/a	0–100	50 points are awarded for EACH of the following that apply: (i) There are no retail price regulations or restrictions AND regulations do not restrict the ability of operators to provide premium quality retail packages. (ii) Regulations do not restrict the ability of operators to reach commercial agreements with digital platforms, digital companies and service providers to host data and/or distribute data traffic.

⚖ Public Policy

Indicator	Sub-indicators	Score	Criteria
Affordability and digital skills	Affordability	0	The country does not have a policy or strategy to address affordability of devices or mobile data
		50	The country has a policy or strategy to address affordability of devices or mobile data but is not tracking progress or impact
		100	The country has a policy or strategy to address affordability of devices or mobile data and is tracking progress and the impact of the policy
	Digital skills	0	The country does not have a policy or strategy to address digital skills and literacy
		50	The country has a policy or strategy to address digital skills and literacy but is not tracking progress or impact
		100	The country has a policy or strategy to address digital skills and literacy and is tracking progress and the impact of the policy
Gender and rural inclusion	Gender inclusion	0	The country has no policy or regulatory initiative to drive digital inclusion among women
		50	The country has a policy or regulatory initiative to drive digital inclusion among women but is not publishing progress on meeting specific targets
		100	The country has a policy or regulatory initiative to drive digital inclusion among women and is publishing progress on meeting its targets.
	Rural connectivity	0	The country has no policy or regulatory initiative to drive digital inclusion among rural populations
		50	The country has a policy or regulatory initiative to drive digital inclusion among rural populations but is not publishing progress on meeting specific targets
		100	The country has a policy or regulatory initiative to drive digital inclusion among rural populations and is publishing progress on meeting its targets
USF management	USF contribution	0	The USF contribution rate by operators is greater than 1% of operator revenues
		100	The USF contribution rate by operators is equal to or less than 1% of operator revenues
	USF disbursement	0	No reports are prepared on USF disbursement rates – or they are, and most of the funds (less than 50%) have not been disbursed to date
		50	No reports are published, but the regulator or relevant authority prepares them and more than 50% of funds have been disbursed to date
		100	Reports or data are published on USF disbursement rates AND the majority of funds (more than 50%) have been disbursed to date
	USF accountability	0	Monitoring and evaluation reports or data that assess the performance or impact of disbursed USF funds are not prepared
		50	Monitoring and evaluation reports or data that assess the performance or impact of disbursed USFs are prepared but not published
		100	Monitoring and evaluation reports or data that assess the performance or impact of disbursed USFs are published
	USF funding	0	No organisations other than telecoms operators contribute to the USF or other programmes that aim to expand connectivity
		100	Other organisations (in addition to telecoms operators) contribute to the USF or other programmes that aim to expand connectivity
Competition policy	n/a	0	There is either no competition policy framework OR there is no independent competition authority that applies competition law to the telecommunications sector
		100	There is a competition policy framework and an independent competition authority that applies competition law to the telecommunications sector
Start-up regulation	n/a	0	There is no Start-up Act that has received legislative passage
		100	There is a Start-up Act that has received legislative passage

03
Data treatment

Imputation of missing data

Having collected data and performed the necessary calculations for the above indicators, we ensure each indicator has data for all countries. The data treatment process requires the imputation of missing data for the DNSI (the DPRI has no missing data). If data is missing, we extrapolate data as a constant value of the nearest reported data, with a cut-off of two to five years depending on the indicator. This process is likely to result in a more accurate estimate for a specific country than using a modelled or imputed value based on data for other countries.

The remaining missing data is imputed with an expectation-maximisation with bootstrapping (EMB) multiple imputation algorithm. The EMB method generates imputed values through an iterative procedure that uses other variables to impute a value (expectation), and then asserts whether the value is most likely to fit the data (maximisation). To account for variation caused by missing data, the model is run 10 times. The average of these 10 imputations is then used to impute the missing value.[7]

Outliers treatment

The next step is to 'treat' the data by addressing outliers. If data is skewed by certain outliers, this can distort the overall index scores. For example, a country with an exceptionally high number of ICT patents compared to others would score very high, but it would also cause all other countries to score relatively low with minimal variation. To identify outliers, indicators are assessed for an absolute skewness above 2 and a kurtosis above 3.5. If these thresholds are met, a winsorization process is applied, where outlier values are trimmed to the nearest value until the indicator falls within the specified ranges for skewness and kurtosis.

For example, if a country has an outlier value of 1,000 and the next highest value is 90, the outlier is trimmed to 90. If this adjustment results in acceptable skewness and kurtosis scores, the process ends there. If not, the two values are further trimmed to the next highest value (which might be 80 in this example). This process continues until the indicator meets the specified skewness and kurtosis thresholds. To avoid adjusting too many observations, a maximum of six observations are trimmed. If this is still insufficient to reduce skewness and kurtosis, a secondary approach is implemented.[8]

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7   The EMB imputation is done using the 'Amelia II' package in R.
8   In this first edition of the DNSI, the winsorization process was enough to ensure the treatment of outliers.

04
Normalisation

Approach to normalisation

Normalisation is required in an index to adjust for different units of measurement and different ranges of variation across the indicators.

For the DNSI, the minimum-maximum method is used, which transforms all indicators so they lie within a range between 0 and 100 using the following formula:

$$I_{q,c} = \frac{x_{q,c} - min_c(x_q)}{max_c(x_q) - min_c(x_q)}$$

Where 'I' is the normalised min-max value, 'x' represents the actual value and the subscripts 'q' and 'c' represent the indicator and country respectively.

For most indicators, the minimum and maximum values used for normalisation are derived from the actual minimum and maximum values of that indicator. However, in some cases, they have been adjusted to establish aspirational targets and/or to permit winsorization of outliers as mentioned in the previous section.

To allow for comparisons of index scores over time, the minimum and maximum for some indicators are planned to be fixed for the next potential updates of the index. Some of the indicator maxima have therefore been adjusted where there are likely to be increases during the next few years in order to give all countries room to improve. These adjustments are based on analysis of historical data and statistical analysis. Table 3 summarises the logic and rationale of the min-max values assigned for each indicator of the DNSI. In the case of the DPRI, the scoring assessment is already based on values between 0 and 100.

Table 3

Rationale for min-max normalisation by DNSI indicator

Source: GSMA Intelligence

Indicator	Min-max rationale
Mobile penetration	Maximum and minimum are based on theoretical limits (0–100%)
Mobile internet penetration	Maximum and minimum are based on theoretical limits (0–100%)
4G/5G smartphone adoption	Maximum and minimum are based on theoretical limits (0–100%)
Mobile data usage	Maximum and minimum are based on the actual rounded values
Digital financial services	Maximum and minimum are based on theoretical limits (0–100%)
Tech start-ups	Maximum and minimum are based on actual values for the sub-indicators
IoT penetration	Maximum and minimum are based on the actual rounded values
Digital patents per capita	Minimum based on actual value, and maximum based on the trimmed maximum
Mobile commerce	Maximum and minimum are based on the actual rounded values
Firms with a website	Maximum and minimum are based on theoretical limits (0–100%)
Digital ID	Maximum and minimum are based on theoretical limits for each of the sub-indicators
E-government participation	Maximum and minimum are based on theoretical limits (0–100)
Govtech maturity	Maximum and minimum are based on theoretical limits (0–100)
Digital health	Maximum and minimum are based on theoretical limits (0–5)
G2P/P2G	Maximum and minimum are based on theoretical limits (0–100%)

05
Weighting and aggregation

Weighting

To aggregate indicators into pillar scores (and pillars into an overall index score), it is necessary to assign a weight to each component of the index. Table 4 shows the weights assigned to the pillars and indicators. For this first edition of the DNSI, considering the balance between the indicators within each pillar and their common relevance to digitalisation, equal weighting has been applied.

Table 4

DNSI indicator and pillar weights

Source: GSMA Intelligence

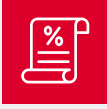| Pillar	Weight pillar	Indicator	Weight indicator
Digital Consumer	33%	Mobile penetration	20%
		Mobile internet penetration	20%
		4G/5G smartphone adoption	20%
		Mobile data usage	20%
		Digital financial services	20%
Digital Business	33%	Tech start-ups	20%
		IoT penetration	20%
		Digital patents per capita	20%
		Mobile commerce	20%
		Firms with a website	20%
		Micro-entrepreneur mobile adoption	NA
		Micro-entrepreneur mobile internet adoption	NA
Digital Government	33%	Digital ID	20%
		E-government participation	20%
		Govtech maturity	20%
		Digital health	20%
		G2P/P2G	20%
		Schools with internet	NA

Table 5 shows the weights assigned to the pillars and indicators in the DPRI. Equal weighting is mostly applied, though for some indicators we apply higher weights where they are more likely to impact mobile adoption and use. For example, with respect to taxation, more weight is given to indicators assessing whether or not there are sector-specific taxes that distort investment or make mobile services less affordable for consumers than for indicators assessing whether governments provide fiscal incentives to invest (for example, tax rebates or VAT exemptions). The weights also consider whether there is more or less variation in the assessment scores (if there is little variation for an indicator, applying a high weight would result in most countries having similar scores).

# DPRI indicator and pillar weights

Source: GSMA Intelligence

Pillar	Indicators	Indicator weight	Sub-indicators	Sub-indicator weights
Licensing and Spectrum 20%	**Licensing framework**	**10%**		
	Spectrum roadmap	**10%**		
	Spectrum assignment	**15%**	Low-band spectrum assignment	40%
			Lower mid-band spectrum assignment	40%
			Upper mid-band spectrum assignment	15%
			mmWave spectrum assignment	5%
	Mobile backhaul	**15%**	Mobile backhaul available	33.3%
			Mobile backhaul process	33.3%
			Mobile backhaul fees	33.3%
	Technology neutrality	**15%**		
	Spectrum fees	**15%**		
	Licence duration	**10%**		
	Spectrum leasing and trading	**10%**	Spectrum leasing	50%
			Spectrum trading	50%
Consumer Protection 20%	**Consumer protection framework**	**20%**		
	Data protection framework	**20%**		
	Cybersecurity	**20%**		
	Cross-border data flow	**20%**		
	SIM registration	**20%**		
Taxation 20%	**Consumer mobile taxes**	**25%**	Consumer taxes on mobile data	80%
			Consumer taxes on mobile money	20%
	Consumer handset taxes	**25%**	Consumer taxes on handsets	90%
			VAT exemption on handsets	10%
	Operator taxes	**25%**		
	Fiscal incentives	**10%**		
	Tax stability	**15%**		

Pillar	Indicators	Indicator weight	Sub-indicators	Sub-indicator weights
Network Regulation 20%	Harmonised deployment	15%		
	Small cell deployment	10%		
	Fibre regulation	15%	Rights of way	50%
			Fibre regulation	50%
	Infrastructure sharing	15%		
	Coverage obligations	15%		
	Quality of service	15%		
	Commercial flexibility	15%		
Public Policy 20%	Affordability and digital skills	20%	Affordability	50%
			Digital skills	50%
	Gender and rural inclusion	20%	Gender inclusion	50%
			Rural connectivity	50%
	USF management	20%	USF contribution	25%
			USF disbursement	25%
			USF accountability	25%
			USF financing	25%
	Competition policy	20%		
	Start-up regulation	20%		

Aggregation

Once weights have been assigned to the indicators and pillars, the next step is to aggregate them to produce the relevant composite scores. For this purpose, we considered both arithmetic and geometric aggregation methods. Arithmetic aggregation implies perfect substitutability, meaning higher scores in one area can fully offset lower scores in another. In contrast, geometric aggregation implies partial substitutability, where trade-offs between indicators or pillars are less flexible.

Given the structure of our model, which includes only indicators and pillars, and the nature of the data, we have chosen arithmetic aggregation for both levels. This approach ensures variations within any pillar are reflected in the overall score.
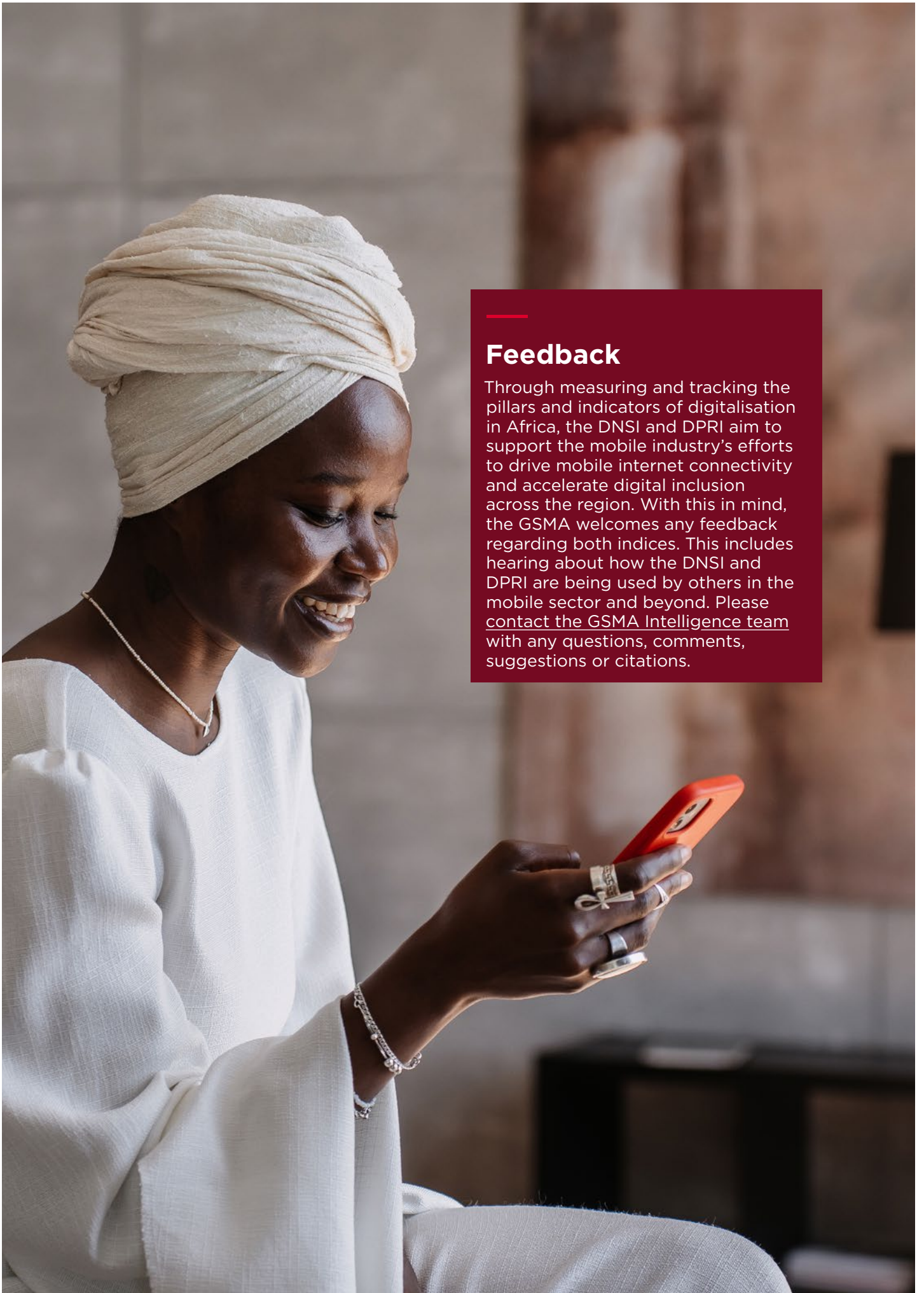
Feedback

Through measuring and tracking the pillars and indicators of digitalisation in Africa, the DNSI and DPRI aim to support the mobile industry's efforts to drive mobile internet connectivity and accelerate digital inclusion across the region. With this in mind, the GSMA welcomes any feedback regarding both indices. This includes hearing about how the DNSI and DPRI are being used by others in the mobile sector and beyond. Please contact the GSMA Intelligence team with any questions, comments, suggestions or citations.