Innovation in Sub-Saharan Africa (SSA): A conceptual and empirical baseline

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Abstract. This study establishes a baseline for improving Sub-Saharan Africa's (SSA) performance in the Global Innovation Index. Using a ten-year time-series analysis of data from the World Intellectual Property Organisation (WIPO) and the United Nations Industrial Development Organisation (UNIDO), supported by a systematic review of literature on innovation and innovation ecosystems, the research highlights persistent regional underperformance. A meta-analysis shows that innovation in SSA is shaped by multidisciplinary perspectives, yet progress remains limited despite global emphasis on innovation-driven development. Descriptive statistical trends across 54 countries reveal that SSA continues to lag behind other regions, with minimal improvement over a decade of WIPO assessments. The findings underscore the need for evidence-based strategies, stronger innovation ecosystems, and coordinated institutional efforts to enhance competitiveness, productivity, and sustainable development across the region.

Keywords: Innovation, Innovation ecosystems, Sub Saharan Africa, Development.

1 Introduction

What is the point of reference or baseline for innovation in Sub Saharan Africa (SSA)? From the inception of measurements and rankings in terms of economic positioning, growth, innovation, and productivity, Sub-Saharan African (SSA) countries have either been relatively lagging or inconsistent in asserting a prime position in the global context.

The factors that underpin this predicament are numerous and, to a certain extent, well documented (Ganda 2024; Worku 2024). However, an understanding of these commentaries for example the role of foreign direct investment (FDI) and total factor productivity indices have not proportionately been followed by impactful research and action. This can be evidenced from persistently intractable development issues and problems facing the continent (Ngwana & Olushola, 2024). Furthermore, various institutional interpretations and interventions have presented and continue to be presented as a means for finding solutions to these problems. However, the evidence from a class of studies such as those of Osei-Kusi *et al* (2024) and Odhiambo (2024) that give reason to persist in pursuing a pathway of leveraging both enterprise and educational research in finding impactful solutions. The above points offer a broad context within which we can justify the purpose of this baseline study.

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As a matter of emphasis, this paper examines three critical and related dimensions of advancement toward the solution or an effective intervention on the roll out of an impactful network of innovation ecosystems and hubs in SSA (Gamidullaeva 2021). The fundamental value position driving our enquiry is drawn from evidence from studies not only as Gamidullaeva's but also related contributions such as Hein *et al* (2019). This cluster of studies found that co-creation in innovation through a network of specific infrastructure such as digital platforms would ease up critical concerns that have held SSA back. This, in essence, implies that efforts made so far on the continent in bridging this gap have either been insufficient or because they function in silos. The explanation would include the argument that such a position diminishes the cumulative or compounding effect of synergy.

The first dimension is to examine the institutional perspectives, for instance the respective stances taken by various institutions within the international systems towards the problem and perceived solutions. Secondly, we systematically delve into fundamental research literature mainly on the key areas and themes of interest to researchers and their translation into policies and actions. The third dimension examines existing empirical data that offer an initial picture. This will serve the purpose of observing progress into the future and parameters for appraising any new efforts and interventions in line with the international systems outlined above. This dimension may intersect with the fundamental efforts of the international systems highlighted earlier but the main thrust here will be on data.

2 International Institutions and Innovation in SSA

Development in SSA has consistently been on the agenda of international institutions and systems. We argue that innovation has both implicitly and explicitly been seen within the framework of these institutions as a factor for advancing their respective development agenda (Bekele *et al* 2024). Furthermore, an additional conjecture here is that, innovation as an economic and business process would have significant impact on most of the 17 sustainable development goals (SDGs) proffered by United Nations Organisation (UNO). An example, amongst others, includes an associated UN institution such as the *United Nations Industrial Development Organisation (UNIDO)*, which carries out systematic appraisal of specific industrial innovation in several areas. One of the approaches is *SDG-9 industry* which focuses on their industrial development over a period of up to 20 years, examines the trends and estimates prospects running into a target year (e.g 2030). The second is production or manufacturing performance across, each country's economy and the most relevant industry. The third area is an appraisal of competitive industries. Understanding and exploring the feasibility of both relative and absolute advantage in specific countries is critical, according to UNIDO. The fourth dimension is an appraisal of the extent to which the country's production capacity is integrated into global value chains.

However, the UNIDO fundamental position on the Global South and SSA, by implication, is that a significant degree of responsibility is left in the hands of governments. According to their commissioned working paper on this subject, Santiago and Zagota (2024), assert that there is significant dearth of capacity in the following areas: 1) the 'ability to systematically assess the

socioeconomic impacts that can be associated with public policy interventions; 2) skills to engage with evidence-based policy learning; and 3) ability to integrate dynamism by networking, infusing collaboration and creating a heterogeneous stakeholder base. The ramification of these findings is that there is the utmost reliance of governments to roll out impactful policies. At the same time this evidence is pointing to a critical lack of capacity for this delivery by governments. This reveals and explains the fundamental lack of progress thereby creating the space for a fresh examination of ways forward as set out in this paper.

The United Nations Development Programme (UNDP) on its part opts to conceptualise innovation in a manner that resonates with its mandate within the United Nations systems. The International Governmental Organisation (IGO) sees innovation as a critical factor for the tackling of development challenges within its remit. They draw from the etymology of the word "innovation" as coming from the Latin word "innovationem," which was used in the 16th century to describe a *new idea, device, or method.* This implies that their energy and priorities would fundamentally focus on engaging with projects that develop new ideas, devices and methods that have *human development outcomes*. This has culminated in assistance to governments to develop policies, leadership skills, and partnering abilities to sustain development outcomes. Upon launching the decade of innovation in 2019, the organisation supported the setting of 91 laboratories in 115 United Nations member states. A success story has been echoed within the framework of the project in India, which improved by 4 spots, to 48th position within the Global Innovation Index (GII) in 2020. This success (just a year from the launching of the decade) was attributed to the facilitation of connections with knowledge, resources and networks or essential stakeholders within what was described as innovation laboratories. This is believed to be what was required for a visible breakthrough, for example improvement in their GII scores.

The IGOs or the United Nations agencies have numerous programmes to address direct or indirect drivers of innovation in SSA. Given the centrality of data in decision making and policy development, the World Intellectual Property (WIPO) assumes the mandate of providing this facility. The organisation evolved from the 1883 Paris Convention which was mainly related to industrial property such as patents, trademarks, industrial designs, utility models, service marks, trade names, geographical marks, and conflict management (e.g on unfair competition).

3 Methodology

The methodological framework for this study is driven by the fundamental question, which is: *What is the point of reference or baseline for innovation performance in SSA*? A key consideration is that the findings here would constitute the basis for future measurement or appraisal of the performance as well as connections of the innovation ecosystems or hubs within the continent. Another basic assumption is that SSA constitutes a homogeneous trading and economic entity as implicitly defined by the establishment of the African Continental Free Trade Area (AfCFTA) and the broader policy framework defined within the agenda 2063 by the African Union (AU). It is also inherent in the classification made in the WIPO and UNIDO world rankings.

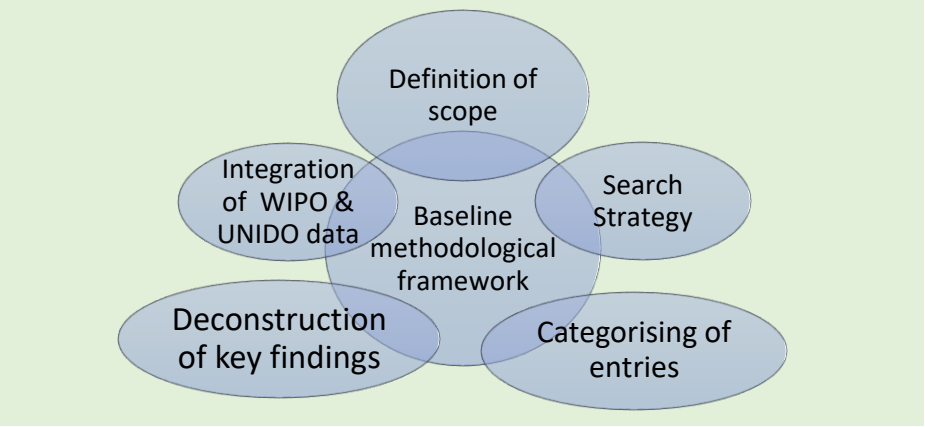

Fig 1. General Baseline Methodological Framework.

The general methodological framework illustrated above is an integration of the main methodological approach which consisted of a time series analysis of selected International Governmental Organisations (IGOs) data over a period of 10 years. The operational and methodological objective was map out the ranks, trends and gaps within the period. The mapping was also inductively generated leading and lagging performers with the SSA group. This was then supplemented by a systematic examination of critical strands of literature on innovation and the ecosystems as an organising structure and identifying SSA position within a global indexing system. The time series data was drawn from WIPO and UNIDO as indicated above. Though there might be other databases and source on innovation in SSA, the selected IGOs have the most comprehensive and appropriately funded systems of data collection globally. This is main legitimised by their affinity to the United Nations (UN) systems. The main thrust of the literature is to highlight the relevant dimensions of interest by researchers as demonstrated in the extant entries, their core findings and a sense of future trends. The empirical thrust, which is mainly time series data from the IGOs establish rankings and trends as a means of developing a measurable/quantifiable baseline.

Given the domination of Artificial intelligence and the use Large Language Models in research, an attempt was made to prompt 4 LLMs tools on the outlook of innovation in SSA. The main objective of this approach was implicitly use the AI outlook to triangulate and time series mapping. The focus was on generic outlook statements across the LLMs and AI tools and their views on inherent challenges (*see table 2*).

4 Approach to literature review

In this second dimension of our baseline, we systematically and exploratively examined empirical research mainly on the key relevant areas. This approach is in resonance with the reflection that innovation as a broad topic can be exceptionally diffused in focus. This means a clear methodological delineation would necessitate streamlining to be impactful in this baseline study. In practice, this would include being explicit about the scope of the review, the literature

search strategy, categorisation of entries interpreting and deconstructing the fundamental findings and indicated in figure 1 above.

Table 1. Dimensions of the review

Phases	Description	Focus
I	Articulation of scope	Review studies emphasised the last 3-year (2023, 2024 and 2025) years on innovation and its ecosystems (generally) and then in SSA.
II	Search Strategy Criteria for inclusion of entries Criteria for exclusion of entries	The key search terms include *innovation ecosystems* and *innovation ecosystems in SSA.*
III	Categorising of entries	Analysis: The term *innovation ecosystems* and various prioritised industries: a meta-analysis The *term innovation ecosystems in SSA* and prioritised industries
IV	Deconstruction of key findings	Interpretation of findings in accordance with the analytical categories

The initial scope for the review is focused on the time and conceptual dimensions. The years 2023,2024 and 2025 are set as time dimension for the review. This will tackle a cursory view of innovation and its ecosystems as a global phenomenon. The justification of the relatively short time dimension is that more historical studies would be relevant, however, we argue that given the pace of developments, there would be comprehensive and sufficient replication of findings into the three years from *2023 to 2025*. The second critical approach to the definition of the scope of the review is mainly geographically specific, for example innovation and its ecosystems in SSA. We drilled the search term(s) down to innovation ecosystems in Sub Saharan Africa SSA, for the purpose of this baseline and to provide a more succinct view and in accordance with the research question. We are conscious of the caveat that SSA may exclude the Arab Maghreb or Northwest Africa (Algeria, Morocco, Libya, and Tunisia) within the continent. There is also the awareness that some of the research findings or challenges faced in SSA countries may also apply in the Arab Maghreb countries.

Another key methodological choice for the review is the categorisation of the entries, their scope and depth. This is an inductive process whereby the categories such dominant industries and sectors of interest are a function of what we gleaned from the literature rather than pre-determined themes. The scope described above would therefore serve the purpose creating a framework and the categorisation which lay out key finding from the framework.

In terms of the source, we drew, as per the defined scope above, from key platforms which are deemed sufficiently comprehensive in terms of grounds covered. For example, we used EBSCO*host*, which is a complete e-resource management system, and which supplies a fee-based online research service with 375 full-text databases, a collection of 600,000-plus ebooks, subject indexes. Access to EBSCo Discovery Service (EDS) via our institutions means we could glean a portfolio of journals and magazines drawing together fundamental and applied research on innovation and innovation ecosystems.

5 Meta-analysis

We draw together some patterns within the literature in the form of a meta-analysis because key narratives in the baseline study could be embedded in the structure or skews in the analysis. We are acutely aware that innovation as a global phenomenon is profuse. A general search on this showed that innovation related projects in the ESBCO platform returned 1,914,436 projects for the years under review. We are also aware of the organic nature of the research landscape which implies that these numbers increase by the days.

In terms of innovation ecosystems in SSA, we deemed it appropriate to examine the level of research engagement and overriding picture in two key dimensions: one is the trends over a period of up to a decade and the other is the discipline-based dimension.

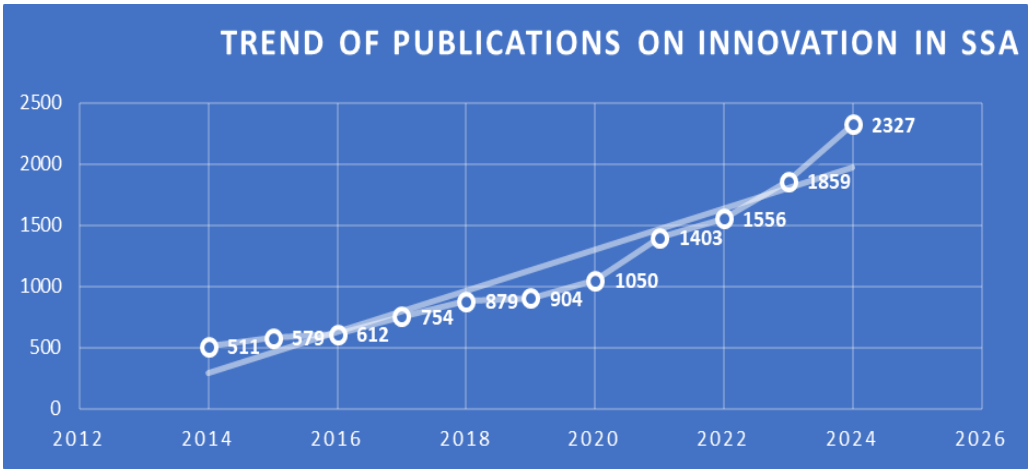

Fig 2. Studies on innovation is SSA since 2014

From about 2014 to date, the focus of researchers on innovation in SSA has been increasing progressively. Though the general trajectory indicates an upward trend, it seems more bullish between 2020 and 2024.

We found that disciplinary interest in the subject of innovation in SSA with the past decade is a preliminary indicator of what counts in the context of the region and areas that are at the forefront of research.

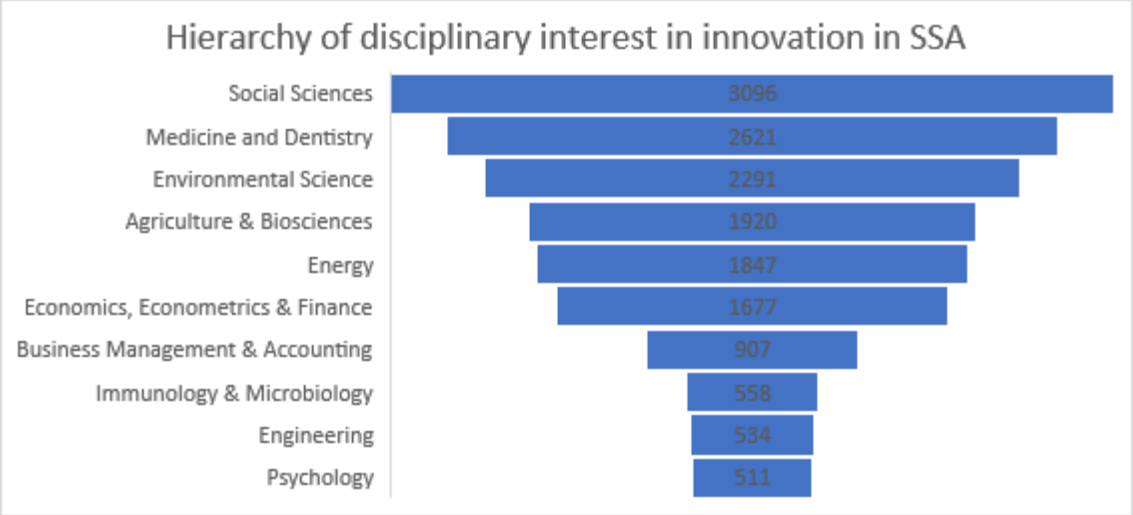

Fig 3. Key Disciplines of research in innovation ecosystems in SSA.

The indicators on above demonstrate the level and number hits or publication entries in specialised areas or disciplines. However, the measurement is not linear because of the intersection of some disciplines and specialities, for example Psychology, Economics, Business Management may broadly be captured in Social Sciences. Though this classification gives a fair idea of where the most efforts are being invested, it does not seem critically robust to assume these categories to be discrete. This implies that innovation, generally and its analysis is the context of SSA is more transdisciplinary than it is otherwise assumed.

5.1 Innovation processes and ecosystems

Envisioning innovation and the ecosystem within which projects take place has been highlighted in literature with noticeable effect. Nascimento Silva *et al* (2024), for example, has undertaken a systematic literature review in which they attempt to develop an integrative framework for innovation in ecosystem settings. The dominant point within this review, indicates that innovation as a standalone concept is a dense area to explore inductively. Therefore, examining it in the context of how it is organised and institutionalised would offer a better scope for application or policy and corporate impact. In the light of the premise and in line with the key emphasis on leveraging the baseline findings for corporate and policy implementation, we dived into the conceptualisation of innovation ecosystems generally before exploring what this would mean in the geopolitical context of SSA. This permitted us to derive robust deconstruction of fundamental learning points in the study.

6 Merits and Models

A critical strand of literature on innovation ecosystems is the cluster of studies which conduct tests and develop illustrative case studies which explore their merits. Our exploration of this facet of the literature did not find any relationship between specific advantages and industries or sector. Rather, the evidence from (Bin Cao, 2023) demonstrates a broader picture depicting that innovation ecosystems have a 'significant spatial spillover effect' and indicates that there is a specific advantage for an ecosystem to be conceived mainly in terms of geographical proximity. They also highlight the proposition that firms do not only benefit from belonging, but they also transform and are transformed by the ecosystem, thereby orchestrating a positive symbiotic effect between the firm(s) and the ecosystem. A recent study by Marcon *et al* (2024) also highlighted that Innovation ecosystem (IE) participation helps startups deal with external contingencies. This means the chances of success for a startup might be higher if they are located physically or virtually within an innovation ecosystem. Wang *et al* 2024 amplifies the argument by attributing success to complementary knowledge from cross-industry actors in the innovation ecosystem. The added point in their findings is that though there is a resource asymmetry problem, the research institutions play what they describe as 'irreplaceable role in facilitating knowledge spillover.

In the recent first quarter of the Century report, a World Bank Group, study found that recent geopolitical fragmentation has had a negative impact on global growth World Bank (2025). This is sometimes seen through tariffs and other restrictions to open and free trade and investment. In the same study, the World Bank Group also found that the Emerging Markets and Developing Economies (EMDEs) did relatively well. In a similar argument, Nylund et al (2023) found that crises can generate new value propositions by driving companies into an ecosystem or relationship in which they draw synergy from an otherwise undefined affinity. In an inductive case study of a water ecosystem in Catalonia in Spain, they described the outcome of the alignment as ecosystem exaptation. The serendipity of their findings is the fact that commonality in value proposition should not be a strict criterion of geographical proximity or an innovation ecosystem.

Two key fundamental findings so far have been that crises may be a blessing in disguise and industry affinity is not the most important criteria for success. Another cluster of studies have focused on identifying feasible models for the development of innovation ecosystems. Gonçalves et al (2024) found an institutionalised collaboration in cities would enhance success. Their study analysed two city cases in south America. These were cities with a cultural context of non-cooperation background. The model which emerged from the cases encompassed three collaboration stages and three roles, namely, the stages of preparing for Collaboration, Strengthening Collaboration and Disseminating Collaboration. Furthermore, the various roles include leaders, supporters, and community.

Huang et al (2023 made three fundamental arguments in their qualitative comparative analysis in relation to human capital development and talent competitiveness. The first was that e-government efficiency is a necessary condition for high talent competitiveness, and the information and communication infrastructure provided by e-government plays a general role in generating high talent competitiveness. The second was that there are three types of innovation ecosystems that generate high talent competitiveness: *business investment-driven*, *e-government-led*, and *R&D-driven*; and the third was that there are four types of innovation ecosystems that generate low talent competitiveness, and an asymmetric relationship exists with innovation ecosystems that generate high talent competitiveness. The key point was that ignoring Government Efficiency (GE) and R&D would undermine and inhibit factors such as increased investment in higher education, increased government investment in information and communication infrastructure, increased government investment in higher technology sector(s). The fundamental implications of these findings is that GE and R&D are a central independent variable, it is important to get the balance right in all these variables.

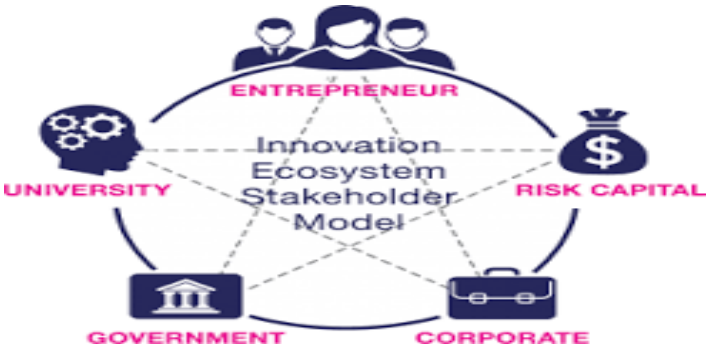

Fig 4. Stakeholder Framework for an Innovation Ecosystem.

Source: Budden and Murray (2019) with their five-stakeholder model.

In terms of practical models for the optimisation of an ecosystem, there is a strand of literature that provide evidence based practical and structural guide on developing a hub. Ozor et al

(2024), for example, used the case study of Eurasant´e in Hauts-de-France to illustrate that the essence of the principle of proximity (highlighted above) and project approach which they term 'middle ground model. The emphasis of their approach is a co-evolutionary project approach where the stakeholders cocreate according to the segments of their participation. These are all touches on an impressionable raft of studies the differ in description but reiterate the same metaphor of ecosystem (borrowed from Biology) emphasising the critical realism of symbiosis and affect in productivity. Typical examples of these models include: Gamidullaeva, *et al* (2021) and their illustration of Cross-Sectoral Digital Platform; Budden and Murray (2019) with their five-stakeholder model; Cao et al (2023) with their elaboration of the concept of symbiosis

7 Caveats on innovation ecosystems

As suggested above, our analyses view the ecosystems as the organising structure for innovation. However, it has emerged from the literature that there is need to make the distinction between innovation ecosystems *per se*, and business ecosystems. According to Vasconcelos Gomes Vasconcelos Gomes et al (2018) for example, business ecosystems emphasise value capture while in innovation ecosystems the emphasis is on value creation. The point made in their analysis is that there is a critical need to transition from business ecosystems to innovation ecosystems without presuming that that they are interchangeable.

Some studies have also demonstrated a rather Inverse U (impact) of over-extensive digital R&D on growth (micro/enterprise level), in the context of innovation ecosystems. Jiang & Wang (2024) in their study of 305 manufacturing SMEs in China they found that integration have an inverted U effect on innovation capability for SMEs in the context of an ecosystems. Their substantive points are that firstly integration in an ecosystem, or ecosystems could be a double-edged sword because of the asymmetric nature of resource capacity or what they describe as dynamic capacity, especially when the integration has not been appropriately measured across the breadth and depth of operations.

These concur a prior fundamental study carried out by Haans et al, (2016) suggesting the need for balance in an argument that '*too much can be as bad as too little'* However, Cao et al (2023) in their own study of a region in China found that the inverse U would be temporal especially if the SMEs can withstand bootstrapping as a part of their strategic objective. This implies that innovation is not solely about the integration of unmeasured research on digital technologies. Yuji, *et al* (2018) Demonstrates that the excitement of associating innovation only to Research and development (R&D) in technology should be treated with caution and full awareness of the confounding factors. Recent research in the measurement of impact of specific technological innovation within the green economy suggests an "inverted U-shaped" non-linear effect.

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8 SSA Positioning in the Indices of Global Innovation

The widely recognised contemporary thrust is in leveraging innovation holistically as a driver for development. The hallmark of such a strategy can be identified in the emphasis by WIPO and the international community to allocate development themes against each year. Over the past 10 years the following themes have been allocated to highlight the organisations and global focus in innovation efforts year-on-year thematic focus in innovation.

Table 2. WIPO Year-on-year development themes on innovation.

Year		Theme
2014		The Human Factor in Innovation
2015		Effective Innovation Policies for Development
2016		Winning with Global Innovation
2017		Innovation Feeding the World
2018		Energizing the World with Innovation
2019		Creating Healthy Lives—The Future of Medical Innovation
2020		Who Will Finance Innovation?
2021		Tracking Innovation through the COVID-19 Crisis
2022		What is the future of innovation driven growth?
2023		Innovation in the face of uncertainty

Furthermore, WIPO has been mandated to collate statistical indices for member states who provide the raw data in accordance with agreed criteria. The current report(s) include up to 132 economies in which the highlight is on their innovation strengths and weaknesses. The fundamental global outlook of innovation as perceived in the 2023, which is *'innovation in the face uncertainty*' is a culmination of trends as documented in successive WIPO annual reports.

In this study, we draw from reports dating back to 2014 (10 years) to examine the global and continental position of the SSA. The key criteria described by WIPO as dashboard parameters include four main categories, which include: 1) *Science and innovation* which encapsulates scientific publication, research and development (R&D) efforts/investments, the injection of venture capital, and number of international patent filings. 2) Technological progress which draws together indicators relating to computing power, cost of renewable energy, electric battery prices, cost of genome sequencing and drug approvals, 3) Technological adoption which considers: safe sanitation, connectivity, robotics, electric vehicles, and cancer radiotherapy and finally 4) Socioeconomic impact, featuring labour productivity, life expectancy and Carbon dioxide emissions Furthermore, the most recent outlook in 2024 indicates that artificial intelligence (AI), quantum computing, genome sequencing, several green technologies and robotics show a new, possibly groundbreaking dynamics and is likely to be a game changer.

This baseline data and premises drawn are in line with the class of studies such as Osei-Kusi *et al* (2024) and Odhiambo (2024) which make critical arguments about drivers of development. They emphasise that evidence-based and targeted understanding (e.g in education and

governance) and the foundations of SSA's global innovation and productivity position are central in driving a development agenda. To enhance robustness, data from WIPO is complemented with those from the *United Nations Industrial Development Organisation (UNIDO)*. The justification for relating these data sets is based on the conjecture that the connections between industrial development, economic growth, and global innovation index (GII) at national as well as regional levels are real.

Table 3. Innovation Index: A Synthesis of global performance.

	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Top Global Performers	64.78	68.3	66.28	67.69	68.4	67.24	62.75	65.5	64.6	67.6
Top SSA Performer(s)	40.94	39.23	35.86	35.8	25.47	24.2	23.44	35.5	34.4	32.1
Least SSA Performer(s)	12.66	14.95	17.24	17.41	8.3	7.29	6.47	15	11.6	10.3
Least Global Performer	12.66	14.95	14.55	15.64	7.9	6.44	6.47	15	11.6	10.3

The WIPO index permits us to identify the top performing country or countries over a 10-year period thereby permitting an observation of the trends. The index scores the 132 nations from whom data is registered on a 0 to100 points indicators as shown in table 3.0 above and documented on the WIPO dashboard. For the period covered by this study, 2 countries Switzerland and Luxemburg topped the performance index. These are the countries referred to in our findings here as *top global performers*. The highest score for the 10 years has been 68.3% or out of the 100 maximum points registered in 2018. Data on SSA as a regional block (*referred to in GII index as SSF*) countries can also indicate the extent to which they measure against the global top performing countries. These findings are critical because the set the baseline for the existing gap that needs to be bridged by any applied programmes and projects.

There are 3 SSA countries which share the top performance from 2014 to 2023 in the GII index. These are Mauritius, South Africa, and Senegal. The fundamental reason for having a baseline picture of the performance on the global innovation index is to create a basis for monitoring and evaluating progress during and after the applied project at the innovation hubs.

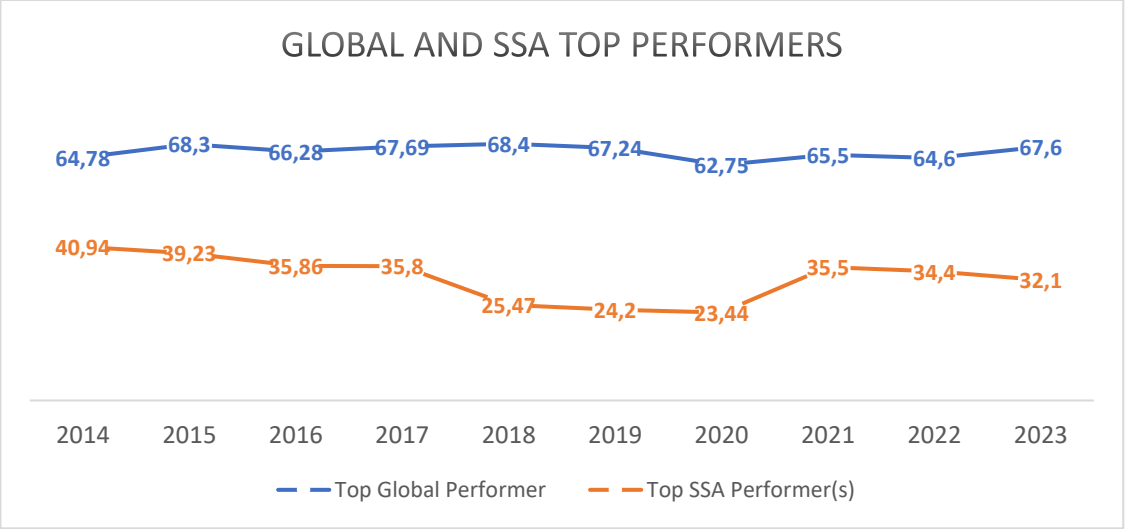

Fig 5. Gap between top global performer and top SSA performer

The scores of the top global performers range from 62.75 to 68.4 out of a maximum of 100. Switzerland dominates the top rank in the innovation index in the 10 years under consideration for this study. However, there has been a certain degree of fluctuation in the scores as indicated in the range mentioned above. The implication of this fluctuation is that there is a risk of slipping as well as enhancement for even the top performer(s).

The highest score ever registered by the top SSA performer is 40.98 out of a maximum score of 100. The fundamental baseline here portrays the gap between the SSA top performance and the global top performance. This means efforts and applied programmes developed with the innovation ecosystem(s) in SSA will aim at bridging this gap. It is also a critical starting point for monitoring and evaluation.

Furthermore, the gap between the least performing countries at global and SSA levels is also critical in measuring grounds covered in development efforts.

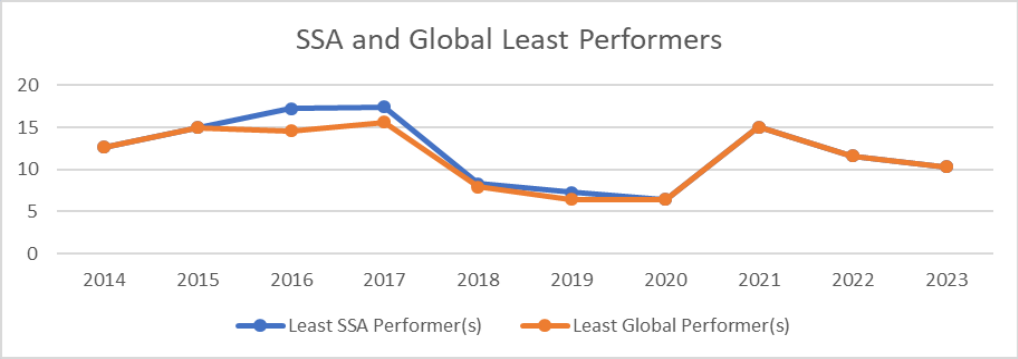

Fig 6. Gap between SSA least performer and global least performer.

A few SSA countries have featured on the least performing list both globally and at continental levels. This is made possible by the methodology of WIPO which splits all measurement into regions and globally. The level of integration and alignment of the trend lines representing the global and SSA is an indication of the extent to which the least performing country was from SSA. A general improvement in performance at global level for SSA would, naturally result in a disentanglement of the 2 trendlines. It is particularly clearly apart from 2016 and 2017, that the least performing country globally is also the least performer within SSA. This also constitutes a baseline finding that would constitute an indicator for the assessment of development impact.

Based on the indicators and data used in this baseline study, the ultimate primary indication of success at the innovation hubs would be to increase the performance of the case study countries within the WIPO measuring criteria. However, a broader view of innovation as a pathway to development would assume an impact on development in general, Sustainable Development Goals (SDGs) or ultimately improvement in the Gross Domestic Product (GDP) of the country.

Consequently, we extended the baseline analysis to include the UNIDO data on how the various United Nations (UN) member states are faring. This is in respect to development towards meeting the SDGs in 2030. The organisation uses what it refers to as the SDG-9 industry-related targets. These are six industry-related indicators under Sustainable Development Goal 9 adopted by the General Assembly on 6 July 2017. The indicators are used to identify the aspects that have impacted on the performance of the various nation-states in accordance with the SDG-9 industry re-related targets. The SDG-9 out of the 17 categories relates to building of resilient infrastructure, developing a sustainable and inclusive industrialisation and fostering of innovation. It comprises of dimensions such as: manufacturing value added, manufacturing employment, technological sophistication of manufacturing production and the manufacturing sector's environmental performance. The data tracks performances of the various countries in relation to other economies in groups and regions based on self-reported data.

For our purpose, we targeted the three tops performing SSA countries within the years under consideration in this study. This also includes UNIDO's perception and outlook for the various targeted countries. Mauritius topped the SSA index in 7 out of the 10 years under consideration in this study. A comparison of the trend of the country's journey is juxtaposed with the SSA trend. The skew of the trend is observed as a determinant of the UNIDO's outlook to the country.

This may also have a certain degree of bearing on the translation of the leading position of the country in the global innovation index (GII) into real manufacturing value added as a percentage of the GDP as well as the journey towards SDG in 2030.

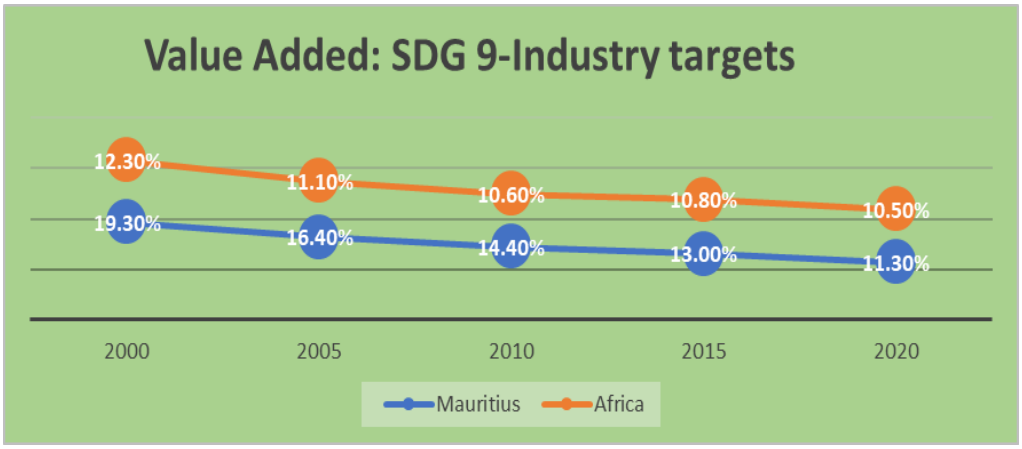

Fig 7. The SSA and Mauritius % value addition to the GDP- 2000-2020.

Based on the observed trend between 2000 and 2020, UNIDO states in its industrial development outlook that for Mauritius to reach SDGs target in 2030 the country has to reverse the negative trend. The trend indicates that the country has progressively moved from a 19.3% manufacturing value added in the year 2000 to 11.3% in 2020. A similar trend was observed for SSA with a performance of 12.3% in 2000 to 10.5% in 2020. The comparative decline between the SSA trend is an indication of the direction of UNIDO outlook which states that for the country to reach SDGs target in 2030 it must accelerate progress. This implies that even the top performing nation within SSA has a specific action plan in this direction that aligns with innovation and development.

South Africa was also recorded as top performer in the GII in SSA index in 2 out of the 10 years under consideration in this study. An examination of trends in its manufacturing value added as a % of its GDP just as it has been done with Mauritius is as seen below.

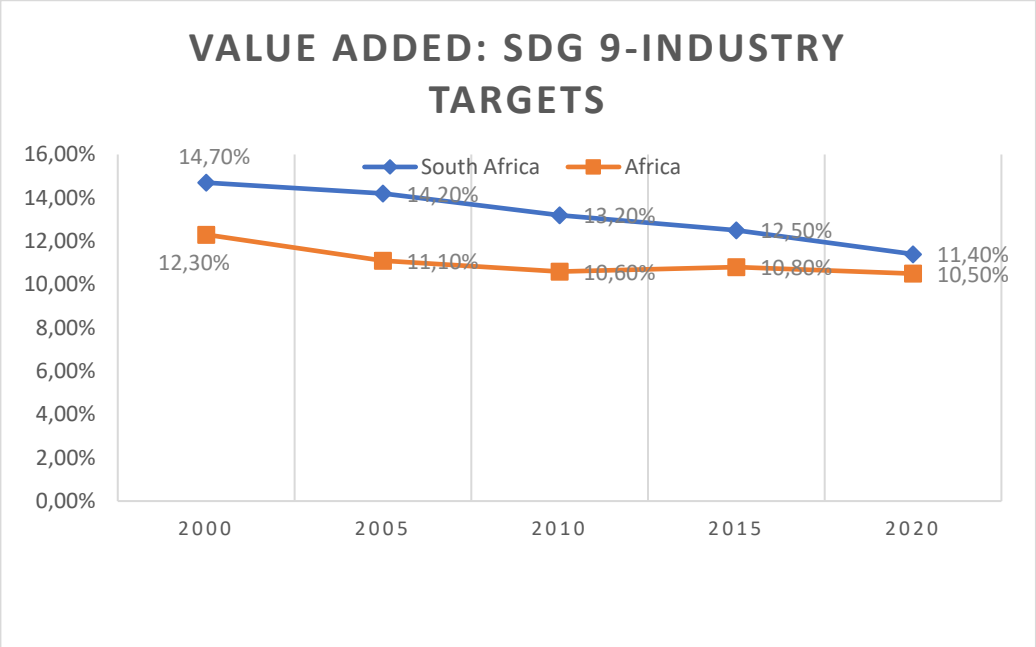

Fig 8. The SSA and South Africa % value addition to the GDP- 2000-2020

The South African trend is also bearish from 14.7% in 2000 to 11.4%% in 2020. This still highlights the consistently undesirable trend for SSA in general and one of the top performers on the GII. This also justifies the UNIDO outlook for both the region and the individual countries.

Senegal was recorded as top performer in the GII in SSA index in 1 out of the 10 years under consideration in this study. This has therefore warranted an examination of trends in its manufacturing value added as a % of its GDP just as it has the other SSA top performing nations which consistently stipulates that the negative trend must be reversed.

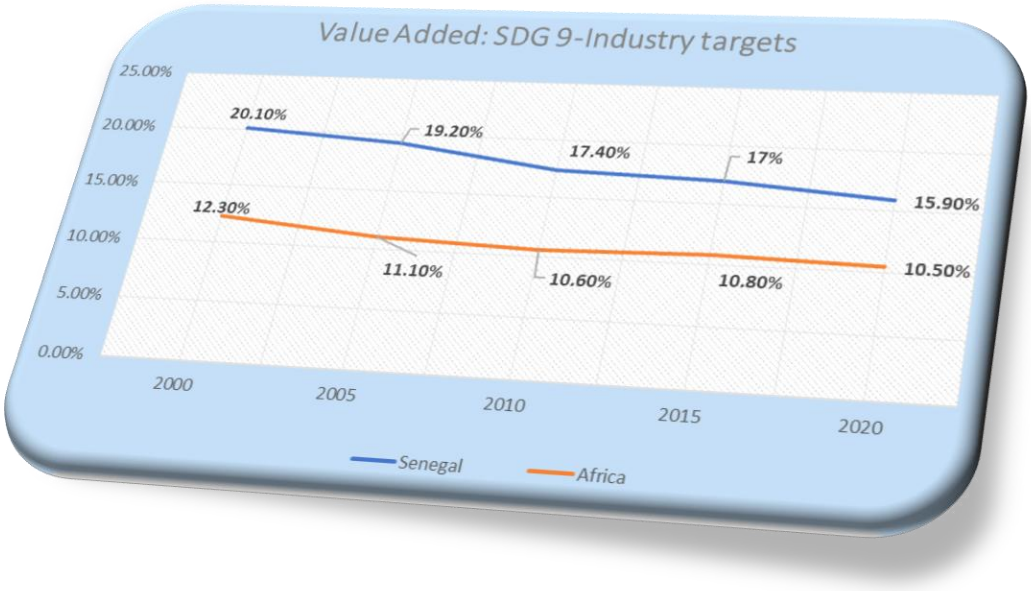

Fig 9. The SSA and South Africa % value addition to the GDP- 2000-2020.

Senegal presented itself in 2000 with a value added within the framework of SDG 9-industry targets of 20.1% but progressively dropped to 15.9% in 2020. This is a significant decline over the period of 20 years. One of the key concerns is also that the decline has been progressive. This lays credence to the UNIDO outlook for the continent which consistently urges nations to reverse the trend.

9 Perspectives on innovation ecosystems in SSA

A grasp of the Innovation in Sub-Saharan Africa (SSA) especially within the context of its organisation along ecosystems, a conceptual and empirical baseline of where SSA is as we drift into the second quarter of the 21st Century, is central for development. This study focused on a global index as well as the knowledge base on the innovation ecosystems globally and specifically in SSA. The critical appraisal of the evidence has been that momentum in this area has stayed consistent for over 10 years. This means the stronger or weaker actors have remained almost the same. For example, Mauritius has remained the dominant nation within the SSA group in the global innovation index (GII). With SSA staying with a very small margin between its weakest nations and the global weakest link, there is need to examine the outlook and possible actions to enhance the current position.

To supplement at empirical findings from the GII, an exploratory question was submitted to 4 artificial intelligence (AI) tools, namely: Gemini, Notion, Chat GPT and DeepSeek as follows:

Chat GPT

The outlook for innovation in Africa is promising, driven by several dynamic factors. Here are key elements shaping the innovation landscape on the continent:

Overall, while challenges exist, Africa's innovation landscape is poised for growth, with many opportunities lying ahead. The continent's unique context offers fertile ground for innovative solutions tailored to meet its diverse

***Challenges Remain**: Despite the positive trends, challenges such as infrastructure deficits, regulatory hurdles, and access to financing remain. Addressing these issues will be crucial for sustaining innovation.*

Gemini AI

The outlook for innovation in Africa is generally very positive, with significant potential for growth.

*Despite the challenges, the overall outlook for innovation in Africa is **promising**. The continent's young population, growing tech ecosystems, and increasing focus on STI are creating a fertile ground for innovation. By addressing the challenges related to infrastructure, funding, and policy, Africa can unlock its full innovation potential and drive sustainable economic growth*

***Challenges** include Limited access to reliable electricity, internet connectivity, and transportation infrastructure can hinder innovation. Funding Constraints:*
eg access to funding remains a challenge for many African innovators and startups.

Policy and Regulatory Environment: Inconsistent or unfavourable policies and regulations can stifle innovation. There is also a need for more skilled workers in areas such as technology, engineering, and science.

Notion AI

Africa's technology and innovation ecosystem has been experiencing significant growth, with tech hubs, startups, and innovation centers emerging across the continent, particularly in countries like Nigeria, Kenya, South Africa, Egypt, and Rwanda.

The outlook appears cautiously optimistic, with significant potential for growth if systemic challenges can be addressed through collaborative efforts between governments, private sector, academia, and international partners.

Despite positive momentum, challenges remain in infrastructure (especially reliable, electricity and internet connectivity), regulatory environment, access to capital and skilled talent retention.

DeepSeek

*Africa is poised to become a **global innovation powerhouse**, leveraging its youthful population, mobile-first economy, and entrepreneurial spirit. While challenges remain, the continent's potential for disruptive solutions in fintech, AI, and sustainability is undeniable.*

*The outlook for innovation in Africa is **highly promising**, driven by a young and tech-savvy population, increasing digital adoption, and a growing startup ecosystem.*

*Key **challenges** to Overcome include funding gaps for example, most investments go to fintech, therefore therefore is need for investment in more areas such as health, edtech, logistics etc. Regulatory hurdles also hamper innovation e.g., Nigeria's crypto ban, strict fintech rules. Brain drain of tech talent through migrating abroad is also to be blamed. Furthermore, electricity & internet access due to bad distribution networks remain inconsistent in some regions.*

Each of the AI tools was given the opportunity to provide an observation of the outlook, examine challenges and offer a concluding remark. There is a significant level of consistency across the four AI tools in terms of the observations. The observations range from cautiously optimistic, promising and highly promising. Infrastructure, regulatory policies tend to be highlighted as key challenges across all the AI tools.

A snapshot of the literature demonstrates a significant gap in interest in the quantity and scope of interest amongst SSA scholars in this area. This makes it difficult for practitioners to offer evidence-based policies for the acceleration of the innovation index at the competitive global level.

10 Conclusions & Future direction

What is the point of reference or baseline for innovation in Sub Saharan Africa (SSA)? The concluding remarks here would serve the purpose of opening new angles for investigating and strategizing for the enhancement of SSA's position within GII. A number of intersecting areas have been identified and worth further exploration. In terms of human capital, for example, Africa has one of the youngest populations in the world, which contributes to a vibrant and dynamic workforce. This demographic is generally tech-savvy, open to new ideas, and eager to embrace innovation. It represents a large pool of potential innovators and entrepreneurs. Generally, the demographic dividend can drive innovation and economic growth.

Furthermore, there is growing recognition of the importance of contextually relevant innovations designed specifically for African markets rather than imported solutions. The pledge of unity and interconnectedness would serve as a key driver for enhancing innovation. This implies that a more Pan African approach to innovation initiatives is likely to add more value. Key studies undertaken and showcased in the literature especially in Asia demonstrate the strength in size and policy synergy. The context of the African Continental Free Trade Area) would boosting cross-border trade and digital economies (AfCFTA). One the evidence on the need for the qualitative enhancement of the human capital, it follows that SSA would enhance

its position upon focusing on skilled workers in areas such as technology, engineering, and science, craft and design thinking.

Discourse on investment in SSA demonstrates that the appeal for investment in the region tends to be dominated by the extractive industry. An example, especially in recent years, is in metals, **minerals, and mineral products** which have **rapidly increased due to the energy transition and urbanization**. This baseline study indicates that an effective extension to this would target or instigate interest from global investors in African tech startups and innovation projects as a key driving force for everything else. An example on the backdrop of the AfCFTA is critical digital technological platforms and networks such as Blockchain Technology and other applications that would instigate synergy by taking advantage of 1.4 billion population of Africa.

Furthermore, another critical premise and observation is that from this baseline is that while gap analysis and perception of the trends over the 10 periods demonstrates a slightly bearish tendency. However, there is an emerging new Pan African policy rhetoric that emphasises continental restraint in the exploration and export of raw materials (Ngwana & Olushola, 2024). Given the critical nature of the various raw materials and rare earth minerals from SSA, key manufacturers would be obliged to set up bases within the continent. Such a scenario is likely to have a positive knock-on effect in not only job creation but in the innovation index of SSA.

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