

Musashino Reflection

Towards G20 South Africa 2025



November 2025
Musashino Institute for Global Affairs (MIGA)

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The outcome of “Musashino University International Forum: Japan-Africa Cooperation on Sustainable Economic Development—Building Circular Economy by Strengthening Digital Logistics -”, held on August 19, 2025, at Musashino University's Ariake Campus, received the following two official approvals:

① Ministry of Foreign Affairs TICAD9 Partner Project

(Approved July 7, 2025)

② T20 South Africa 2025: Task Force 1: Trade and Investment Side Event

(Approved August 7, 2025)

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Musashino University

About the illustration

: The haiku "The Milky Way stretching across the rough seas and Sado Island" by Basho symbolizes the immense power that Africa will harness to overcome challenges and thrive in the future filled with light.

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Acronyms List

Acronym	
ADB	Asian Development Bank
AEO	Authorized Economic Operator
AfCFTA	African Continental Free Trade Area
AGO	African Growth and Opportunity Act
ASYCUDA	Automated System for Customs Data
AWB	Air Waybill
C/O	Certificate of Origin
CIF	Cost Insurance and Freight
CKD	Complete Knock down
COMESA	Common Market for Eastern and Southern Africa
DCTMC	Doraleh Container Terminal Management Company
EAC	East African Community
EIC	Ethiopian Investment Commission
ELV	End of Life Vehicles
EOL	End of Life
EPA	Economic Partnership Agreement
EPR	Extended Producer Responsibility
EPZ	Export Processing Zone
Ethiopia-Sudan FTA	Ethiopia-Sudan Free Trade Agreement
EU	European Union
EU-ACP	European Union - African, Caribbean and Pacific Group of States Agreement
EU-EAC EPA	European Union - East African Community Economic Partnership Agreement
EU-SADC EPA	European Union - Southern African Development Community Economic Partnership Agreement
EV	Electric Vehicle
E-waste	Electronic and Electrical Wastes
FTA	Free Trade Agreement
FTZ	Free Trade Zone
HEV	Hybrid Electric Vehicle
I/V	Invoice
iCMS	Integrated Customs Management System
ICT	Information and Communication Technology

IMMEX	Industria Manufacturera, Maquiladora y de Servicios de Exportacion
IP	Industrial Parks
IPDC	Industrial Parks Development Corporation
ICD	Inland Container Depot
MoTI	Ministry of Trade and Industry
MUB	Manufacturing Under Bond
NGV	Natural Gas Vehicle
NXRIX	NX Logistics Research Institute and Consulting Inc.
OSBP	One Stop Border Post
PIC	Public Investment Corporation
P/L	Packing List
PPP	Public-Private Partnerships
RFID	Radio Frequency Identification
SABS	South African Bureau of Standards
SACU	Southern African Customs Union
SACU-EFTA FTA	Southern African Customs Union - European Free Trade Association Free Trade Agreement
SACU- MERCOSUR	Southern African Customs Union - Southern Common Market Agreement
SADC	Southern African Development Community
SARS	South African Revenue Service
SEZ	Special Economic Zone
SKD	Semi Knock down
SW	Single Window
TANCIS	Tanzania Customs Integrated System
TEU	Twenty-foot equivalent unit
TIC	Tanzania Investment Centre
TIDCA	Trade and Investment Development Cooperative Agreement
TIFA	Trade and Investment Framework Agreement
TPT	Transnet Port Terminals
UK	United Kingdom
UK-Kenya FTA	United Kingdom - Kenya Free Trade Agreement
VAT	Value Added Tax
VC	Value Chain
WCO	World Customs Organization

Musashino Reflection

Musashino Reflection

Prof. Hidetoshi NISHIMURA, Director, Musashino Institute for Global Affairs;
Specially Appointed Professor, Musashino University.

Prof. Mitsuhiro MAEDA, Visiting Professor, Musashino University.

Ms. Yu AKIYAMA, Visiting Researcher, Musashino University.

I. Background

The Musashino Institute for Global Affairs (MIGA) has, since fiscal year 2024, continued its work through successive study groups to examine the content of developmental strategies that Global South countries should adopt going forward, within the broader framework of the evolutionary path of modern civilization. The results of this work were compiled in ‘Path Diversity for “No One Left Behind”’ (Musashino Institute for Global Affairs (MIGA), November 2024). This report was subsequently distributed to all sherpas at the G20 Sherpa Meeting held in Rio de Janeiro in November 2024. It was also presented at the G20 Social Summit (14 November 2024), held in conjunction with the G20 Leaders' Summit, thereby disseminating information globally.

The central proposal in ‘Path Diversity for “No One Left Behind”’ is the concept of multilinear evolutionary path for Africa, specifically a "leapfrog-type" developmental strategy. This approach contrasts with the traditional, linear evolutionary path.

The linear evolutionary path posits that all social systems on Earth must follow the same evolutionary path—first practiced by Europe and then by Asia—to achieve sustainable, long-term economic growth. Specifically, this entails initiating industrialization through labour-intensive industries. Applying this concept to Africa today would require Africa to focus on promoting labour-intensive manufacturing for the foreseeable future. This strategy shall mean, within the international community, Africa would remain perpetually far behind Europe and perpetually trailing Asia.

The "leapfrog-type" developmental strategy challenges this fundamental assumption. It posits that Africa can pursue a developmental path entirely different from the labour-intensive manufacturing-led strategies experienced by Europe and Asia. By doing so, Africa could rapidly ascend to a position of global leadership within the international community.

The reality enabling this “leapfrog-type” developmental strategy is, of course, the rapid advancement of digital technology, including the accelerated development of communication infrastructure and AI. We will collectively refer to this as DX (Digital Transformation). Moving forward, regions that accurately grasp the significance of DX and successfully build new social systems to respond appropriately will lead the global system.

Today's Africa is uniquely positioned to directly adopt the most advanced DX achievements generated worldwide. Therefore, by building new social systems that respond immediately to these cutting-edge DX outcomes, a "leapfrog-type" developmental strategy becomes entirely feasible.

To advance the examination of the specific content of this "leapfrog-type" developmental strategy, which MIGA began researching in earnest in fiscal year 2024, MIGA convened the

'Africa Master Plan Formulation Project Study Group' in fiscal year 2025. This group undertook the "Master Plan Formulation Project for Resource Circulation Formation through Enhancement of Digital Connectivity in Regional Logistics in Africa." The primary theme of this project is to build a circular economy system through enhancement of logistics digital connectivity. We believe that this very construction, as a form of “leapfrog-type” developmental strategy, will bring about rapid economic growth in Africa and significantly enhance its standing within the international community.

Based on this concept, MIGA held the 'TICAD 9 Musashino University International Forum on Digital Supply Chains for Economic Growth in Africa'. This forum provided a platform for extensive exchange and discussion with African policymakers participating in TICAD regarding policy proposals for building international resource circulation systems between Africa and Japan. It examined the feasibility of implementing the master plan in Africa and compiled the outcomes as the "Musashino Reflection." The "Musashino Reflection" was presented to the audience by Prof. Hidetoshi Nishimura, Director of the MIGA, at the conclusion of this International Forum. It was adopted unanimously by the audience.

The following day, on 20 August 2025, MIGA held the "Seminar on Digital Supply Chains for Economic Growth in Africa" as an official thematic seminar of TICAD 9 at the TICAD 9 venue of Pacifico Yokohama. The seminar formally introduced the "Musashino Reflection," adopted the previous day, to Japanese and African policymakers and facilitated discussions on concrete methodologies for its implementation.

To summarize the above, the "Musashino Reflection" is a policy proposal compiled to concretely advance the establishment of a circular economy system through enhancement of logistics digital connectivity. This proposal builds upon the "leapfrog-type" developmental strategy concept presented by MIGA in its 2024 publication 'Path Diversity for “No One Left Behind”'. It was developed as part of the 2025 project 'Master Plan Formulation Project for Resource Circulation Formation through Enhancement of Digital Connectivity in Regional Logistics in Africa.' These recommendations were unanimously adopted by the audience at the Musashino University International Forum held on August 19, 2025. They were then formally introduced to Japanese and African policymakers at the official thematic seminar of TICAD 9 and "Seminar on Digital Supply Chains for Economic Growth in Africa" (hosted by (MIGA)) .

II. Musashino University International Forum

The "Musashino Reflection" was adopted by unanimous consent of the audience at the conclusion of the Musashino University International Forum. The Musashino University International Forum was held on August 19, 2025, at Musashino University's Ariake Campus as an official side event of TICAD 9 and T20 South Africa. Participants included H.E. Mr. Patrick Dlamini, President of the Public Investment Corporation of South Africa (PIC); H.E. Dr. Bambang Brodjonegoro, Dean and CEO of Asian Development Bank Institute (ADBI); Dr. Elizabeth Sidiropoulos, Chief Executive of The South African Institute of International Affairs (SAIIA); Mr. Takehiko Matsuo, Vice-Minister for International Affairs of the Ministry of Economy, Trade and Industry (METI); and Mr. Kentaro Doi, Vice-Minister for Global Environmental Affairs of the Ministry of the Environment, Japan (MOEJ) among approximately 400 participants.

The Musashino University International Forum focused on the following three themes:

- **Integrating Logistics and Policy:** As exports of automobiles and electronic components from Asia to Africa increase, developing two-way supply chains premised on the collection and recycling of used batteries and other materials is an urgent task. Discussions highlighted that institutional development in Africa and strengthening digital logistics are essential for creating a circular system for strategic resources like lithium.
- **Generating New Wisdom:** To advance Africa's circular economy system, discussions focused on methodologies for democratically and systematically aggregating global wisdom. Strategies for utilizing interoperable platforms on Cyber Physical Systems (CPS) were explored.
- **Full Utilization of Digitalization:** Digitalization, extending beyond mere productivity gains, possesses the power to transform manufacturing. As a concrete policy to harness this power within Asia-Africa cooperation, a new methodology called SEZ (Special Epistemic Zones) was proposed.

Schedule	
9:30 – 9:40	Opening Remarks Prof. Hidetoshi Nishimura, Director, Musashino Institute for Global Affairs; Specially Appointed Professor, Musashino University.
9:40 – 11:20	Opening Speech Prof. Takako Konishi, President, Musashino University. Mr. Takehiko Matsuo, Vice Minister for International Affairs, Ministry of Economy, Trade and Industry (METI). Mr. Kentaro Doi, Vice Minister for Global Environmental Affairs, Ministry of the Environment, Japan (MOEJ). H.E. Dr. Bambang Brodjonegoro, Dean and CEO, Asian Development Bank Institute (ADBI); Former Minister of Finance, Republic of Indonesia. H.E. Mr. Patrick Dlamini, CEO, the Public Investment Corporation of South Africa (PIC); Former President, the Development Bank of South Africa (DBSA). Mr. Naoki Ando, Senior Vice President, Japan International Cooperation Agency (JICA).
11:20 – 11:30	Photo session
11:30 – 12:30	Scene Setting Presentation: <i>Report of the GSM (Geographical Simulation Model) analysis by IDE–JETRO, based on the data of trade and logistics surveys and field research conducted by NX Logistics Research Institute and Consulting Co., Ltd., and the OSBP Status Report (AUDA–NEPAD & JICA, 2024).</i> Mr. Ikumo Isono, Director, Economic Integration Studies Group, Institute of Developing Economies, Japan External Trade Organization (IDE–JETRO). Ms. Maika Watanuki, Senior Consultant, NX Logistics Research Institute and Consulting Inc. (NXLIX).
12:30 – 13:30	Lunch Break

13:30 –15:00	Session 1: Achieving a Global (trans–Continental) Circular System among Japan, Asia and Africa Keynote Speech: Dr. Elizabeth Sidiropoulos, Chief Executive, South African Institute of International Affairs (SAIIA). Dr. Venkatachalam Anbumozhi, Senior Research Fellow for Innovation, Economic Research Institute for ASEAN and East Asia (ERIA). Moderator: Mr. Michikazu Kojima, Chief Senior Researcher, Institute of Developing Economies, Japan External Trade Organization (IDE–JETRO). Panelists: Mr. Fusanori Iwasaki, Consulting Fellow, Research Institute of Economy, Trade and Industry (RIETI). Ms. Pamla Gopaul, Senior Programme Officer and Data Analyst, African Union Development Agency – New Partnership for Africa’s Development (AUDA–NEPAD). Q&A
15:00 – 15:20	Coffee Break
15:20 – 16:50	Session 2: Strengthening Digital Connectivity and Logistics, Exploring New Industrial Cooperation Between Africa and Japan “SEZ: Special Epistemic Zones” Moderator: Prof. Mitsuhiro Maeda, Visiting Professor, Musashino University. Panelists: H.E. Mr. Patrick Dlamini, CEO, the Public Investment Corporation of South Africa (PIC). Dr. Masahiro Nakamura, President and CEO, Lexer Research Inc.; Chairman, Green CPS Consortium; Professor, Tokyo City University. Mr. Isao Wada, Vice President, Isuzu East Africa. Q&A
16:50 – 17:00	Closing Session (Adoption of the Musashino Reflection) Prof. Hidetoshi Nishimura, Director, Musashino Institute for Global Affairs; Specially Appointed Professor, Musashino University.

(1) Opening Speech

Prof. Takako Konishi, President, Musashino University

Prof. Takako Konishi, President of Musashino University, opened the forum by expressing heartfelt gratitude to all participants joining from around the world to celebrate this officially recognized TICAD 9 side event. She emphasized that this gathering embodies the true spirit of TICAD — a platform where Asia and Africa come together to design new models of sustainable, inclusive growth.

This year marks the 101st anniversary of Musashino University's founding, an institution grounded in the Buddhist vow of the Four Universal Aspirations (*Shi Gu Sei Gan*) — to save all sentient beings, to deepen knowledge, to overcome worldly desires, and to realize the ultimate truth. President Konishi highlighted how these ancient vows continue to guide the university's modern philosophy: "Creating Peace and Happiness for the World." The university, she explained, seeks to transform wisdom into social good, advancing global well-being through education, research, and international collaboration.

As both a university president and a psychiatrist who has long worked in victim support and global health, Dr. Konishi expressed profound respect for Africa's progress in gender equality and social inclusion, calling it a source of inspiration for Japan. She proposed that cooperation between Africa and Japan should be based not only on technology transfer but also on mutual empathy and human dignity.

In today's era of AI, IoT, and digital transformation, she said, technological development must never lose sight of the human spirit. For regions confronting climate change, inequality, and conflict, a human-centred and culturally respectful approach is essential.

President Konishi concluded by reaffirming Musashino University's mission: to serve not merely as a place of learning, but as the spiritual foundations of peace and sustainability for the students. She called upon all participants to work together — Japan, Africa, and Asia —, to build a future where education, ethics, and innovation converge in harmony.

Mr. Takehiko Matsuo, Vice Minister for International Affairs, Ministry of Economy, Trade and Industry (METI)

Mr. Takehiko Matsuo expressed his gratitude to the MIGA for convening a forum of great relevance to the future of the global economy. He focused on three essential points defining the strategic importance of Asia–Africa cooperation in terms of Circular Economy and Digital Logistics.

First, he stated that the restructuring of global supply chains has become a defining challenge of our time. The combined impact of the U.S. tariff shifts, the war in Ukraine, and China's export restrictions on rare earth elements has revealed the fragility of supply dependence. "It is now imperative," he said, "to establish resilient and trustworthy supply networks among like-minded nations, with circular economy principles serving as their foundation."

Second, he emphasized that the world is entering a period of twin transformations: the Green Transformation (GX) and the Digital Transformation (DX). These transitions require not only renewable energy and hydrogen infrastructure but also a trusted digital ecosystem that enables data sharing, transparency, and AI-driven logistics. Digital logistics, he said, will be central to both industrial efficiency and carbon reduction.

Third, he underlined the need for Japan to reduce its overreliance on the U.S.–China axis and instead strengthen ties with the ASEAN and Africa. Africa's population growth, resource potential, and digital leapfrogging capacity make it an essential partner for sustainable global supply chains.

Concluding, Mr. Matsuo said that Japan, emerging from a long deflationary period, is now positioned to play a leading role in rebuilding global value networks based on trust, innovation, and shared prosperity. He expressed his hope that this forum would contribute concrete pathways for cooperation ahead of TICAD 9, advancing the spirit of partnership between Asia and Africa.

Mr. Kentaro Doi, Vice Minister for Global Environmental Affairs, Ministry of the Environment, Japan (MOEJ)

Mr. Kentaro Doi, at first, expressed his sincere appreciation to Musashino University for hosting such a timely and visionary forum. He emphasized that the circular economy was not only about recycling or waste management, but rather a comprehensive paradigm for aligning economic growth with environmental sustainability. It simultaneously addresses addressed climate change, biodiversity loss, and pollution - the triple planetary crisis — while promoting inclusive economic opportunities.

He recalled that at the G20 Osaka Summit in 2019, Japan launched the Osaka Blue Ocean Vision, a global commitment to reduce additional marine plastic pollution to zero by 2050. This initiative has now been endorsed by over 80 countries and regions, serving as a cornerstone for international collaboration on circular economy transition. Domestically, Japan adopted its Fifth Fundamental Plan for Establishing a Sound Material-Cycle Society in 2023, identifying circular economy as a national strategy to create value through resource efficiency, innovation, and cross-sectoral partnerships.

Mr. Doi further explained Japan's expanding cooperation within Asia and Africa. In March 2024, Japan hosted the 12th Asia-Pacific 3R and Circular Economy Forum in Jaipur, India, where the Jaipur Declaration (2025–2035) was adopted to accelerate regional transition toward circularity. In Africa, Japan launched the African Clean Cities Platform (ACCP), which has now grown to include 47 countries and nearly 200 municipalities, becoming the largest waste-management network on the continent. The upcoming 4th ACCP General Meeting, to be held alongside TICAD 9 in Yokohama, will adopt the New Yokohama Action Guidelines, defining shared priorities for the next three years.

He announced Japan's plan to establish a preparatory research fund with international partners such as the World Bank to promote infrastructure for waste management and recycling in Africa. Moreover, he highlighted the ASEAN–Japan Resource Circulation Partnership, launched in 2023, as a practical model for tackling e-waste and critical mineral recovery — experiences that can inform Africa's circular transition.

Mr. Doi concluded by noting that Musashino University's focus on integrating productive (arterial) and circular (venous) industries through digital technologies exemplifies the next frontier of circular innovation. He expressed his hope that the outcomes of this forum would guide both Japan and Africa in creating a shared roadmap for sustainable prosperity — extending Japan's environmental leadership from Osaka to Yokohama, and from Asia to Africa.

H.E. Dr. Bambang Brodjonegoro, Dean and CEO, Asian Development Bank Institute (ADBI)

H.E. Dr. Bambang Brodjonegoro, expressed his deep gratitude to Musashino University and the organizers of this important forum. He stated that the dialogue between Asia and Africa is not only regionally significant but vital for global development, especially as both regions seek pathways toward shared prosperity amid the middle-income trap.

Citing the World Development Report 2024, he noted that three-quarters of the global population — over six billion people — now live in middle-income countries, yet only 34 nations have successfully transitioned to high-income status since the 1990s. Economic growth alone, he stressed, does not guarantee enduring prosperity. However, Asia’s experience demonstrates that this trap can be overcome. Japan, Korea, China, Vietnam, and Bangladesh each provide unique models of successful transformation through industrialization, education, infrastructure, and governance.

He emphasized that Africa, while facing distinct challenges — with 38% of its population still living in extreme poverty — also holds enormous opportunities. Over 60% of Africans are under the age of 25, and the African Continental Free Trade Area (AfCFTA) could raise the continent’s income by USD 450 billion by 2035. Africa’s digital economy is projected to exceed USD 700 billion by 2050, while its vast reserves of critical minerals, such as lithium and cobalt, position it at the heart of the global energy transition.

Dr. Brodjonegoro proposed that advancing a circular economy and enhancing digital logistics are essential to transform Africa’s role from a resource supplier to a value creator within integrated global supply chains. Emerging technologies — AI, IoT, and blockchain — can strengthen traceability and transparency, enabling sustainable trade.

He mentioned the concept of a “Special Epistemic Zone” — a knowledge-based innovation hub distinct from traditional economic zones — where universities and research institutions in Asia and Africa collaborate to drive industrialization, digitalization, and capacity-building in the Global South.

Concluding his address, Dr. Brodjonegoro urged that poverty reduction and escaping the middle-income trap will not happen by chance but through deliberate policy choices and long-term investment in people. He expressed hope that this forum would give rise to a new “Musashino Reflection” — a shared framework for Asia–Africa collaboration contributing to global platforms such as G20 and T20.

H.E. Mr. Patrick Dlamini, CEO, Public Investment Corporation of South Africa (PIC)

H.E. Mr. Patrick Dlamini opened his remarks by expressing sincere gratitude to Musashino University, METI, MOEJ, and JICA for convening a forum of great strategic importance. He also

acknowledged the presence of Dr. Brodjonegoro and the leadership of the ADBI, recognizing the long-standing collaboration between African and Asian development institutions.

H.E. Dlamini reflected on his own experience leading major financial institutions that collectively managed nearly USD 200 billion in assets, much of which has been invested across Africa and globally, including in Japan. He noted that the theme of this year's G20 presidency under South Africa—Solidarity, Equality, and Sustainability—resonates strongly with the goals of this forum and the upcoming TICAD 9.

He praised Japan's resilience, innovation, and long-term commitment to social harmony, stating that these are values Africa deeply admires and seeks to emulate. Japan, he said, has built prosperity not from natural resource abundance, but from human capital, trust, and education—a lesson of immense relevance for Africa today.

H.E. Dlamini emphasized that Africa's sustainable growth depends on strengthening regional supply chains, promoting intra-African trade, and integrating the continent into global networks through digital logistics. Africa's vast reserves of rare earth and critical minerals, including those in South Africa, are essential to the low-carbon transition for electric vehicles and renewable energy systems.

He urged both Japanese and African partners to leverage these resources responsibly through sustainable circular value chains and to foster deeper industrial cooperation that benefits both continents.

He also highlighted the importance of education and youth empowerment. With most of Africa's population under 25, he said, quality education will determine whether the continent can transform its demographic dividend into economic success. He called on academic institutions, including Musashino University, to play a leading role in nurturing capable, ethical, and innovative leaders.

Turning to technology, H.E. Dlamini said that the Fourth Industrial Revolution and AI offer Africa a chance to leapfrog traditional barriers to development. He predicted that in the next decade, super artificial intelligence would transform global production and governance systems, making it essential to shape an inclusive and equitable digital society.

He also underscored South Africa's strong commitment to women's empowerment, noting that more than 53% of leadership positions in the PIC and other public institutions are held by women. Gender equality, he said, is not merely a policy but a principle that drives the nation's progress.

Concluding his speech, H.E. Dlamini expressed his hope that TICAD 9 will mark a new chapter in Japan–Africa economic relations, particularly in the automotive and clean-energy sectors, where South Africa and Japan share long-standing ties. Through solidarity, innovation, and human-centered development, he said, Africa and Japan can build a shared future of prosperity and equality.

Mr. Naoki Ando, Senior Vice President, Japan International Cooperation Agency (JICA)

Mr. Naoki Ando began by congratulating MIGA on hosting such an important international forum. Speaking on behalf of JICA, he emphasized that Africa's demographic and economic transformation make it one of the most critical regions for global prosperity. By 2050, Africa will represent one quarter of the world's population and one third of the world's youth.

He expressed his hope that this forum and TICAD 9 would encourage deeper engagement between Japan and Africa, especially among young generations and private enterprises. Africa's economy, he observed, is gradually shifting from resource-based exports toward industrial development and endogenous growth, but small market sizes and inland geography make continental economic integration essential. This goal, he noted, is at the heart of the African Union's Agenda 2063.

Mr. Ando outlined JICA's multifaceted support: infrastructure development including ports, roads, and bridges; capacity building in border management and trade facilitation; promotion of agriculture, Small and Medium Enterprises (SMEs), and renewable energy within economic corridors. He particularly welcomed Musashino University's research on Africa's digital transformation strategies, which aligns closely with JICA's vision for innovation-driven cooperation.

He mentioned the development of the Geographical Simulation Model (GSM) — a data-based analytical tool incorporating JICA's field studies — as a promising outcome of Japan–Africa research collaboration. He praised the university's network of African partners and expressed confidence that DX-based approaches would open new frontiers for sustainable business and investment.

Concluding, Mr. Ando reaffirmed JICA's commitment to advancing Africa's self-sustaining growth through infrastructure, human resource development, and digital innovation, wishing for the forum's success and the well-being of all participants.

(2) Scene Setting Presentation

Mr. Ikumo Isono, Director, Economic Integration Studies Group, Institute of Developing Economies, Japan External Trade Organization (IDE-JETRO)

Ms. Maika Watanuki, Senior Consultant, NX Logistics Research Institute and Consulting Inc. (NXLIX)

This session served as a “scene-setting” presentation for building a transcontinental circular economy through digital logistics enhancement. Ms. Watanuki from NX Logistics Research Institute and Consulting opened with findings from literature reviews and field interviews conducted in South Africa, Kenya, Ethiopia, and Tanzania, focusing on three themes: trade & logistics, automotive industry, and circular economy. Sixteen policy proposals were identified.

1. Trade and Logistics

Eight major structural challenges were outlined:

1. Investment incentives are confined to SEZs/EPZs with limited duration and flexibility.
2. The absence of FTAs with Asia keeps tariffs on Asian goods relatively high, undermining price competitiveness.
3. Although AfCFTA ratification has progressed, actual implementation remains limited, logistics infrastructure bottlenecks and border delays persist.
4. Port operations suffer chronic congestion and low productivity (though Tanzania's partnership with DP World shows early improvement).
5. Hinterland road connectivity remains underdeveloped.
6. Customs procedures have yet to achieve full digital integration: Single Window systems coexist with paper documents and duplicate data entry; AEO and advance-ruling mutual recognition is limited.
7. While trunk roads are improving, cross-border processing and data-sharing gaps continue to impede flow.
8. Railways connect ports to inland hubs but are constrained by aging infrastructure and limited scheduling.

From these observations, two core policy proposals emerged:

- **Introduce Non-Resident Inventory Scheme:** Allow foreign firms without local incorporation to store goods in bonded warehouses and pay duties/VAT only upon sale. This reduces lead-time for shipments from Asia, enables just-in-time delivery, small-lot supply, and test marketing. Indonesia's Bonded Logistics Center model was cited—permitting up to three years of bonded storage with light processing (repacking, labelling) and declaration upon dispatch.
- **Strengthen “Non-Stop Single Window” with RFID use:** Equip cargo and vehicles with RFID tags for automatic identification, reducing border stops and paperwork, enabling real-time visibility, and linking customs and transport data streams seamlessly.

In parallel, the study recommended strengthening **Asia–Africa FTA/EPA frameworks** and harmonizing **rules of origin** (including cumulation) to extend tariff preferences to regional goods incorporating Asian components—thus promoting value-chain formation and investment attraction.

2. Automotive Industry

Africa's transition toward electrification begins with **two-wheel EVs** rather than passenger cars.

- **South Africa** pursues a manufacturing-hub strategy, banning imports of used commercial vehicles while exploring hybrid-vehicle (HV) to introduce.
- **Kenya and Tanzania** still rely on used-car markets but have rapidly drafted e-mobility policies; two- and three-wheel EVs are entering mass-market phases.
- **Ethiopia** is distinctive: in 2024 it became the world's first country to ban imports of internal-combustion-engine vehicles altogether, leveraging low electricity prices to trigger an EV boom.

Parts supply chains depend heavily on Asia and Europe; local content outside South Africa remains low, with most production in CKD/SKD form. Start-ups assembling two-wheel EVs are emerging, but the **after-sales and reverse-logistics** segments remain opaque because of weak vehicle inspection systems and a broad informal repair/reuse sector.

Key policy proposal: equivalent to Mexico's **IMMEX** program by introducing a bonded or temporary-import regime that links component processing, assembly, and logistics operations tax-free until the final good is cleared. Digital monitoring would attract tiered suppliers, create employment and technology transfer, and raise local-content ratios.

3. Circular Economy

Legislation on waste management, EPR, and Basel/Bamako Conventions compliance is advancing, yet experience with **lithium-ion batteries (LIBs)** remains scarce because large-scale EV-battery disposal has not yet begun. Lead-acid battery recycling offers precedents, but a robust LIB collection system is still missing.

Key proposals to build LIB collection framework:

- Establish ICT-based **traceability** and user-incentive schemes.
- Design an **inclusive model** that formally integrates informal recyclers.
- Develop a **“milk-run” collection network**—operators make scheduled rounds linking dealers, swap stations, and repair shops as local collection points. Each battery receives a digital ID for tracking through reuse, repurpose, and recycling phases.

4. Simulation Findings (IDE–GSM)

Mr. Isono of IDE-JETRO presented results from the **Geographical Simulation Model (GSM)**, comparing two development scenarios:

1. **Conventional Corridor Development:** Roads + border facilitation + SEZ/FTA expansion.
2. **Leap-Frog Model:** Excludes major new road investment, focusing instead on border efficiency, port capacity, and digital productivity.

Findings show that the leap-frog model can generate almost equivalent economic effects over wider areas. However, if Asian connectivity advances without improving African productivity, manufacturing sectors may be displaced by import surges. Therefore, **human-capital and skill development** must accompany digital connectivity.

Mr. Isono further emphasized that physical roads have **psychological and behavioral effects**: they foster outward-oriented mindsets and market exploration among firms. Digital substitutes must therefore be designed to reproduce these effects through capability building and demand linkage.

5. Key Discussion Points (Q & A)

1. **On shrinking USAID activities:** participants saw an opportunity for Japan to fill the gap, especially in digital sectors. China's approach is shifting toward coordination and co-development rather than rivalry.
2. **Digital payment × battery recovery:** cashless transactions are becoming standard via app-linked swap stations.
3. **Road investment vs. leap-frog approach:** optimal balance depends on geography and corridor structure; JICA-supported Northern and Central Corridors still demonstrate large payoffs.
4. **Cultural differences and NTBs:** though high, once reduction start it accelerates. Cities gain even greater significance in the digital age as hybrids of physical and virtual interaction.
5. **Corporate best practice:** Daikin's subscription-based service model was cited as exemplary.
6. **Regional integration:** the future should follow a flexible, ASEAN-style path rather than a rigid EU imitation—an Africa-specific model blending pragmatism with innovation.

(3) Session 1 Achieving a Global (Trans-Continental) Circular System among Japan, Asia and Africa

This session commenced with two keynote speeches, followed by a panel discussion and a question-and-answer session.

Keynote Speech 1 : **Dr. Elizabeth Sidiropoulos**, Chief Executive, South African Institute of International Affairs (SAIIA)

Dr. Sidiropoulos began by reaffirming that the G20 has historically served as a vital platform for bringing together systemically important countries to generate new ideas and solutions to global challenges. She emphasized that today's most pressing task is the reconstruction of a sustainable economic model. The traditional model of consumption-driven and growth-dependent development, she argued, has already reached its limits given the planet's ecological constraints. In an era where even the foundations of the SDGs are being questioned in some countries, she urged the audience to move beyond self-interest and excessive consumption toward a circular economy grounded in global coexistence.

Four Priority Areas of South Africa's G20 Presidency

(1) **Strengthening Disaster Resilience and Response:** With natural disasters becoming more frequent and severe—particularly affecting developing economies—South Africa places top priority on expanding post-disaster reconstruction mechanisms and building resilient infrastructure across energy, digital, transport, and traditional sectors.

(2) **Ensuring Debt Sustainability for Low-Income Countries:** The post-COVID debt crisis across Africa has deepened structural inequality. Dr. Sidiropoulos stressed the need to address the unequal cost of capital and the lack of transparency in credit-rating practices. She called for the

creation of a fairer financial environment, stronger domestic resource mobilization, and reduced dependence on foreign-currency borrowing.

(3) **Mobilizing Finance for a Just Energy Transition:** South Africa emphasizes not only the quantity but also the quality of climate finance—its concessionality, duration, and coordination mechanisms. Beyond decarbonization, the presidency focuses on community empowerment, job creation, and skills development to ensure a fair and inclusive energy transition.

(4) **Harnessing Critical Minerals for Inclusive and Sustainable Growth:** Recognizing Africa's pivotal role in supplying minerals essential for AI and digital transformation, she argued for breaking free from the historical “extraction-export” model. Instead, Africa should promote local processing, regional value-chain development, and the circular use of mineral resources to ensure both sustainability and socio-economic inclusion.

Three Cross-Cutting Task Forces

(1) **Inclusive Growth, Industrialization, Employment, and Inequality Reduction:** This task force seeks to move beyond GDP-centric metrics toward frameworks integrating equity, employment, environmental sustainability, and social protection. Dr. Sidiropoulos highlighted the G20's potential as a platform for exchanging new economic policy ideas that can guide global transformation.

(2) **Food Security:** To address instability in global food markets, the G20 will coordinate with the Financial Stability Board and UNCTAD to establish regulations and standards for commodity markets and cross-border trade. In Africa, regional “food basket” initiatives are being developed to strengthen food self-sufficiency and climate-resilient agricultural systems.

(3) **Artificial Intelligence, Data Governance, and Innovation:** South Africa announced the AI for Africa Initiative (to be launched in late September and early October) aimed at positioning Africa within global AI governance debates. It will also establish a Technology Policy Assistance Facility for both G20 and non-G20 members, presenting principles for ethical, sustainable, and environmentally responsible AI.

Reforming the Global Financial Architecture and Carbon Markets

To expand sustainable development financing, South Africa advocates: (1) the use of Special Drawing Rights (SDRs), (2) de-risking mechanisms to attract private capital, (3) the introduction of climate-resilient debt clauses, (4) the expansion of adaptation finance, and (5) the correction of insurance protection gaps in agriculture, social protection, and real estate. Additionally, enhancing transparency and financial integrity in carbon credit markets is a key focus to ensure genuine climate accountability.

Institutional Challenges and Recommendations for the G20

Dr. Sidiropoulos concluded by identifying three systemic challenges—consensus, cooperation, and impact—as the main hurdles for the G20: (1) **Difficulty in Building Consensus**, even highly technical issues have become politicized, making collective agreements harder to reach; (2) **Reaffirming Multilateralism**, the recognition that only cooperation and respect for international rules can address planetary challenges such as climate change and resource depletion; (3) **Delivering Tangible Impact**, The G20 must go beyond formal pledges to demonstrate practical,

results-driven cooperation. As an agile informal forum, it should complement formal multilateral institutions and generate measurable global outcomes.

Keynote Speech 2: **Dr. Venkatachalam Anbumozhi**, Senior Research Fellow for Innovation, Economic Research Institute for ASEAN and East Asia (ERIA)

Dr. Anbumozhi emphasized that the G20—comprising both advanced and emerging economies—is a central platform for driving the sustainable development agenda. He noted that ERIA played a key role within the G20’s Think Tank Engagement Group and co-leads the climate finance track. For countries such as South Africa and Indonesia, this was a historic opportunity to leapfrog the unsustainable linear models of developed economies and directly adopt circular and sustainable systems.

Dr. Anbumozhi organized his discussion around three core perspectives on the circular economy. First, it serves as an inclusive growth model that generates new industries and green jobs such as waste management and resource recovery. Second, it enhances economic resilience by reducing dependence on virgin materials and maximizing the value of existing resources, including critical minerals. Third, integration with digital technology can accelerate this transformation.

He focused on the theory and practice of the circular economy. Emerging economies, he explained, face systemic inefficiencies—structural waste, supply-chain fragility, and resource losses—that circular models can effectively correct. He highlighted disparities in resource productivity between developed countries (like Japan or Germany) and emerging ones, noting that new business strategies that account for resource constraints are essential across national, regional, and corporate levels.

Dr. Anbumozhi then illustrated five forms of value creation through the convergence of the digital and circular economies: (1) Improving efficiency in extraction and manufacturing through digitalization; (2) Using AI and IoT to optimize resource use and predict waste generation; (3) Ensuring transparency and fair trade within supply chains; (4) Shifting consumption from ownership to “use-based” models such as car sharing or pay-per-use services; and (5) Increasing material recovery via urban mining and automated e-waste recycling. Together, these lead to an inclusive and efficient industrial paradigm shift.

He identified four foundational pillars for successful circular economy transitions: (1) Innovative business models; (2) Closing material cycles and building circular value chains; (3) Circular product design for improved material use; and (4) Enabling markets through education, awareness, and policy frameworks.

Comparing Southeast Asia and Africa, Dr. Anbumozhi explained that ASEAN countries fall into three readiness clusters—advanced (Singapore, Indonesia), early movers (Malaysia, Thailand, Philippines), and transition states (others). Similarly, Africa’s 42 nations exhibit diverse levels of readiness, hindered by inadequate digital infrastructure and limited integration of the informal sector. Formal inclusion of informal workers, he stressed, is indispensable to the success of circular transitions.

He then outlined three pillars of Japan–Africa cooperation: (1) **Technology and knowledge transfer**, sharing Japanese expertise in waste collection, automated sorting, and e-waste recycling; (2) **Green investment and startup ecosystem support**, extending beyond PPP into

4P partnerships—People, Public, Private, and Partnerships—integrating SMEs and local communities; (3) **“Made in Africa for the Circular Economy”**, promoting the design and manufacture of durable, repairable, and recyclable products to reduce import dependency and linear economic patterns.

In conclusion, Dr. Anbumozhi presented six key recommendations from the G20 Task Force 5 communiqué: (1) Setting targets and KPIs for circular material transitions; (2) Coordinating trade and investment policies to support circular supply chains; (3) Establishing dedicated circular economy finance mechanisms; (4) Enhancing ESG metrics aligned with circularity principles; (5) Localizing circular transitions by mobilizing regional resources and informal economies; and (6) Developing digital logistics platforms to ensure national, regional, and transcontinental connectivity.

He noted that these proposals have already been incorporated into the official G20 Sherpa communiqué and concluded by reaffirming that digitalization and circularity together form the foundation of a resilient, inclusive, and sustainable global future.

Panel Session:

In Session 1, perspectives were shared, particularly from the African side, regarding current efforts to build a circular economy system and future outlooks. It was stated that while challenges are significant, building a circular economy system in the near future is entirely feasible with appropriate initiatives. The moderator was **Mr. Michikazu Kojima**, Chief Senior Researcher, Institute of Developing Economies, Japan External Trade Organization (IDE-JETRO).

Mr. Fusanori Iwasaki, Consulting Fellow of the Research Institute of Economy, Trade and Industry (RIETI) gave a presentation mainly on the current state of the automotive industry in Africa, focusing on the perspective of the automotive industry in Africa and how issues such as the circular economy and economic security are interrelated. He also stated some possibilities of future automotive transformation in Africa, particularly the hybrid electric vehicles and battery electric vehicles penetration encouraged by global OEM players.

Ms. Pamla Goupal, Senior Programme Officer and Data Analyst at the African Union Development Agency – New Partnership for Africa’s Development (AUDA-NEPAD), noted that while Africa is experiencing a demographic dividend through rapid urbanization and a growing youth population, this momentum is accompanied by increasing pressure on natural and economic resources. Within this context, she emphasized that the circular economy offers a significant opportunity to drive sustainable transformation across the continent. Ms. Goupal highlighted several challenges impeding its advancement, including supply-chain fragmentation, limited interoperability, restricted access to green finance, and deficiencies in waste-management systems. In her presentation, she outlined AUDA-NEPAD’s current initiatives and the integration of digital technologies to enhance circular-economy practices, while also proposing avenues to strengthen cooperation between Japan and Africa. She underscored the importance of Japan and Africa working collaboratively to co-create solutions that serve not only their mutual interests but also contribute to the well-being of the planet, concluding her remarks with an expression of gratitude.

Afterwards, Q&A session started. In response to a question on how Africa can leverage its critical minerals within the current geopolitical order, Dr. Sidiropoulos emphasized a paradigm shift from extraction to value creation. She cited regional value-chain initiatives—such as Zambia and the DRC’s battery-manufacturing partnership—as early examples of this transformation. She

also referenced the African Union's Green Minerals Framework and her institute's cooperation with the African Minerals Development Centre to support regulatory and infrastructural development. On revitalizing multilateralism, she stated that although some countries are retreating from cooperative frameworks, those who still believe in the principles of rule-based international cooperation must demonstrate through concrete action that such systems can deliver for the common good—addressing both human and planetary sustainability. She stressed the importance of utilizing the African Continental Free Trade Area (AfCFTA) to build value chains within the region. Regarding the question for institutional mechanisms, Dr. Anbumozhi responded to questions that Japan should simultaneously provide its cutting-edge recycling technology and financing mechanisms to eliminate the time lag between technology introduction and funding. He noted that due to varying levels of development among African and ASEAN countries, a common framework and clear division of roles should be established while considering each nation's capabilities. He also suggested expanding the scope of university networks and existing international organizations (AfDB and ADB and ERIA) to create technological and financial opportunities while supporting capacity building.

(4) Session 2 Strengthening Digital Connectivity and Logistics, Exploring New Industrial Cooperation Between Africa and Japan "SEZ: Special Epistemic Zones"

In Session 2, the importance of establishing Cyber Physical Systems as a methodology for promoting the construction of circular economy systems through enhancement of digital logistics in Africa was discussed. A SEZ (Special Epistemic Zone) developmental strategy was proposed, which involves establishing and supporting universities/research institutions in Africa's rural areas as SEZs to undertake digital human resources development and cyber-physical system construction/operation, thereby advancing regional development through this initiative. In response, the African side expressed strong expectations, stating this could enable a “leapfrog-type” developmental strategy for Africa.

Speech by the Moderator: Prof. Mitsuhiro Maeda, Visiting Professor, Musashino University

At the beginning of the session, Prof. Mitsuhiro Maeda, served as the moderator, raised the following issues.

In this session, we will discuss methodologies for concretely advancing 'Building a Circular Economy System Covering Asia and Africa through Enhancement of Digital Logistics.'. Today, we are encountering an event that fundamentally changes the way modern civilization itself functions, within the evolution of the modern civilization over the past several hundred years. It is the rapid development of digital technology. We will collectively refer to this as DX (Digital Transformation). It is a concept that includes the rapid development of communication infrastructure as well as the rapid advancement of AI.

In the era before DX, it was believed that the promotion of modernization had to follow the following path. That is, first promote labour-intensive manufacturing industries, then advance manufacturing industries (promote capital-intensive manufacturing industries), and afterward,

pursue digitalization (promote knowledge-intensive industries). On the other hand, there is also an idea to start digitalization (promoting knowledge-intensive industries) prior to the promotion of manufacturing industries. This is called a “leapfrog-type” developmental strategy. At MIGA, over the past several years, we have mainly examined the potential application of this “leapfrog-type” developmental strategy in the African region. It should be noted that today's proposal, 'Building a Circular Economy System Covering Asia and Africa through Enhancement of Digital Logistics,' can be regarded as an example of this “leapfrog-type” developmental strategy. So why does 'Building a Circular Economy System Covering Asia and Africa through Enhancement of Digital Logistics' bring such a major transformation? This is because, to practically promote this initiative, it is essential to tackle the following three major challenges.

The first challenge is to build a comprehensive Cyber Physical System in the targeted regions. Logistics digital connectivity fundamentally requires the ability to fully track where and in what condition goods subject to logistics are currently located. On that basis, it implements the necessary control to realize efficient logistics. In other words, a system is needed in which complete digital tracking and control of goods can be achieved, and this is possible within a comprehensive Cyber Physical System. Furthermore, building a circular economy system proposes an integrating of productive (arterial) industry and circular (venous) industry. Therefore, it is necessary to completely track and control all resources digitally, going beyond the scope of what has traditionally been considered as resources in production activities. This includes items previously regarded as waste (garbage). Moreover, to reintegrate these new "resources" into the production process, in addition to tracking and controlling the new resources, it is essential to accurately capture and control the capacity of production facilities. The means to achieve this is the construction of a comprehensive Cyber Physical System. Conversely, attempting to promote the establishment of logistics digital connectivity and a circular economy system without constructing a comprehensive Cyber Physical System is practically extremely difficult. It should be noted that the type of system whose construction is being advocated here is not a Cyber Physical System specialized for industrial use, but a comprehensive Cyber Physical System covering all areas of human activity within the targeted region.

The second challenge is to develop a methodology to drive new value creation in relation to a circular economy system, a new philosophy in the history of the modern civilization. To fully operate a circular economy system, new wisdom regarding the developmental strategy of productive (arterial) and circular (venous) industries integrated systems will be required. At present, to generate such new wisdom, it is necessary to systematically aggregate global knowledge in a de-centralized (democratic) manner. The approach to realize this can only be to establish a new methodology for driving value creation through an interoperability platform within a Cyber Physical System.

The third challenge is Digital Human Resource Development (d-HRD). To implement digital logistics systems in most of the Global South, it is necessary to have the required digital human resources in place across all regions. Furthermore, constructing Cyber Physical Systems will require highly skilled digital personnel in rural areas of the Global South. As outlined above, to practically promote the 'Building a Circular Economy System Covering Asia and Africa through Enhancement of Digital Logistics,' it is essential to focus on digital human resource development and the construction of Cyber Physical Systems, thereby driving the overall digital transformation (DX) of the social system.

Finally, I propose the concept of the "Special Epistemic Zones (SEZs)." Usually, SEZ refers to Special "Economic" Zones, but here it signifies "Epistemic" rather than "Economic". This approach considers local universities and research institutions fulfilling the following four functions as "Special Epistemic Zones," and drives the digitalization of the entire social system through their initiatives.

The first function is the construction of comprehensive Cyber Physical Systems. To build a circular economy system, it is necessary to digitize, visualize, and control all human activities in the target regions, not limited to the industrial and logistics sectors, but also including agriculture, commerce, governance, and culture. What is required for this is the construction of comprehensive Cyber Physical Systems.

The second function is d-HRD (Digital Human Resource Development). To extend the benefits of DX throughout the social system, a vast number of digital human resources are required in the region. The challenge is that this large-scale development must be accomplished in a short period of time. Universities are perfectly suited to serve such a function. Of course, universities are higher education institutions and are not institutions intended for secondary or vocational education. Nevertheless, it is entirely possible for higher education institutions to utilize their systems to provide secondary and vocational education, whereas the reverse is not feasible.

The third function is the command of digital logistics. This is a field where Cyber Physical Systems—relating not only to industrial and logistics sectors but also to the activities of a wide range of people in terms of demand forecasting—truly demonstrate their value.

The fourth function is the construction and management of a transcontinental circular economic system linking Asia and Africa. This cannot be considered without an information-sharing system covering the vast continental area, and it is essential to connect comprehensive Cyber Physical Systems developed in each region through a common platform.

In implementing the new developmental strategy, as described above, universities and research institutions in rural Africa are expected to appropriately perform these four functions. We would like to refer to these universities and research institutions engaging in such functions in rural Africa, not as Special Economic Zones, but as Special Epistemic Zones (SEZ), meaning "Special Wisdom Nodes."

Panel Presentation 1: Prof. Dr. Masahiro Nakamura, President and CEO, Lexer Research Inc.; Chairman of Green CPS Consortium; Professor, Tokyo City University.

Dr. Nakamura presented from a technical perspective supporting the practical foundations of DX and GX (Green Transformation). He stated that his company is advancing an integrated approach to "virtual manufacturing," "production optimization," and "environmental impact reduction," and is promoting social transformation = industrial structural transformation centered on Cyber Physical Systems and explained as follows.

First, he explained that the essence of DX is "value creation." It is not merely about efficiency; DX's essence lies in generating new value through the "semantic connection (contextual connection)" of data with data. He emphasized that the democratization of "experience and

wisdom," rather than superficial logical processing like generative AI, is important, and that the next stage of human civilization will be opened by this reorganization of knowledge.

Second, he explained the technical structure and philosophical significance of Cyber Physical Systems. While referring to Germany's Industry 4.0, he proposed a concept of a "cyber-physical system for the entire society" that goes beyond it. By mirroring the physical and digital worlds and performing data connections with meaning (semantics), he depicted a framework to systematize wisdom.

Third, he explained the path to knowledge aggregation beyond generative AI. The essence of human work lies in "wisdom beyond logic," and the key is how to incorporate areas that generative AI cannot reach into Cyber Physical Systems. To achieve this, he proposed the "Collective Wisdom Initiative" and mentioned that a knowledge infrastructure is being developed in collaboration with the University of Tokyo and others to database experts' tacit knowledge.

Fourth, he explained the applicability in Africa. He emphasized that with the latest technologies (IoT, 3D printing, drones, distributed power generation, etc.), it is possible to concretely implement a 'leapfrog' developmental strategy that launches local economies without waiting for conventional infrastructure development. In particular, he pointed out that distributed manufacturing technologies like 3D metal printing and micro gas turbines will foster new industries in distributed societies.

Panel Presentation 2: **Mr. Isao Wada**, Vice President, Isuzu East Africa

Mr. Wada reported on the realities of industrial base formation based on his experience in manufacturing and distribution on the ground in Africa. The factory, established in 1975 as a joint venture between GM and the Government of Kenya, became an Isuzu subsidiary in 2017 and has since developed into a hub for manufacturing, sales, and education in Africa, centered in Kenya. The Kenya plant primarily creates local employment through truck assembly. And they promote the development of local suppliers and operates in line with the "Buy Kenya, Build in Kenya" policy. In addition to manufacturing and sales, they emphasize post-sales maintenance, education, and human resource development. Service improvements through dialogue with local customers are being promoted. Looking toward 2030, they consider industrialization and transportation infrastructure development in African countries. In particular, they stated that technical education for the younger generation is key to future industrial development, and expanding hands-on training is important. Mr. Wada emphasized that Africa has the potential not merely as a market, but as a center for manufacturing and innovation, and explained the necessity for Japanese companies to demonstrate a stance of "creating growth together".

Q and A session:

During the Q&A session, the following question was raised from the audience:

"While I find the concept of SEZs centred around the operation of Cyber Physical Systems interesting, what is crucial is Africa's response. How do African policymakers view promoting developmental strategies in Africa where universities and research institutions take the initiative according to this concept?"

In response, **H.E. Mr. Patrick Dlamini**, delivered the opening speech and participated as a panellist in the second session, replied as follows:

"For Africa's sustainable development, it is essential to strengthen regional supply chains, promote intra-regional trade, and achieve international integration through digital logistics. I also believe it is important to utilize the continent's critical mineral resources within a circular value chain and to deepen industrial cooperation between Japan and Africa. To that end, the practical role of Cyber Physical Systems is extremely important. Furthermore, in Africa's future, youth education is a critical issue, and if we also consider women's empowerment, universities have a very significant role to play. From these perspectives, I find the concept of SEZs that assign important roles to African universities and research institutions extremely interesting, and we would like to continue examining this concept going forward."

(5) Closing Session Adoption of the “Musashino Reflection”

At the conclusion of the Forum, Prof. Hidetoshi Nishimura, Director of MIGA, proposed the outline of the “Musashino Reflection”. This outline was adopted unanimously by the participants.

III. TICAD 9 Thematic Seminar

(1) Summary

On 20 August 2025, MIGA held the "Seminar on Digital Supply Chains for Economic Growth in Africa" as an official thematic seminar of TICAD 9 at the TICAD 9 venue, Pacifico Yokohama. The seminar formally introduced the "Musashino Reflection," adopted on 19 August 2025, to Japanese and African policymakers and facilitated discussions on concrete methodologies for its implementation. Participants included H.E. Mr. Patrick Dlamini, CEO of the Public Investment Corporation (PIC) of South Africa; Dr. Patrick Ndzama Olomo, Acting Director of Department for Economic Development, Trade, Tourism, Industry and Minerals, Head Economic Policy & Sustainable Development, African Union; Prof. Fukunari Kimura, President of Institute of Developing Economies, Japan External Trade Organization (IDE-JETRO).

(2) Introduction of the “Musashino Reflection”

Prof. Hidetoshi Nishimura, Director of MIGA, introduced that the “Musashino Reflection” has been adopted unanimously in previous day of 19 August 2025, at ‘Musashino University International Forum: Japan-Africa Cooperation on Sustainable Economic Development - Building a Circular Economy by Strengthening Digital Logistics’. He also explained the outline of the “Musashino Reflection”.

- (3) Opening Remarks: **H.E. Mr. Patrick Dlamini**, CEO, the Public Investment Corporation (PIC) of South Africa

H.E. Mr. Mr. Patrick Dlamini emphasized that building digital supply chains and circular economies are essential themes for Africa's sustainable development. He stressed the importance of supply chain digitalization and creating employment opportunities for young people. He also stated that TICAD 9 presents an excellent opportunity for the business communities of Africa and Japan to promote meaningful cooperation. PIC, in collaboration with JICA and JETRO, can support African entrepreneurs in accessing capital and realizing their dreams of creating jobs.

- (4) Keynote Presentation: **Prof. Mitsuhiro Maeda**, Visiting Professor, Musashino University

Prof. Mitsuhiro Maeda presented specific implementation methods for "Building a Circular Economy Supply Chain through Enhancement of Digital Logistics." He identified four key challenges: the "Global Digital Human Resource Development (d-HRD) Connectivity," the "Global Cyber Physical Systems Connectivity," "Global Digital Logistics Connectivity," and the "Global Circular Economy Connectivity." He proposed a new concept, the "Special Epistemic Zones (SEZs)," positioning universities and research institutions in the Global South as "Special Wisdom Nodes." He explained that the developmental strategy through SEZs represents a typical "leapfrog-type" developmental strategy.

- (5) Keynote Presentation: **Dr. Patric Ndzana Olomo**, Director of Economic Development, Integration and Trade, Head of Economic Policy and Sustainable Development, Development for Economic Development, Trade, Tourism, Industry and Minerals of the African Union Commission.

Dr. Patric Ndzana Olomo explained the current state and challenges facing the African economy. He cited the establishment of the African Continental Free Trade Area (AfCFTA), digital transformation (DX), greenfield investment, and economic resilience as future challenges. He further emphasized the importance of a "leapfrog" developmental strategy and expressed his expectations for cooperation with Japan, calling for cooperation to move the Special Epistemic Zones (SEZ) concept from the conceptual stage to concrete implementation.

- (6) Presentation: **Dr. Masamu Kamaga**, President, Global Digital Human Resource Development (d-HRD) Connectivity

Dr. Masamu Kamaga Connectivity pointed out the "industry-academia gap" based on his educational experience in Cambodia, where the traditional education system is unable to respond to the rapidly changing technology of modern business. He introduced a new approach to digital human resource development in the Global South to overcome this challenge.

- (7) Presentation: **Prof. Dr. Masahiro Nakamura**, President and CEO, Lexer Research Inc.; Chairman, Green CPS Consortium; Professor, Tokyo City University.

Dr. Masahiro Nakamura emphasized the importance of integrating the latest digital technologies with Japan's experience and wisdom in Africa's new industrial infrastructure development strategy. He highlighted the significance of the SEZ (Special Epistemic Zones) approach as a "leapfrog" developmental strategy, promoting digitalization starting with the latest digital technologies even before manufacturing foundations are fully developed.

- (8) Presentations: **Ms. Maika Watanuki**, Senior Consultant, NX Logistics Research Institute and Consulting Inc. and **Mr. Ikumo Isono**, Director, the Economic Integration Studies Group, Institute of Developing Economies, Japan External Trade Organization (IDE-JETRO).

They stated that integrating digital solutions into logistics and circular economy processes enables the construction of more sustainable and efficient global supply chains. They reported simulation analysis results using the IDE-GSM model. They compared the effectiveness of traditional infrastructure-centric strategies versus "leapfrog" developmental strategies utilizing digital technology in African economic corridor development, demonstrating that the latter generates economic impact comparable to or exceeding the former.

- (9) Panel Comments: **H.E. Mr. Patrick Dlamini**, CEO, the Public Investment Corporation (PIC) of South Africa.

H.E. Patrick Dlamini emphasized the potential of a partnership between the African continent and the Japanese economy, highlighting the importance of engaging youth and advancing the African Continental Free Trade Area (AfCFTA).

- (10) Panel Comments: **Prof. Fukunari Kimura**, President, Institute of Developing Economies, Japan External Trade Organization (IDE-JETRO).

Prof. Fukunari Kimura pointed out that while the stable preconditions seen in East Asia have long been absent in Africa, digitalization has the potential to fundamentally change the situation. He stressed that digital technology alone is insufficient for merely enhancing efficiency, emphasizing the necessity of creating added value and fostering core industries.

IV. "Musashino Reflection"

Proposal 1. Set circular material transition targets and key performance indicators (KPIs) to promote circular product design and related services.

(Commentary)

Focusing on plastic waste spurred innovation globally. However, clarity on other materials, especially in trade flows, is lacking. Emphasis should be on easily processed mass-consumption materials. Material disclosure mechanisms are crucial for transparency in hazardous chemical use. While EU regulations like REACH and CLP advance disclosure, implementation costs for safer substitutes risk setbacks, especially for SMEs. Lack of enforcement and reliable information sharing risks a chemical safety divide.

Eco-labelling for material efficiency should link to material passport databases to identify mixes and track reuse. Despite high material circularity in emerging industrial countries, there's no mechanism to valorise its GDP contribution. Redesigning global companies' production-consumption based on integrated manufacturing and recycling and waste management is vital. Global collaboration on material efficiency cannot be limited to high-level discourse. G20 countries need a comprehensive approach, including KPIs, to influence behaviour from producer to consumer. Interventions should align with digital divide reduction investments and research infrastructure improvements. Linking economic valuations to efficient material flows can yield significant trade benefits with targeted transition strategies.

Proposal 2. Identify specific measures and promote cooperation so that trade and investment policies support circular supply chains. Improve logistics that presuppose resource circulation through measures such as promoting FTAs and utilizing digital technologies like RFID.

(Commentary)

Trade is crucial for efficient circular supply chains, promoting access to goods, services, and technologies, and creating economic opportunities. Governments must collaborate to prevent illegal or under-regulated trade in waste. Challenges include distinguishing reusable materials from waste, diverse national regulations, and trade-distorting measures.

A reliable, transparent policy environment is needed to encourage long-term circular supply chain investments from global firms and Global South (GS) suppliers. WTO members increasingly focus on circular supply chains, discussing waste/chemical management, EPR, recycling, and e-waste support for developing countries. Circular economy issues are priorities in WTO initiatives like TESSD and IDP. Developing the circular economy industry can attract investment to GS suppliers and integrate them with manufacturing industries as "quality recycled materials" providers.

G20 should lead the WTO in enhancing transparency through policy dialogues on trade and circular supply chains. This includes identifying actions and fostering collaboration. WTO deliverables could include circular economy considerations in environmental goods and services negotiations. Full digital technology use is also crucial. The G20 should use CTE, TESSD, and IDP to share experiences and find solutions to enhance trade and investment policy supportiveness.

Proposal 3. Strengthen financing for the circular economy by establishing innovative financing mechanisms, such as Security Token Offerings (STO) via blockchain, centered on blended finance (a combination of public, private, and philanthropic funds).

(Commentary)

Circular finance lacks harmonized frameworks, taxonomies, and metrics. While financial institutions slowly advance solutions, some setting multi-billion-dollar targets, circular economy funding remains low compared to the linear economy. Current investment is insufficient for large-scale transition. COVID-19 recovery packages offer a chance to promote a low-carbon circular economy, though they primarily supported resource-intensive systems previously.

For mainstreaming circular finance in advanced economies, "just transition" must be internalized in investments. This track impacts on winners and losers, ensuring equal access to opportunities from global circular value chains. Beyond traditional development finance, we propose including all societal stakeholders.

G20 should consider blended finance, combining public, private, and philanthropic capital for challenging infrastructure and riskier innovations. Policymakers should offer economic incentives and fiscal interventions: taxes on virgin plastics and raw material extraction, VAT reductions for reuse/repair, shifting tax burdens, and changes in depreciation for circular products. Circular economy finance can be de-risked by making it "opt-out" through policies and standards, nudging banks towards sustainable investments. G20 countries should collaborate to establish a new development finance ecosystem using blockchain technology (e.g., STO systems) to facilitate stakeholder entry.

Proposal 4. Develop ESG indicators to evaluate corporate performance based on circularity principles and use them as criteria when funding agencies allocate capital in accordance with their missions.

(Commentary)

Sustainable finance investors increasingly use ESG Rating Providers (ERPs) to assess companies' commitment to climate change mitigation using circularity principles. ERPs evaluate investment opportunities and risks, linking them to finance access and cost. With 85% of institutional investors committed to ESG, G20 countries must develop a consensus-led multilateral framework for ESG ratings. Methodologies, which determine rating scores, vary among ERPs and can be ambiguous or inconsistently applied. Taxonomy defines circularity mechanisms and includes products, components, and lifecycle stages. ERP taxonomy also varies widely across sectors, policies, and geographies.

ESG ratings often use broad metrics that don't automatically imply integrated circularity in global supply chains. Large companies operate across multiple geographies, with products part of various interconnected value chains. Companies often claim high ESG ratings based on final assembly, even if components are externally manufactured in low-rated value chains. Companies need unified multinational ESG ratings, fairly accounting for end-to-end product lines. ESG rating developers and auditors are often ill-equipped for detailed checks, leading to inaccuracies or manipulation.

Governments are addressing this; India's market regulator proposed ERPs have specialists in data analytics, sustainability, finance, infotech, and law. ASEAN developed a Sustainable Finance Taxonomy. Developed countries primarily defining ESG ratings risks their dominance in developing countries' sustainable finance options. ESG rating inequities also hinder multinational circular value chain harmonization. G20 countries must invest in building an equitable ESG rating system with unified scoring methodologies and taxonomies, considering each member's unique context. They also need to build globally accepted auditing and reporting mechanisms and work towards a common taxonomy for circular investments. This multilateral ESG rating system should include circularity principles to minimize climate impact and maximize resource efficiency.

Proposal 5. Promote the transition to region-based circular economies by shortening value chains using local resources, reducing emissions, strengthening local economies, and maximizing long-term value creation by allowing diverse pathways in transitions and value creation within local communities.

(Commentary)

A localized, decentralized circular economy transition encourages regions, SMEs, and social entrepreneurs to utilize local resources. This shortens value chains, reduces emissions, boosts local economies, and increases long-term sustainability. A decentralized approach, including renewable energy, helps local areas increase self-reliance. Due to diverse local resources, this transition allows for path diversity.

The COVID-19 crisis highlighted the need for resilient production-consumption systems fostering sustainability and circularity, involving local infrastructure and actors. The combination of crises and opportunities from the pandemic, decarbonization, and circular economy underscored the importance of equity, safety, welfare, health, education, and public services at the local level. While recent international agreements set ambitious sustainability goals, the societal outcome is unclear. The challenge is balancing local circular economy transition with embedded circularity in supply chains.

Supply chain risk assessment typically focuses on normative guidelines, with limited exploration into resilience and circular economy linkages. A regional circular economy transition offers regions a chance to demonstrate creativity in development strategies. While regional creativity emerged previously, it didn't form a national movement. Japan's "Regional Circulating and Ecological Sphere" is a decentralized system to optimize carbon/material circulation and efficiently reduce waste.

G20 should build local governments' capacity as facilitators, forming decentralized loops for materials, finance, and people. Investing in social entrepreneurship and promoting public/private investment for adapted model cases can enhance the transition. To close circularity gaps, global value chains should introduce sustainability criteria, standards, and KPIs, especially where sustainability is scarce. By linking digital opportunities to localized value chains, G20 countries can encourage socio-technical innovation fostering new business models and lifestyles.

Proposal 6. Develop open digital platforms to ensure digital connectivity for product and component traceability across national, regional, and continental circular value chains, supported by global EPR standards and other economic incentive mechanisms, to make the transition to a circular economy fair, inclusive, and fully optimized for global sustainability.

(Commentary)

G20 countries should support less developed nations in infrastructure development, education, and skill development to strengthen domestic and international connectivity, building a foundation for manufacturing industries. Building Special Epistemic Zones (SEZ), a new type of wisdom agglomeration, might be a tangible milestone to meet the above requirements. Concurrently, they can foster circular (venous) industry encouraging producers to design disassemble products. The G20, collaborating with GS, can establish circular economy principles-based criteria for a just transition, engaging all relevant actors to close the loop by connecting productive (arterial) industry and circular (venous) industry, and reverse logistics processes.

A circular economy will be achieved by improving efficiency across manufacturing industries and recycling and waste management using tools like Kaizen, lean production, robotics, ICTs, and AI. For the GS to realize its full potential, an open digital platform is crucial for supporting dynamic optimization of circular value chains based on economic changes. Integrating circular product design, financial incentives, and circular logistics into a digital platform allows circular value chains to create new added value and become sustainable. Digitalization is essential for managing path diversity. This will promote circular economy industries and initiate leapfrog industrial development in GS countries through "high-quality recycled materials" production, a leapfrog of industrial development in GS will be initiated.

In 2017, global material consumption exceeded 100 billion tons annually. 90% of these resources were exported by GS countries for their own consumption but often used by Global North economies. Despite vast production networks supplying multinational companies, investment in "end of use" infrastructure for products sold globally is limited, especially in developing countries with nascent manufacturing, remanufacturing, recycling, and recovery capabilities. This can be overcome by creating a global EPR system to enhance capabilities in developing countries, contributing to a just transition.

Multinational companies in G20 must include supply chain constraints for circular material flow from final destinations to factories in their decisions. The scarcity of facilities at destinations must influence product design, involving supply chain actors for global collaboration on material efficiency. Producers must design circular processes throughout reverse logistics, including local actors in the GS. They can incentivize circularity by facilitating material recovery systems. G20 countries can formulate practical product recovery guidelines and collection systems in the GS by encouraging remanufacturing, refurbishing, and repair. Thus, G20 countries should create favourable conditions for a global EPR standard between developed and developing countries.

Beyond field-level Kaizen, optimizing business processes to eliminate "waste of time and processes" is crucial. Overcoming information sharing challenges among stakeholders (government, industry, public) in the GS is key. Promoting new systems using modern digital technology like blockchain is essential to address this.

Proposal 7. Propose new industrial location policies (Special Epistemic Zone, not special economic zone) that make full use of digital technologies to realize leapfrogging in Africa.

(Commentary)

It is necessary to address the three challenges specific to the construction of a circular economy system. The first challenge is the construction of Cyber Physical Systems, the second challenge is the development of methodologies to promote new value creation related to the circular economy (interoperability platforms for Cyber Physical Systems), and the third challenge is the cultivation of digital talent.

Establishing a circular economy system fundamentally requires manufacturing technologies that connect the accumulating manufacturing industries with the recycling and waste management. The basic approach is to accelerate the economic system within the scope enabled by the advancement of the elemental manufacturing and processing technologies that underpin the circular economy system. For example, in the automotive industry, the used car market necessitates the existence of manufacturing-related elemental technologies that realize the circular economy. Therefore, it is advisable to advance the development of the circular economy system starting from such business models.

In addition to these, the unique challenges of adopting a "leapfrog-type" developmental strategy include the accumulation of human capital and social capital through the promotion of digital education targeting a wide range of society, and the promotion of the penetration of modern institutions into the country and society.

The first challenge is the promotion of small and medium-sized enterprises utilizing digital technology (labour-intensive IT industry promotion). The second challenge is advancement of the regional economy through promotion of large-scale corporate organization in IT industry (so-called "heavy and chemical industry" transformation of digital services), and the third challenge is the renewal of existing manufacturing industries and their participation in supply chains in order to fully enjoy the fruits of DX.

It is expected that universities and research institutions in the local regions of the Global South countries will play a particularly important role in enabling these regions to appropriately address the aforementioned challenges. Universities and research institutions possess the necessary capabilities to address the aforementioned challenges effectively. First, universities and research institutions with engineering and information science departments are well-positioned to advance the development of Cyber Physical Systems and interoperability platforms for such systems in the local regions of the Global South countries. Regarding digital human resource development, universities can provide secondary education-level education programs separately from regular higher education. Regarding the challenge of promoting the penetration of modern systems into countries and societies, in the regional areas of the Global South countries, universities often have close ties with local governments, and their policy recommendations are not unlikely to be adopted by local governments. Therefore, it is reasonable to place sufficient expectations on universities in this regard.

When promoting a "leapfrog-type" developmental strategy, universities are strongly required to go beyond their role as higher education institutions, and research institutions are required to go beyond their role as institutions that carry out research on assigned tasks, in order to address the above issues.

A "leapfrog-type" developmental strategy is one that prioritizes the development of knowledge-intensive industries from the outset, rather than following the traditional sequence of labor-intensive manufacturing, and thus advances both labour-intensive industry and knowledge-intensive industry, capital-intensive manufacturing, and then knowledge-intensive industries. Naturally, this strategy places significant demands on the level of intellectual activity. In the regional areas of the Global South countries, there are no institutions other than universities and research institutions that can demonstrate such a high level of intellectual activity.

Thus, universities and research institutions that go beyond their originally assigned roles of implementing higher education and conducting research to contribute to the implementation of leapfrog-type developmental strategies in the regional areas of the Global South countries are required to undertake new tasks related to "wisdom" that transcend the conventional concepts of physical capital and human capital (as industrial human resources), and connect humans and the world in civilization.

From this, we believe that universities/research institutions that are serving roles in promoting "leapfrog-type" developmental strategies in regional areas of the Global South countries would be called "SEZ (Special Epistemic Zone)".

Furthermore, unlike the conventional industrialization model of advanced nations—which followed a phased process of first the power revolution, then the production system revolution, and finally the automation revolution—the leapfrog development strategy emerging in the Global South centres on cutting-edge digital technologies like Cyber Physical Systems. This approach promotes digitalization before manufacturing foundations are fully developed. By utilizing new technologies such as drone delivery, an industrial structure that does not require a parts manufacturing industry driven by 3D metal printers, a distributed power grid network using small gas turbine power generation. This approach is expected to enable the realization of a decentralized economy that does not rely on traditional, centralized infrastructure.

Proposal 8. Create systems that integrate cyber and physical domains, achieve concrete knowledge integration, link industrial domains, and generate new value.

(Commentary)

Since the first industrial revolution, which is said to have begun in the mid-18th century, industrialization has been understood as consisting of three types of human activities: production, logistics, and consumption. After consumption, waste (garbage) is generated, which is considered economically worthless because it must be disposed of at a cost and cannot be reused in new production activities. Furthermore, since disposal incurs costs, it is regarded as having negative value.

On the other hand, a circular economy system involves reintegrating waste (garbage) generated as a result of the three types of human activities—production, logistics, and consumption—into the supply chain as resources for new production. This requires a fundamentally different philosophy from the traditional industrialization paradigm. To implement such a new system in society, it is necessary to construct a fundamentally different way of thinking from the traditional notion that the three types of human activities unfold sequentially and that industrialization comes to an end with the end of consumption. In particular, since waste (garbage) becomes a resource

for new production activities and is incorporated into the supply chain, it must be recognized as having positive value, and a new supply chain system must be constructed based on this premise.

In other words, to fully operationalize a circular economy system, it is insufficient to merely revise certain aspects of traditional industrialization concepts or add new factors partially. Instead, it is necessary to comprehensively evolve the concept of industrialization within the modern civilization and develop new wisdom regarding the nature of an artery-vein integrated developmental strategy. Based on the various research findings currently being made on methods for "creating wisdom," it is considered necessary to systematically aggregate the wisdom of the entire world in a decentralized (democratic) manner in order to generate such new wisdom.

Furthermore, the wisdom referred to here involves conceptualizing, designing, and verifying the feasibility of how this technology—based on the foundational elemental manufacturing and processing techniques for integrating arteries and veins—can be incorporated into existing industrial systems to realize a circular economy system that generates new value.

The only feasible method for achieving this is to establish a new methodology for promoting value creation through an interoperability platform for Cyber Physical Systems. In other words, the construction of Cyber Physical Systems also serves as an indispensable intellectual infrastructure for value creation to address entirely new challenges in the industrialization of the modern civilization, such as the construction of a circular economy system.

Proposal 9. Utilize digital technologies to realize the development of Africa's circular economy through collaboration between manufacturing industries and recycling and waste management.

(Commentary)

It can be said that to practically advance the construction of a circular economy system through the enhancement of logistics digital connectivity in each industrial sector, it is necessary to address the following three major challenges.

The first challenge is to establish a comprehensive cyber-physical system in the target region.

Digital connectivity for corporate activities requires, as a prerequisite, the ability to fully complement information regarding each company's action plans and the current location and status of materials. Based on this, control measures necessary for efficient coordination of corporate activities must be implemented. In other words, an adaptive control system enabling the complete digital complementation and control of each company's activity plans is required, and this can be achieved through a comprehensive cyber-physical system.

Furthermore, in the construction of a circular economy system, it is necessary to digitally track and control all resources that have the potential to be recycled, beyond the scope of resources traditionally considered as inputs for production activities. This includes many items that were previously regarded as waste (garbage). Additionally, to reintroduce these new "resources" into the production process, it is essential that the tracking and control of these new "resources" are complemented by accurate tracking and control of the capabilities of production facilities. Furthermore, to appropriately predict the generation and availability of new "resources" in the near future, it is necessary to grasp extensive information beyond industrial fields, including information related to people's daily lives.

In other words, it will be necessary to grasp and control comprehensive information not only about industrial and logistics fields but also about people's lives in general within the target region, and the means to achieve this will be the construction of a comprehensive cyber-physical system. The greatest challenge in promoting the practical implementation of a circular economy system through the enhancement of logistics digital connectivity is the construction of a comprehensive cyber-physical system in the target area.

It is important to note that the necessity of construction being emphasized here is not for Cyber Physical Systems specialized for industrial use, but rather for comprehensive Cyber Physical Systems.

The concept of Cyber Physical Systems was first proposed by Germany in the 2010s as part of its Industrie 4.0 initiative. Since then, Germany has introduced RAMI 4.0, a data architecture framework, and GAIA-X, a conceptual model for industry, and is advancing the development of data integration systems such as CATENA-X for the automotive industry.

In contrast, we argue for the construction of a comprehensive cyber-physical system that encompasses all human actions within the scope of the target area, not limited to the industrial or logistics fields. This is because human behaviour not only directly triggers economic movements as consumption behaviour but also forms the foundation for the creation of new value required for the construction of a circular economy system. Here, we will distinguish between specific-purpose Cyber Physical Systems, such as GAIA-X and CATENA-X, which are tailored to specific industries, and the comprehensive Cyber Physical Systems described in this study, which we refer to as general-purpose Cyber Physical Systems.

Proposal 10. Strengthen circular supply chains by utilizing digital transformation (DX) and green transformation (GX), which enables connectivity to deepen between Asia and Africa as trusted partners.

(Commentary)

The challenge lies in building new, resilient circular supply chains that are environmentally sound and span both Asia and Africa in the context of the circular economy. Such new supply chains can only be constructed by fully leveraging the achievements of cutting-edge digital transformation (DX). This DX would bring about improvement in supply chain visibility and in efficiency of business processes of trade and logistics.

Digital connectivity in logistics requires cargo visibility as a prerequisite, which is the ability to completely supplement information on the current location and status of cargos to transport. Based on this visibility, it is possible to make trade procedures and control facilitated, and corresponding business processes can be simplified. In addition, visualized various logistics data can contribute to consider the best transport mode as well as efficient bidirectional logistics (such as container round use) to reduce GHG emissions.

Digitalization in the logistics industry is evolving from mere data conversion (digitization) to the streamlining of entire business processes (digitalization). This evolution would enable customs procedures to automate with a system like “non-stop single window” utilizing RFID and data sharing platforms, which would result in reducing lead times and reduction of unnecessary inventory, and enhanced supply chain reliability. Furthermore, achieving a circular economy

requires both forward logistics and reverse logistics to be facilitated to support for circulating products and materials. For example, in the lithium-ion battery sector, it would be crucial that end-to-end traceability covers all lifecycles from sales, collection, reuse, to disposal based on Extended Producer Responsibility (EPR) domestically to international trade.

Proposal 11. Build digital infrastructure that can replicate the entrepreneurial ripple effect traditionally sparked by road development—where new or improved roads inspire people to start businesses and success stories encourage others to follow. Digital policies should go beyond connectivity and include platforms that stimulate entrepreneurship and promote the sharing of success stories to inspire wider participation.

(Commentary)

Using simulation analysis with the IDE-GSM model, we compare the effectiveness of the conventional infrastructure-centric strategy (traditional model) and the “leapfrog” strategy (leapfrog model), which leverages digital technology in the development of Africa’s economic corridors. The IDE-GSM model is a spatial general equilibrium model employed by institutions such as the World Bank and the Asian Development Bank (ADB), allowing for detailed simulation of the impacts of infrastructure development and trade facilitation on regional economies.

The traditional model prioritises physical infrastructure such as roads and industrial parks, whereas the leapfrog model deliberately excludes road construction and instead emphasises digital connectivity, border facilitation, and human capital development through “Special Epistemic Zones.”

Simulation results indicate that the leapfrog model generates economic impacts comparable to those of the traditional model. However, this outcome is based on the assumption that digital technology can adequately substitute not only the time-saving benefits of roads, but also their ability to trigger what we call an entrepreneurial ripple effect—where the construction or improvement of roads inspires individuals to start new businesses, and successful cases further motivate others in the community to follow suit. In fact, the model analysis reveals that the greatest barrier to international trade is not tariffs or transport costs, but rather “a lack of motivation to operate internationally.”

This highlights the importance of human capital development and investment in young people through digital means, suggesting that “leapfrog development is not a compromise on infrastructure, but a strategic choice.”

(※ From Proposal 1 to Proposal 6 quote Anbumozhi, V., H. Nishimura, P. Gopal, A. C. Castro, and S. Prabakar. (2025). *Embedding Circularity in Global Trade: A G20 Road Map for Catalysing Circular Value Chains*. T20 Policy Brief.)

V. The Results of the “Musashino Reflection,” TICAD 9 “Yokohama Declaration” and African side’s statements

The “Musashino Reflection” adopted at Musashino University International Forum on 19 August 2025, presented a vision for a circular economy and digital connectivity as a “leapfrog-type” developmental strategy. This vision directly resonates with the Yokohama Declaration adopted on 22 August 2025, and the statements made by the African side during TICAD 9.

The principles upheld by the ‘Musashino Reflection’ are, first, that in the 21st century, the Global South will take the lead in constructing a new philosophy of modern civilization, using the establishment of a circular economy covering the continents of Asia and Africa as a catalyst. Second, it aims to build a new world system significantly different from that of the mid-20th century through the construction of this new philosophy and the promotion of a new developmental strategy based upon it. This new philosophy, originating in the Global South and the concept of a new world system, deeply resonates with the “Yokohama Declaration” and the vision presented by South African President, H.E. Cyril Ramaphosa, at TICAD 9 (August 21, 2025, Yokohama). Furthermore, they are deeply related to the basic theme of the 2025 G20 South Africa Summit: “Solidarity, Equality, Sustainability.”

At the TICAD 9 plenary session, President of South Africa, H.E. Cyril Ramaphosa, the host country of the 2025 G20 summit, presented a developmental strategy based on regional integration, industrial platforms, and the green economy. Furthermore, at the South Africa-Japan Business Forum, he called for “integrated supply chains within strategic sectors, such as battery minerals, automotive components, renewable energy equipment and hydrogen technologies.” These initiatives are based on the concept of promoting the African Continental Free Trade Area (AfCFTA) as a breakthrough to make the African continent a leader in new developmental strategies based on the new philosophy. This resonates with the “Musashino Reflection” philosophy, which seeks to build a new path of modernization based on diversity and evolution, with the circular economy as its fundamental concept.

If, grounded in broad solidarity within the Global South, South Africa becomes an industrial platform and the construction of a circular economy on the African continent leads to the pioneering development of a new sustainable civilization ahead of other regions on Earth, this would bring about an unprecedented world system. This would herald the emergence of a new solidarity within the Global South, grounded in the principle of equality. With this solidarity at its core, global development would advance, leading to the construction of a world system fundamentally different from the traditional relationship between developed and developing nations.

From this perspective, a clause-by-clause examination of the ‘Musashino Reflection’ and the ‘Yokohama Declaration’ and the African side’s statement reveals shared following key principles:

First, connectivity in transport and logistics.

Second, digital transformation.

Third, trade facilitation, digital trade, and value chains; and

Fourth, waste management and the circular economy.

The following confirms this using actual documents of the ‘Yokohama Declaration’.

First, on the principle of Connectivity in Transport and Logistics

[Yokohama Declaration 3.1.1] states “We aim to accelerate efforts to develop value-chains addition in Africa and integrate African countries into global supply chains through a free, open, and fair trade and investment environment, so as to be able to secure a fair share in the growth of world trade and investment commensurate with the needs of their economic development. “, and “Building on the accomplishments of the Eighth Tokyo International Conference on African Development (TICAD 8), we will continue to promote regional integration and connectivity through the African Continental Free Trade Area (AfCFTA). We also stress the importance of connectivity with other regions such as the Indo-Pacific region. We take good note of the initiative of a Free and Open Indo-Pacific as announced by Japan at TICAD 6 in Nairobi, Kenya. We acknowledge Japan’s contribution in the past years to enhance connectivity, resilient institutions and human resources development in Africa. The strategic significance of Africa continues to grow, driven by the continent’s remarkable demographic expansion and dynamic market potential.”

H.E. Selma Malika Haddadi, Vice Commissioner of African Union Commission, stated in the TICAD 9 Ministerial Meeting Opening Remarks (19 August 2025), as “...strategic investments in critical infrastructure... resilient health systems and social stability...” (source: African Union Commission, Opening Remarks by H.E. Selma Malika Haddadi, TICAD9 Ministerial Opening, 19 August 2025) https://au.int/sites/default/files/speeches/45215-sp-Opening_Remarks_DCP.pdf).

President of South Africa, H.E. Cyril Ramaphosa stated in his Remarks to the Plenary Session 2 on the Economy at the TICAD 9 on 21 August 2025, as “South Africa is making progress in enabling our economy to participate in the rapidly changing global environment. We have stabilised our energy supply and are modernising our infrastructure. We are opening our ports and rail to private sector investment.” (source: The Presidency of South Africa: <https://dirco.gov.za/president-cyril-ramaphosa-remarks-to-the-plenary-session-2-on-the-economy-at-the-tokyo-international-conference-on-african-development-summit-21-august-2025/>).

Second, on the principle of Digital Transformation

[Yokohama Declaration 3.1.2] states as “We also recognize the importance of ethical and responsible utilization of data as a foundational element of digital transformation, including facilitating cross border data flows based on regional frameworks such as the AU Data Policy Framework and Data Free Flow with Trust (DFFT), while making data available to drive innovation and ensuring protection of privacy and human rights in the digital space. We reaffirm that effective and responsible utilization of digital technology, including AI, satellite data, and clean energy as well as the adoption of good practices could facilitate the co-creation of innovative solutions to the challenges facing Africa and the world. Increased collaboration with the private sector is essential for catalysing transformative and sustainable solutions.” and “We encourage expanded cooperation in digital infrastructure and innovation ecosystems to accelerate Africa’s digital transformation. Japan’s expertise in robotics, AI, and smart cities can play a pivotal role in building resilient African economies. We encourage joint Africa-Japan initiatives to support AI development including the promotion of hubs for innovation to nurture startups, promote digital skills, and facilitate technology transfer on mutually agreed terms, across the continent.”.

Third, on the principle of Trade Facilitation, Digital Trade, Value Chains

[Yokohama Declaration 3.1.3] states as “In this regard, we underline the importance of supporting key initiatives that will improve intra-Africa transport connectivity, including the full operationalization of the Single African Air Transport Market (SAATM). We also recognize the importance of air transport connectivity between Africa and Japan and stronger air connectivity, as well as enhanced cooperation and strategic partnerships in the future, the implementation of the African Integrated Railway Network (AIRN), establishment of multimodal and smart corridors, accelerating the implementation of the Trans-African Highway links and work to support improvement of ports and shipping industry.”.

[Yokohama Declaration 3.1.9] states as “As a premise of these efforts and initiatives, trade facilitation, especially simplified and harmonized customs procedures, is essential in developing and promoting intra-Africa trade. We recognize that enhanced trade and increased investments between Africa, Japan, and the rest of the world, both traditional and high end would contribute greatly to this regard.” and “We also recognize the importance of attracting investment from the private sector and sharing innovative solutions, knowledge, and technology within Africa. In this regard, we are committed to co-creating and promoting a conducive business environment and accelerate inclusive industrialization. We recognize the importance of the WTO moratorium on customs duties on electronic transmissions for member countries and underscore the need for expanding digital trade between Africa and Japan through training programs for African SMEs in e-commerce standards and integration with Japan’s digital retail platforms.”.

President of South Africa, H.E. Cyril Ramaphosa stated in his Remarks to the Plenary Session 2 on the Economy at the TICAD 9 on 21 August 2025, as “South Africa seeks to deepen intra-African trade while becoming a continental industrial platform from which Japanese and other global firms can export into Africa. We are actively working with the AfCFTA Secretariat to finalise value-chain protocols in automotive, agro-processing, pharmaceuticals and textiles. We support Rules of Origin harmonisation to encourage manufacturing in Africa and the upgrading of border infrastructure to enable faster movement of goods.” (source: The Presidency of South Africa: <https://dirco.gov.za/president-cyril-ramaphosa-remarks-to-the-plenary-session-2-on-the-economy-at-the-tokyo-international-conference-on-african-development-summit-21-august-2025/>).

Also President of South Africa, H.E. Cyril Ramaphosa, stated in the South Africa-Japan Business Forum on the margins of the TICAD 9 on 21 August 2025, as ” There are immense opportunities for South Africa and Japan to collaborate on integrated supply chains within strategic sectors, such as battery minerals, automotive components, renewable energy equipment and hydrogen technologies.”.(source: The Presidency of South Africa: <https://dirco.gov.za/address-by-president-cyril-ramaphosa-to-the-south-africa-japan-business-forum-on-the-margins-of-the-tokyo-international-conference-on-african-development-summit-yokohama-japan-21-august-2025/>).

Fourth, on the principle of Waste Management and the Circular Economy

[Yokohama Declaration 3.2.5] states as “We emphasize the urgency of reducing marine pollution, promoting biodiversity conservation, and implementing effective waste management, including through the newly established fund for promoting the development of waste management infrastructure with international donors under the African Clean Cities Platform (ACCP) in order

to protect Africa's natural ecosystems and advance the continent's sustainable development and environmental security.”.

President of South Africa, H.E. Cyril Ramaphosa stated in his Remarks to the Plenary Session 2 on the Economy at the TICAD 9 on 22 August 2025, as “We are incentivising electric vehicles and battery production and supporting green hydrogen value chains through infrastructure and skills investment.” (source: The Presidency of South Africa: <https://dirco.gov.za/president-cyril-ramaphosa-remarks-to-the-plenary-session-2-on-the-economy-at-the-tokyo-international-conference-on-african-development-summit-21-august-2025/>).

Also, President of South Africa, Cyril Ramaphosa, stated in the South Africa-Japan Business Forum on the margins of the TICAD 9 on 21 August 2025, as “South Africa is one of the most cost-effective hydrogen producers globally. We have introduced policies to promote the development of the electric vehicle industry in South Africa. We invite co-investment on manganese, vanadium, platinum group metals and rare earths beneficiation aimed at the clean energy and mobility markets.” (source: The Presidency of South Africa: <https://dirco.gov.za/address-by-president-cyril-ramaphosa-to-the-south-africa-japan-business-forum-on-the-margins-of-the-tokyo-international-conference-on-african-development-summit-yokohama-japan-21-august-2025/>).

Based on the above, it can be concluded that the ‘Musashino Reflection,’ the TICAD 9 Yokohama Declaration, and the African side's statement share the following key principles: First, connectivity in transportation and logistics; Second, digital transformation; Third, trade facilitation, digital trade, and value chains; and fourth, waste management and the circular economy.

Musashino Reflection

A Collection of Strategic Policy Recommendations

Chapter 1

Overview

Chapter 1: Overview for Digital Logistics/Circular Economy in the Global South

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1. Introduction

Musashino Institute for Global Affairs (MIGA) and NX Logistics Research Institute and Consulting, Inc. are collaborating on the "Master Plan Development Project for Enhancement of Logistics Digital Connectivity in the African Region to Facilitate Resource Circulation." The primary theme of this project is to establish a circular economy system through enhancement of logistics digital connectivity, with the following objectives:

【Objective 1】 Present policy proposals to contribute to the construction of a circular economy within the Asia-Africa region and to enhance economic security in both regions.

【Objective 2】 To propose concrete policies from a logistics perspective to solidify the "circular supply chain" between Asia and Africa by leveraging digital technology to promote the entry of private-sector companies.

This research project aims to develop a master plan that incorporates resource circulation formation and the enhancement of logistics digital connectivity in the African region. The master plan consists of two major pillars representing different perspectives.

I. Circular Economy Policy

Achieve the construction of a circular economy in Africa and Asia and contribute to economic security.

Contribute to the formulation of policies that allow African countries to make autonomous decisions and implement measures in the context of international resource circulation.

Propose measures to enhance the efficient use of strategic resources through the establishment of a circular economy and to support the expansion of Japanese companies.

II. Strengthening the Supply Chains of Private Companies

Propose measures to promote the supply chain and logistics sector between Asia and Africa.

Trade is becoming more active from Japanese companies' manufacturing bases in India and ASEAN countries to African markets or production bases within Africa. We will make proposals to further promote private-sector initiatives and investment.

2. Summary of each chapter

This final report was compiled based on the issues and background identified in the master plan. The following sections provide an overview of each chapter.

Chapter 1: Overview

Special Article 1: From Bali to Johannesburg: How the Global South Presidencies of G20 reshaped the Framework Conditions for Circular and Low-Carbon Economy Transition?

Starting in 2022, the consecutive G20 presidencies of Indonesia, India, Brazil and South Africa mark a pivotal moment in realigning the group's priorities to those of the Global South's aspirations. Together, these four countries have championed a revival of the sustainable development and inclusive growth agenda centred on accelerating progress towards the circular economy, digital economy, and climate action, during a time of waning multilateralism, rising inequality, and stalled progress on global sustainable development goals. To mainstream their aspirations, they launched targeted initiatives and institutionalized their priorities in the ministerial and sherpa working groups and engagement groups such as Think 20, Business 20, and Youth 20. Rather than isolated national agendas, these presidencies reflect coordinated the Global South leadership that embedded development within the G20's institutional architecture. Their collective efforts provide a model for sustained influence in multilateral governance reforms, centred not on rhetoric but on agenda-setting, alignment of priorities, and concrete goals to stimulate innovation and action in global governance for sustainable and inclusive growth

Chapter 2: Circular Economy

This chapter argues that the circular economy (CE) and digital connectivity (Industry 4.0) are key drivers of sustainable industrial development in the Global South, particularly in African countries. CE, which replaces the traditional "extract-manufacture-dispose" economy, aims to achieve both job creation and environmental conservation through efficient resource management and waste reduction. To achieve this, it is essential to integrate advanced sorting and recycling technologies with digital technologies (AI, IoT, sensors). In Africa, recycling of electronic waste, plastics, textiles, and other materials, as well as resource recovery from organic waste, are progressing, but there are fragmented policies and barriers to technology introduction. Regional initiatives such as the African Circular Economy Alliance (ACEA) and the African Development Bank's CE facilities are steadily expanding. Going forward, it will be necessary to develop digital infrastructure, introduce ESG indicators, and implement vein-artery integration development strategies that leverage regional resources.

Special Article 2: The Progress and Challenges of Global Warming Negotiations

Global climate regime has been evolving from the evolution from the Kyoto Protocol's rigid, top-down structure to the Paris Agreement's flexible, universal approach. Kyoto's binding targets—applied only to developed countries—were inequitable and unsustainable, as rapidly growing emissions from emerging economies rendered the framework obsolete. Japan's decision not to join Kyoto's second commitment period, while supporting the 2010 Cancún Agreements, marked a pivotal shift toward the voluntary, bottom-up system later institutionalized by the 2015

Paris Agreement. The post-Paris rise of “1.5°C absolutism,” which treats the 1.5°C and 2050 net-zero goals as non-negotiable imperatives despite their practical infeasibility, deserves criticism. Achieving these trajectories would require annual global CO₂ reductions of around 8–9%, far beyond historical experience or the developmental priorities of the Global South. The first Global Stocktake (COP28, Dubai) acknowledged the need to “transition away from fossil fuels,” but only in a nationally determined manner. While it recognized nuclear, CCUS, and natural gas as transition tools, the deeper challenge remains financing: achieving global neutrality by 2050 would require US\$4–5 trillion annually. COP29 (Baku, 2024) failed to bridge divides over the new climate-finance goal—settling uneasily on US\$300 billion, far below developing countries’ demand for US\$1.3 trillion. Energy transitions must be grounded in economic and technological realities, not moral absolutism. Imposing uniform fossil-fuel bans risks “eco-colonialism” against developing nations still struggling for basic energy access. Finally, given the improbability of the 1.5°C pathway, climate finance should be rebalanced toward adaptation and resilience—an urgent priority for COP30 in Belém (2025).

Chapter 3: Overview of African Politics and Economics

African countries have seen drastic changes in economic activity through the development of infrastructure and mobile communications. However, the economic activities are still concentrated in agriculture and the informal sector in terms of employment, and thus, poverty rates remain among the worst in the world. This chapter argues that a shift in the industrial structure to one based on non-agriculture and the formal sector is essential for economic growth. Structural transformation has been a central issue since independence, but industrial policies were rejected in the structural adjustment policies in the 1980s and 90s until they have been revived recently. Recent efforts include the establishment of SEZs and support of local industries through an import-substitution strategy, and digital technologies have the potential to realize drastic changes in institutional development. However, African governments have not successfully introduced institutions administering the application of digital technologies, and we see problems such as serious fraud in online shopping and weak regulations in mobile banking services. Given the shortage of experience and knowledge in industrial policy among African governments, they need to develop an understanding of their own economies. To provide support, donor countries also need to understand the uniqueness of African economies and the coordination among diverse donors.

Chapter 4: Automotive Industry

Africa's automotive industry has low production volumes relative to its population size, with the used car market dominating and production capacity concentrated in South Africa and Morocco. However, in recent years, the introduction of electric vehicles by European and US manufacturers and the entry of Chinese and Indian manufacturers have led to the expansion of assembly operations to other countries. For the industry to develop in earnest in the future, it will be important to (1) nurture the new car market, (2) introduce safety and environmental regulations, (3) link supply chains with Asia, and (4) respond to electrification. In particular, regarding electrification, the establishment of battery recovery and recycling systems is essential, and Chinese manufacturers may consider ASEAN as an export hub for right-hand drive EVs. If ASEAN advances the localization of EV and battery production, improves end-of-life vehicle management systems, and participates in recycling systems for EVs targeting the African market, Asia and Africa could collaborate to foster the sustainable development of the automotive industry.

Chapter 5: Logistics

This study conducts a comprehensive investigation and analysis of the logistical challenges and prospects for achieving resource circulation between Africa and Asia, focusing on four countries: South Africa, Tanzania, Ethiopia, and Kenya. Focusing on three areas—international trade, the automotive industry, and the circular economy—this study identified current conditions and barriers through field research and literature reviews, covering investment environments, logistics infrastructure, customs clearance, transportation, waste management, and recycling. From the perspective of private companies, it presents recommendations for addressing challenges and future directions for promoting the African automotive industry and achieving sustainable resource circulation.

Chapter 6: Digital Leapfrog

This chapter proposes the establishment of a unique industrial paradigm called "the Global South Industry 1.0 (GSI 1.0)" for the economic growth of Global South (GS) countries, which does not follow the traditional Global North-type industrial development model (Industry 4.0) but instead introduces digital technology and Cyber Physical Systems (CPS) from the initial stages. In particular, it focuses on "connectivity," which generates economic value without relying on physical concentration, by leveraging cutting-edge technologies such as distributed infrastructure, drones, 3D printers, and sustainable materials. Furthermore, it demonstrates a method for strategically creating economic and social value through "Special Epistemic Zones (SEZ)," which are formed by combining data from different fields. SEZ can be formed beyond physical space, enabling the sharing and optimal utilization of industrial knowledge across regions. On CPS, by incorporating proven methodologies such as lean production through the use of System of Systems (SOS) architecture, industrial upgrading and human resource development can be achieved simultaneously. Furthermore, the digital sharing of specialized knowledge and human resource development are emphasized as key elements for the development of the GS.

Special Article 3: Prospects for Improving Electrification Rates and a Circular Economy in Africa

The International Energy Agency (IEA) foresees that 600 million people in Africa will not access electricity until 2030. One of the reasons is that some African people cannot pay the electricity bill due to their lower income level. Therefore, Africa should achieve higher economic growth through inviting industrial clusters. Meanwhile, international trends show decarbonisation becoming mainstream, and conventional industrial clusters cannot respond to these global developments. Thus, we recommend attracting circular (venous) industries clusters instead of conventional industry clusters. In the urban area, attracting electricity-intensive circular (venous) industries contributes to increasing the electrification rate through economic growth and electricity development. Large-scale villages which have enough labour force can attract circular (venous) industries with less electricity consumption for contributing to electrification. Remote villages can only rely on rooftop-type solar PV systems to increase electrification, with financial support provided by governments and international societies. However, electricity enables people in the local villages to get more income through engaging in additional work under lighting, even at night. Thus, it is considered feasible for recipients to repay the initial financial support. Attracting circular (venous) industries should be a policy package to achieve economic growth, an increase in employees and an electrification rate simultaneously in Africa.

Chapter 7: Geographical Simulation Analysis

This chapter analyses the development of economic corridors in Africa and their impacts using an economic geography simulation model (IDE-GSM). First, the development of economic corridors is a critical factor for the success of the African Continental Free Trade Area (AfCFTA). Here, we discuss the conditions for the success of a leapfrog-type economic corridor development strategy that introduces digital technology and renewable energy, rather than the traditional step-by-step economic corridor approach. The leapfrog approach prioritizes digital education, skill development, and the electronic reduction of non-tariff barriers over physical infrastructure development, demonstrating the potential to achieve high economic effects in a short period. Japan's cooperation could play a significant role in constructing efficient and reliable economic corridors.

Chapter 8: Developmental Strategy

To build a circular economy system through enhanced logistics and digital connectivity, three major challenges must be addressed. The first challenge is to establish a comprehensive cyber-physical system in the target region. The second challenge is to develop methodologies to promote new value creation based on the new philosophy of circular economy systems that have emerged in modern civilisation. Specifically, it will be necessary to develop new methodologies to promote value creation through interoperability platforms in Cyber Physical Systems, focusing on the development of arterial-venous integrated development strategies. The third challenge is digital human resource development (d-HRD). To address these challenges, it will be necessary to adopt a "leapfrog" development strategy that differs from the conventional model of promoting labour-intensive manufacturing first and instead promotes knowledge-intensive industries and DX before promoting any manufacturing. Universities and research institutions in the local areas of the Global South countries are expected to play a particularly important role in addressing the many challenges we face. We propose a new concept, "Special Epistemic Zones (SEZ)," to capture the role of universities and research institutions in creating various forms of "knowledge."

Special Article 1: From Bali to Johannesburg: How the Global South Presidencies of G20 reshaped the Framework Conditions for Circular and Low-Carbon Economy Transition?

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1. Introduction

In December 2021, when Indonesia took over the G20 presidency from Italy, followed by India, Brazil and South Africa, the consecutive Global South presidencies presented a unique opportunity for the world to resurrect a global development agenda through G20 collectively. At a time when the world was recovering from the disruption caused by the global pandemic, facing increasing food insecurity, debt stress, and adverse effects of climate change, the four presidencies have focused attention on the challenges and priorities of the Global South, which they represent and are part of. More importantly, it has ensured policy continuity through the leadership transitions from 2022-2025 and consolidated the sustainable global growth and development agenda for the G20. Although the G20 represent nearly 85 percent of global gross domestic product, its commitments are non-binding and operate on a voluntary, consensus-based model. Therefore, implementation depends largely on the political will of individual member states, which limits policy continuity. Without a permanent secretariat, the mechanism of the G20 Troika, comprising the past, current, and future presidencies, was designed to carry forward the commitments and proposals from one presidency to the next. However, in the past, the G20 agenda has been set and driven by current presidencies and often reflects their own priorities and issues that demand immediate attention, for example, the global financial crisis, the COVID-19 pandemic and climate financing. The last four Global South presidencies have been able to translate policy continuity into new institutions, which will continue to advance development goals in the Global South.

To address the global health crisis, the Indonesian Presidency (2022) made efforts in harmonization of regulations and established a Global Pandemic Fund. To address the debt crisis and the need for low-cost, sustainable finance in the Global South, India's presidency (2023) convened an independent Expert Group and developed a detailed roadmap to increase development assistance and reform the multilateral development banks. Brazil's G20 presidency (2024) launched the Global Alliance Against Hunger and Poverty and highlighted the role of digital public infrastructure for inclusive digital transformation in countries of the Global South. South Africa takes over the presidency of the G20 in 2025, with a unique opportunity to elevate African voices into the connectivity deliberations on the circular bioeconomy

While the Leaders' Declarations themselves have been an achievement given the complex geopolitical context since the beginning of the Russia-Ukraine conflict in 2022, the groundwork was laid by the four countries coordinating their positions in the numerous working groups and task forces that provide inputs into the negotiations in the Leaders' Summit. This paper analyses

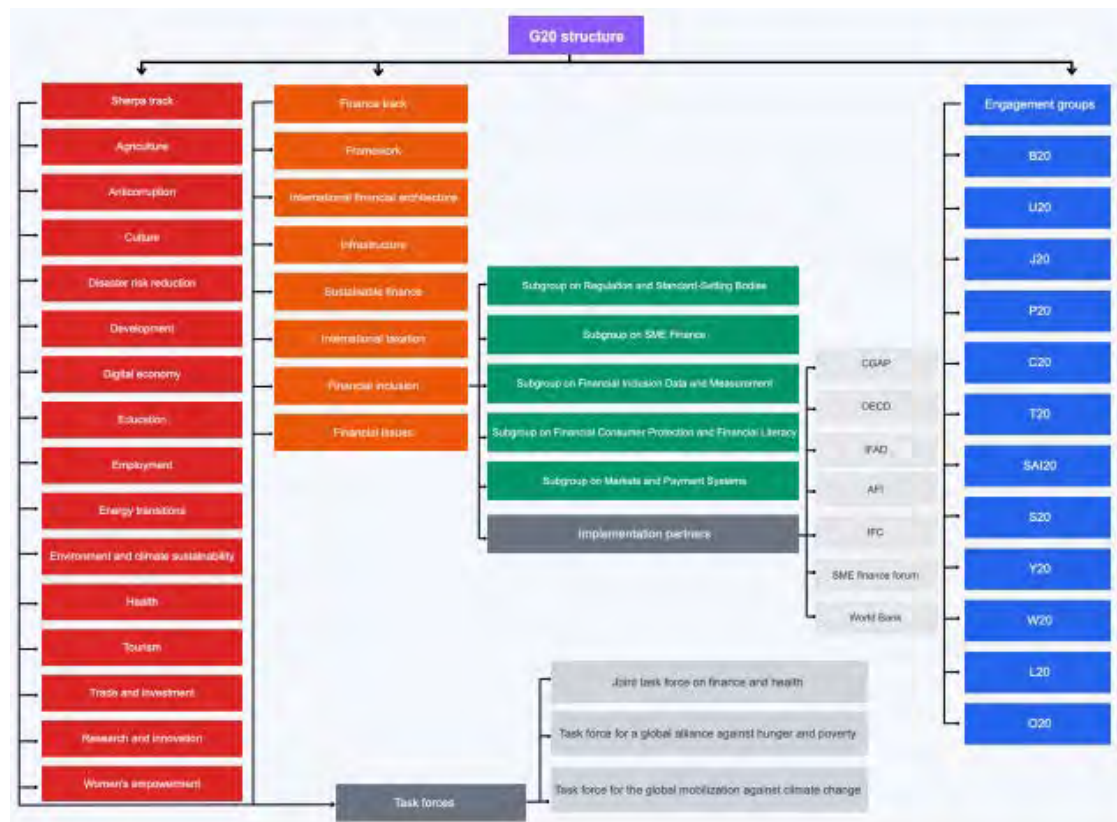
the process through which the policy continuity for accelerating circular, low-carbon, green growth was achieved, taking into consideration the aspirations of the Global South. To analyse G20's pivot to sustainable and inclusive growth, the scope of the paper covers four key priorities mentioned in the Bali, New Delhi, and Rio de Janeiro Leaders' Declarations and South Africa's working group deliberations, namely SDGs, food security, digital transformation, and circular economy and climate action. We map these priorities with the corresponding working groups (or groups) and undertake an extensive review of publicly available outcome documents from the Indonesia, India, and Brazil presidencies. For South Africa, we review the summary of working group deliberations available currently, giving us an early indication of the continuation of policy coordination across the Global South presidencies.

2. G20 Structure for Policy Coordination and Global Economic Governance

The institutional structure of the G20 has evolved over the past two decades. Starting from a grouping primarily focused on financial stability and coordination following the 2008 global financial crisis, it now has two tracks. The Finance Track coordinates global macroeconomic policy among finance ministries, central banks, and multilateral agencies. The Sherpa Track focuses on development priorities in fifteen sectors, bringing together coordinating ministries and agencies in the G20 countries. Figure 1 shows the institutional structure of G20 sherpa and finance ministerial tracks and the profile of engagement groups.

Starting in 2021, the consecutive G20 presidencies of Indonesia, India, Brazil and South Africa mark a pivotal moment in realigning the group's priorities to those of the Global South's aspirations. Together, these four countries have championed a revival of the sustainable development and inclusive growth agenda centered on accelerating progress towards the circular economy, digital economy, and climate action, during a time of waning multilateralism, rising inequality, and stalled progress on global sustainable development goals. To mainstream their aspirations, they launched targeted initiatives and institutionalized their priorities in the ministerial and sherpa working groups and engagement groups such as Think 20, Business 20, and Youth 20. Rather than isolated national agendas, these presidencies reflect coordinated Global South leadership that embedded development within the G20's institutional architecture. Their collective efforts provide a model for sustained influence in multilateral governance reforms, centered not on rhetoric but on agenda-setting, alignment of priorities, and concrete goals to stimulate innovation and action in global governance for sustainable and inclusive growth

Figure 1. Institutional Structure of G20 tracks, taskforces and engagement groups



G20, particularly starting from 2023, continues to strengthen partnerships and expand dialogue with a wide range of actors, including States, international organisations and civil society, to collectively shape the G20's approach to issues requiring international cooperation. The participation of non-governmental stakeholders reflects the overall commitment to a broader and more inclusive G20 Presidency, which is also reflected in the respective presidencies' overall theme and deliverables during this year. Dialogues with civil society and other non-governmental institutions are being conducted by engagement groups such as the Business 20 (B20), Civil 20 (C20), Labour 20 (L20), Parliament 20 (P20), Science 20 (S20), Start-up 20 (SU20), Supreme Audit Institutions 20 (SAI20), Think-tank 20 (T20), Urban 20 (U20), Women 20 (W20) and Youth 20 (Y20), the Oceans 20 (O20) and the Judiciary 20 (J20). The representatives of the G20 Engagement Groups, in coordination with Sherpa and Finance Ministry tracks, define joint positions on the group's agenda topics within their independent dialogue processes, with the responsibility for the opinion-forming processes lying entirely in the hands of these groups. The work undertaken by Engagement Groups will lead to recommendations, which usually reach the mid-year Foreign Ministers, the Finance and Central Bank Ministerial Meetings, as well as the Leaders' Summit. These groups have the fundamental role of offering a solid structure for channeling the demands and aspirations of the societies of the G20 countries to their leaders, exerting influence on the grouping's decisions. In Brazil and South Africa's G20 Presidencies, modalities have been developed to involve a wide range of these engagement groups through organizing the G20 Social Summits to reflect on societal aspirations, just before G20 leadership summits.

3. Policy Continuity, Consistency and Convergence among the Consecutive Global South G20 Presidencies

The consecutive G20 presidencies of Indonesia, India, Brazil, and South Africa presented a historic opportunity for the Global South to advocate for policies that align with their shared interests while creating momentum toward revitalizing the 2030 Sustainable Development Agenda. The pandemic, financial stress, and geopolitical instability have shaped the last five years of leaders' declarations and commitment towards sustainable and inclusive growth.

During Indonesia's presidency, the Development Working Group (DWG) committed to advancing the SDGs through collaboration, partnership, multilateralism, and leaving no one behind. Financing for sustainable development was another key priority, which also included the release of the G20 Principles to Scale Up Blended Finance in Developing Countries, aimed at tailoring blended finance to local contexts, supporting domestic financial systems, scaling impact, and promoting transparency and accountability. Under India's G20 presidency, the DWG placed sustainable development at the center of the international cooperation agenda, responding to challenges exacerbated by the COVID-19 pandemic. The G20 Ministers introduced the 2023 Action Plan to Accelerate SDG Progress, focusing on digital transformation, empowerment of all women and girls, and fostering sustainable, inclusive, and just global energy transitions, all committed to leaving no one behind. Reflecting the priorities of the Global South, India's G20 leadership also adopted the G20 High-Level Principles on circular economy and Lifestyles for Sustainable Development to advance the intersection of development, climate, and environment and their associated goals. Building on Indonesia and India's DWG, Brazil's G20 DWG prioritized reducing inequality, improving access to water and sanitation services, and strengthening trilateral cooperation. Under Brazil's leadership, the G20 Development Ministers endorsed the Leaving No One Behind: G20 Ministerial Declaration, which underlined the need to reduce inequalities within and among countries and create opportunities for all. Brazil recognized the importance of trilateral cooperation, among other things, to promote partnerships, unity, and cooperation to accelerate fair, inclusive, and equitable development and to achieve the SDGs.

In alignment with previous G20 presidencies, South Africa has committed to revitalizing and accelerating progress toward achieving the SDGs, bioeconomy and digital transformation, highlighting the challenges faced by countries in Africa. The availability of development finance or investment for circular transition and climate actions is crucial among several factors necessary for advancement. The three proposed priorities for South Africa are high-level principles on global public goods and global public investment, mobilizing finance for growth, and mobilizing means of implementation and building resilience by introducing social protection floors. Ensuring Social Protection Under Indonesia's presidency, improving food security and sustainable agricultural practices were central to the deliberations of the Agricultural Working Group (AWG). With rising food insecurity and malnutrition continuing to be a major concern, India carried forward Indonesia's emphasis on circularity and sustainability by prioritizing climate-smart, sustainable agriculture and the use of digital technology to improve productivity. India also adopted the Deccan High-Level Principles on Food Security and Nutrition. The launch of the Global Alliance Against Hunger and Poverty during Brazil's presidency was a major outcome led by the joint efforts of the troika. The Global Alliance provides a forum to mobilize finance and enhance the sharing of replicable and scalable good practices that advance the SDG 1 (no poverty)

and SDG 2 (zero hunger). Additionally, Brazil concentrated on advancing efforts to promote community engagement in the shift towards regenerative food systems, drawing on the High-Level Principles on Lifestyles for Sustainable Development

While these initiatives represent important steps toward institutionalizing sustainable development priorities, their long-term impact will be highly dependent on the implementation capacity, resource mobilization, and political follow through. Without reliable commitments on delivery and uptake, the effectiveness of platforms such as the Global Alliance Against Hunger and Poverty, the Global Biofuels Alliance and other G20 initiatives remains uncertain. Continuing with the Global South G20 Presidencies policy continuity on sustainability, South Africa outlined its priority deliverables to focus on innovation and technology transfer in agriculture, industry and digital services and building climate resilience.

Building Consensus on Digital Economy: Effective use of digital technologies can accelerate development outcomes but is hampered by weak digital infrastructure and digital literacy. During Indonesia's G20 presidency, the Digital Economy Working Group (DEWG) developed the G20 Toolkit for Measuring Digital Skills and Digital Literacy. With inputs from India, Brazil, and South Africa, the toolkit addresses the need for policymakers in the Global South as they invest in digital infrastructure and skills needed to manage the digital transformation. India's G20 presidency focused on DPI as a framework for countries to leverage digital transformation for development priorities. Drawing on India's experience, the DEWG drafted the G20 Framework for Systems of Digital Public Infrastructure, highlighting how a combination of digital ID, payments and data exchange – a “digital stack” – can accelerate financial inclusion, enable governments to improve the delivery of public services and support private sector innovation. Brazil's presidency advanced this momentum, emphasizing the importance of building safe and inclusive DPI to reduce poverty and tackle global crises such as climate change. Like India's Unified Payments Interface (UPI), Brazil has demonstrated how adequate digital public infrastructure, such as the PIX digital payments system, can be scaled quickly and democratize the use of digital technologies to benefit the most vulnerable sections of its population. The South African presidency has committed to building on the achievements of India and Brazil by prioritizing four areas: inclusive digital connectivity, digital innovation ecosystems for micro and medium enterprises, digital transformation through DPI, and equitable, inclusive, and just frameworks for the adoption of artificial intelligence (AI) tools and capabilities.

Climate Action and Sustainable Finance Amid ongoing climate, energy and resources, and geopolitical challenges, the past four Global South G20 presidencies have advanced growing alignment and continuity in addressing climate change, accelerating the just energy transition, and scaling up climate finance. Each presidency has contributed to a progressive, mutually reinforcing agenda, laying the foundation for long-term sustainable development and climate action cooperation.

Table 1: Policy Consistency, Continuity and Convergence of G20 Global South Presidencies towards accelerating sustainable and inclusive economic growth

Presidency	Indonesia (2022)	India (2023)	Brazil (2024)	South Africa (2025)
Theme	Recover Together, Recover Stronger	One Earth-One Family-One Future	Building a Just World and a Sustainable Planet	Solidarity, Equality, Sustainability
Sustainable Development Goals (SDGs) Declarations	1. Global health architecture. 2. Sustainable energy transition. 3. Digital transformation.	1. Digital transformation. 2. Gender equality and women's empowerment. 3. Implementing sustainable, inclusive, and just transitions globally, while leaving no one behind.	1. Social inclusion and the fight against hunger and poverty. 2. Sustainable development, energy transitions, and climate action. 3. Reform of global governance institutions	1. Strengthen disaster resilience and response. 2. Ensure debt sustainability for low-income countries. 3. Mobilize finance for a just energy transition. 4. Cooperate on critical minerals for inclusive, sustainable growth.
Climate Action, Circular Economy and Green Finance Declarations	1. Speed up clean, affordable, and inclusive energy transitions to ensure energy security and reach net zero emissions by mid-century. 2. Achieve universal energy access and end energy poverty, guided by the Bali Compact and Energy Transition Roadmap. 3. Protect and restore biodiversity using nature-based solutions and address marine	1. Commit to accelerating clean, sustainable, just, affordable, and inclusive energy transitions. 2. Recognize the crucial role of public finance in enabling climate action by leveraging private finance through blended instruments and risk-sharing. 3. Support balanced efforts on adaptation and mitigation to achieve ambitious	1. Commit to urgent, scaled-up action on climate change, biodiversity loss, desertification, and pollution. 2. Lead bold, timely structural reforms nationally and globally to accelerate climate action and align with sustainable development goals. 3. Support Brazil's G20 initiative to create TF-	1. Advocate for a just and inclusive energy transition that considers developing countries' developmental needs and capacities. 2. Promote increased access to affordable, sustainable financing for climate adaptation and mitigation in the Global South. 3. Support reforms to the global financial architecture to better align

	and coastal ecosystem challenges. 4. Increase and mobilize climate and environmental financing, urging developed countries to meet the USD 100 billion annual commitment through 2025.	NDCs, carbon neutrality, and net-zero, while considering different national circumstances.	CLIMA, integrating climate into global finance and development agendas.	capital flows with climate-resilient and low-carbon development pathways.
Digital Economy Declarations	1. Promote inclusive and affordable digital connectivity. 2. Foster a safe, secure, and trusted digital environment. 3. Enable an open, fair, and non-discriminatory digital economy. 4. Advance cross-border data flows with trust to support sustainable, human-centric digital growth.	1. Deepen the discussions on digital innovation and inclusion, digital skilling, and security in the digital economy. 2. Recognize the role digital public infrastructure (DPI) can play in furthering meaningful connectivity and accelerating progress toward implementing the 2030 Agenda for achieving SDGs. 3. Foster a digital economy that promotes respect for human rights, privacy, and protection of personal data for all, and contributes to the	1. Promote digital inclusion and achieve Universal Meaningful Connectivity (UMC). 2. Develop a trustworthy and inclusive Digital Public Infrastructure (DPI) for effective digital governance. 3. Ensure the integrity of online information and build trust in the digital economy. 4. Leverage artificial intelligence for inclusive, sustainable development and to reduce inequalities.	1. Promote inclusive and affordable digital connectivity for broad digital development. 2. Develop and support digital public infrastructure (DPI) with tools to enhance implementation. 3. Foster digital innovation ecosystems to empower MSMEs and unlock their potential. 4. Ensure artificial intelligence (AI) is equitable, inclusive, and just.

		implementation of the 2030 Agenda for achieving SDGs.		
Energy Transition Working Group (ETWG)	1. Set out voluntary multiyear actions to advance the SDGs and pursue Net-Zero or carbon neutrality, aligned with national circumstances and principles of clean, just, affordable, and inclusive transitions. 2. Strengthened international cooperation on low-emission technologies in power and hard-to abate sectors, supported	1. Called for increased public and private investment, with MDBs supporting regional energy links in developing countries. 2. Supported access to low-cost financing for clean and sustainable energy technologies. 3. Promoted global cooperation, best practices, and risk mitigation strategies, including India's Voluntary Action Plan to reduce the cost of energy transition finance.	1. Accelerated financing for energy transitions, especially in developing countries. 2. Supported the social dimension of energy transitions. 3. Set out innovative perspectives on sustainable fuels.	1. Energy security, affordable and reliable access. 2. Just, affordable, and inclusive energy transitions. 3. Diverse local supply chains, regional integration, and interconnectivity
Environment and Climate Sustainability Working Group (ECSWG)	1. Committed to reduce land degradation by 50 percent by 2040 on a voluntary basis, and actively promoting and mainstreaming ecosystem restoration, particularly land	1. Called for scaled-up climate finance from MDBs, IFIs, the private sector, and others. 2. Recognized the role of forests in	1. Adopted the Ministerial Declaration on Environment and Climate Sustainability, reaffirming commitment to urgent action on climate change, biodiversity loss,	1. Support implementation of the Convention on Biological Diversity (CBD) and Global Biodiversity Framework (GBF) through National Biodiversity

	and forest restoration on all types of ecosystems. 2. Stressed the importance of mainstreaming biodiversity protection and conservation into all policies and recognizing the crucial role of traditional and indigenous knowledge in sustainable land use and preventing deforestation. 3. Emphasised on the importance of strengthening efforts and international cooperation for marine litter management, including through the continued implementation of the G20 Implementation Framework for Actions on Marine Plastic Litter. and supported the development of a legally binding international treaty to combat plastic pollution.	climate and biodiversity. 3. Supported private and blended finance for biodiversity and welcome the launch of the Global Biodiversity Framework Fund (GBF Fund). 4. Emphasized urgent action on climate resilience and loss and damage, and support COP27 outcomes, including the new fund and the work of the Transitional Committee.	desertification, ocean and land degradation, drought, and pollution. 2. Produced and published four technical papers addressing key issues: (i) oceans; (ii) payments for ecosystem services, (iii) waste and circular economy, (iv) enhancing adaptation action and finance in climate change contexts.	Strategies and Action Plans 2. Address land degradation, desertification, and drought to protect biodiversity, ensure soil health, and secure food systems for a growing global population. 3. Improve access to information and alternatives to hazardous chemicals to reduce risks to human and environmental health.
Sustainable Finance Working Group (SFWG)	1. Committed to just and affordable transitions aligned with the 2030 Agenda,	1. Mobilized climate finance through improved risk-sharing by MDBs, DFIs,	1. Optimized the operations of the International Environmental and Climate Funds to deliver	1. Mobilize sustainable finance to support global growth, stability, and the transition

	UNFCCC, Paris Agreement, and Biodiversity Convention.	and development banks, including enhanced guarantees to attract private investment.	sustainable finance.	to greener, more resilient, and inclusive economies.
	2. Promoted diverse policies, including carbon pricing and phasing out inefficient fossil fuel subsidies with support for vulnerable groups.	2. Enabled innovation ecosystems by promoting policies that support corporate R&D, climate tech start-ups, and early-stage green technologies	2. Advanced, credible, robust, and just transition plans.	2. Identify institutional and market barriers to sustainable finance and develop options to address them.
	3. Urged developed countries to deliver USD 100 billion annually in climate finance to help developing countries meet mitigation goals.		3. Analysed implementation challenges related to sustainability reporting standards, including for SMEs and EMDEs.	3 Align the international financial system with the goals of the 2030 Agenda and the Paris Agreement.
			4. Finance Nature-Based Solutions (NbS)	

Indonesia placed the energy transition at the centre of its presidency through the Energy Transition Working Group (ETWG), which focused on enhancing energy access, advancing clean energy technologies, and mobilizing finance for clean energy initiatives. These efforts culminated in the Bali Compact, a set of nine voluntary principles promoting a just, sustainable, and affordable energy transition through a whole-of-government approach. Indonesia also advanced climate cooperation through the Just Energy Transition Partnership (JETP), establishing a model for developed and developing countries to collaborate on financing technology and capacity building to support shifting from coal to cleaner energy sources. At the same time, the Indonesian Environment Deputies Meeting and Climate Sustainability Working Group (EDM-CSWG) supported international partnerships to finance land restoration and nature conservation programs and projects. India built on this momentum by reinforcing an action-oriented, agreement-based approach to environmental and climate issues. The Environmental and Climate Sustainable Working Group (ECSWG) established priority areas, including halting land degradation, protecting biodiversity, ensuring climate-resilient water resource management, and supporting a circular economy. During the Indian G20 presidency -an alliance for circular economy- the Resource Efficiency Circular Economy Industry Coalition (RECEIC), focusing on technological cooperation, partnership, and finance, was established to enhance the impact and scale-up of initiatives.

One concrete outcome of the Indonesia, India, and Brazil trio was the creation of the Global Biofuels Alliance, announced at the New Delhi Leaders' Summit in November 2023. The alliance comprises 27 member countries and 12 international organizations. The Alliance recognizes the

importance of circular economy and biofuels to support the energy transition in the Global South, with the three countries leading efforts to increase their share in the energy mix. Increasing access to climate finance for the Global South was brought to the centre stage during Indonesia and India's presidencies. Although Indonesia could not secure new finance promises for the \$10 billion annual climate goal announced at COP26, India has advocated for fair global carbon budget allocations, guided by the principle of Common but Differentiated Responsibilities (CDR). Brazil carried this agenda forward with a strong focus on climate finance reform and nature-based solutions. The Sustainable Finance Working Group (SFWG) called for enhancing coordination among multilateral development banks (MDBs) and vertical climate funds. Financial instruments for nature-based solutions -using nature to benefit both lives and lands- also figured strongly in the outcome document, reflecting the importance of Brazil as the largest country in the Amazon basin, which contains 15 to 20 percent of the world's biodiversity.

In summary, the importance of coordination across the multiplicity of institutional processes to achieve convergence of priorities and continuity of outcomes is underscored across the four consecutive Global South presidencies. This continuity reflects a shared urgency around accelerating the progress of the SDGs and reforming MDBs, a common focus on circular economy and climate resilience and joint efforts to utilize data and digital infrastructures as tools for inclusion and equity. Additionally, these presidencies have advanced a unified agenda on climate action and green finance, emphasizing the need for greater access and affordability for a just transition, and the alignment of climate goals with broader sustainable development objectives. Together, they have helped reorient the G20 process to reflect and reinforce the challenges and priorities of the Global South.

Under South Africa's presidency, the G20 continues to pursue policy coherence and practical implementation across just energy transition, climate action, and sustainable finance. South Africa's ECSWG advances the circular economy dimension within the 2030 Agenda for Sustainable Development and its SDGs through various priorities, such as global partnerships (SDG 17), technology transfer, and climate finance mobilization. Additionally, it maintains the continuity of land restoration as an essential issue that has been on the G20 agenda since Indonesia and India's presidencies. As the G20 president, South Africa is also under pressure to build on Brazil's progress by aligning climate and financial agendas to drive momentum towards an ambitious outcome at COP30, which coincides with the G20 South Africa summit on 22-23 November in Johannesburg. By leading with continuity, consistency, and convergence and credibility, ambition, we are confident the South Africa G20 presidency will see new Global Frameworks that push for meaningful reform that serves the aspirations.

4. Conclusion

Historically, the G20 was created back in 1999 as a group of twenty of the world's largest economies to deal primarily with multifaceted aspects of existing global economic, trade, health, climate change and political issues. Every year, the leaders of the G20 members meet to discuss mainly economic and financial matters and coordinate policy on some other issues of mutual interest. Over the years, the wider agenda has evolved, now includes trade, sustainable development, health, agriculture, energy, the environment, climate change, digital economy. These agenda initiatives are not only to drive economic progress but also to accelerate and support long-term investment opportunities across the continents, especially in the developing countries of the Global South in Asia, Africa and Latin America. Often G20, projected as an alternate platform to set the parameters for effective global economic governance, has been criticized for

not readjusting and adapting to a collective approach that represents diverse perspectives and includes practicing models of operations to complement and support development initiatives of the Global South for shaping a more equitable and a more balanced global order.

The consecutive G20 presidencies of Indonesia, India, Brazil, and South Africa presented a historic opportunity for the Global South to advocate for sustainable development and inclusive economic growth policies that align with their shared interests while creating momentum toward revitalizing the global action agenda for accelerating the circular economy and low-carbon green growth aided by digital technologies. These G20 presidencies have demonstrated sustained leadership and delivered concrete outcomes, showcasing the Global South's ability to influence and revitalize the global economic governance agenda. These efforts aim to reverse the growing proportion of people living in extreme vulnerability to climate and economic uncertainties, as well as address a key challenge to advance the transition to a green and inclusive growth in the future. In the current fractured geopolitical landscape where resources for development challenges are becoming scarce, the consecutive Global South presidencies demonstrated the power of collaboration and collective action to transform statements of intent into actionable strategies for the future. Working together during their presidencies, Indonesia, India, Brazil, and South Africa have provided a blueprint for development cooperation where new ideas, initiatives and institutions flow from the G20 deliberations, engagement with other key stakeholders such as think tanks, businesses and civil societies in providing a framework for sustained engagement and connectivity among the Global South collectively.

Chapter 2

Circular Economy

Chapter 2: Circular Economy -- Circular Economy and Digital Connectivity as Drivers for Sustainable Economic Growth in the Global South

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1. Introduction

The circular economy (CE) is ‘the economic system in which resources are kept at the highest possible level of functionality at all times.’ A systemic approach to material management within this economy is critical to its success. The circular economy has the ambition to minimise material usage per unit of functionality and to manage materials in the system in such a way that losses are minimised. On a product level, the CE strives to repair, re-use, and remanufacture before materials are recycled. Whereas the Circular Economy is a central term in the EU and Chinese policy, Japan refers to the material cycle society. In many other countries e.g. in Asia, material policy is typically based on 3R: re-use, reduce, recycle. The circular economy adds upstream measures (e.g. in product design) to this 3R principle.

The introduction of the circular economy generates new technological and non-technological needs. The change in ownership and material management concepts, both at a consumer and at a business level, generates a need for the introduction of new business concepts, such as products as a service, sharing platforms, peer-to-peer interactions, and industrial symbiosis. Many of these are based on the availability of efficient IT tools, such as apps, websites, consumer/user platforms, and databases.

Looking from an industrial perspective, the CE generates technological needs in the field of manufacturing, processing, identification and recycling of materials and products. The main needs are:

- advanced sorting and recycling technologies,
- efficient materials processing technologies and
- production technologies that support design for circularity.

These needs are covered by robotics, analytics and (artificial) intelligence, sensors and connectivity, machine learning, human-machine interfaces. All these technologies are typically designated as ‘digital technologies and or Industry 4.0’. Until now, the frameworks of digital technologies and the circular economy have not been connected in policy initiatives and R&D programs.

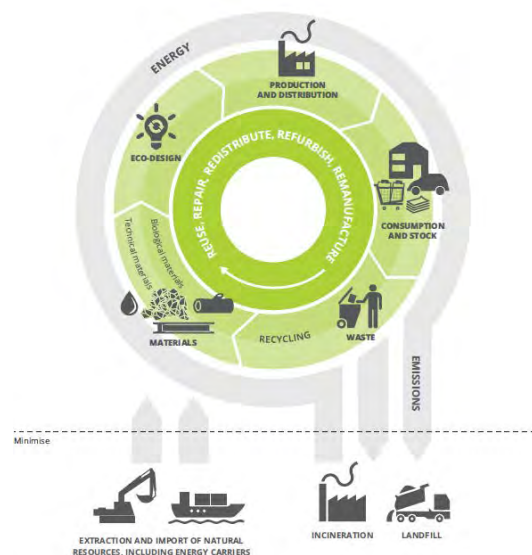
This paper tries to clarify and explore the possible complementarity between both concepts. This paper presents some basic insights from partner contributions, which will serve as a basis for the Africa circular economy master plan being discussed.

2. Circular Economy from an Industrial or Business Perspective

In essence, a circular economy represents a fundamental alternative to the linear take-make-consume-dispose economic model that currently predominates (ASEAN 2021). ERIA defines a circular economy as one that is restorative, and one which aims to maintain the utility of products, components and materials while retaining their value (ERIA 2016). This approach minimises the need for new inputs of materials and energy, while reducing environmental pressures linked to resource extraction, emissions and waste. It goes beyond just waste, requiring that natural resources are managed efficiently and sustainably throughout their life cycles. A circular economy thus provides opportunities to create well-being, growth and jobs, while reducing environmental pressures. The concept can, in principle, be applied to all kinds of natural resources, including biotic and abiotic materials, water and land.

In a circular economy, eco-design, repair, reuse, refurbishment, remanufacturing, product sharing, waste prevention and waste recycling are all important. At the same time, losses of materials through landfill and incineration will be reduced, although these processes will continue to play a much smaller role in safely removing hazardous substances from the biosphere and recovering energy from non-recyclable waste. Several concepts and visualisations of a circular economy exist; Figure 1 shows a simplified model. The main idea is that waste generation and material inputs are minimised through eco-design, recycling and reusing of products. This will create economic and environmental co-benefits, as the dependency on extraction and imports declines in parallel with a reduction in the emissions to the environment caused, for example, by extraction and processing of materials, incineration and landfill.

[Figure 1]: A simplified model of the circular economy for materials and energy



(Source: ERIA (2016))

The circular economy generates new opportunities and needs for business. These can be grouped according to 4 archetypes that each represents a specific business focus as the main entry point for developing a circular business model (EIT 2017):

- relationship with **customer**: providing a service instead of a product,
- **product or process**: circular product or process design,
- relationship with the **value network**: building circular value networks,
- sustainable **identity**: circularity as a unique selling proposition.

In most cases a company will combine elements of each archetype in its business approach.

An alternative categorisation of circular business approaches has been given by the Ellen McArthur Foundation, in their RESOLVE Framework: **RE**generate – **S**hare – **O**ptimise – **L**oop – **V**irtualise – **E**xchange (EMF 2015).

3. Digital Technology for Industry or Business EFFICIENCY

The term digital technologies that also often referred to as Industry 4.0 is applied to a group of rapid transformations in the design manufacture, operation and servicing of manufacturing systems and products. The term originated in Germany but developments in other parts of the world have resulted in other labels, such as *Smart factories*, the *Industrial Internet of Things*, *Smart industry*, or *Advanced manufacturing*.

The ASEAN Agreement on Digital Products and Services mentions “Digitalisation for productivity and growth” an area of which Industry 4.0 builds. Similarly, Accenture has identified 10 digital, engineering and hybrid technologies that will enable the disruption of the current linear economy to bring in the circular economy (Accenture 2015) (see Table 1).

[Table 1] Classification of potential technological developments for Industry 4.0 and Circular Economy

Digital Technological developments for Industry 4.0	Ten disruptive technologies for circular economy according to Accenture
•Information and communication technology •Cyber-physical systems •Network communications- Internet of Things (IoT) •Simulation •Advanced data analytics •Robots, augmented reality and intelligent tools for support of human workers	•Mobile technology •Machine-to-machine communication •Cloud computing •Social media for business •Big data analytics •Modular desing technology •Advanced recycling technology •Life and material science technology •Trace and return systems •3D Printing

(Table and text based on input from FUTURING, H2020 project, D. Georgoulis co-ordinator)

PwC presents a framework for digital technologies, based on 3 elements (PwC 2017):

- Digital business models and **customer** access
- Digitalisation of **product and service** offerings
- Digitalisation and integration of vertical and horizontal **value chains**

Their approach is represented in Figure 2.

[Figure 2]: Circular economy framework that contributing digital technologies



(Source: PWC (2017))

4. Starting Point for Circular Economy Transition Aided by Digital Technologies

If we compare the elements of this framework to the archetypes for circular businesses, it is striking that similar concepts emerge. Both circular economy and digital economy are based on:

- a change in the approach of customers,
- new product and process offerings, and
- an integration of value chains.

From this perspective, it becomes clear that the digital economy and circular economies at least share a similar vocabulary. Within the sustainable development paradigm of the Global South, particularly in countries in Asia, Africa and Latin America, we could explore the extent to which extent they also share a common future vision and a common goal for the industry towards 2030. A goal that is in line with the SDGs 9 and 12.

Circular economy is considered a driver for envisioning the industrial framework in 2030 that meets the Net Zero emission targets in 2050, while the digital economy provides the driver for technological innovation. Thus, there are several interlinkages we can discuss the interaction between both and consider how the development can be diversified over different regions of the Global South in the world.

The discussions and policy debates could be on 3 thematic issues

- business potential and investment needs for circular economy
- envisioning a circular economy-based industry in 2030
- the future of the waste industry in view of CE and digital connectivity

SDG 12 calls to ensure sustainable consumption and production patterns. Progress is indicated by e.g. material footprint and domestic materials consumption, food loss, recycling rates and hazardous waste production, sustainable public procurement actions. All these indicators are directly affected by the implementation of circular economy or 3R policies. CE and 3R go beyond the efficient collection and recycling of waste. They aim at the introduction of a sustainable lifestyle, in which producers and consumers move away from the linear make-use-dispose model and introduce sharing, leasing, repair and remanufacturing concepts.

SDG9 aims to build resilient infrastructure, promote sustainable industrialization and foster innovation. Sub-target 9.4 aims to upgrade infrastructure and retrofit industries to make them sustainable, with increased resource-use efficiency and greater adoption of clean and environmentally sound technologies and industrial processes, with all countries taking action in accordance with their respective capabilities. This calls for a smart introduction of technologies and a deliberate choice of industrial development.

5. Value pools and investment potential for Circular Economy in the Global South

Circular Economy is a driver for new business creation. In a first analysis in Asia, Africa and Latin America, there is huge business potential for resource efficiency in the raw materials sector, which can be considered the sector of prime interest for the transition to circular economy in the Global South, as it covers the value chain from mining over processing (including recycling) to production and consumption.

The global raw material market is challenged by a huge potential for operational improvement on the one hand, calling for a much better inclusion of key enabling technologies and cross-sectional impulses. The raw material or mining sector in South, Southeast and Central Asian countries as well as African continent and Latin American countries like Brazil, Chile and Peru, appears yet to be hardly stable, with significant variances in material demand and constantly changing patterns of trade, and with disruption and market failure being present for particular raw materials.

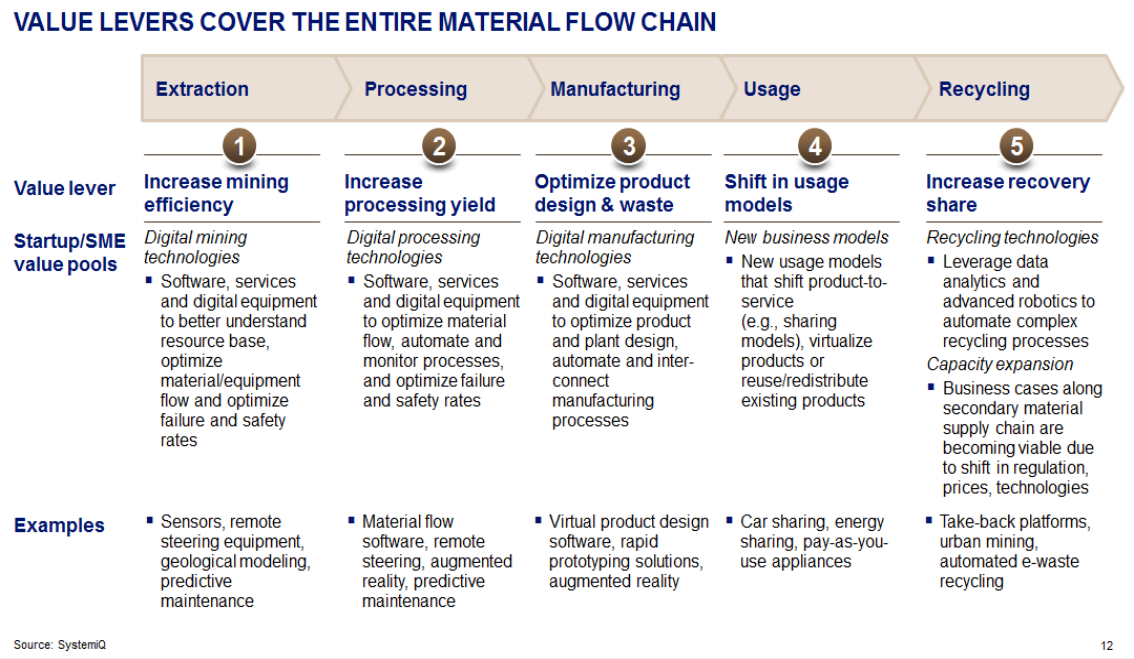
Traditionally, the mining sector is driven and dominated by large corporations. This is mostly linked to the high CAPEX intensity, long payback periods of investment and rather low fungibility of assets in operation. However, new disruptive technologies, business model innovations and regulatory changes are transforming the competitive landscape of the mining sector. An adjacent raw material sector is emerging, with value pools around technologies increasing the efficiency of material supply and reducing waste and material usage, such as those related to:

- Digital or Industry 4.0 type technologies for mining and processing companies
- Advanced sorting, dismantling and recycling technologies
- Waste management for e-waste, precious and specialty metals
- New usage models that shift products to services, virtualize or redistribute products

Naturally, incumbent players would be rather slow in exploiting such newly arising opportunities. Start-ups, not having the need to defend legacy business, are generally more agile in this field. The relatively limited number of viable new ventures in the raw material sector compared to the economic potential however indicates market barriers that impede entry or scale-up of new technologies and ventures. Such barriers include as explained earlier high upfront capital and specialised knowledge requirements, market-specific trading patterns and market reflexivity. Altogether this results in high underlying volatility and risk with regards to new venture activity.

Figure 3 presents the contributing value levers and technologies for business creation in the different steps of the material value chain. It is shows that digitalization technologies are central in this.

[Figure 2]: Value Levers for business creation across the material value chain



(Source: SystemIQ (2024))

From a second viewpoint, we can consider the future of global supply chain development from the perspective of developing countries in the Global South. Since 2012, the UNEP’s Eco-Innovation project has supported entrepreneurs in creating businesses in the developing and emerging economies of the Global South. The project provides methods and tools to implement eco-innovation in small and medium-sized companies. The business cases that have been generated through this programme have been evaluated concerning of the role of technology in the implementation, including its connection with the circular economy approach.

6. Envisioning a circular economy-based industry in the Global South towards 2030/2050

The circular economy aims to produce a resource-efficient society in which the consumption and production systems operate within the boundaries of our ecosystem's resilience. This will affect all actors of society. As well as producing new business opportunities, as identified above, it will also affect the roles of policy makers, financiers, consumers, suppliers, and designers. From this perspective, it is important to look ahead and envision what this future will look like. Industrial sectors need to redefine their role and approach, identifying business opportunities and research and innovation needs. Countries and regions need to assess their strengths and evaluate their possible pathways.

At the European level, projects such as the Vision and Roadmap for European Raw Materials bring together industrial actors and researchers. The project aims to produce a common long-term vision and roadmap to 2050 for the most relevant raw materials, including metals, industrial minerals, aggregates and wood. At the ASEAN level, the circular economy framework states that Southeast Asia's industry sector needs to foster the sustainable supply and use of raw materials to feed existing and new value chains, while ensuring a base load of resources from ASEAN, decreasing import dependency and ensuring the resilience of the ASEAN and East Asia industrial base through resource diversification. The future vision is based on the idea that the right materials need to be made available in the right place for the right product. Coupling this diversification concept with the principles of the circular economy leads to a different approach to the sourcing and management of materials.

The Regional 3R Forum for Asia and the Pacific gathers 35 countries, that have signed the Jaipur Declaration towards the promotion of circular economy in achieving resource efficient societies in Asia and the Pacific in line with the 2030 Agenda for Sustainable Development. United Nations Centre for Regional Development (UNCRD) coordinates this initiative. In the declaration, the signing parties express their commitment to strengthening coordination in order to adopt and implement circular economy plans, and a whole-of-value chain approach, as well as strategies and tools to reduce, reuse, and recycle natural resources in production, consumption and other life cycle stages (7th Regional 3R Forum in Asia and the Pacific, 2025, Jaipur 3R Declaration, India).

Several studies recognise the need for more efficient resource management in view of increasing consumption patterns, as well as the inherent strengths of Asian societies with regard to recovery and recycling as well as digital technologies. Combining these factors could enable a direct transition to effective (circular) systems, avoiding linear system lock-ins (EMF 2017). The Economic Research Institute for ASEAN and East Asia (ERIA) has gained insights into the international perceptions towards Industry 4.0 and the circular economy and can provide input on the progress and problems of its implementation.

The UNEP International Resource Panel has performed pioneering research into responsible resource management and resource efficiency in Africa. The Panel identified priority products and materials, advised on decoupling between economic activity, resource use and environmental impact and identified the critical role of recycling of metal stocks and flows (UNEP 2012). The African Union (AU) recently launched the Continental Circular Economy Action Plan (CEAP), a ten-year strategy to foster sustainable industrialization and climate-resilient growth in Africa by incorporating circularity into key economic sectors (Käsner et al. 2024).

7. The future of the Circular Economy and the Digital Economy in the Global South

The circular economy is based on the make-use-dispose logic of the linear economy. These businesses have made a business from taking ownership and responsibility for the materials that industry and society want(ed) to dispose of. They have assumed a central role in the management of hazardous materials and the reduction of exposure to toxic substances. With the introduction of the circular economy, the material ownership and risk allocation will change (Velis and Vrancken 2015). Material recycling industries in sectors such as automotive need to re-evaluate their business concepts and make the transition to material management in a changed industrial and consumption context. This is a system in which materials are exchanged, pooled, and shared, where value is maximised, and therefore safe sinks are still necessary.

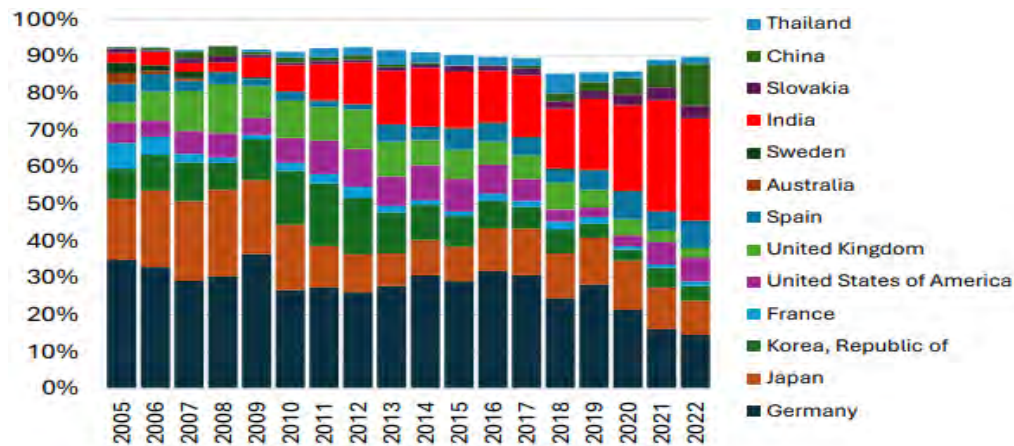
The Global Waste Management Outlook (GWMO) report was presented by UNEP IETC in 2015 (UNEP 2015). One of its actions called to move the focus of ‘waste management’ upstream, to become ‘resource management’ as an integral part of a circular economy.

The introduction of the digital economy will be a determining factor for the future of the waste sector. Material management will no longer be a merely logistical concept. In current practice, waste collection services are already optimised using digital technology. The introduction of sensors, identification and tracking allows data collection on the flow and destination of goods and components. Data analysis and intelligence, together with the Internet of Things, will enable the mapping of materials and initiate a new range of material management services.

The introduction of advanced characterisation techniques using digital technologies and robots could transform waste sorting and material processing. The introduction of large-scale sorting installations will enable the production of higher value recovery materials and the production of new higher-grade secondary products. This will have an impact on waste collection and recycling schemes and could allow significant progress to be made in material recycling as well as impacting current landfilling practice.

The automobile sector poses a vast source of investment for Africa. In 2024, the African automotive market was valued at \$20.5 billion, expected to grow by \$6 billion by 2029 (CII, 2024), however, this market is currently dominated by imports of used vehicle from Europe, the United States, and Japan (EMF, 2024). International car manufacturers are increasingly establishing manufacturing plants across Africa to bolster supply chains presence on the continent.

[Figure 4]. Used Vehicle Imports to South Africa by Country %



(Source: Tardemap.org)

Figure 4 shows the sources of vehicle imports to South Africa. East Africa predominantly imports used vehicles from Japan, whereas West Africa imports them from North America. Nigeria is the main market for these imports accounting for 16% of total African used vehicle imports, followed by Libya (11%), Tanzania (9%), Guinea (6%), and Ghana (5%). Among African countries, only South Africa, Egypt, Tunisia, Algeria, and Morocco have legislated bans on the import of second-hand vehicles, while some countries impose no restrictions, and others have age limits for imported used vehicles. The affordability of used cars, due to lower disposable incomes, limited credit and vehicle finance access, and the higher cost of new vehicles, makes them a favorable option for African consumers.

The circular economy in the automotive sector is characterized by sharing, electrification, automation, materials evolution, and a system-level integration of transport modes. Adopting the circular economy, aided by digital platforms in the Global South, aids in the minimization of e-waste, the repurposing and harvesting of raw materials, and the electrification of materials. (T20 2025).

8. The State of the Circular Economy Transition in Africa

The African Circular Economy Alliance (ACEA) was founded in 2016 by the governments of Rwanda, South Africa, and Nigeria in partnership with UNEP and WEF to share best practice regarding circular economy policy development. Current members are Nigeria, South Africa, Rwanda, Ghana, Burkina Faso, Benin, Sudan, and the Ivory Coast.

The following thematic areas have been identified for implementation

- Converting food waste to organic fertilizer
- Recycling plastic packaging
- Promoting e-waste collection and recycling
- Promoting the use of mass timber
- Recycling clothing and textiles waste

The Africa Circular Economy Facility (ACEF), established by the African Development Bank in 2022, provides financial backing for the intra-national circular economy transition. The ACEF outlined a three-point approach for forwarding the circular economy transformation at all levels in Africa, comprising capacity building and policy development, circular business development, and advocacy and knowledge sharing.

There are some converging efforts in the application of circular economy policies in Africa and ASEAN. Figure 5 below shows the types of existing policies in Africa as per country in 2020

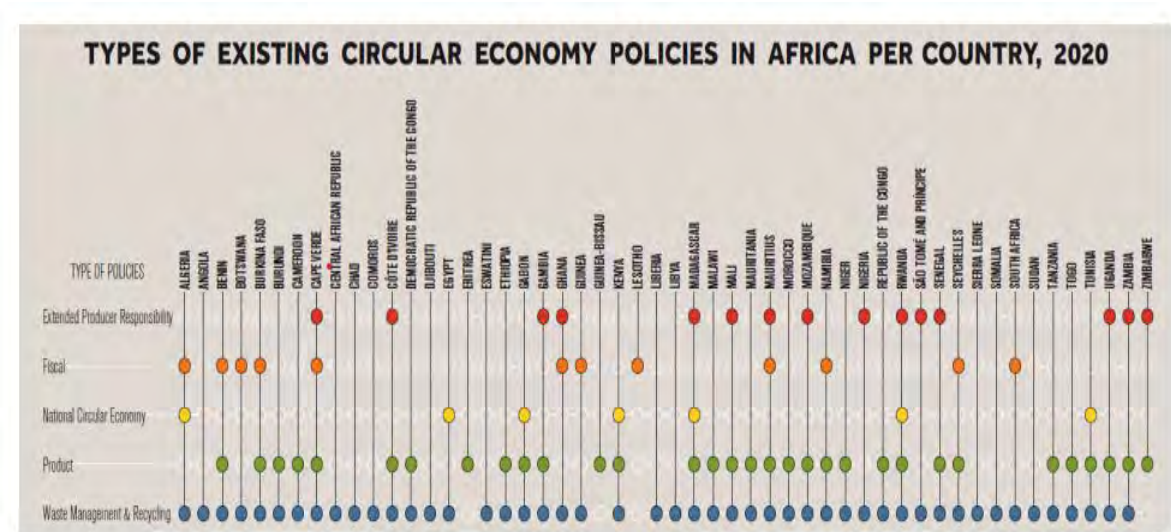


Figure 21.1 CE-related policies, regulations and initiatives in a selection of African countries (Source: GRID-Arendal, ACEN, Footprints Africa and ICLEI, 2021)

[Source]: GRID-Arendal, ACEN, Footprints Africa and ICLEI, 2021.

As could be seen in the figure and the table 2 below across the continent of Africa, countries are in the different stages of adopting circular economies.

[Table 2] Current level of Circular Economy initiatives in the African continent

Sub-Region	Key Features
Intra-Regional	The African Circular Economy Alliance (ACEA) was founded in 2016 by the governments of Rwanda, South Africa, and Nigeria in partnership with UNEP and WEF for best practices regarding circular economy policy development. The current members are Nigeria, South Africa, Rwanda, Ghana, Burkina Faso, Benin, Sudan, and the Ivory Coast. Five thematic areas: - Converting food waste to organic fertilizer - Recycling plastic packaging - Promoting e-waste collection and recycling - Promoting the use of mass timber

	- Recycling clothing and textiles waste
Eastern Africa	- Rwanda: 2019, revised its Environment and Climate Change Policy called for the establishment of a legal and institutional framework on the circular economy. - 2017, the East African Community (EAC) adopted a resolution named Polythene Materials Control Bill aimed at regulating the use of polythene in the region. - In Kenya, the National Environment Management Authority (NEMA) has drafted the legislation on the ‘Environmental Management and Co-ordination (E-waste management). Kenya has emerged as a leader of digitalization in Sub-Saharan Africa. - Nairobi city government has launched campaigns to make the city zero-waste. - Multiple governments are members of key working groups to develop policy implementation strategies.
Western Africa	- Cameroon and Ivory Coast, Nationally Determined Contributions (NDCs) include the circular economy in their adaptation commitments. - Senegal in the process of developing such plans - Ghana established the Ghana National Plastic Action Partnership, a country-wide platform for multi-stakeholder engagement tasked with establishing a regional model for the circular economy transition and managing plastics. - Lagos State, Nigeria organized the Lagos State Roundtable on Circular Economy in 2020 and presented plans for incorporating the circular economy in the 30-year development plan.
Northern Africa	- Morocco is in the process of developing such plans for circular economy action plan - Demco, a clothing manufacturer in Tunisia incorporates the recycling of water, energy, and textile waste to recycling partners.
Southern Africa	- In 2020, South African stakeholders, government, and NGOs created the South African Plastics pact chaired by GreenCape. - South Africa aims to bolster its policies regarding Extended Producer Responsibilities (EPR)—policies related to packaging and recycling of electrical and electronic equipment. In addition to industry regulation, these policies aim to fund a salary scheme for workers in the informal sector. - South Africa: Digital Society South Africa (2017) - Cape Town South Africa, launched Africa’s first circular economy action plan on a city level

Early adoption involves a fragmented approach anchored on integrated waste management and a limited understanding of the benefits and components of the circular economy. The East Africa sub-region's readiness remains at the moderate transition phase, characterized by a few articulated policies and/or strategies to establish the circular economy and national initiatives supported by donors and governmental funds. The Southern African sub-region represents an integration phase of the circular economy with industrial policies. This advanced integration is aided by emerging EPR laws and policies, clearly identified sector-specific circular opportunities, and potential for increased investment from commercial investors. On the national level, multiple African countries, including Rwanda, Cameroon, Ivory Coast, Senegal, Morocco, South Africa, and Ghana have either established a component of circular economy transitions in their climate change and national adaptation policy commitments. In 2019, Ghana joined the international Global Plastic Action Partnership, established by the World Economic Forum (WEF) and set up the Ghana National Plastic Action Partnership - a national platform fostering cooperation between government, business, and civil society. African governments at a local, national, and international levels are increasingly recognizing the circular economy as a strategic framework for sustainable development — integrating it into policy, fostering public-private partnerships, and advocating for equity in global sustainability.

There are vast opportunities in Africa that lie in the informal economy. This sector underpins the backbone of activities such as textile reuse, metal and e-waste recycling, and repair-based entrepreneurship. According to the ILO (2023), formalising and scaling these practices could create 7–8 million new jobs in the Global South, particularly in Africa. Yet the lack of research and implementation in African countries highlights a significant knowledge gap.

Africa can leverage its material resources, such as copper, cobalt, and rare earth elements, and its maritime access, to further its position on the global stage. The east coast of Africa, part of the Indo-Pacific region, is poised to harness the blue economy, which the United Nations Economic Commission for Africa has dubbed the “new frontier of African renaissance.” With 90% of Africa's trade passing through maritime routes, the Bab-el-Mandeb Strait and the Indian Ocean trade corridors position African countries as indispensable to the global supply chains (Nkala, 2021). However, only 1.2% of the world's ships are African-owned underscoring Africa's invisibility in maritime trade.

9. Summary and Recommendations

The Global South could become a critical driver in shaping the transition to a global circular economy grounded in resilient and sustainable industrial development. With some of the world's fastest-growing urban centres, the largest informal workforce, and an abundance of natural resources, developing countries of Asia, Africa and Latin America are well placed to demonstrate how circularity can address the specific socio-economic development challenges. However, there are still gaps. Many countries in the Global South are in the early stages of adopting integrated circular economy and digital strategies, with fragmented policy environments and limited capacity for Industry 4.0 technologies. The circular economy transition relies on sufficient digital technological knowledge and infrastructure to formalize waste regeneration. Currently, this knowledge is limited in several African countries, so implementation plans must be tailored to the national context.

The following serve as recommendations for such a partnership and contribute to building Africa's Circular Economy Master Plan

- Establish circular material transition targets and key performance indicators (KPIs) to encourage the circular design of products and associated services.
- Identify actions and foster collaboration for making trade and investment policy supportive of circular supply chains.
- Enhance circular economy financing and establish dedicated funding mechanisms.
- Develop ESG metrics that evaluate company performance against circularity principles. These metrics are used by financing institutions to deploy capital in line with their institutional mandates.
- Nurture a localised circular economy transition, harnessing regional resources to shorten value chains, reduce emissions, bolster local economies, and create long-term value. Allow Path Diversity towards the transition and the value creation across local communities to maximize the long-term value.
- Develop an open digital platform to ensure national, regional, and transcontinental digital connectivity along circular value chains that make the transition to a circular economy just, inclusive, and entirely optimal for the Global South with the support of the above-proposed global EPR standards and other economic incentive mechanisms.

Built upon an intercontinental partnership between Asia, Japan and Africa, this Master Plan presents a shared opportunity for sustainable and equitable development across the Global South. Japan and Africa's increased connectivity through circular supply chains and digitalisation is set to spearhead the transition to sustainability. Although challenges remain in terms of financing, policy and infrastructure, there is still potential for mutual growth through innovation, regional integration and private sector investment. Global forums such as the G20 and TICAD can catalyse this transformation by advancing coordinated policy frameworks, financing mechanisms, and digital infrastructure, making circularity an environmental goal and a driver of economic resilience and South–South prosperity.

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Special Article 2: The Progress and Challenges of Global Warming Negotiations

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1. Introduction

I have participated in nineteen COP meetings since COP6 (The Hague) in 2000. From 2000 to 2002 and again from 2008 to 2011, I served as a negotiator for the Ministry of Economy, Trade and Industry (METI). In particular, from 2008 to 2011, as METI's Chief Negotiator, I was directly engaged in the process leading to the Cancún Agreements (2010). Drawing on these experiences, I would like to share my reflections on the key challenges confronting the international framework for addressing global warming.

2. From the Kyoto Protocol to the Paris Agreement

The United Nations Framework Convention on Climate Change (UNFCCC), adopted in 1992, provided the first international framework for addressing global warming. The Kyoto Protocol was adopted in 1997, following recognition that the stabilization targets outlined in the Convention—which called on Annex I countries (developed countries) to return greenhouse gas emissions to 1990 levels by 2000—were unlikely to be achieved.

The Kyoto Protocol imposed binding reduction obligations only on developed countries, exempting developing countries from any commitments. While consistent with the UNFCCC principle of “common but differentiated responsibilities,” this framework proved ineffective in addressing a global challenge. Moreover, the numerical targets were asymmetrically advantageous to the EU. For example, owing to factors unrelated to climate efforts—such as the UK's “dash for gas” and the reunification of Germany—the EU had already achieved its 8% reduction target by the time the Protocol was signed. By contrast, the United States withdrew under the Bush administration, while Japan, having already pursued extensive energy efficiency, found its -6% target extremely challenging. Meeting it required purchasing overseas credits exceeding one trillion yen, which was widely regarded as a diplomatic setback for Japan. Participating in the negotiations for the first time in 2000, I keenly recognized the inherent irrationality of the Kyoto Protocol.

Climate negotiations have long been characterized by deep divisions between developed and developing countries. During my tenure as Chief Negotiator (2008–2011), negotiators from major emerging economies such as China and India consistently maintained the dichotomy that developed countries should remain bound by legally binding targets under the Kyoto Protocol, while developing countries should be limited to voluntary actions. Yet by then, the rapid rise in emissions from emerging economies—particularly China—made it evident that a framework imposing obligations only on developed countries was no longer viable.

Japan and other developed countries argued that differentiation was legitimate—developed countries should reduce absolute emissions, while developing countries could pursue intensity-based reductions relative to GDP—but both groups must contribute within a common framework. Reflecting this position, at COP16 (Cancún) I declared: “*Japan will not participate in the second commitment period of the Kyoto Protocol under any conditions.*”

Japan indeed declined to join the second Kyoto commitment period, but it did participate in the Cancún Agreements, which required all major countries, including the US and China, to set voluntary targets, report progress, and undergo review. The key differences from Kyoto were: (1) all countries took on targets or actions; (2) these were nationally determined rather than negotiated; and (3) no punitive measures applied for non-achievement. This bottom-up approach enabled broad participation, including from the US and China.

The Paris Agreement, adopted in 2015, institutionalized this pledge-and-review approach. Having endured the frustrations of the Kyoto framework, I felt profound relief that at last a universal framework had been established.

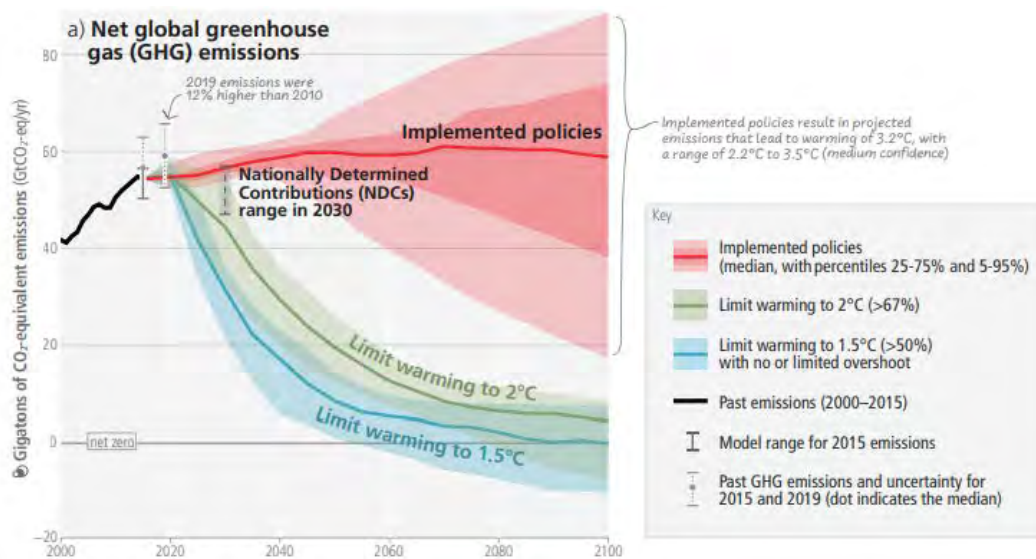
3. The Rise of 1.5°C Absolutism

While the Paris Agreement’s bottom-up framework secured universal participation, environmental groups and some governments increasingly argued that global temperature goals—particularly limiting warming to 1.5°C—should take absolute priority. Since the IPCC Special Report on Global Warming of 1.5°C (2018), the UN, EU, and NGOs have pressed for net-zero emissions by 2050 and strengthened 2030 targets.

The Paris Agreement sought a delicate balance between top-down goals and bottom-up flexibility. Yet recent COPs have increasingly elevated the 1.5°C target and the 2050 net-zero goal into de facto absolutes, marginalizing the nationally determined aspect.

At COP26 (Glasgow, 2021), the debate over coal phase-out highlighted this rift. The UK proposed “phase-out” of coal in the Glasgow Pact, but India insisted on changing the term to “phase-down,” provoking strong dissatisfaction among Europe and small island states. If carbon neutrality by 2050 is treated as a non-negotiable imperative, then arithmetically, not only new coal plants but also existing plants—and indeed the entire fossil fuel sector—would require rapid phase-out.

The feasibility of the 1.5°C pathway is extremely doubtful. The IPCC Sixth Assessment Report estimates that achieving it with minimal overshoot requires global CO₂ reductions of 48% by 2030 and 65% by 2035 compared to 2019 levels.

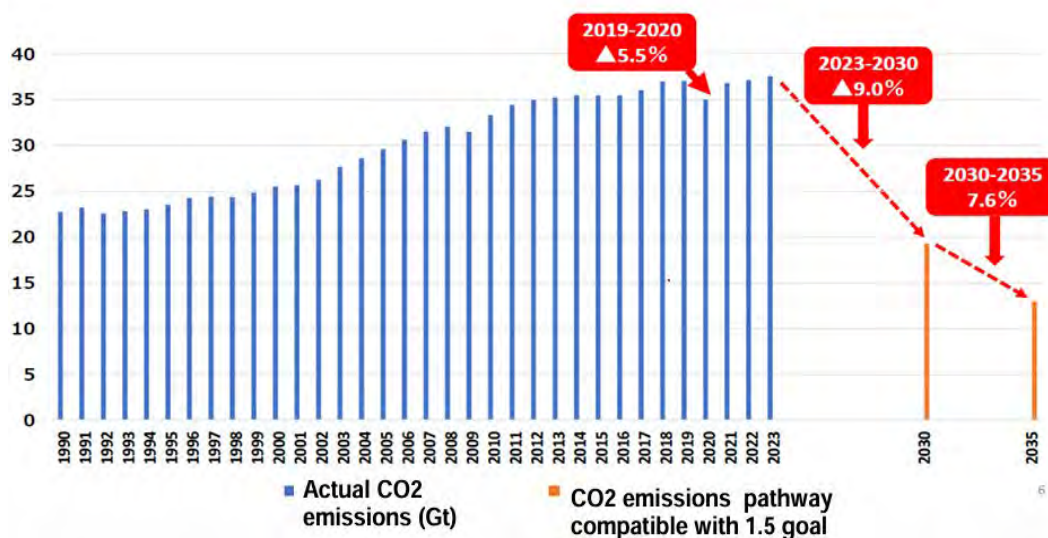


		Reductions from 2019 emission levels (%)			
		2030	2035	2040	2050
Limit warming to 1.5°C (>50%) with no or limited overshoot	GHG	43 [34-60]	60 [49-77]	69 [58-90]	84 [73-98]
	CO ₂	48 [36-69]	65 [50-96]	80 [61-109]	99 [79-119]
Limit warming to 2°C (>67%)	GHG	21 [1-42]	35 [22-55]	46 [34-63]	64 [53-77]
	CO ₂	22 [1-44]	37 [21-59]	51 [36-70]	73 [55-90]

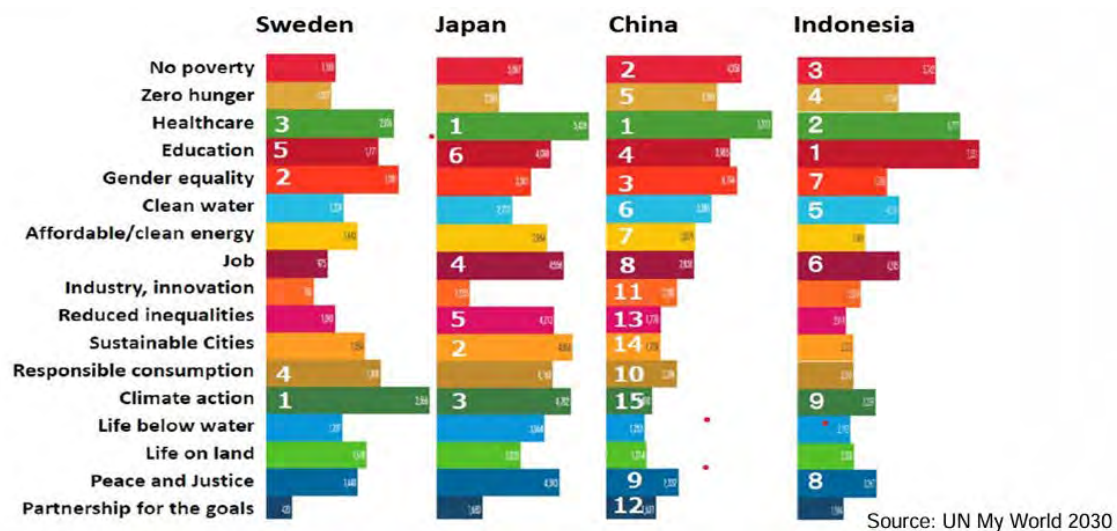
Source: IPCC AR6 Summary for Policy Makers

Even during the COVID-19 pandemic in 2020, global CO₂ emissions declined by only 5.5%. Meeting the 1.5°C pathway would demand annual reductions of 9% from 2023 to 2030 and 7.6% from 2030 to 2035—clearly unrealistic given the development needs of the Global South.

Global CO₂ emission pathway required to achieve the 1.5°C target



For many developing countries, urgent priorities remain poverty eradication, education, health, energy access, and employment. Climate mitigation, unlike for developed countries, is not their foremost SDG priority. Despite this, since COP26, the 1.5°C target has become the prevailing standard—though its feasibility is virtually nil—fueling further contention.



4. Global Stocktake and Energy Transition

The first Global Stocktake (GST) was completed at COP28 (Dubai, 2023). Its aim was to evaluate collective progress toward the Paris Agreement goals and inform future target-setting. A central controversy was whether to explicitly mandate fossil fuel phase-out. Western countries, small island states, and NGOs insisted it was essential for the 1.5°C goal, while oil-producing states and Russia emphasized emission reductions rather than targeting specific energy sources. The compromise language adopted was “transitioning away from fossil fuels.”

However, the GST’s operative paragraph on energy transition lists eight efforts under the chapeau “Calls on Parties... in a nationally determined manner, taking into account the Paris Agreement and their different national circumstances.” Transitioning away from fossil fuels was only one item in this “à la carte menu,” as Saudi Arabia’s oil minister remarked. It is difficult to imagine that such wording alone will accelerate global energy transitions.

The GST text “recognized” figures such as peaking emissions by 2025 and reducing them 60% by 2035, as cited in IPCC AR6. Yet these are aspirational references, not binding targets for China, India, or others. Notably, for the first time, nuclear power, CCUS, and transition fuels (natural gas) were explicitly acknowledged alongside renewable expansion and efficiency gains—reflecting the geopolitical realities underscored by the Ukraine war.

Still, achieving these transitions in developing countries would require massive financing. The GST recognized that meeting global neutrality by 2050 would demand \$4–5 trillion in annual

clean energy investment. Calls for higher ambition at COPs thus inevitably translate into higher financial “invoices” from developing to developed countries.

5. The Feasibility of the New Collective Quantified Goal

This financing question dominated COP29 (Baku, 2024), where Parties debated the New Collective Quantified Goal (NCQG) for climate finance from 2025 onward. Developing countries demanded at least \$1.3 trillion annually in concessional public finance. Developed countries countered that the donor base should expand to include wealthier emerging economies such as China and oil exporters, and that mobilization of private finance was essential. They proposed \$200 billion, which was denounced as grossly inadequate. Ultimately, a compromise figure of \$300 billion was set—but India and others strongly criticized the agreement as unacceptable. Meanwhile, proposals for stronger mitigation measures, such as fossil fuel phase-out, were dropped entirely.

The outcome left both sides dissatisfied. Moreover, the achievability of \$300 billion is questionable, especially since the Trump administration in Washington has declared it will provide no funds at all. It is unrealistic to expect Japan or the EU to cover the US shortfall. Without credible financial commitments, raising developing countries’ mitigation ambition is unlikely.

6. A Realistic Energy Transition

The world is not moving in unison toward the 1.5°C goal. Some blame the Paris Agreement’s bottom-up flexibility, arguing that enforceable Kyoto-style obligations are needed. But even if the Agreement were tightened with penalties, major emitters like the US and China would not accept such terms. Moreover, binding obligations would simply incentivize countries to adopt low-ambition, easily achievable targets. Imperfect as it is, the Paris framework remains the only viable option.

Current debates often prescribe specific transition pathways—rapid fossil fuel phase-out, tripling renewables, etc.—but these diverge from the realities of emerging economies. Phasing out coal plants mid-life may suit Europe but is unrealistic for Asian economies facing surging power demand. Similarly, blanket restrictions on financing natural gas in Africa, promoted by Europe and the Biden administration, ignore the fact that no developed country relies solely on renewables. Western responses to the Ukraine war—Norway expanding gas exports, Germany reopening coal mines, the US urging OPEC to pump more oil—reinforce perceptions in the Global South of double standards and “eco-colonialism.”

Around 660 million people still lack electricity, mostly in Africa. For them, “energy transition” means shifting from biomass to modern energy, not from fossil fuels to renewables. Expanding agriculture requires fertilizer; building infrastructure requires cement and steel—all fossil-fuel intensive. Denying these fuels contradicts poverty eradication.

As Daniel Yergin has argued, transitions are driven by economic viability and technology, not imposed blueprints. High-cost transitions are politically unsustainable even in rich countries.

Clean energy supply chains also pose new geopolitical risks, as critical minerals are concentrated in few countries.

Thus, fixation on 2050 carbon neutrality only deepens divides between North and South. A more realistic transition discourse, grounded in the development realities of the Global South, is essential.

Despite setbacks—such as the Trump administration’s withdrawal from Paris—no other country has exited the Agreement. Efforts continue worldwide, albeit reflecting each nation’s political, economic, and social circumstances. What has collapsed is the unrealistic post-COP26 assumption that all countries would unconditionally pursue 1.5°C and 2050 neutrality as supreme values. The bottom-up spirit of Paris—each country doing what is feasible—has reasserted itself.

7. The Need to Focus on Adaptation

Finally, climate finance must rebalance toward adaptation. Between 1996 and 2016, about two-thirds of flows went to mitigation, while less than a quarter supported adaptation. Mitigation delivers diffuse, global benefits, whereas adaptation brings immediate, tangible resilience in host countries.

Given that 1.5°C and 2050 neutrality are unlikely, and that climate impacts will fall disproportionately on the Global South, prioritizing adaptation is both urgent and politically stabilizing. Advancing discussions on the Global Goal on Adaptation (GGA) is therefore a critical task for COP30 (Belém, 2025).

Chapter 3

Overview of African Politics and Economy

Chapter 3: Overview of African Politics and Economy -- For Sustaining Growth in Sub-Saharan Africa: In Search of Structural Transformation

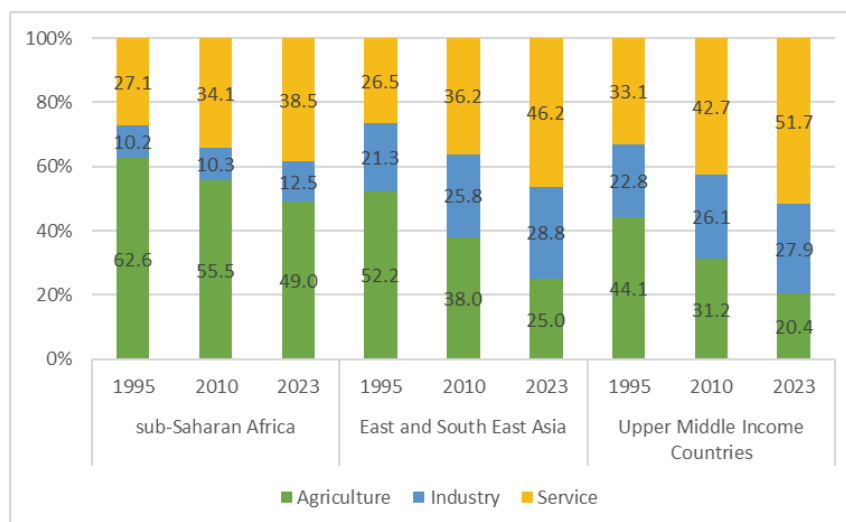
Takahiro FUKUNISHI Ph. D, Senior Research Fellow, Institute of Developing Economies, Japan External Trade Organization (IDE-JETRO)

Recently, many stakeholders expect transformation of African economies through application of digital technology removing constraints on firm activities. While digital technology has delivered productivity gain in African firms, it is not clear if they lead to structural transformation from agriculture to industries, and from informal-based to formal-based economy, which is necessary to realize sustained economic growth. Based on a brief history of industrial policies in sub-Saharan Africa, this chapter argues that potential and challenges of the recent industrial policies.

1. Need for Structural Transformation

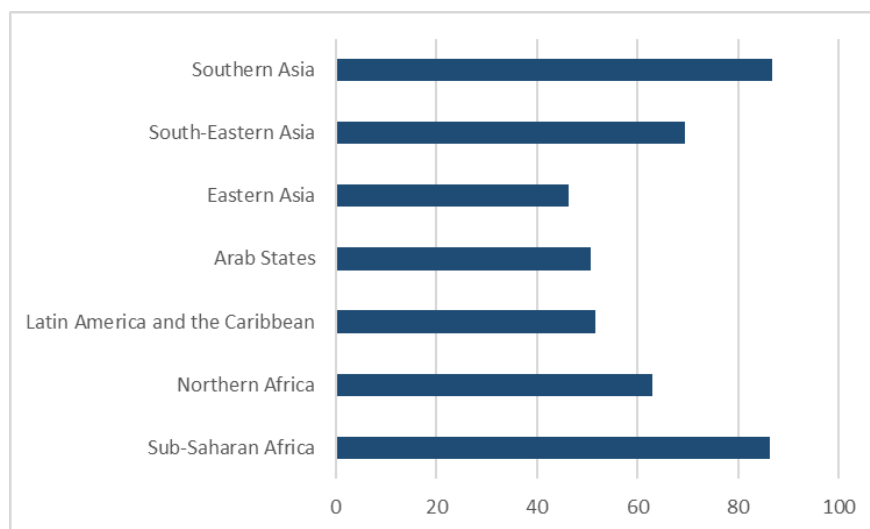
The economies of sub-Saharan African countries (hereafter referred to as “Africa”) have experienced major changes in recent years. Since the mid-2000s, direct investment from developed and emerging countries has increased in transportation infrastructure such as roads, railroads, and ports, as well as residential and commercial facilities. More recently, as Internet access becomes widely available with the development of mobile communication networks, mobile money is spreading rapidly, and online shopping is becoming common, especially in urban areas. While these are positive changes for growth and poverty reduction, African countries still suffer from the highest poverty rate, headcount ratio under the international poverty line, in the world.

[Figure 1] Employment Share by Sector



(Source: World Development Indicators)

[Figure 2] Fraction of Informal Employment (% , 2024)



NOTE: Informal employment includes employment in informal sector and employment in formal sector without a contract complying with labor laws.

(Source: ILO STA)

Persistent poverty is related to the two features of the African economies. First, employment is concentrated in agriculture with small fraction in the manufacturing sector. In sub-Saharan Africa as a whole, employment in agriculture is the largest, while employment in industry is the smallest (Figure 1). Although there has been a gradual shift of labor from agriculture to services, structural changes from agriculture to manufacturing has not yet realized in African countries except for a few countries such as South Africa and Mauritius. And the two largest sectors, agriculture and service are composed of small farmers and self-employed, with low labor productivity. These micro-scale producers form the informal sector, which are not registered with the government and evade the obligation to comply with various regulations. Another characteristic of African economies is that the informal sector employs more workers than the formal sector, in which employment is better paid and protected by labor regulations (Figure 2).

Africa has one of the highest population growth rates in the world (2.5%, 2023 WDI). The number of young workers will continue to grow, with the ILO estimating that young workers in the sub-Saharan Africa region will increase by approximately 72.6 million between 2023 and 2050 (ILO, 2024). For this growing number of young people to get out of poverty, they need to move to cities and find employment in the manufacturing and service industries in formal sector. In other words, the poverty rate will not decline unless the number of decent jobs in non-agricultural sectors increases, and at a faster rate than the growth rate of the labor force (Bandiera et al. 2022). This means that Africa needs high growth in both the number and quality of jobs.

2. Industrial Policies in Africa

The structural transformation of the economies has been the most important challenge for African countries since independence. Given an economic structure specializing in primary commodities such as agricultural products and natural resources, created in the colonial era, the new African governments pursued import-substitution industrialization through the active

industrial policies. Modest growth shown in the 1960s did not sustain and turned stagnated after the Oil Shocks in the 1970s, leaving large government debt. In the 1980s, the World Bank and the International Monetary Fund introduced the structural adjustment programs focusing on economic and trade liberalization as a condition of loan. Many state-owned enterprises were abolished or privatized, support for local industries including protective tariffs on imports, subsidies and low-interest loans were largely eliminated. The government's role was limited to stabilizing the macroeconomic conditions. Subsequently, establishing effective institutions for smooth functioning of markets was emphasized as a part of good governance in developing countries, while active intervention in private sectors was not allowed. During the 1980s and 1990s, however, African economies experienced serious stagnation and poverty deepened.

Given the persistent poverty in Africa, Jeffrey Sachs, who initiated the UN Millennium Development Goals, argued that these countries had been captured in a poverty trap and needed large scale of aid to escape the trap (Sachs et al. 2004). He argued that poverty reduction cannot be achieved by simply liberalizing the economies. While his argument induced controversy with those sceptical of aid, it triggered discussions on development strategies, and the need for structural transformation. At the same time, witnessing China's industrial growth and the resulting stagnation of the manufacturing sector, some African governments began to set industrialization as a policy target. In the mid-2000s, African countries experienced resource-led economic growth for a decade but resulting in quite limited employment generation. This encouraged African governments, donors, and development agencies to emphasize the diversification of economic structures and African governments began to pursue industrialization as a key channel to economic growth.

From the late 2000s onward, African countries started active industrial policies. Special Economic Zones (SEZs) have been established to attract foreign direct investment. Some countries have also begun to explicitly support industries through expanding supply in the domestic market. Rwanda, for example, has started a policy to increase share of local products in the domestic market. It designates construction materials (especially cement), light industry (textiles, etc.), and processing of agricultural products as target industry, providing financing in leading domestic companies and giving priority in government procurement. Oil-producing countries have implemented local content policies that require foreign mining companies to procure materials, parts, and related services from local firms. These are import-substitution industrial policies that were strongly rejected in the structural adjustment programs.

Currently, mainly two types of policies are implemented for industrialization. The first is to facilitate efficient business environment to remove constraints on business activities. It includes stable macroeconomic policies, effective contract enforcement and property rights, public services related to business such as licensing and customs clearance, access to finance, and infrastructure such as electricity and transportation. These have been imposed by aid agencies on African countries since the 1990s, and some progress has been made, but the business environment in African countries remains ineffective in the world (World Bank 2024). The other is to support for industries to achieve economies of scale. Given increasing-return-to-scale technology in the manufacturing sector, large-scale investment is required to achieve productivity comparable with industries in foreign countries. Policies inducing large investment are considered effective for industrialization, which include provision of public finance and protecting the domestic market from imports to ensure market share of domestic firms. These approaches were actively adopted in many countries after independence but had been rejected under the structural adjustment program. Only recently, have they been reintroduced in the menu of industrial policies.

3. Toward Structural Transformation

There have been high expectations for digital technology to bring about economic growth in Africa. With poor wired communication networks, mobile communication technology has had a major impact, rapidly spreading among urban and rural populations. In particular, it facilitates penetration of mobile money as financial infrastructure. The spread of mobile money has led to the proliferation of online shopping in urban areas, combined with SNS, e-commerce platforms, and motorcycle delivery services. Online services have greatly increased opportunities for informal micro-businesses to search for and exchange information with consumers and suppliers, improving the efficiency of marketing and procurement. In addition, microfinance through mobile money has become available to many micro-businesses. Digital technology including mobile networks has the potential to eliminate constraints on economic activity in Africa (e.g., Goh 2025).

The development of digital technology may induce growth driven by the service sector rather than the manufacturing sector that has been stagnating in Africa. While the arguments on leading sectors in growth process are still inconclusive, in order to realize sustained economic growth, digital technology needs to generate productivity gain in the whole economy, which entails transformation of economies from informal-sector based to formal-sector based through the growth of firm size. Therefore, it must lead to productivity improvements of medium and large-sized enterprises, while currently we see significant changes rather among the informal micro-businesses. For this purpose, rather than growth potential of ICT sector, the most promising impact of digital technology on economic growth is transformation of business environment that has been improved only slowly for the recent decades. It needs to streamline business licensing, improved access to finance, stabilization of power supply, and simplifying cross-border logistics procedures, so that firms in formal sector are benefitted by reduced operational and transaction costs.

The realization of these goals requires strong initiative of public sectors, while based on past performance, it is not clear if the African governments will promote necessary actions in the digital field. For example, M-Pesa, the most popular mobile money service launched in Kenya, was a technology led by a private company with little involvement of Kenyan government. While the private-sector-led approach has been successful for the spread of mobile money (Tyce 2020), users have suffered from serious problems. Frequent online frauds have discouraged consumers from contacting unknown shops and people online (Fukunishi and Inoue 2024). Furthermore, since interest rates for mobile finance were not regulated until recently, extremely high interest rates were set, leaving many users unable to repay their loans. It has been argued that the government does not prioritize consumer protection over the interests of mobile communication operators (Upadyaya et al. forthcoming). Those cases raise questions about the effectiveness of African governments in changing the business environment by digital technology.

Industrial policies in Africa are still in their infancy. With the exception of Ethiopia, South Africa, and Mauritius, many African countries have lost their experience and knowledge during the period of the structural adjustment policies. Since the roles of government were limited in internal governance, policy makers did not develop an understanding of constraints and potential of local industries. Therefore, communication between private sectors and governments has remain sparse, and many countries have not even conducted census surveys of firms for many years. With rapid advances in digital technology, industrial technology is experiencing major changes, and labor-intensive manufacturing may no longer be the only entry point of industrialization. Considering these factors, African governments need to start by understanding

private sector through frequent dialogues and develop unique industrial policies tailored to country's socioeconomic conditions. To this end, donor countries and aid agencies, which used to provide standardized and common policy recommendations need to support formulation of unique industrial policies through gaining a detailed understanding of the societies and economies of African countries. Given increasing diversity among the donor countries in terms of their industrial experiences, coordination of policy recommendation between the traditional and emerging donors are also required to avoid inconsistencies in policy formulation.

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Chapter 4

Automotive Industry

Chapter 4: Automotive Industry -- A Leading Sector of Circular Economy Development

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1. Introduction

This chapter aims to provide an overview of the current state of the automotive industry in Africa, its development to date, and future prospects. Key characteristics of the automotive industry in Africa can be summarised as the low number of vehicles productions relative to the population size and the uneven distribution of production facilities. A significant portion of new vehicles sales within Africa are of imported vehicles. While South Africa and Morocco have well-established production bases with a certain level, production in other countries remains extremely limited. On the other hand, imports of used vehicles remain strong, particularly in countries with rapidly growing economies such as Kenya. However, there are signs of change to the current situation. In recent years, there has been a significant increase in news about European and the United States automakers starting sales and production of battery electric vehicles (BEVs), as well as Chinese manufacturers entering the market with local sales and production. These trends are spreading to countries other than South Africa and Morocco. The extent to which such movements will expand, backed by robust economic growth, could become a key focus for the future development of the automotive industry.

The following section provides an overview of the current state of the African automotive industry based on various figures, with a focus on information obtained from media reports, and discusses the latest trends and outlook.

2. Trends in Automotive Production and Sales in Africa

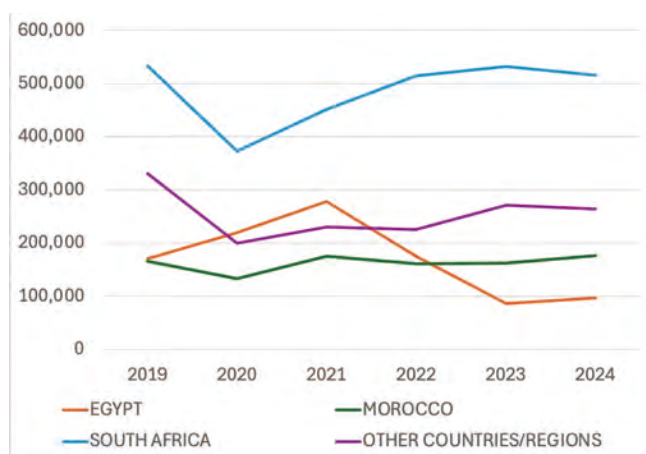
According to information released by the OICA (International Organisation of Motor Vehicle Manufacturers), new vehicle sales in Africa have fluctuated around the 1 million units per year, although there have been some deviations. This figure is roughly equivalent to domestic sales in Thailand and Indonesia (however, it should be noted that sales in these two countries have recently declined significantly). New car sales in Africa have not expanded significantly relative to the population size. South Africa accounts for approximately half of all new car sales in Africa. The three countries of South Africa, Egypt, and Morocco together account for approximately 70–80% of total sales in Africa, while the remaining 50 or more countries share the remaining 20% of sales, reflecting the geographical concentration of the African automotive market (Table 1). However, some estimates show that Algeria's 2021 new vehicle demand at 400,000 units and view Algeria as Africa's second-largest automotive market (JETRO, 30 January 2023). In Nigeria, 10,000 units were produced in 2021, but imports exceeded 30 times that figure (NADDC, 2023). Additionally, Kenya's new vehicle registrations in 2024 are projected to reach 69,000 units (JETRO 2025, March 11), representing a market size that cannot be ignored even when compared to Egypt.

[Table 1] New vehicle sales in Africa

	2019	2020	2021	2022	2023	2024
AFRICA	1,200,291	925,708	1,133,520	1,075,740	1,050,105	1,053,611
Egypt	170,568	219,732	277,805	175,125	86,044	96,862
MOROCCO	165,916	133,308	175,435	161,409	161,504	176,401
SOUTH AFRICA	532,898	372,633	450,674	514,178	531,557	515,853
OTHER COUNTRIES/REGIONS	330,909	200,035	229,606	225,028	271,000	264,495

(Source: OICA)

[Figure 1] Trends in automotive sales in Africa



(Source: Compiled by the author based on OICA data)

Next, we focus on production volume. According to OICA statistics, automotive production in Africa in 2024 is estimated to be approximately 1.177 million units. South Africa and Morocco each produce over 500,000 units annually, accounting for 98% of Africa's automotive production (Table 2). South Africa, the largest automotive producer in Africa, ranks 21st globally in terms of production volume in 2024. However, this is nearly 200,000 units less than Malaysia, which ranks 20th with 790,000 units production, and only about half of Indonesia, which ranks 15th with 1,197,000 units production. Note that Egypt's production figures in Table 2 have been zero since 2021, as these were not captured in OICA data. According to JETRO (2025, June 9), out of Egypt's 2024 new vehicle sales, 63,666 were locally assembled vehicles. Even if there were exports of locally produced vehicles, Egypt's local production volume is likely to be lower than that of Morocco or South Africa. It should also be noted that 94,413 locally assembled vehicles were sold in Egypt in 2020 (JETRO 2025), which exceeds the OICA statistics. In addition to Egypt, 11,555 vehicles will be assembled in Kenya in 2024 (JETRO 2025). There are also reports that 10,000 vehicles will be produced in Nigeria in 2021 (NADDC 2023). As such, it appears that

automotives are being assembled in countries other than those reported in the OICA statistics. Although there are limitations to the statistics, these data suggest that the African automotive industry is geographically uneven in terms of production.

[Table 2] Trends in automotive production in Africa

	2019	2020	2021	2022	2023	2024
AFRICA	1,095,151	776,247	907,302	1,022,783	1,170,447	1,177,400
ALGERIA	60,012	754	5,208	2,773	2,456	30,108
Egypt, annual only	18,500	23,754	0	0	0	0
Egypt (AMIC)	90,295	94,413	116,650	93,578	48,831	60,366
MOROCCO	403,218	328,280	403,007	464,864	535,825	559,645
SOUTH AFRICA	631,921	447,213	499,087	555,889	632,362	599,755

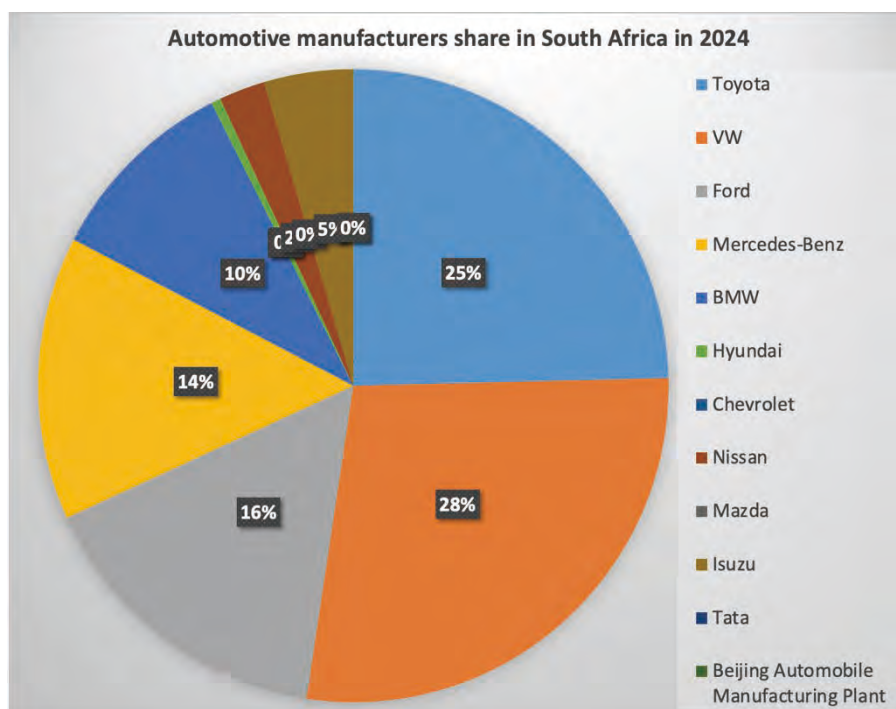
(Source: OICA. Note that the production figures for Egypt are not zero from 2021 onwards; rather, they were not captured in OICA's data. For reference, the data on local assembly of new vehicle sales from the Automobile Market Information Committee (AMIC) included in JETRO (2024; 2025) has also been included.)

There are significant differences between Morocco and South Africa in terms of the companies that have entered the market and their target markets. In Morocco, production has expanded as a result of the establishment and expansion of production bases, primarily European automakers, including Renault and Stellantis. As shown in Tables 1 and 2, Morocco is characterised by a situation in which production significantly exceeds domestic sales. While Morocco serves as a production hub for European manufacturers, its role is more as an export hub targeting the European market across the Mediterranean Sea rather than for local production and sales.

Unlike Morocco, South Africa is home to a diverse range of Japanese, European, and American automotive manufacturers with production bases. Historically, thanks to government export promotion policies, German manufacturers expanded production in South Africa as an export base for right-hand drive vehicles, while Japanese and American manufacturers expanded production as a supply base for small commercial vehicles for African countries (FOURIN 2016). Unlike Morocco, South Africa has a domestic market of 500,000 vehicles, so production is carried out for both the domestic market and export markets, including within Africa. In 2024, 391,000 units (65% of total production) out of 599,000 units produced were exported to 155 countries. The largest export destination is Europe (75.7% of exports), followed by Asia (7.5%), Africa (6.6%), and North America (6.5%). Another difference from Morocco is that production and sales figures are roughly equal in South Africa (Tables 1 and 2). This means that South Africa imports approximately the same number of completed vehicles as it exports. In 2024, South Africa imported 304,000 small vehicles (passenger cars and light commercial vehicles) from 24 countries worldwide. This accounts for 62.8% of small vehicle sales (485,000 units). The largest source of small vehicle imports is India (57.1% of total imports), followed by China (17.1%),

Germany (5.6%), and Japan (4.2%). In recent years, imports from India and China have increased significantly (NAACAM 2025).

[Figure 2] Automotive Production by Manufacturer in South Africa



(Source: Compiled by the author based on MarkLines data)

[Table 3] Breakdown of automotive production by manufacturer in South Africa

Manufacturer	Model	2017	2018	2019	2020	2021	2022	2023	2024
Toyota	Corolla	17987	18861	15603	7292	7414	5071	4995	N/A
Toyota	Corolla Cross	-	-	-	-	3683	16203	21001	26210
Toyota	Fortuner	14820	14869	14051	10614	9798	8688	10750	9862
Toyota	Hilux Revo	76305	87843	90257	70783	78662	72564	97644	84737
Toyota	Dyna	-	2768	2229	1187	1213	1067	1219	1022
Toyota	Hiace	14272	16198	11152	11801	13875	12374	16891	14378
VW	Polo	84233	101675	125197	103355	113009	116264	117941	115741
VW	Polo Vivo	26043	25452	28042	19607	19816	20370	27344	22678
VW	Amarok	-	-	-	-	-	-	13121	15270
Hyundai	Porter	3016	3225	2905	2226	2580	2267	2565	2735
Ford	Everest	5062	4876	3834	1709	2263	1132	-	-
Ford	Ford Ranger	82086	93420	91968	64542	75327	73375	78114	87314
Nissan	NP200	15047	18819	18510	10356	13150	13297	13266	2413
Nissan	Nissan Frontier (Navara)	-	-	-	-	6803	7832	9440	10683
Nissan	unknown	7531	15191	14326	8937	5484	-	-	-
Mercedes-Benz (-2022-)	C-Class	-	-	-	-	-	77302	N/A	80170
Mercedes-Benz (-2021)	C-Class	118216	101904	86414	55768	54027	-	-	-
BMW	BMW 3 Series	52867	8051	-	-	-	-	-	-
BMW	BMW X3	-	43719	69524	50963	58456	61329	67437	54976
Mazda	BT-50	444	581	-	-	-	-	-	-
Isuzu	D-Max	18394	17645	18746	15884	20712	22161	25572	25291

(Source: Compiled by the author based on MarkLines data)

Next, let's examine the market share of manufacturer in South Africa. According to Figure 2, which illustrates the percentage of production volume percentage, Toyota and Volkswagen (VW)

each account for around a quarter of the market share, followed by Ford, Beijing Automotive, and BMW. Although their market share is smaller, Japanese manufacturers such as Nissan, Mazda, and Isuzu also follow closely behind. Referring to Table 3, which shows production volumes by brand, the production trends in South Africa become clearer. A notable feature is that the Toyota Hilux, Ford Ranger, and Isuzu D-Max account for a significant proportion of production, all of these vehicles are classified as pickup trucks. In terms of passenger vehicles (including SUVs), the Volkswagen Polo holds a significant share. Considering the condition of unpaved roads in Africa, it can be inferred that pickups remain popular. In 2024, the export ratio for light commercial vehicles was approximately 53%, significantly lower than the 78% for passenger vehicles, with statistics also indicating this trend (NAACAM 2025).

3. Trends in African automotive manufacturers

Next, we will examine trends among automotive manufacturers in Africa based on web information regarding local production. As with sales and production statistics, data on production bases in Africa varies depending on the data source. Some brands have established their own factories, but in many countries, knock-down (KD) production is carried out at assembly plants operated by local companies. Automotive manufacturers are outsourcing KD production to local companies with sales networks and assembly facilities, while reorganising their production systems in response to changes in local policies and demand. Furthermore, information on withdrawals and production suspensions is lacking. For these reasons, it is difficult to make a reliable assessment of the current state of automotive production in Africa based solely on information found on the web. Table 4 attempts to organise the vehicles assembled in Africa by brand based on web information, despite these limitations.

According to Table 4 and information from the web survey, automotive production bases (including SKD and CKD) in Africa are mainly located in Algeria, Egypt, Ghana, Kenya, Morocco, Nigeria, and South Africa (JAMA 2024), where Japanese car manufacturers have expanded their operations. They are also present in Tunisia, Rwanda, and other countries. However, as of 1999, production in Botswana, Libya, and Zimbabwe was reported by the OICA. In Rwanda, Volkswagen announced the opening of an automotive assembly plant in June 2018 (Reuters 2018, June 27), but the current status of operations is unknown. Information on production by local companies is difficult to understand without an on-site investigation. Examples include CNG vehicle manufacturing by Lanre Shittu Motors based on an initiative by the Nigerian government, an EV project by Kiira Motors in Uganda, and GIAD Motor and GIAD Truck in Sudan. This information can be found online. As previously mentioned, the OICA statistics referenced in this paper have coverage issues, such as the failure to capture production and sales figures for Egypt and inaccurately counting assembly by local companies. It should be noted that more detailed information gathering, and field research are necessary to gain a comprehensive understanding of the African automotive industry. Despite these data limitations, not only are European and American car brands, but also brands from developing countries such as China, India, and Russia, as well as local brands such as Nord, are being produced locally in Africa (Table 4).

Under these circumstances, as shown in Table 4, major Japanese brands are also assembling passenger cars and commercial vehicles locally, suggesting that they have established a certain presence in the local new car market. According to JAMA (2024), Japanese automakers are producing four-wheeled vehicles at 176 overseas plants (as of the end of March 2024). Of these, seven countries in Africa—Algeria (1), Egypt (5), Ghana (3), Kenya (4), Morocco (1), Nigeria

(2), and South Africa (5)—house 21 factories (12% of the total), surpassing Europe (14), Latin America (19), and North America (United States and Canada) (20) in terms of the number of factories. In 2023, overseas production accounted for only 2.1% of total production, but it still reached 231,000 units.

[Table 4] Brand-specific automotive assembly facilities in Africa

Country	Car brands (including contract manufacturing)
Algeria	Mercedes-Benz, Renault, Stellantis
Egypt	BMW, BYD, Changan Automobile, Chery, GM, King Long, Hyundai, Isuzu, LADA, Mercedes-Benz, Mitsubishi Fuso, Nissan, Proton, Stellantis, Suzuki, Toyota, Volvo
Ethiopia	Hyundai, Isuzu
Ghana	Honda, Kia, Nissan, Suzuki, Toyota, Volkswagen
Kenya	Beiben Heavy Duty Truck, Hyundai, Hino, Isuzu, Mahindra, Mitsubishi Fuso, Proton, Scania, Stellantis, Tata Daewoo, Toyota, UD Trucks, Volvo, Volkswagen
Morocco	Dongfeng Motor, Irizar, Mitsubishi Fuso, Renault, Shaanxi Automobile, Stellantis
Nigeria	Ashok Leyland, Honda, Nissan, Nord, Stellantis
South Africa	Beijing Automotive Industry Corporation (BAIC), BMW, First Automobile Works (FAW), Ford, Hino, Hyundai, Irizar, Isuzu, Iveco, Mahindra, Mercedes-Benz, Mitsubishi Fuso, Nissan, Tata, Toyota, Renault, Stellantis (scheduled to begin operations in 2025), UD Trucks, Volvo, Volkswagen

(Source: JETRO (July 1, 2024), MarkLines, Africa Business Partners (2023), compiled by the author based on internet information)

Non-Japanese companies are also increasingly establishing production bases and expanding their production capacity in Africa. Among European automakers, Stellantis has set a target to increase sales in Africa and the Middle East to 1 million units by 2030, with 90% of those units manufactured within the region. The company plans to open a new factory in Algeria in 2023 and another factory in South Africa by the end of 2025 (JETRO, 21 December 2023). Stellantis also plans to develop local suppliers in Africa (JETRO, 16 June 2025). In addition, Volkswagen announced plans to resume vehicle production in Kenya in December 2024. Among Asian automakers, Hyundai Motor is expanding exports to Africa from India while preparing to start production in Algeria. Mahindra has signed a memorandum of understanding with the Industrial Development Corporation (IDC), South Africa's investment promotion agency, in February 2025 to begin feasibility studies for the commercialization of a CKD plant in South Africa.

In terms of automotive electrification, Ford began production of the Ranger PHEV at its Silverton plant in South Africa in March 2025. Meanwhile among European companies, Stellantis

is doubling its production capacity in Morocco and expanding local EV production. The company has increased its production of small EVs such as the Citroën “Ami,” Opel “Rocks-e,” and Fiat “Topolino” from 20,000 units to 70,000 units by January 2025. Starting in July 2025, it will begin producing an electric three-wheeler developed by Moroccan engineers at an annual scale of 65,000 units.

However, the automakers actively expanding into overseas markets through market development and local production are Chinese car manufacturers responding to economic tensions with the United States by advancing overseas market expansion. Neta Automobile (NETA) opened its first store in Africa in Kenya in June 2024, marking its full-scale entry into the African market. In November 2024, the company also began supplying its small electric SUV, the NETA V, to taxi drivers in Nairobi for use in a ride-hailing service provided by Kenya's MojaEV. In October 2024, BAIC Motor agreed to establish an electric vehicle (EV) production plant in Egypt with Alkan Auto, a subsidiary of Egyptian International Automotive Motors (EIM). The company aims to begin production in the second half of 2025, targeting both the Egyptian market and exports to the Middle East and Africa. Initially, the plant will produce 20,000 units per year, a figure which is expected to increase to 50,000 units by the fifth year. Geely's EV brand Zeekr also entered into a partnership with EIM in October 2024 to build a sales and service network and launched two models in the Egyptian market in February 2025. In April 2025, Geely launched the RD6 bakkie in South Africa under its electric pickup truck brand Riddara. In February 2025, Rox Motor signed a memorandum of understanding with Ronor Motors Ghana, an automotive dealer based in Ghana and West Africa, for the sale of the ROX 01, a mid- to large-sized PHEV SUV. In February 2025, emerging EV manufacturer U POWER Tech partnered with Ghana's Majesty Group to develop a minibus based on its skateboard chassis, produce vehicles in Ghana via KD assembly, and create a new energy vehicle (NEV) brand exclusive to Ghana.

Additionally, in June 2024, four EV manufacturers—Naza, Wuling, Chery, and Seres—reached an agreement with the Indonesian government to utilize Indonesia as a production hub for right-hand drive vehicles destined for 54 countries worldwide. Considering that Thailand, where BYD and others have started local production, is also a major automotive manufacturer in ASEAN where right-hand drive vehicles are widespread, the agreement with Indonesia suggests the possibility that Chinese EV manufacturers will utilize Thailand as an export base for right-hand drive countries in Africa.

[Table 5] News related to the automotive industry in Africa

date	news report
26 June 2024	Four Chinese OEMs, including NIO, plan to utilise Indonesia as an export hub for right-hand drive EVs
2 July 2024	NIO opens its first store in Africa, a flagship store in Kenya
30 October 2024	Beijing Automotive plans to establish an EV production plant in Egypt
31 October 2024	Geely-owned Zeekr enters Egypt to expand into the African market

12 November 2024	Neta Automobile to supply electric SUV 'NETA V' for taxis in Kenya
5 December 2024	Volkswagen to resume vehicle production in Kenya
6 December 2024	Zimbabwe government reduces import tariffs on EVs from 40% to 25%
12 December 2024	Congo, Morocco, and Zambia partner to develop electric mobility value chain
16 December 2024	Toyota introduces new MT option for Land Cruiser 70 series in South Africa
17 December 2024	Morocco's Al Mada partners with China's CNGR for domestic production of EV battery components
29 January 2025	Hyundai Motor and Saud Bahwan Group to produce vehicles in Algeria
5 February 2025	Hyundai Motor expands exports to Africa from India, considers exporting electric SUVs
26 February 2025	Chinese emerging EV manufacturer U POWER Tech plans NEV assembly in Ghana
28 February 2025	Mahindra signs memorandum of understanding with South African investment promotion agency to begin feasibility study for CKD plant
3 March 2025	China's Luoqi Automobile to launch plug-in hybrid SUV 'ROX 01' in Ghana
4 March 2025	Great Wall Motor to launch pickup truck 'P300' in South Africa
17 March 2025	Stellantis to accelerate expansion of Tafraoui plant in Algeria
31 March 2025	Ford to begin production of "Ranger" PHEV at Silverton plant in South Africa
4 April 2025	BYD to enter Nigerian market
9 April 2025	Riddara, a subsidiary of Geely, to launch electric pickup truck 'RD6 bakkie' in South Africa
18 April 2025	VW to carry out major renovations at its Kariega plant in South Africa for the production of a third model
18 July 2025	Stellantis to expand production capacity for engines and EVs at its Kenitra plant in Morocco

(Source: Compiled by the author based on MarkLines data)

4. Automotive Exports to Africa

Although automotive assembly capabilities are developing in Africa, local assembly plants are relatively small in scale and are thought to rely heavily on imported KD kits. In addition, more than half of the finished vehicles produced in major automotive producing countries such as South Africa and Morocco are manufactured and exported for foreign markets. Consequently, a significant proportion of the demand for automobiles in Africa is met by imports from outside the continent. This includes a considerable number of imported used cars. According to Deloitte Africa (2016), 80% of imported vehicles in Ethiopia (which has since banned imports of internal combustion engine vehicles), Kenya, and Nigeria were used. Some reports indicate that used vehicles account for 85% of all vehicles in Africa (Mordor Intelligence, n.d.).

Trade statistics also confirm that new and used cars are exported from major automotive-producing and -consuming countries to Africa, establishing the continent as a global importer of used cars. According to UNEP (2024), 33% of the used small vehicles exported by Japan, the EU, the United States, and South Korea—the major exporters of used small vehicles—were imported by Africa between 2015 and 2022. In 2022 alone, 46% of Africa's imports of used small vehicles were from the EU, and 31% were exported from Japan.

The UAE is considered a major transit point for used cars bound for Africa. A special economic zone dedicated to used cars has been established in Dubai, where used cars collected from around the world are traded among dealers who have entered the special economic zone. In the industrial area of the Emirate of Sharjah, vehicles are dismantled and used car parts are traded. Used cars and parts exported from Japan also flow into Africa via the UAE (JETRO, 22 February 2024).

With these circumstances in mind, the authors examine trade data below. This paper uses export data from UN Comtrade. As UN Comtrade's product classification is limited to six-digit HS codes, even for subcategories, so it is not possible to distinguish between new and used cars when compiling data. However, it is sufficient to confirm the overall trend in exports of automobiles (HS 8702-8705) to Africa.

Table 6 shows the value of automotive exports to Africa in 2019 and 2023. In both 2019 and 2023, the Asia-Pacific region is the largest exporter of automobiles to Africa. Europe is the second largest exporter, followed by the Asia-Pacific region. The Asia-Pacific region's share of global exports to Africa rose from 47.6% in 2019 to 52.1% in 2023. During the same period, Europe's share declined from 37.2% to 31.7%. However, Europe's global share of exports to North Africa remained above 50% during this period, increasing slightly from 54.5% in 2019 to 57.7% in 2023. Conversely, the Asia-Pacific region's global share of exports to the sub-Saharan region increased from 51.7% in 2019 to 59.7% in 2023, securing more than half of the market during this period.

Of all the region in the Asia-Pacific area, East Asia exports the most to Africa. In 2023, East Asia accounted for 27.6% of global exports to Africa. This was followed by West Asia at 13.0% and South Asia at 8.2%. The high share of West Asia may be influenced by exports of used vehicles. Although Southeast Asia's share was only 3.1%, it experienced the fastest growth rate of all the subregions, at 40.1%, exceeding the overall growth rate of 30.4% for the Asia-Pacific region.

Table 7 shows the top 15 countries that exported automobiles to Africa in 2023 ranked by export value. The top three countries were China, Japan and Germany, followed by the UAE in fourth place and India in fifth place. The UAE's high ranking is likely due to the inclusion of used

car exports in its export value. Thailand, a global supply base for pickup trucks, ranks 12th among Southeast Asian countries. This highlights the importance of the pickup truck market in Africa.

[Table 6] Automotive Exports to Africa (HS 8702-8705) (in thousands of dollars)

2019	Africa	Northern Africa	Sub-Saharan Africa
Asia & Oceania	11,850,852,339	3,865,392,857	7,985,459,482
Eastern Asia	6,189,886,303	2,027,007,653	4,162,878,650
Southeast Asia	666,532,148	151,434,968	515,097,180
Southern Asia	1,809,660,807	354,681,688	1,454,979,119
Western Asia	3,158,735,326	1,328,037,419	1,830,697,908
Oceania	26,037,755	4,231,129	21,806,626
Europe	9,247,357,271	5,142,887,878	4,104,469,393
Americas	1,999,116,323	331,392,335	1,667,723,988
Northern America	1,921,578,440	324,304,370	1,597,274,069
Latin America and the Caribbean	77,537,883	7,087,965	70,449,918
Africa	1,781,800,527	93,835,274	1,687,965,253
Northern Africa	120,502,494	85,120,970	35,381,523
Sub-Saharan Africa	1,661,298,033	8,714,304	1,652,583,730
Grand Total	24,879,126,461	9,433,508,345	15,445,618,116

2023	Africa	Northern Africa	Sub-Saharan Africa
Asia & Oceania	15,449,906,357	4,022,875,686	11,427,030,671
Eastern Asia	8,177,465,675	2,022,923,743	6,154,541,932
Southeast Asia	933,637,600	214,087,190	719,550,410
Southern Asia	2,417,676,412	304,231,232	2,113,445,180
Western Asia	3,858,194,990	1,481,580,026	2,376,614,964
Oceania	62,931,681	53,495	62,878,186
Europe	9,394,081,871	6,056,475,619	3,337,606,252

Americas	2,201,698,951	338,863,146	1,862,835,805
North America	2,110,491,792	321,975,812	1,788,515,980
Latin America and the Caribbean	91,207,159	16,887,334	74,319,825
Africa	2,597,818,972	71,278,193	2,526,540,779
Northern Africa	105,737,084	61,382,712	44,354,372
Sub-Saharan Africa	2,492,081,888	9,895,481	2,482,186,407
Grand Total	29,643,506,152	10,489,492,644	19,154,013,507

(Source: UN Comtrade, compiled by the author)

[Table 7] Top 15 Exporters of Automobiles (HS 8702-8705) to Africa in 2023 (in thousands of dollars)

	Country	Region	Sub-region	Africa Total
1	China	Asia & Oceania	Eastern Asia	3,854,182,124
2	Japan	Asia & Oceania	Eastern Asia	3,015,494,596
3	Germany	Europe	Western Europe	2,918,289,081
4	United Arab Emirates	Asia & Oceania	Western Asia	2,735,718,760
5	India	Asia & Oceania	Southern Asia	2,413,486,576
6	USA	Americas	Northern America	1,747,373,254
7	South Africa	Africa	Sub-Saharan Africa	1,590,039,378
8	France	Europe	Western Europe	1,315,409,360
9	Rep. of Korea	Asia & Oceania	Eastern Asia	1,303,029,140
10	Spain	Europe	Southern Europe	975,390,195
11	United Kingdom	Europe	Northern Europe	787,269,439
12	Thailand	Asia & Oceania	South-eastern Asia	763,318,359
13	Turkey	Asia & Oceania	Western Asia	751,226,897
14	Italy	Europe	Southern Europe	606,666,578
15	Czech	Europe	Eastern Europe	547,568,053

(Source: Compiled by the author based on UN Comtrade data)

5. Future Prospect

The African automotive industry has been shaped by the influx of used cars from automotive manufacturing countries such as Japan, other Asian countries, Europe, and the United States, as well as by automotive manufacturing in North African countries such as Morocco and Egypt and in South Africa. In recent years, in addition to the start and expansion of local production by European companies that have traditionally used Africa as a production base, there has been an increase in new entrants and local production by Chinese and Indian companies. As Africa's population and economy grow, so too is the expected growth in automotive production and sales. The following industrial structure is expected to develop, and policy responses are needed accordingly.

The first step is to expand local production. Currently, local production is mainly carried out by some car brands in their own factories and by local companies through KD assembly. As many developing countries that produce automobiles have shifted from KD production to full-scale automotive production, if new car sales expand in Africa, it will be possible to form a full-set automotive industry covering everything from parts production to assembly locally in the future. The electrification of automobiles will require production systems that pursue economies of scale more than ever before, and policies for the formation and development of local new car markets will be necessary.

Second, safety and environmental regulations related to automobiles will increasingly impact on the automotive industry. The African automotive market is currently dominated by used cars. While the influx of inexpensive used cars makes it possible for a wide range of income groups to purchase automobiles, but it not only limits the development of the local new car market, it also has a negative impact on traffic safety and the environment. Safety and environmental regulations on the import of used cars and registered vehicles are expected to become increasingly important, as they will affect not only the pace of development of the new car market and the automotive industry in Africa, but also the healthy development of the transport society.

Third, as North Africa strengthens its position as a production base for exports to Europe, it is likely to take the lead over the Sub-Saharan region in forming supply chains that comply with EU environmental regulations. The global automotive industry is required to respond to environmental concerns. The Sub-Saharan region, which is strengthening its links with the highly cost-competitive Asian supply chain, is no exception. The African automotive industry needs to aim for the development of a low-environmental-impact automotive industry in cooperation with Asia, while also keeping an eye on competition and cooperation with Europe.

Fourth, the advancement of electrification. Electrification is also expected to advance in Africa. According to UNEP (2024), 105,273 small battery electric vehicles (BEVs) were traded worldwide between 2017 and 2022, but imports by Africa accounted for only 1% of that, or 1,432 vehicles. However, in Ethiopia, the spread of electric vehicles (EVs) is progressing due to a ban on imports of petrol and diesel vehicles in 2024. The Zimbabwean government reduced import tariffs on EVs from 40% to 25% in 2025. Chinese companies are also increasing their investment in the African EV market. As the market for two-wheeled electric vehicles, which offer lower fuel costs than gasoline vehicles, expands in African countries, the electrification of four-wheeled vehicles is also expected to progress. Widespread adoption of electric vehicles requires not only the development of maintenance personnel and the establishment of power generation and charging infrastructure, but also the long-term development of battery collection and recycling systems in Africa. Chinese EV manufacturers are leading the way in introducing EVs to Africa

ahead of Japanese, American, and European manufacturers. This could be seen as a strategic move toward localising EV production in Africa. At the same time, Chinese EV manufacturers are also establishing EV production facilities in Thailand and Indonesia. Both countries could serve as export hubs for right-hand drive EVs from Chinese companies, and it is also anticipated that EVs will be exported from these countries to the African right-hand drive vehicle market, including South Africa. The potential role use of Thailand and Indonesia in China's EV recycling process could be influenced not only by the localisation of EV and battery production in these countries but also by the establishment of systems for dismantling and disposing of end-of-life vehicles (Iwasaki et al., 2025).

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Chapter 5

Logistics

Chapter 5: Logistics -- Development of Digital Trade and Logistics for Strengthening Supply Chain

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This chapter examines the potential obstacles and ideal approaches to develop a resource circulation system between Africa and Asia from a logistics perspective. Trade from manufacturing bases of Japanese companies in India and various ASEAN countries to the African market or to production bases in the African continent is becoming more active. In order to further promote private sector activities and investment, strengthening the resilience of supply chains is essential. Additionally, it is important to establish a global system for circulating resources contained in products supplied from Asia from the economic security perspective.

Although Africa consists of a diverse range of countries, this study focused on four countries (South Africa, Tanzania, Ethiopia, and Kenya) for detailed study, aiming to form an overall picture of Africa while examining the situation in these countries.

With the aim of expanding industrial development in Africa through improvements in logistics, we focused on three themes: (1) logistics and international trade, (2) the automotive industry, and (3) the circular economy. This study started with the desktop review of existing domestic and international literature and information. In addition, interviews (22 cases) with private companies and industry associations in the target countries were conducted to understand and summarize the current situation in each country. The content of this study is current as of March 2025.

Based on the study results, issues were identified in each target country, and measures to improve logistics efficiency to promote investment from Japan were derived. As a result, this chapter proposes recommendations on logistics, particularly from the perspective that both Africa and Japan should benefit from the future development of resource circulation in the automotive-related industry.

1. Logistics and Trade (Import/Export)

(1) Current status of logistics and trade systems in target countries

An initial overview of investment promotion frameworks in each target country was conducted. Subsequently, the current logistics and trade environments were analyzed based on the following elements: import regulations, required documentation, infrastructure, customs clearance procedures, tariffs, and transportation systems.

We also assessed the implementation status of trade-related systems such as customs broker licensing, advance filing, advance rulings, deferred tariff payments, and trade facilitation mechanisms like Authorized Economic Operator (AEO) programs.

Regarding digitalization, we reviewed the development of electronic customs systems and the status of single-window platform implementation.

Based on this analysis, we identified key logistical challenges in each country and examined potential improvement measures to enhance efficiency. Additionally, we emphasized the importance of capacity building to support these improvements.

(2) Analysis of collected information

① Investment Promotion Systems

The investment incentives offered in each country are summarized in the table below. A comparison of the investment environments in the target countries—South Africa, Tanzania, Ethiopia, and Kenya—shows that most incentives are closely tied to the characteristics of Special Economic Zones (SEZs) and Export Processing Zones (EPZs), which are typically located in urban centers or near ports.

Preferential treatment is generally granted to products with a high export ratio from Africa. Consequently, foreign companies aiming to serve local markets may find these incentives less beneficial, diminishing the overall appeal of these countries as investment destinations.

Moreover, the relatively short duration of incentive programs has been identified as a factor that may discourage long-term business commitments by Japanese enterprises in the region.

[Table 1] Key investment incentives

	South Africa	Tanzania	Ethiopia	Kenya
Foreign Investment Law	Investment Act 100% foreign ownership in principle	TIC Investment Act 100% foreign ownership possible; foreign firms protected upon TIC registration	Investment Proclamation Some sectors have ownership limits; restrictions in telecom, finance, aviation (49% for logistics)	Investment Promotion Act 100% foreign investment allowed
Investment Incentives	SEZ Program 15% corporate tax in SEZ; exemptions for manufacturing goods; specific bonded manufacturing permitted	EPZ Act, SEZ Act, TIC Certificate Tax and duty exemptions in EPZ/SEZ; incentives available via TIC registration; multiple zones under public development	Industrial Parks Proclamation, EIC Incentives Tax incentives through national industrial parks or EIC certification; parks fully equipped with infrastructure	EPZ Act, SEZ Act, MUB Program Tax incentives available in EPZ/SEZ; corporate tax and duty exemptions within industrial parks
Key Locations	Near cities and ports	Major cities and coastal areas (e.g., Bagamoyo, Kigombe)	Bole-Lemi, Adama, etc. Developed by IPDC	Concentrated in Nairobi and Mombasa
Export Requirements	No explicit export obligation, but	Generally requires 80% or more export ratio	Minimum 80% export ratio; businesses with	80–100% export ratio; domestic sales not eligible for incentives

	incentives favor export orientation		high domestic sales not eligible	
Tax Incentives Outside SEZ/EPZ	-	SEP Standalone allows bonded manufacturing (requires 80% export ratio)	Tax/duty exemptions possible outside parks with Investment Board certification, but parks preferred	-

(Source: Compiled by NXRIX based on various materials.)

② Trade agreements

The trade agreements currently in effect in the target countries are summarized in the following table. A comparison of Free Trade Agreements (FTAs) indicates that none of the countries have established FTAs with Asian nations.

In contrast, several FTAs have been signed with European countries, giving European products a competitive edge over those from Asia. This imbalance creates challenges for sourcing materials from Asia and for promoting local production by Asian companies.

[Table 2] Existing trade agreements in force

Agreement	South Africa	Tanzania	Ethiopia	Kenya	EU	USA	Asia	Japan
SACU	✓							
SADC	✓	✓						
AfCFTA	✓	✓	✓	✓				
AGOA	✓	✓	✓	✓		✓		
TIDCA	✓					✓		
EU-SADC EPA	✓				✓			
SACU-EFTA FTA	✓				✓			
SACU-MERCOSUR	✓							
TFTA	✓	✓	✓	✓				
EAC		✓		✓				
COMESA			✓	✓				
TIFA				✓		✓		
EU-ACP		✓	✓	✓	✓			
EU-EAC EPA		✓		✓	✓			
Ethiopia-Sudan FTA			✓					
UK-Kenya FTA				✓	✓			

(Source: Compiled by NXRIX based on JETRO and other official sources)

③ Port infrastructure

The status of major port infrastructure in the target countries is summarized in the following table. Overall, port facilities in these regions are aging, and inefficiencies in port operations have emerged as a major concern.

In particular, at Durban Port and Mombasa Port, public-sector-led operations have resulted in delays in cargo handling and rising logistics costs.

[Table 3] Port profiles

Port	Durban	Dar es Salaam	Djibouti	Mombasa
Terminal Operator	TPT (public)	CT1: DP World / CT2: ADANI (AIPH)	DCTMC (semipublic)	Kenya Ports Authority (public)
Container Handling Capacity	3.6 million TEU	1,000,000 TEU	350,000 TEU	2.3 million TEU
Container Throughput	2.65 million TEU	820,000 TEU	635,000 TEU (2022)	1.62 million TEU
Number of Berths	10	7 (Berths No. 5–11)	2	6
Total Berth Length	914 m	1,288 m	400 m	1,399.6 m
Number of Gantry Cranes	16	8	4	16
Maximum Draft	12.2–12.5 m	13.5 m	9.5-12 m	12.5–14 m
CPPI Performance Rank (World Bank, 2023)	399/405	373/405	337/405	335/405
Automation	None	None	None	Plan to expand automation
Rail Link	Available (16% rail share)	Available	Available (approx. once a week)	Available
Operating Hours	7/24	7/24	7/24	7/24
Road Access	Good highway connections	Major roads available but poor traffic control near the port	Main road to Addis Ababa developed	Port access roads frequently congested; truck terminals underdeveloped
Current Situation	Centrally managed by state; strikes and chronic delays	Centralized at Dar es Salaam; chronic congestion and traffic	Heavy reliance on Djibouti Port (landlocked country); limited political stability	Centralized at Mombasa Port; infrastructure development ongoing under LAPSET plan

(Source: Compiled by NXRIX from official sources and local interviews)

④ Customs procedures

The current state of customs procedures and related systems in the target countries is outlined in the table below. Each country has its own documentation requirements, and the complexity of these requirements presents a significant challenge. Notably, the need to submit original Certificates of Origin (C/O) often causes delays and increases operational costs.

While some countries have introduced deferred payment schemes, advance ruling systems, and Authorized Economic Operator (AEO) programs, these mechanisms are mostly limited to domestic application and have not substantially improved intra-regional customs procedures. Furthermore, none of the countries have implemented a non-resident inventory system, limiting operational flexibility for Japanese businesses.

Although single-window (SW) systems are under development or partially operational, in many countries, multiple government agencies still operate independently. This results in redundant data entry and inefficient procedures, collectively lowering logistics efficiency.

[Table 4] Overview of customs procedures

Category	South Africa	Tanzania	Ethiopia	Kenya
Customs Declaration	Via SARS eFiling	Via TANCIS	Submit through ASYCUDA	Submit via iCMS
Required Documents	I/V, P/L, B/L, AWB (surrendered B/L acceptable), Importer Tax ID, Import License (for regulated items), C/O, Quarantine Cert., SDS, Product Certifications, Import Contract & Order	I/V, P/L, B/L, AWB, Import License, Duty Exemption Cert., Packing List, Certificate of Origin, Compliance Certificates, Originals required for port customs clearance (matched with TANCIS)	I/V, P/L, Import License (MoTI), TIN, B/L, AWB, C/O, Compliance Cert., Customs POA, Insurance, Proforma Invoice (for foreign exchange approval), Originals required	I/V, P/L, B/L, AWB, C/O, Freight Invoice, Translated vehicle logbook, Import License, PIN Certificate, Exemption Certificate (if applicable), Purchase Order/Contract, Vehicle Maintenance Certificate, Letter of Credit
Deferred Customs Payment System	Implemented *Deferral of up to 30 days is permitted	Not implemented	Not implemented	Not implemented
Advance Ruling	Available (domestic use only), 4–6 weeks for official rulings (fee-based)	Available (domestic only), valid for 12 months	Available (domestic only), rulings are binding on customs	Available (domestic only), valid for 12 months
Customs Broker Qualification	At least one certified representative required: CSK exam open to non-citizens	No national license system like Japan's; at least one staff must hold EACFFPC	Only Ethiopian nationals or companies allowed; brokers must hold customs license; 1,086 licensed brokers exist	Must complete customs training and obtain certification

AEO Program	Available; SARS launched expanded AEO in 2023; ~80 companies certified; no mutual recognition	Available (EAC Regional AEO); 9 companies certified as of Apr 2022	Available; ~46 companies certified as of 2023; no mutual recognition	Available (EAC Regional AEO)
Single Window System	Not yet implemented (under development); no transport data sharing	Partially implemented; 30 out of 60 gov. agencies connected; full ops by FY2024/2025; no transport data sharing	16+ gov. agencies connected, but multiple separate interactions still required; no transport data sharing	Implemented (KenTrade); over 35 gov. agencies & 42 stakeholders integrated; data input duplication still occurs; no transport data sharing
Tariff Rates	CIF basis; General goods: 0–30%, Apparel: 40%, Yarns: 15%, Fabrics: 22%, Vehicles: 25%, Auto Parts: 20% (until 2035); Raw materials/capital goods may be duty-free if unavailable locally; VAT: 15%	CIF basis; Finished goods: 25%, Dairy/Meat/Textiles/Leather: up to 35%; Intermediate goods not produced in EAC: 10%, produced: 25%; Capital goods: 0%; VAT: 18%	CIF basis (valuation not based on declared I/V, but customs-assessed); 6 brackets: 0%, 5%, 10%, 20%, 30%, 35%; Raw materials/capital goods: 0–10%; Semi-finished goods: 20%; Consumer goods: 35%; Excise tax: 5–500%; VAT: 15%	CIF basis; Finished goods: 25%; Intermediate: 10–15%; Selected raw materials: 0%; VAT: 16%
Non-resident Inventory Scheme	Not available	Not available	Not available	Not available

(Source: Compiled by NXRIX based on official sources and local interviews)

⑤ Transportation (road and rail)

In the target countries, there is a heavy reliance on road transport, with minimal progress in shifting to alternative transportation modes. Although the benefits of rail transport are increasingly recognized, the lack of supporting infrastructure continues to hinder its broader adoption. In particular, the development of container rail transport remains insufficient, limiting the potential for cost savings and high-capacity freight movement compared to road transport.

Due to the underdevelopment of logistics hubs for rail usage and overall inefficiencies, the performance of logistics networks has been negatively affected. Additionally, cross-border transportation procedures remain inefficient, marked by limited data sharing and incomplete implementation of one-stop border processing systems. These issues result in repeated documentation, redundant data entry, and the physical submission of paperwork, all contributing to delays and higher transaction costs at borders.

Moreover, the absence of integrated cargo information systems across countries further exacerbates delays in cross-border logistics coordination.

[Table 5] Overview of transport (road and rail)

(Road)

Item	South Africa	Tanzania	Ethiopia	Kenya
Road Infrastructure	Highways and trunk roads are relatively well-developed and paved	Main roads are being developed; rural roads are poorly paved and difficult to access during rainy seasons	Trunk roads under construction; rural areas mostly unpaved; port and hub access remains a challenge	Some well-developed areas, but rural/remote areas lack infrastructure; frequent congestion on major roads
Major International Routes	N3 (Durban–Johannesburg), N1/N12 (Cape Town–Johannesburg), Maputo Corridor, Trans-Kalahari Corridor	Central Corridor (Dar es Salaam–Dodoma–Mwanza–Rwanda/Burundi), Southern Corridor (Mtwara–Southern Mines–Zambia), Namanga Corridor (to Nairobi), TAZARA route	Addis Ababa–Djibouti Port (handles 95% of import/export cargo), Mojo–Kaliti/Gelan, Walaita/Samara corridor	Northern Corridor (Mombasa–Nairobi–Malaba border), LAPSET (Lamu–Lodwar–Ethiopia/South Sudan), Namanga Corridor (to Tanzania), Southern Corridor (bypass to Tanzania)
Truck Transport Features	Container transport predominant; road conditions relatively good	90% reliance on road; higher risk of damage and delays	Mainly connected via dry ports; Djibouti connection is a bottleneck	SGR used partially; heavy reliance on trucks
Distance to Major Cities (Est. Time)	Durban–Johannesburg: 600 km (~10h), Cape Town–Johannesburg: 1,400 km (~18–22h)	Dar es Salaam–Dodoma: 450 km (~10–12h), Mwanza: 1,100 km (~20h)	Addis Ababa–Mojo: 75 km (~2h), Addis Ababa–Djibouti Port: 900 km (2–3 days)	Mombasa–Nairobi: 500 km (~10h), Nairobi–Malaba: 400 km (~8–10h)
Cross-Border Transport Issues	Some paper documents still required; congestion and theft risk at borders	Poor rural road conditions, rainy season access issues; road widths and signs not standardized	Long distances between ports and inland areas raise logistics costs; chronic delays	Congestion, customs delays; non-standard road design and aging infrastructure

(Rail)

Item	South Africa	Tanzania	Ethiopia	Kenya
Railway Operator	Transnet Freight Rail (TFR)	Tanzania Railways (TRC), TAZARA	Ethiopian Railways Corporation (ERC)	Kenya Railways Corporation (SGR operated by Africa Star)
Network Overview	Approx. 22,000 km	~3,000 km including Central Corridor and TAZARA	SGR line from Addis Ababa to Djibouti built with Chinese support	SGR (Mombasa–Nairobi–Naivasha) and legacy MGR lines
Track Gauge	1,067 mm	Mostly 1,000 mm	Partially upgraded to 1,435 mm	1,435 mm (SGR), 1,000 mm (legacy MGR)
Port Connectivity	Connected to multiple ports (e.g., Durban, Cape Town)	Connected to Dar es Salaam Port	Connected to Djibouti Port	Connected to Mombasa Port

Main Container Routes	Durban–Johannesburg: 688 km (Rail: 5 days, Road: 3 days)	Dar es Salaam–Dodoma	Addis Ababa–Djibouti: Rail: 12h, Road: 3 days	Mombasa–Nairobi
Inland Hubs / ICDs	Around Johannesburg	Isaka ICD, Morogoro	Addis Ababa, Mojo ICD	Nairobi ICD, Naivasha ICD
Regional Connectivity	Connected to Zimbabwe, Botswana, Namibia, etc.	Planned connections to Zambia, Rwanda, Burundi (via TAZARA)	Direct connection only to Djibouti; no other links	MGR links to Uganda, Rwanda; SGR extension plans
Utilization Status	Low utilization rate; competition from road transport	Below 10% utilization; network undergoing renovation	Operates only 1 service per week; still low usage	Limited usage due to truck competition

(Source: Compiled by NXRIX from official sources and field interviews)

(3) Logistics challenges and future policy recommendations

Logistics serves as a fundamental driver of economic growth. However, a range of logistical issues in the target countries is impeding trade facilitation and broader economic development. These challenges can be broadly categorized as follows:

1. Limitations of investment incentive schemes

Existing incentives are often constrained by geographic and export-oriented conditions, limiting the scope of operations for Japanese enterprises. This reduces investment motivation and increases entry barriers.

2. Absence of FTAs with Asian countries

The lack of Free Trade Agreements with Asian countries, including Japan, makes Asian products less competitive in African markets compared to those from Europe or the U.S.

3. Inadequate infrastructure

Underdeveloped road and rail systems, along with aging and inefficient government-operated port infrastructure, result in shipment delays and higher logistics costs.

4. Complicated and inefficient customs procedures

Customs processes involve complex documentation requirements—especially the frequent need to submit original Certificates of Origin. Deferred payment and AEO systems are inflexible and lack cross-border functionality. Single-window systems remain incomplete, and insufficient transport data sharing further reduces customs efficiency.

To address these challenges, the following policy proposals are proposed:

Proposal 1: Redesign of investment incentive system

The current investment incentive system, centered around Special Economic Zones (SEZs), lacks flexibility and long-term stability. This creates challenges for companies aiming to enter the AfCFTA market. To address this, we propose to introduce a more flexible system that does not geographically fix SEZs, allowing manufacturers to designate their production facilities as SEZs (similar to India's Private Bonded Facility (PBF) or the U.S. Foreign Trade Zone system). Additionally, to encourage long-term investment, we suggest extending the preferential period up to 15 years based on performance. This approach aims to improve logistics efficiency, boost regional economies, and enhance market responsiveness. The system will be gradually implemented following pilot testing in selected countries, with Japan providing support through system design and collaboration with relevant agencies.

Proposal 2: Promote Asian investment in Africa through strategic new FTAs

Currently, there are no free trade agreements between Asia and Africa. This results in high tariffs and a lack of competitiveness for Asian products due to the non-application of EPA rules of origin. We propose forming FTAs to gradually reduce tariffs and unify rules of origin, including cumulative systems, to enhance Asian companies' competitiveness and promote local production. Implementation will include phased liberalization of key items and consideration for local industries. Japan would assist by supporting the design of rules of origin, cumulative systems, and local capacity building.

Proposal 3: Enhance port operations with PPP (Public-Private Partnerships) models

Ports in South Africa and Kenya, managed mainly by the government, face issues like long berthing times and unclear fees. To improve efficiency, we recommend adopting a PPP model where the government retains ownership but outsources management to private companies through competitive bidding. This model aims to cut costs and boost transparency. Japan would leverage its PPP experience to support modernization, including technical assistance and training.

Proposal 4: Implement a fully digital application system

Export and import processes often require original documents and physical signatures, making procedures slow and costly. We recommend digitalizing import permits and quarantine certificates, implementing one-stop EDI applications, and enabling data sharing among relevant agencies. This will reduce costs and speed up cross-border procedures. Japan would support implementation by helping with system design and local training.

Proposal 5: Establish a post-customs payment system

In some countries, customs duties and VAT must be paid before goods are released, causing cash flow issues. We propose a 'post-customs payment system' for certified importers, allowing payment within 30 to 90 days after cargo release. This would reduce lead times and encourage trade. Implementation would include secure payment systems and digital infrastructure, with Japan providing system design support.

Proposal 6: Improve advance ruling systems for better tariff clarity

While some countries have advance ruling systems, tariff code determination can be slow, and mutual recognition within regions is lacking. We suggest creating a unified system for advance tariff determination and mutual recognition, ensuring transparency and smoother customs procedures. Japan would offer expertise in designing internationally standardized systems and operational guidance.

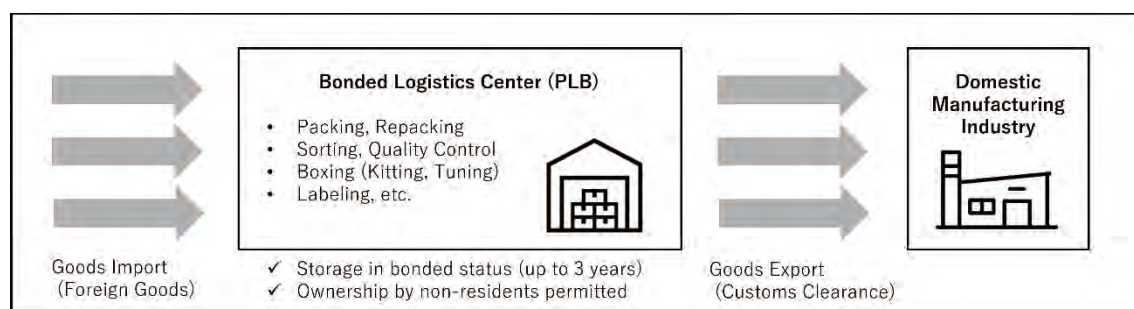
Proposal 7: Mutual recognition of accredited importers and exporters

Existing systems for recognizing reputable businesses are often not mutually recognized between countries, limiting their effectiveness. We propose establishing a system for mutual recognition between import and export countries to simplify or waive cargo inspections, reducing customs time and increasing logistics efficiency. Japan would provide guidance based on WCO standards and operational expertise.

Proposal 8: Introduce a non-resident inventory system

Currently, non-residents cannot store inventory without establishing a local corporation, hindering flexible supply systems. We propose a system allowing non-residents to use bonded warehouses and pay customs duties and VAT upon sale. This would make market entry easier for Japanese companies. Japan would support trial implementation, legal structuring, and rule creation.

[Figure 1] Reference case: Indonesia's bonded logistics center (PLB)

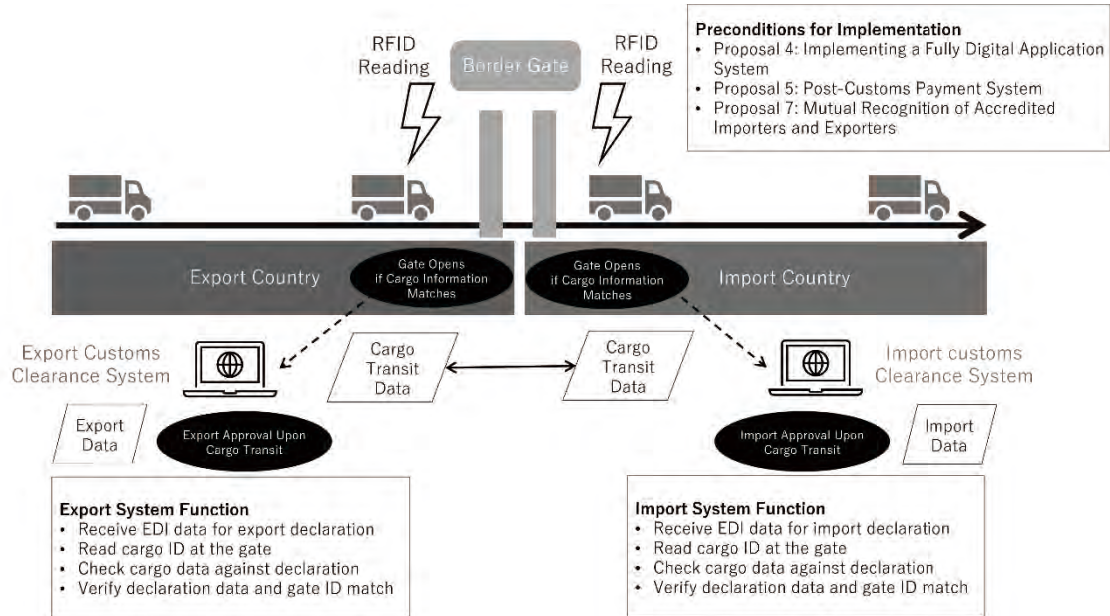


(Source: JETRO (<https://www.jetro.go.jp/biznews/2017/04/d3ec8d9caa5a8904.html>))

Proposal 9: Enable seamless cross border transport with RFID technology

Despite some progress, many cross-border transport procedures still involve paperwork. We propose using RFID tags on cargo vehicles to share data electronically among agencies, enabling seamless transport. This would reduce waiting times and improve logistics. Japan would support technology introduction and system design.

[Figure 2] Seamless cross border transport with RFID technology concept image

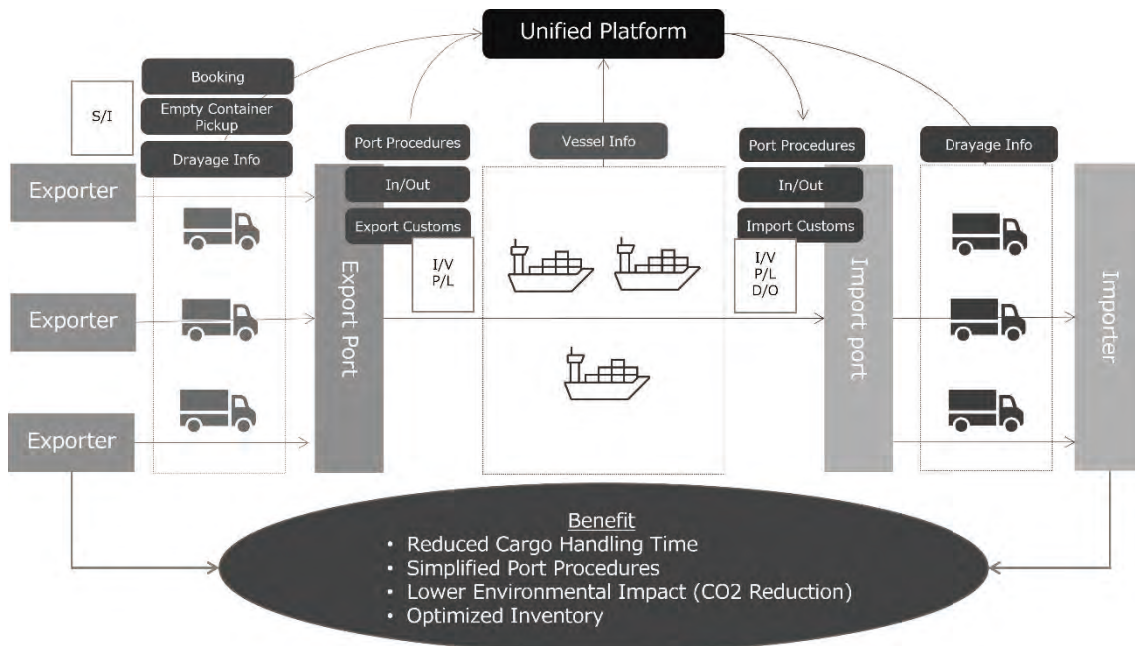


(Source: NXRIX)

Proposal 10: Build a unified transport information platform

Transport data in the region is fragmented, causing delays and inefficiency. We propose creating a common platform that consolidates data and connects customs and port systems through data integration. This will reduce cargo handling times and simplify processes. Japan would support the platform's development by proposing data integration plans and providing capacity building for local stakeholders.

[Figure 3] Unified Transport Information Platform Concept Image



(Source: NXRIX)

Proposal 11: Strengthen rail transport through intermodal connectivity

Rail-to-road connections in Africa are underdeveloped, leading to low logistics efficiency. We suggest promoting intermodal transport by prioritizing rail as the core and enhancing road connectivity. Developing hubs and digital coordination will lower logistics costs and environmental impact. Japan would support infrastructure development and digital integration using its railway expertise.

2. Automotive Industry

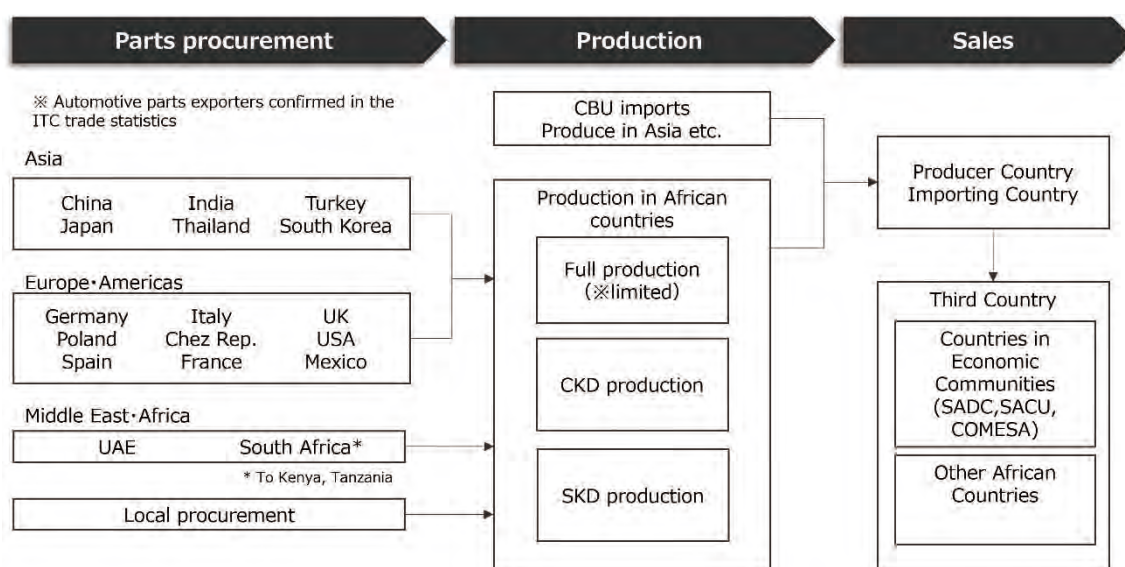
(1) Current status of the automotive industry in target countries

This research examined the supply chain of the automotive industry and the life cycle of vehicles after sales to understand the surrounding circumstances of the industry. The research also studied automotive industry policies, local production trends, and the spread of EVs, including not only four-wheelers but also two- and three-wheelers. Furthermore, we identified issues related to the industry and the handling of EVs and lithium-ion batteries from a logistics perspective. In addition, this reviewed the promotion of the automotive industry as well as the supply chain and life cycle of vehicles and parts.

(2) Analysis of collected information

In the supply chain for new automobiles and two-wheelers, production parts are imported from Asia and Europe, and the exporting countries are also those with thriving automotive production. In the target countries, except for South Africa, CKD/SKD production methods are adopted, and local procurement of parts remains limited. Some car makers export vehicles to neighboring countries, but production is mainly for the domestic market.

[Figure 4] Supply chain of automobiles

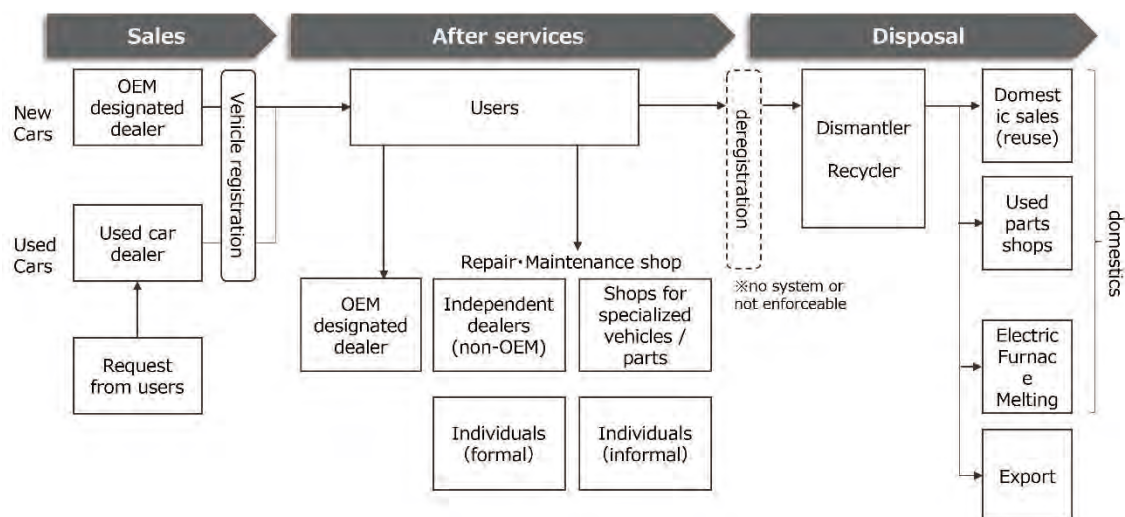


(Source: International Trade Center, NXRIX study)

Regarding the vehicle life cycle from after-sales care to disposal, it is difficult to understand the situation from after-sales maintenance to disposal in the target countries. Since the supplier of new vehicles is clear, after-sales service is often provided by car maker-designated dealers during the warranty period, but after the warranty expires, users choose cheaper after-sales services. Because there is no vehicle inspection system, there is no enforcement for vehicle maintenance. Used cars are not related to car maker dealers, thus after-sales service is provided by large independent repair shops, small private repair shops, or even informal operators working under trees.

Whether to scrap a vehicle is left to the user's decision, and the government's vehicle deregistration system is not thoroughly enforced, such situation makes it difficult to grasp the actual number of vehicles on the road. For scrapping, users bring vehicles to repairers, dismantlers, or recyclers. In addition to certified recyclers, many informal businesses and individuals are involved in the end-of-life vehicle industry, and the sources of parts and scrap collected by recyclers are diverse. Along with scrap from products other than automobiles, the final destination of resources is determined domestically or internationally.

[Figure 5] Automobiles life cycle



(Source: JICA (2022), NXRIX study)

Automotive-related policies and regulations shape the structure of the automotive industry in each country. All countries have policies or guidelines related to EVs, but the speed and degree of implementation vary greatly. The spread of EVs is closely related to electricity prices and its supply conditions.

Reflecting various regulations, the automotive market in each country is divided into new and used car markets, affecting the supply of finished vehicles and the supply chain for production and replacement parts. Four-wheel EVs are not produced locally and are not widespread in the target countries except for Ethiopia. On the other hand, two- and three-wheel EVs are spreading ahead. Two-wheel EVs are used for short-distance delivery and taxis in urban areas where charging is less of a concern, but the lack of charging infrastructure for four-wheel EVs is pointed

out in all target countries and is hindering their spread. Two-wheel EVs also use lithium-ion batteries, and an increase in battery imports is expected. If a battery circulation system for two- and three-wheel EVs can be established, it may be applicable to battery management and recycling systems when four-wheel EVs become widespread.

[Table 6] Summary of automotive/EV trends in target countries

Country	South Africa	Tanzania	Kenya	Ethiopia
Automotive Industry Policy	Policy exists → Aiming to be Africa's auto manufacturing hub	No policy: Framework for EV policy being developed	Policy exists → Strengthening auto manufacturing	No policy: EV policy in draft
Automotive Market	New cars (Used commercial vehicle imports banned)	Used cars	Used cars	Used cars → New cars (Ban on fuel vehicle imports)
EV Status	4wheel: × 2wheel: × Hybrid possible	4wheel: × 2wheel: ○ 3wheel: ○ Gasoline vehicles dominant, some shift to NGV	4wheel: × 2wheel: ◎ Hybrid possible	4wheel: ◎ 2wheel: ◎ EVs rapidly spreading as national policy
Electricity Price (per kWh, Mar 2024, TIGC)	USD 0.182	USD 0.087	USD 0.255	USD 0.003

(Source: NXRIX Study, Tanzania Investment and Consultant Group: TIGC)

(3) Issues and policy recommendations for the automotive industry

Considering the promotion of the automotive industry and the progress of EV adoption in the target countries, there are issues that may hinder its development. The following issues and recommendations are identified:

1 Lack of overall automotive policy

Some countries are taking the lead in formulating EV policies instead of long-term policies for the entire automotive industry, making it difficult to see the overall picture of the automotive industry. Even where EV incentives exist, frequent policy changes prevent reliable implementation, making it difficult for private businesses to consider long-term investment.

2 Small local new car market

In countries where used cars dominate, the new car market is small, and CKD/SKD production is mainstream, making it difficult for related industries such as parts suppliers to enter.

3 Inability to track end-of-life (EOL) for vehicles and parts

Due to incomplete or non-existent deregistration systems at scrapping, the number of vehicles currently on the road cannot be tracked. Furthermore, it is unclear whether user or disposal

operator is responsible for reporting at the time of disposal. The lack of clear control points at vehicle/parts disposal prevents reliable resource recovery.

Aiming to improve issues mentioned above, here are some policy recommendations.

Proposal 12: Formulate automotive policies including EOL regulations for vehicles and batteries

When developing mid- to long-term automotive policies including EV policies, also establish policies for handling lithium-ion batteries. Cover not only four-wheelers but also two- and three-wheelers and formulate automotive policies in conjunction with EPR regulations, considering the EOL of vehicles and batteries, to create an environment where manufacturers can invest with confidence.

Proposal 13: Develop systems to facilitate entry of automotive manufactures and parts suppliers

Establish a temporary import (equivalent to Mexico's IMMEX) or bonded system (equivalent to Foreign Trade Zone (FTZ) sub-zone system of the United States) that allows auto parts suppliers (from Tier 1 to Tier 3) to store, process, assemble, and transport parts with deferred tariff payment until final assembly, and build a digital system to track/manage progress.

3. Circular Economy

(1) Current status of efforts toward circular economy transition in target countries

This research studied the status and recent trends of waste management laws and regulations, and summarized recycling trends. Focusing on lithium-ion batteries, we particularly examined trends related to E-waste. Through case studies in the target countries, general trends and issues in Africa are summarized.

(2) Analysis of collected information

① Legal basis for waste management

Waste management policies have existed for some time, but since the 2020s, policies have become more detailed, targeting specific wastes such as plastics and e-waste. Recently, EPR regulations have begun to be strengthened, requiring manufacturers, importers, wholesalers, and retailers to take responsibility throughout the product life cycle, including collection and reverse logistics.

Although EPR regulations specify "post-sale management responsibility," the process from post-sale to disposal is not yet traceable. As the regulations have just started, the extent of rule enforcement is unclear.

Transboundary movement of waste is managed under two international treaties: the Basel Convention (global) and the Bamako Convention (Africa-specific).

[Table 7] Legal basis for waste management

	Domestic Waste Management Policy	Domestic EPR	International Law (Basel)	International Law (Bamako)
Overview	Regulates the process up to disposal for all or specific products	Requires manufacturers/importers to take responsibility throughout the product life cycle (collection, recycling, recovery, etc.), and to hand over waste to certified recyclers	Basel Convention: Regulation of transboundary movement of hazardous waste (global framework)	Bamako Convention: Regulation of import and transboundary movement of hazardous waste within Africa (Africa-specific)
Countries Adopting	All 4 target countries (with different details)	All 4 target countries for specific products (enacted or drafted regulations)	All 4 target countries	All 4 target countries
Scope of regulations				
New products	N/A	✓	N/A	N/A
Lifecycle after sales	N/A	✓	N/A	N/A
used/second-hand products (as waste)	✓ (waste)	✓ (include reuse, recycle)	✓	✓
Control point	At disposal	At import/post-sale	At export	At import

(Source: NXRIX study)

② E-waste policy

Regulations on E-waste are progressing in each country, especially for the ICT industry, which uses and disposes of large amounts of cables and electronic devices. For certain ICT-related companies, authorities impose collection responsibilities.

For general consumer electronics, EPR laws are being developed for manufacturers, importers, and sellers. While electronic devices are managed at the time of manufacture/import, tracking up to disposal by general users is impossible, and there is no enforcement by businesses.

Reverse logistics (collection/transport) is not established for all electronic devices. The value chain from post-use to disposal is heavily dependent on informal sector operators and individuals, making it difficult to understand the actual flow to disposal. Therefore, various batteries are also subject to EPR management, but the actual status of reuse, recycling, and disposal is not accurately known.

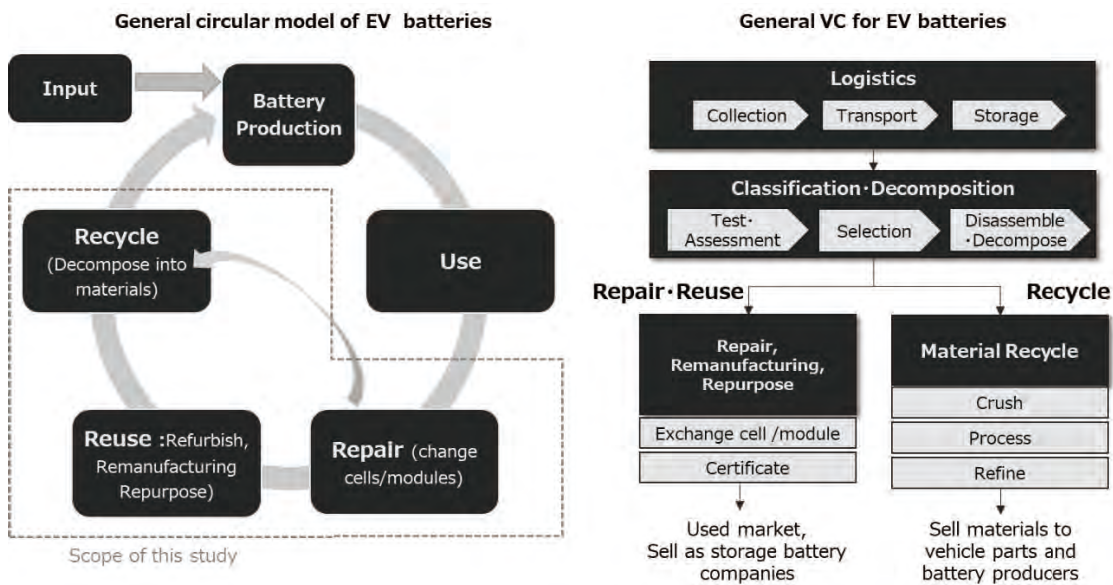
Furthermore, there are currently no clear domestic regulations for the disposal of end-of-life vehicles or batteries.

③ Lithium-ion battery recycling

General circular economy model consists of stages before recycling, such as "repair," "remanufacturing/refurbishing," and "repurposing." In Africa, battery reuse (equivalent to repair/refurbish) is carried out mainly by small businesses, and repurposing is also emerging.

In Japan and the West, there are the general circular model and the value chains for EV batteries, but in the target countries, "battery" refers to lead-acid batteries, hybrid vehicle nickel-metal hydride batteries, two-wheeler EV and portable lithium-ion batteries, and does not include large lithium-ion batteries for four-wheel EVs. This report summarizes the current status of these battery cycles.

[Figure 6] General EV Battery Circulation Model



(Source: NXRIX)

(i) Repair

In the target countries, due to the lack of periodic vehicle inspection systems, users bring vehicles for repair at their own discretion, choosing repairers based on the vehicle's age and repair budget. Bringing vehicles to car maker dealers is mostly limited to those within the new car warranty period.

The repair flow is similar in the West and Africa, but the informal sector plays a larger role in Africa. Especially for used vehicles, car maker dealers rarely get involved in repairs.

The destination of replaced old batteries or defective cells is unclear and left to the discretion of repairers. For example, in Kenya, lead-acid battery collection by battery manufacturers is conducted, but there is no such system for lithium-ion battery collection.

(ii) Reuse/Repurpose

In the target countries, battery reuse is carried out mainly by small businesses. Only defective cells are replaced, and refurbished batteries are sold as used batteries, allowing users to purchase used batteries during repairs. Battery reuse in the target countries combines repair and refurbishing.

In the West and Japan, logistics and qualified recycling operators are involved in reverse logistics, requiring safe collection, transport, and storage, but in the target countries, responsibility, and rules for collecting old batteries are unclear.

To replace defective cells during reuse, good cells from used batteries are needed; therefore, reuse/repurpose operators procure used batteries in various ways. These operators are small-scale businesses, and major logistics companies are not involved in domestic transport of batteries; logistics are arranged in-house or procured from individuals. There is no systematic rule or system for collecting lithium-ion batteries. Since domestic procurement of used batteries is insufficient, used batteries are imported from overseas in compliance with import regulations.

Reuse operators are also starting to develop repurposing businesses. Batteries unsuitable for reuse are sometimes sold as small home storage batteries, but the business scale is still very small. Since storage batteries may be useful in rural areas, both the government and private sector are highly interested in repurposing.

(iii) Recycling

Currently, lithium-ion battery recycling is not conducted in the target countries. Certified recyclers exist, and waste from businesses is legally required to be handed over to certified recyclers. Recyclable resources (iron, plastic, etc.) are crushed to scrap level and then purchased by specialized resource companies for material recycling. However, handling lithium-ion batteries is dangerous, and there is no processing technology in the target countries. Items that cannot be processed domestically are exported overseas for recycling.

(3) Issues and policy recommendations for circular economy development

Although there are many efforts toward a circular economy, the process up to battery recycling and management of disposal is still being developed. The following issues have been identified:

① Lack of awareness and technology for battery recycling

Although legal changes toward a circular society have occurred in recent years, governments have not yet considered actual battery recycling. Battery reuse and repurposing are emerging on a small business basis.

② Lack of legal regulations for two-wheeler EV battery recycling

With the rapid spread of two-wheeler EVs, a large number of small lithium-ion batteries are expected to reach end-of-life in a few years, but there are no clear legal regulations for their disposal.

③ Involvement of informal operators and individuals

Informal operators and individuals are the main players in resource collection, making the sources and procurement methods of resources unclear and legally opaque. The amount and method of collecting reusable lithium-ion batteries cannot be tracked.

④ Technical barriers

Lithium-ion batteries require advanced technology for dismantling, making domestic recycling impossible at present. As a result, valuable resources are being exported overseas.

⑤ Overlapping e-waste regulatory authorities

E-waste, including batteries, spans multiple sectors such as ICT and automotive industries, each with its own regulatory authority. Coordination with the Ministry of Environment, which comprehensively regulates all waste, might be insufficient.

Aiming to address these issues, the following policy recommendations are to be proposed.

Proposal 14: Establishment of a reliable lithium-ion battery collection scheme

Build a safe and efficient lithium-ion battery collection network utilizing digital technologies. In doing so, design incentives to encourage cooperation from lithium-ion battery users and aim for a symbiotic model that also involves informal operators and individuals.

Proposal 15: Government-led promotion of battery reuse and repurposing

Expand reuse and repurposing (such as battery storage businesses) under government leadership, involving local businesses, Japanese companies, and partner country enterprises.

Proposal 16: Construction of a lithium-ion battery recycling value chain

In the process from collection to recycling, collaborate with locally certified recyclers to establish standards for state of health and safe handling methods for batteries. Implement technical cooperation on lithium-ion battery recycling from Japan and India.

These policy recommendations aim not only to facilitate the physical flow of goods, but also to enhance the visibility of the movement of goods and resources. For this purpose, digitalization should be maximally utilized, and barriers to information sharing between government and private sector operators should be eliminated. If logistics between Africa and Asia are streamlined, connectivity will be strengthened, which would contribute to the promotion of global resource circulation.

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* A list of abbreviations is provided at the beginning of this publication.

Chapter 6

Digital Leapfrog

Chapter 6: Digital Leapfrog -- Promoting the Digitalization of the GS Industry Development Paradigm

Prof., Dr. Masahiro NAKAMURA, President and CEO, Lexer Research Inc.; Chairman, Green CPS Consortium; Professor, Tokyo City University.

1. A New Paradigm for Industrial Development in the Global South

The future direction of the Global South's evolution does not need to be positioned as an extension of the Global North's industrial development paradigm. By leveraging the latest digital technologies in light of the current situation in the Global South, it is possible to realize an industrial development paradigm specific to the Global South.

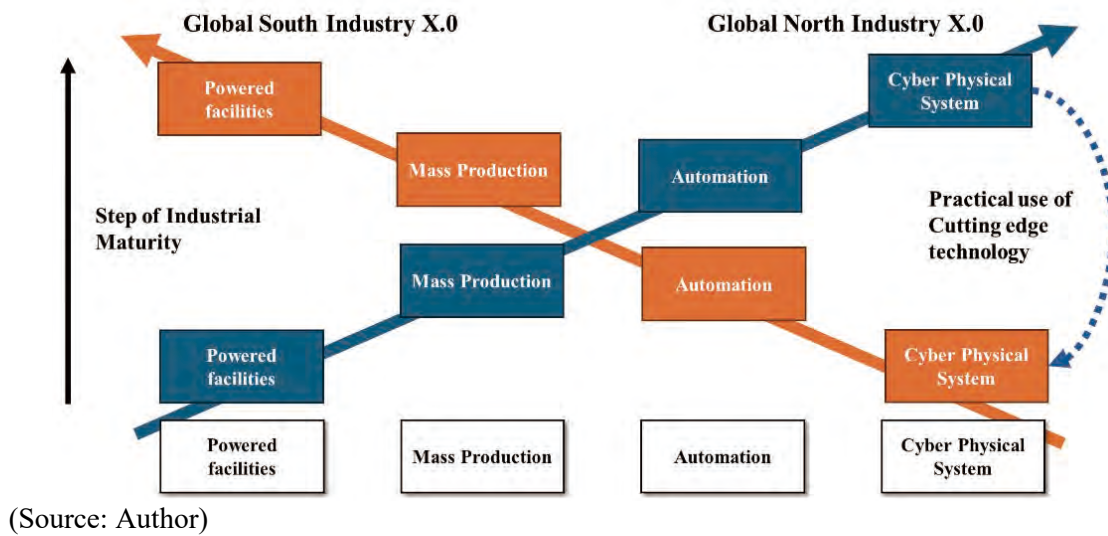
Until now, the industrial development paradigm of the world has been the Global North-type Industry 4.0, which originated in Europe. Industrial policies based on this maturity model have been promoted in countries of the Global South, but they strongly reflect the Global North's perspective on economic value creation. While contributing to the global expansion of business scope and trade flows, they do not generate leading economic value for the Global South.

The Global South Industry Strategy

Considering the existing Global North-type industrial development paradigm, namely the framework of Global North Industry X.0, the following developments are being advanced: (1) the introduction of concepts such as the development and shared use of power infrastructure and the aggregation of physical resources, (2) the introduction of process concepts and the efficient utilization of resources through role division, (3) the transition away from labor dependency through automation and robotization, and (4) the optimal utilization of resources and dynamic connection with the market through digital technology and Cyber Physical Systems (CPS). This constitutes a maturity model for development. Today, with the ability to leverage cutting-edge technologies such as digital technology from the early stages, it is possible to design a new industrial development paradigm distinct from traditional industrial policies to promote economic value creation in the Global South.

In today's global business environment, connectivity enabled by digital technology can achieve “penetration in the industrial space” and dynamically connect demand and supply to generate economic value. In other words, even in the early stages of industrial development, where industrial clusters are insufficiently developed, it is a realistic approach to invest in cutting-edge technology

[Figure 1]: Design of the industrial development paradigm in the Global South



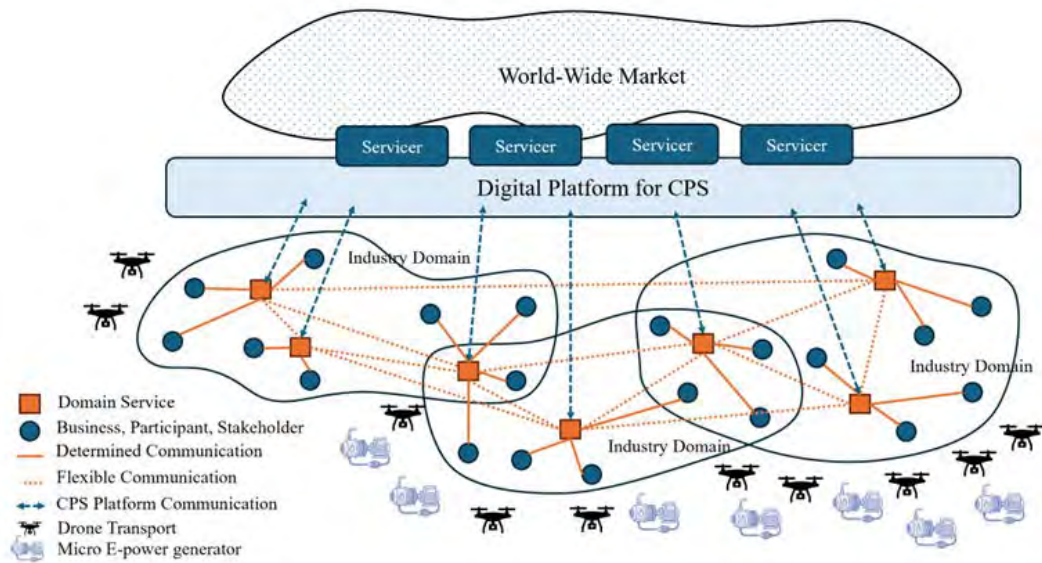
while considering the current level of industrial clustering and advanced digital networking to create an economic value generation model. In other words, we propose considering the approach of generating value by starting with industries that utilize digital technology and CPS for dynamic connectivity, referred to as the Global South Industry 1.0 (GSI 1.0). We propose exploring the concept of positioning this approach—which involves prioritizing digitalization and enhancing industrial infrastructure by reversing the steps of Global North Industry X.0—as the Global South-type industrial development paradigm (Figure 1).

The Global South Industry Strategy

The following section introduces the concept of promoting the Global South Industry X.0 (hereinafter referred to as GSI X.0) (Figure 2). First, while the training of IT professionals is already underway in the Global South, rather than providing these industrial resources as business resources for the Global North, they will be utilized to build an information infrastructure that promotes the development of the Global South. Along with regional network infrastructure, a group of IT startups will be launched to promote the valorization of primary industry regional resources through digital technology.

Furthermore, to integrate regions and resources where industrial collaboration is difficult due to their dispersed nature into an industrial infrastructure, we will leverage cutting-edge technologies unique to the present era, such as satellite communications, drone wireless communication networks, and the widespread adoption of decentralized ultra-small-scale power generation. Regarding energy, we will promote sustainable energy policies by utilizing plant-based fuels derived from local plants rather than relying on fossil fuels. Furthermore, we will utilize new technological methods that were previously unimaginable to launch new industries, such as the advanced use of drone-based unmanned transport in environments with poor transportation infrastructure, and the use of additive manufacturing (3D printing) technology to manufacture business equipment at dispersed regional bases. In this way, we

[Figure 2]. GSI 1.0 implementation image



(Source: Author)

will maximize the use of digital connectivity to leverage the strengths of those who lack resources, transitioning from centralized to decentralized systems and accelerating the establishment of a circular economy.

By connecting these diverse element systems at the meta-level (upper layer) through CPS and integrating them for optimized operations, we will digitize methods and insights such as “lean production” to realize value creation in the Global South.

These concepts can be realized through digital and new technologies (such as decentralized energy, drones, 3D printers, and sustainable materials) and are feasible measures that can be implemented today. By leveraging these as an industrial strategy, we can establish the foundation for the Global South Industry 1.0 (GSI 1.0).

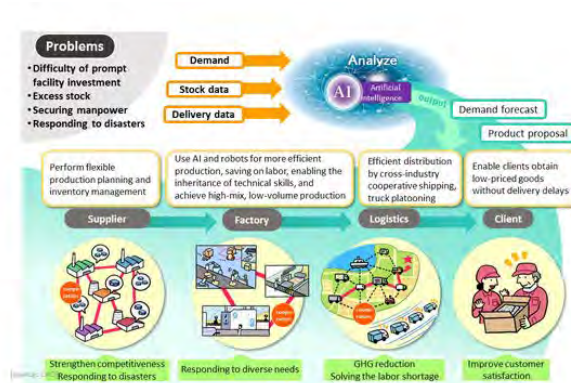
In this chapter, we will discuss the digitalization policies essential for advancing the Global South industrial development paradigm and GSI 1.0, after introducing the essence of digitalization.

2. Current Status of Industrial Data Space Strategies

In this section, we will examine the current state of digitization. In considering the future of GSI X.0, we will review the industrial strategies and approaches to digitization of the Global North and then examine the elements that should be incorporated into the GSI X.0 strategy.

Global trends in the industrial data space

[Figure 3] Realization of Society 5.0



(Source: CAO, Government of Japan)

[Figure 4] Ouranos Ecosystem



(Source: METI)

As part of the Global North's industrial strategy, companies are promoting collaboration strategies that leverage data spaces. In industrial data space strategies, various industrial policies are being introduced in each country with the aim of linking individual companies in supply chains and engineering chains. In the EU, based on the Gaia-X policy, the construction of data spaces such as Catena-X for the automotive manufacturing sector, Manufacturing-X, Cofinity-X, and Space-X is being promoted across various industrial sectors. In Japan, industrial data space policies aimed at realizing Society 5.0, the future envisioned by the social system, are being implemented.

Society 5.0

In Japan, the concept of Society 5.0 has been proposed (Figure 3). In the Japanese government's Fifth Science and Technology Basic Plan, it was proposed as “a human-centered society that achieves both economic development and the resolution of social issues through a system that highly integrates cyberspace and physical space.”

The realization of Society 5.0 hinges on two key elements: the means of “integration of cyberspace and physical space” and the values of “a human-centered society.” In Society 5.0, the aim is to transform society by first constructing digital twins of all societal elements in cyberspace, then restructuring systems, business designs, urban and regional development, and other aspects, and finally reflecting these changes in the physical space. Furthermore, by incorporating human-centered values into such new processes, each individual citizen and global citizen is elevated to the center of the decision-making stage, enabling society to flexibly and dynamically evolve into a better form. Although some time has passed since this vision was announced, it continues to be respected as a forward-looking vision by other countries, including those in Europe and the United States.

In order to transition to Society 5.0 and utilize new technologies in society, it is necessary to take a comprehensive view of the ethical, legal, and social implications (ELSI) that arise, and to

build a system that can utilize “comprehensive knowledge” that encompasses not only natural sciences but also humanities and social sciences.

Ouranos Ecosystem: Aiming for Society 5.0

Aiming to realize Society 5.0, the Japanese government has established the Ouranos Ecosystem, a platform for cross-industry data infrastructure and system integration and is promoting the resolution of social issues and innovation through DX.

Currently, as an institution supporting the calculation of a product's carbon footprint (CFP) using primary data beyond individual companies in the supply chain, the government has begun promoting the adoption of a platform that enables the sharing of activity data across diverse organizations and is working to expand the scope of services in the future.

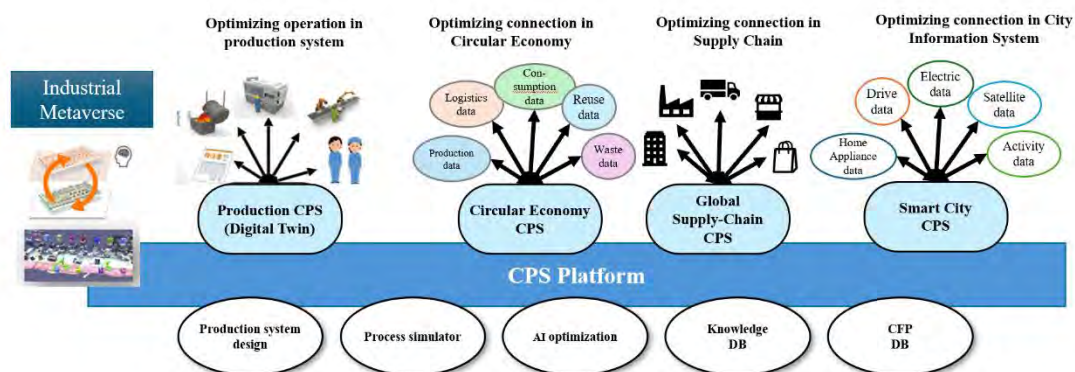
The Ouranos Ecosystem is currently being expanded into various data spaces, with case studies and demonstrations underway with a focus on Global South adoption. There is significant anticipation for its future expansion into effective data spaces in the Global South.

3. The Essence of Digitalization and Value Creation through Data Integration across Different Domains

As one of the strategic industrial policies to realize the potential of the Global South, such as GSI 1.0 mentioned in Section 1, we must discuss how to utilize digital technology. The advancement of elemental technologies, including automation and robotization in labor-intensive industries, the use of drones for logistics, the development of transportation system infrastructure, and the optimization of distributed energy networks, can realize their potential through the use of digital technology to integrate and operate them.

Furthermore, connecting the demand side and the supply side appropriately and in a timely manner through digital technology is what creates economic value today.

[Figure 5] Value creation by connecting different domains and data using CPS



(Source: Author)

The essence of digitalization

It is important to note that if digitalization in business operations is limited to the use of IT for information transmission, data sharing, and functionality provision, as well as the utilization of large-scale language-based AI, which are now accessible to anyone around the world, it will not contribute to enhancing Africa's potential. Moreover, if Africa were to remain merely a source of labour for IT development for the Global North, the future of the Global South could not be created. To realize Africa's potential through ICT utilization, it is necessary to understand the essence of digitalization, leverage digital technology, and build a strategic approach tailored to Africa's characteristics and positioning.

Here, we will explain the essence of digitalization. The true aim of digitalization is not merely the transfer of data, but rather the “connectivity that creates new added value through the integration of diverse elements belonging to different domains, such as different ‘spaces,’ ‘times,’ and ‘organizations’” (Figure 5). By connecting heterogeneous data from heterogeneous domains to achieve data penetration, fragmented activities can be guided toward a common purpose, generating synergistic effects and contributing to the creation of new value across domains.

Formation of epistemic economic scope and value creation through data penetration framework design

Next, we will explain value creation through data penetration achieved by connecting heterogeneous domains. By setting the scope of combining heterogeneous information with strategic intent, it is possible to establish epistemic (epistemological) relationships. In other words, by assigning special relationships to the scope that has received the intent, it is possible to design special activities that create distinctive characteristics through the collaboration of members within that scope. Furthermore, by giving special functions or powers to this set scope, we can make its uniqueness more obvious. For example, we can think of methods that create high value in business operations or providing specialized knowledge to solve problems we face.

For example, when forming a value chain network,

- We can intentionally form distinctive business strengths by connecting distinctive resources and functions with a specific purpose.
 - Providing engineering navigation based on excellent methodologies such as “lean production” developed by leading industries
 - Promoting advanced decision-making by understanding past experience, the wisdom of predecessors, future changes, and predictions across time
 - Providing AI agent services that support business operations like a Sherpa in addressing issues encountered in various tasks
 - Monitoring activities at remote locations, comprehensively understanding various organizational operations, and optimizing the entire value chain system
- and so on.

By providing support mechanisms to enhance collaboration and coordination beyond data penetration, it is possible to create economic value by forming a framework that gives strategic intent, or epistemic positioning, to the scope in question (Figure 6). By combining heterogeneous information to achieve “industrial space penetration” and enhancing the interoperability realized there, it is possible to highlight the characteristics of the business and create new social and industrial value.

Introduction of Special Epistemic Zones (SEZs) to drive industrial advancement with specialized knowledge

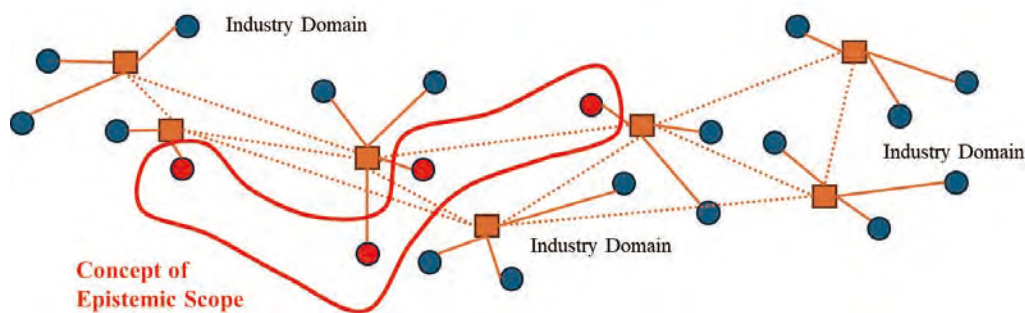
Next, we will examine economic growth strategies in the Global South through the connectivity and epistemic frameworks described in the previous section.

By combining heterogeneous information, it is possible to form epistemic relationships, or societies. By combining heterogeneous information, it is possible to form epistemic relationships, or societies. Today, relationships that are perceived as “supply chains,” “industry structures,” and “industrial ecosystems” generate economic value through epistemic societies created by some form of integration. Since these relationships lead to economic benefits, the key to creating economic value lies in determining what to integrate and how to form epistemic relationships.

In the future growth of the Global South, it is easy to imagine and inevitable that differences in growth rates will emerge in each region as a result of macroeconomic development policies. On the other hand, based on the principle of “leaving no one behind” in the Global South, it is essential to formulate economic policies that promote balanced economic development across the entire Global South while leveraging the characteristics of each region. When considering growth across the Global South as a whole, we propose a data policy that creates economic value within each scope while achieving overall balance by establishing the epistemic relationships described above. We design this data policy by defining epistemic scopes (societies) as Special Epistemic Zones (SEZs) and deploying specialized knowledge services tailored to each scope (Figure 7). The key feature here is that, rather than defining zones based on traditional regional boundaries, we can form a hyper-distributed zone that transcends regional boundaries through digital networks. By strategically assembling effective pieces that transcend regional boundaries, we can achieve effective value creation.

In advancing GSI X.0 as mentioned in Section 1, we start from the CPS as the origin, but the data strategy that drives economic value here is the SEZ. Rather than merely focusing on data penetration, this strategy connects the physical layer and cyber layer to capture business realities, thereby ensuring

[Figure 7]: Epistemic economic scope created by penetration, interoperability and knowledge sharing in industrial space



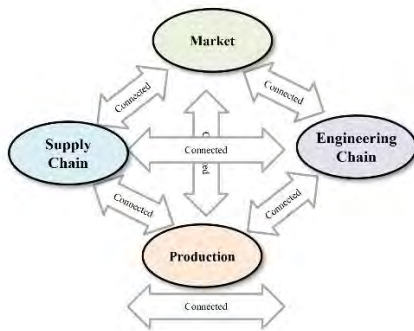
(Source: Author)

the reliability and effectiveness of each data set. By strategically applying SEZ on a CPS where such conditions are ensured, we can build a data-driven social system that fosters economic growth in a manner akin to nurturing a tree of growth.

4. Digitalization Approach towards GSI X.0 and SEZ Strategy

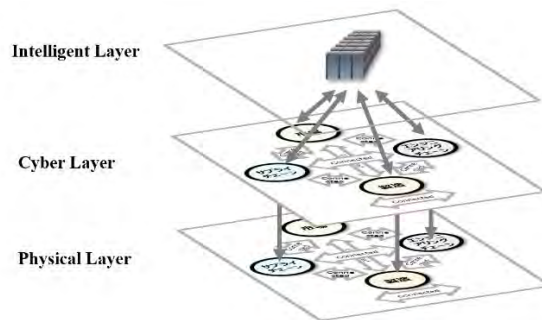
This section outlines the concepts and approaches for advancing digitalization toward the Global South Industry X.0. Here, we introduce the concept of CPS as an architecture for promoting value creation through connectivity via digitalization and explain the steps for its social implementation. The presence of a CPS foundation enhances the effectiveness of SEZs and accelerates economic growth. In particular, we will explain the technologies and methodologies that should be introduced in preparation for the launch of GSI 1.0, as well as the role of human resource development in promoting these initiatives.

[Figure 6] Value creation through interconnection between domains



(Source: Author)

[Figure 7] CPS architecture



(Source: Author)

Potential for industrial value created through digitalization

In order to enhance the value of industries through digitalization, it is necessary to promote activities that increase market value by connecting different domains, as described in Section 2 (Figure 6).

- Improving productivity, increasing operating rates, and reducing waste through automation and systemization at industrial bases
- Accelerating the maturation of industrial systems in the engineering chain/design, implementation, and operation
- Creation of a circular economy community across the Global South through collaboration between supply chain hubs and regions
- Appropriate integration between the market as the demand side and the industrial sector as the supply side
- Digitalization that takes these considerations into account directly contributes to value creation in GSI 1.0.

The significance of CPS for creating value through new combinations

In the growing Global South, it is possible to create new industrial added value by building a commercial distribution network centered on key zones in the Global South. Going forward, it will be important to establish a model that allows for flexible collaboration across the entire emerging Global South, even if it is decentralized. To establish this collaboration model, the concept of CPS will be introduced.

CPS is positioned as the final stage of social implementation in Industry 4.0, but since it requires a solid industrial foundation, it is positioned as a future initiative in Industry 4.0 activities.

In GSI 1.0, the enhancement of industrial and social infrastructure is positioned as a later-stage activity, and the challenge is to determine how much value can be generated using the CPS concept within the current industrial infrastructure. As mentioned in Section 1 of this chapter, if the current social infrastructure can be managed using cutting-edge technology, it may be possible to establish a paradigm for the Global South era that surpasses the industrial growth paradigm of the Global North.

CPS architecture that connects different elements and activities to create value

The CPS architecture involves digitizing various types of organizations and activities in the cyber layer and then connecting heterogeneous information to generate value (Figure 7).

Therefore, when introducing CPS, systematic management using a structured data architecture from the field activity layer to the top management layer is necessary in order to appropriately connect diverse heterogeneous information.

The goal is to flexibly coordinate diverse organizational activities, and therefore, it can be positioned as a higher-level management system for organizational activities. Since it is a system that integrates existing systems, this concept is called System of Systems (SOS). By implementing SOS in society, it becomes possible to achieve optimal connectivity between social infrastructure, industrial infrastructure, and the market, thereby maximizing the potential of each.

Specifically, GSI 1.0 implementation will be advanced through the following activities.

- Digitalization to enhance transparency of activities at each location (clarification of processes)
- Design of a common framework (model) to achieve SOS interoperability toward supply chain formation
- Supply chain optimization to strengthen connectivity within the supply chain (utilization of logistics, economic simulations, etc.)

In the SOS management layer, the methodology for optimally integrating various heterogeneous activities is a key point.

Methodology for creating value in CPS

Next, we will strategically define what kind of value will be created through digitization using CPS architecture and consider the methodology for achieving this.

In the implementation of GSI 1.0, the key point is to introduce a methodology that optimally integrates heterogeneous domains through the CPS architecture. This is a concept that creates value through mutual collaboration between various industrial domains and requires a corresponding framework and knowledge.

In Africa, where the advancement of industrial infrastructure is a future endeavor, a bottom-up approach to creating methodologies is not advisable. It is more effective to leverage existing methodologies, integrate them into the CPS SOS management system, and advance problem-solving through specialized expertise. Select appropriate methodologies, democratize value-creating techniques across the CPS, and utilize them appropriately. Optimize individual actions in actual operations within guidelines that lead to value creation across the Global South and navigate and accelerate actions from the management layer to the field activity layer.

Strategies for Effective Application of Value Creation Methodologies

An important point in promoting industrial advancement through digital technology on the CPS platform is the appropriate use of value-creating methodologies. In the industrial development paradigm, as we move from GSI 1.0 to the next stage, we will introduce appropriate methodologies for each stage and promote social implementation. Here, we will flexibly utilize the excellent methodologies realized by the Global North and adapt them to methodologies that are effective in the Global South.

A useful example of methodology utilization is the introduction of methodologies such as “Lean Production,” which connects the demand side and supply side in the supply chain to create market value while maximizing operational resource efficiency without waste (loss).

In GSI 1.0, the focus is on industrial network collaboration methodologies, but it is effective to incorporate the knowledge and experience that led to the success of Japanese manufacturing. Furthermore, it is necessary to establish digitalization methods that can be applied to the industrial sector in the Global South and to promote the development of corresponding human resources. “Lean production” is based on the insights developed by Japan, which has achieved success in manufacturing, to optimize material flow and industrial resource utilization. By restructuring these insights and establishing them as a methodology and then digitizing them and incorporating them as a method within the SOS system in the CPS architecture, we can accelerate the creation of new industries as part of GSI 1.0.

Utilizing highly specialized knowledge support services

In addition, it is important to incorporate specialized knowledge and expertise that is difficult to integrate into the SOS method in CPS. Digital systems cannot cover all activities. There is knowledge that is difficult to incorporate into digital systems as algorithms or logic. The utilization of such knowledge is the final piece needed to enhance industrial value, making the dissemination of knowledge services crucial. By leveraging digital technology that enables non-experts to utilize experts' insights, we can democratize the sharing of expert knowledge and accelerate the advancement of Africa's leapfrog strategy.

It should be noted that the expertise discussed here differs from the general-level knowledge provided by large language models (LLMs) or AI based on machine learning. Instead, it refers to specialized knowledge that is not publicly available online. In addition to the use of data-collection-based AI such as LLMs and machine learning, it is advisable to incorporate the use of knowledge technologies that handle expertise such as operational know-how and problem-solving methods into industrial policies.

Currently, research on knowledge technology and digital implementation is progressing in Japan, and contributions to GSI X.0 are expected. The utilization of the knowledge accumulated by Japanese manufacturing is useful for promoting the industrial development paradigm as the Global South. In activities that operate CPS covering the business processes of society as a whole, it is an effective measure to employ expert knowledge.

Developing human resources to promote value creation in digitalization

There is no question that it is necessary to develop human resources who can promote the digitalization approach described above. In order to promote digital human resource development activities, it is necessary to carry out the following activities.

- Designing a national framework for human resource development
- Preparing skill standards for human resource development that supports industrial technology
- Developing human resource development programs that promote DX-GX
- Training instructors for human resource development courses that promote DX-GX
- Cultivating talent capable of building specialized knowledge support services to assist industrial talent
- Institutionalizing organizations and partners to promote industrial talent development courses
- Establishing systems to support on-the-job training (OJT) alongside talent development courses

What is crucial here is the preparation of talent development skill standards aligned with GSI X.0. Rather than simply adopting the global north-type human resource development skill standards, it is necessary to design a human resource development maturity model within the GSI X.0 framework and define the skills required at each stage.

The most important point is not to provide digital talent from the Global South as human resources to the global north, but rather to prepare the social framework for how digital talent can be utilized to advance industrial development in the Global South.

5. Summary/Digital Measures Corresponding to This Master Plan

Let's summarize the paradigm of industrial development in the Global South through digitization that we have discussed so far.

- As a new industrial development paradigm for the Global South, there is no need to follow the industrial development steps taken by the Global North. Strategically implementing steps to build an industrial foundation based on digitalization and CPS will enable the Global South to achieve leapfrogging, which is worth considering.
- Although industrial data space strategies are being promoted in various countries, the current situation is still in its infancy and remains a challenge for the future. The Global South should not follow suit but instead plan an industrial data space based on its own industrial growth strategy.
- It is important to reexamine the essence of digitalization, and in the Global South, we should consider value creation through the integration of data from different domains. Here, strategic consideration of SEZ (Special Epistemic Zone) to realize the formation of an epistemic economic scope through the design of a data penetration framework is worth considering.

- Digitalization toward GSI X.0 and SEZ strategies will lay the foundation for economic growth policies by introducing CPS-based industrial systems. For the Global South to achieve growth “without leaving anyone behind,” it is important to design the relationships within the industrial data space, select industrial resources that highlight its characteristics, and employ appropriate specialized knowledge to accelerate value creation.
- In particular, it is effective to establish a system for developing industrial human resources and a support system for specialized knowledge that promotes the added value and acceleration of industrial activities in line with the maturity of the Global South.

Digitalization will play an important role in the future economic growth of the Global South, so we expect the promotion of strategic development based on the introduction of specialized knowledge support services and scope design, rather than simply digitalization, data penetration, and AI utilization.

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Special Article 3: Prospects for Improving Electrification Rates and Circular Economy in Africa

—An Examination Using a Two-Tier Model of Urban Grid Power and Rural Distributed Power Sources—

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1. Introduction

The low electrification rate across the African continent is said to be partly due to low incomes resulting from delayed economic growth. According to projections by the International Energy Agency (IEA), approximately 600 million people are expected to lack access to electricity even by 2030. Looking at the famous photograph of Africa at night, the lag in electrification is particularly evident in the interior regions, namely the rural areas. Therefore, under the concept of leapfrogging as an industrial cluster contributing to Africa's economic growth, this study examines electrification in the urban area envisaging circular industrial clusters. In addition, it examines rural electrification based on the premise that the effects of this economic growth will extend somewhat into inland areas.

Circular industrial clusters include electricity-intensive industries such as electric arc furnace steelmaking using scrap iron, waste plastic reprocessing, and EV battery recycling, all of which require large and stable power supplies. The conventional approach centered on mini-grids composed of solar panels and batteries is suitable for low-load rural electrification but insufficient to meet the power demands of these high-load industrial sectors. This paper examines the challenges of the conventional model and considers power supply systems for urban areas capable of attracting industrial clusters and for rural areas where grid power is difficult to utilize.

2. The Problem

Conventional discussions have treated PV+BESS (photovoltaic + battery storage) mini-grids as a "universal solution." However, this system is effective only in cases where electricity demand is not particularly high, such as on remote islands. It is unsuitable for high-power-consumption industries like electric arc furnaces and plastic recycling. The issues are listed below.

- ① **Power Shortfall for High-Load Industries:** Electric arc furnaces and plastic recycling require power exceeding data centers depending on scale (due to thermal utilization of power), making PV+BESS alone insufficient.
- ② **Overestimation of PV operating hours:** 2400 hours/year is unrealistic; 1500-1700 hours/year is more appropriate.
- ③ **Unrealistic electricity tariff rates:** USD 0.25/kWh is too high for developing country markets; USD 0.15–0.20/kWh is realistic.

- ④ **Inadequate backup power:** Diesel generators are primarily small-scale due to high fuel costs; gas-fired power is more suitable for industrial infrastructure.
- ⑤ **Ambiguity in electrification rate indicators:** Village-based (considering a village as "electrified" if even one household uses electricity) and population-based (proportion of the total population) measures are confused, leading to discrepancies in policy impact estimates. Generally, village-based electrification rates are higher than population-based rates.

3. Dual-Source Power Model for Urban and Rural Areas

Urban Areas and Special Economic Zones

Urban areas have high electrification rates and reasonably developed distribution grids, making grid power the primary option. Income levels are also higher than in rural areas, resulting in strong electricity demand and the ability to pay electricity bills. These are regions where electrification is advanced on a commercial basis by state-owned power companies and IPPs. Key points for power supply in urban areas are as follows:

- **Base Load:** Maximize utilization of existing grid power (medium/large-scale gas-fired power plants) and international transmission lines (where feasible).
- **Supplement:** Limit PV (with BESS if necessary) to peak cut and demand response.
- **Future Option:** Power supply using stationary fuel cell generation or hydrogen power generation utilizing hydrogen produced from surplus PV.

→ Target Industries: Electricity-intensive circular industries such as steel production by electric arc furnaces feeding scrapped iron, waste plastic chemical recycling, and EV battery recycling.

Rural Areas and Regional Cities

Rural areas generally have poor access to grid power, making stand-alone power sources preferable for electrification. Therefore, solar power installation is a candidate. For large rural villages capable of attracting light-load industries, PV + BESS based on a mini-grid is recommended. For small villages where household power supply is dominant, rooftop systems with small-capacity batteries are recommended. However, the cost of these power systems remains prohibitively high for residents of small villages, making some form of support essential. Below is a summary of power systems for rural areas. The third power system is a combined power and heat supply system utilizing stationary fuel cell systems. This requires hydrogen produced by electrolysis units powered by surplus PV electricity.

- **Industrial (including suburban residential):** Mini-grid (PV + BESS).
- **Residential:** Solar Home System (SHS).
- **Demonstration:** Small-capacity fuel cells using hydrogen generated from surplus PV (especially for nighttime and rainy season coverage).

→ Target: Light-load circular industries (repair/remanufacturing, e-waste reuse, textile/agricultural product recycling) and household electricity.

4. Numerical Models and Investment Payback

Assumptions

Here, five cases were considered as power systems supplying the circular industry cluster. Cases D and E also consider remote household power supply.

- A. Cape Town (South Africa): Crude steel production using electric arc furnaces. PV + BESS considered as supplementary power source. (PV: 50 MW, BESS: 200 MWh)
- B. Casablanca (Morocco): Automotive battery recycling operation. PV + BESS considered as supplementary power source. (PV: 30 MW, BESS: 120 MWh)
- C. Mombasa (Kenya): Waste plastic molding project. Considering PV + BESS as a complementary power source. (PV: 40 MW, BESS: 160 MWh)
- D. Kano (Nigeria): Repair and remanufacturing project. Considering PV + BESS as power source. (PV: 20 MW, BESS: 60 MWh)
- E. Luanda Province (Angola): E-waste processing project. Considering PV + BESS as power source. (PV: 10 MW, BESS: 30 MWh)

Below, we examine the economic viability (profitability) of the investment required for the power system, excluding the investment cost for the production facilities needed in each case.

Evaluation Formula for Investment Profitability

- **Payback Period**

This indicates how many years it takes to recover the investment required to construct the power system. The calculation formula is:

$$\text{Payback Period} = \text{Investment Amount} / \text{Annual Revenue}$$

Note that the annual revenue is the electricity sales revenue, which is the compensation for the electricity supplied by the PV + BESS system.

- **Internal Rate of Return (IRR)**

The Internal Rate of Return (IRR) represents the rate of return (profit margin) on the investment amount put into the power system. A higher IRR indicates a more attractive investment opportunity. However, electricity is a form of social infrastructure with significant economic ripple effects (generating substantial added value through electricity consumption), so it does not require the high IRRs typically sought by private investments.

$$\text{Investment Amount} = \sum \frac{R_i}{(1+r)^i}$$

R_i : Revenue in year i

r : IRR, $i = 1, 2, \dots, n$ (years)

In other words, the discount rate is determined by finding “ r ” that makes the sum of the present values ($i=0$) of each year's revenue equal to the investment amount. This discount rate (r) is the IRR.

Site-Specific Estimates

By referring to various literature and data, we estimated the investment amount and annual revenue for each case and calculated the payback period and IRR. The results are shown below.

Location	CAPEX (M USD)	IRR (%)	Payback Period (Years)	Special Notes
Cape Town	300	Approx. 8	7–8	Electric furnace support, grid + PV supplementation
Casablanca	120	7–8	7–9	Battery Recycling
Mombasa	150	8–9	7–8	Plastic Waste Remolding
Kano	80	7–8	Approx. 8	Repair and Remanufacturing Base
Luanda Province	60	6–8	8–9	E-waste Processing

Table Interpretation

- Urban hubs consume significant electricity for thermal utilization. Consequently, while the investment scale is large, the high returns resulted in an IRR below 10%. This was also aided by the grid electricity enabling the loss-free utilization of electricity generated by PV + BESS.
- Rural hubs show an IRR of 6–8%, slightly lower than urban areas, yet still a higher value for a public good. This is likely due to higher residential electricity rates in rural areas. Residential rates must be below 10 cents/kWh for PV to be viable, necessitating some form of policy support.
- Combining public support with results-based financing (RBF) and providing it to SMEs and the household sector could further reduce electricity rates. This would secure electricity consumption by SMEs and households, creating additional value. Furthermore, this added value could facilitate the recovery of public support funds.

5. Electrification Rate Trends and Policy Effects

As previously mentioned, urban areas already have established power grids for industrial electricity supply. Furthermore, since urban residents are engaged in the industrial and commercial sectors, their incomes are relatively high. Consequently, the electrification rate of the urban household sector is expected to increase under BAU (Business As Usual) conditions. Conversely, in rural areas, the poor situation of the power grid means accessing grid electricity will take time. Rapid electrification is possible by utilizing stand-alone power sources like solar. However, solar power systems are expensive, making their installation difficult given rural income levels. Therefore, policy support, including from the international community, is required. According to a simple calculation, 60 million of the 100 million people can be supplied with electricity from urban areas and industrial parks. As support, the state-owned power company is required to develop new distribution networks. The remaining 40 million people will have no choice but to use Stand-Alone solar power. This requires an investment of approximately \$8 billion. Assuming half of this is covered by policy support, the policy support amount would be approximately \$4 billion. Electricity provides lighting and power to households even at night, contributing to increased household value. Therefore, even if this policy support takes the form of loans (microfinance), rural households are likely to have the repayment capacity if the repayment period is medium to long-term (5-10 years). Assuming this policy support, even by 2030—when the IEA projects 600 million people will still lack access to electricity—100 million people could gain access. This stems from increased incomes for Africans driven by industrial development. Here, we envision the growth of high-value-added circular industries, rather than traditional industrial promotion.

6. Ripple Effects from the Circular Economy

Post-COP26, momentum for decarbonization has intensified. Europe is considering implementing the Carbon Border Adjustment Mechanism (CBAM), which would impose tariffs on carbon-intensive imported goods at its borders. Consequently, manufacturing low-carbon-intensity products has become essential. Furthermore, electric vehicles are gaining prominence as a key solution for decarbonization, driving rapid growth in demand for batteries containing critical minerals. However, critical minerals are concentrated in specific regions. Considering the security of critical mineral supply, recycling becomes indispensable. Therefore, as mentioned in the case study, we propose the following industrial clusters that can be termed "venous industries":

- **Urban Areas:** ① Electric Arc Furnace (EAF) production of crude steel is already established, primarily in developing countries. While not a leapfrog industry, it emits significantly less CO₂ compared to blast furnace crude steel production (depending, of course, on the power mix of the electricity generation system). Therefore, crude steel produced by EAFs is considered low carbon intensity. However, steel products from electric furnaces are unsuitable for high-quality applications like automotive steel sheets due to impurity content, so they are used for construction materials and general machinery. ② Plastics are manufactured from petroleum, and increased plastic demand leads to higher oil consumption. Consequently, the reuse (reforming) of existing plastics is gaining attention. Reworking involves processes such as cutting (electricity) to pelletize the material and melting it down

to extrude it into molds (heat). Of course, there are also cases where plastic is heated and processed directly. While heat sources require fossil fuel consumption, using low-carbon fuels like gas, synthetic fuels, and hydrogen can reduce carbon intensity. ③EV batteries degrade rapidly due to frequent charging and discharging (consumption). However, used EV batteries can be repurposed as stationary Battery Energy Storage Systems (BESS) to level out load fluctuations from sources like solar power (BESS do not require charging/discharging as frequently as EVs). This reduces dependence on critical minerals.

- **Rural Areas:** ① Discarded electrical and electronic equipment contains both hazardous substances and valuable resources. Therefore, it is crucial to process and dispose of this equipment while reusing (recycling) the valuable resources. The processing steps involve first removing hazardous substances like lead and mercury, then shredding the e-waste to extract valuable materials (precious resources) such as gold, silver, copper, and critical minerals. Resource recovery from this e-waste has surged in recent years. Attracting industries that enhance recycling rates for electrical and electronic equipment through proper processing and disposal, thereby contributing to the transition to a circular economy, is now required. Electricity is the primary energy source used. ② An industry that regenerates old, unused clothing into new garments. While many garments are discarded in developed countries, this concept involves sorting reusable items and exporting them as new clothing to developed nations and neighboring countries. It is a labor-intensive industry that utilizes electricity.
- **Employment Creation:** High-value-added industries in urban areas are proposed to generate foreign exchange-earning jobs, while labor-intensive jobs centered on women and youth are proposed for rural areas. Simple estimates suggest this could create approximately 10,000 new jobs.

7. Policy Implications

As seen above, this paper demonstrates how attracting circular (venous) industries, considering leapfrog industries, can raise local residents' income levels and thereby promote electrification in the region. Essential policy considerations for achieving this are outlined below.

1. In urban areas, strengthening existing grid power and developing cross-border wide-area transmission networks are essential. Circular (venous) industries attracted to urban areas often involve significant thermal utilization of electricity, resulting in high power consumption. Therefore, relying solely on PV + BESS is challenging. Grid connection to the power grid, supported by clean thermal power generation, remains indispensable. Furthermore, establishing grid connections with neighboring countries would enable power supply from those countries in emergencies, contributing to stable production activities for the recycling industries. As this is a region with high economic growth potential, progress in attracting Independent Power Producers (IPPs), developing the grid network, and increasing electrification rates in the household sector is expected under the Business-As-Usual (BAU) scenario.
2. Industries introduced in rural areas will primarily be small-scale, with relatively low power consumption, suggesting PV + BESS could cover a significant portion. If necessary, owning small-scale gas-fired power plants for self-generation is recommended as backup.

Additionally, supplying electricity to nearby residents is also feasible. However, for electrification in rural areas far from this industrial cluster, rooftop PV is appropriate, but this requires policy support (funding). That said, electrification enables nighttime work, generating further added value, so repayment of policy support funds is considered feasible.

3. We mentioned installing gas-fired power generation as a backup. However, we also see potential in backup power systems using hydrogen-fired power generation or stationary fuel cells instead of gas-fired power generation. To achieve this, it is important to bring forward technology demonstrations and develop them as candidates for low-carbon baseload power generation from the 2030s onwards.
4. Steel products made by electric arc furnaces have low carbon intensity, but due to their impurity content, they cannot be used for high-quality steel plates and are mainly supplied to the green steel market for construction and infrastructure.
5. In urban and rural areas where circular (venous) industries are attracted, approximately 100 million people will have access to electricity through the power supply systems (mainly PV + BESS) introduced for this purpose and existing power sources. In rural areas where circular (venous) industries are not attracted, the introduction of rooftop PV systems with policy support will greatly contribute to improving the electrification rate. Electricity is an essential energy source for Africa's economic growth.

8. Conclusion

Africa's electrification rate is said to be low. Indeed, according to the IEA, it is projected that approximately 600 million people will still lack access to electricity even by 2030. One contributing factor is Africa's low-income levels, a result of delayed economic growth due to poor industrial clustering. Therefore, promoting industrial clustering and achieving economic growth is necessary. However, considering recent trends like decarbonization and the shift towards a circular economy that curbs resource waste, replicating past industrialization processes cannot be considered a policy aligned with current trends. This paper proposes a circular industrial cluster centered on the circular (venous) industry. It explores generating wealth and sharing it with local residents to raise their income levels, while increasing electrification rates through a power supply system comprising grid electricity and large-scale PV+BESS systems. Nevertheless, many rural areas remain distant from such industrial clusters. For these regions, the paper examines increasing electrification rates by promoting rooftop PV systems. However, since income levels in these rural areas are not as high as in urban areas, policy support (funding) is essential for the widespread adoption of rooftop PV. On the other hand, electricity use enables nighttime work, bringing added value to rural households. Therefore, such policy support funds are considered repayable if the repayment period is medium to long-term. This paper presents a policy package that can simultaneously achieve electrification for approximately 100 million people, CO₂ reduction, the creation of 10,000 jobs, and foreign exchange earnings (income improvement).

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Chapter 7

Geographical Simulation

Analysis

Chapter 7: Geographical Simulation Analysis--The Economic Significance of Leapfrog-Type Economic Corridor Development Strategies

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1. Introduction

The development of economic corridors in Africa aims to deepen regional integration, promote trade, and achieve sustainable growth. In particular, the African Continental Free Trade Area (AfCFTA), which came into effect in 2019, seeks to expand intra-regional trade, and its success largely depends on the functioning of efficient and reliable economic corridors.

Japan is also actively cooperating in the development of economic corridors in Africa. The Japan International Cooperation Agency (JICA) focuses on high-quality investment principles for sustainable growth and contributes to the development of economic corridors through a combination of hard and soft infrastructure. The Northern Corridor, which connects the Port of Mombasa in Kenya to several inland countries, is prioritised by the East African Community (EAC) as a top development agenda. For example, JICA has supported the expansion and modernisation of the Port of Mombasa, the renovation and construction of major trunk roads, and the establishment of One-Stop Border Posts (OSBP) to eliminate bottlenecks and improve functionality. The Nacala Corridor, starting from the Port of Nacala in Mozambique, is crucial for the development of Southern Africa, contributing to the improvement of local livelihoods and macroeconomic stability by promoting resource exports. Additionally, JICA has supported the modernisation and expansion of the Port of Nacala, the development of major road networks, the construction of bridges, the renovation of railway infrastructure, the introduction of OSBP, and the training of logistics personnel.

Traditional economic corridor development has taken a phased approach, starting with road development, followed by border facilitation, and then the establishment of Special Economic Zones (SEZ), as suggested by the historical definition of economic corridors as an advanced form of transport corridors. The development of economic corridors brings positive outcomes such as reduced logistics costs and increased trade, but challenges remain in terms of financing, political cooperation, and environmental sustainability. Achieving multiple objectives, such as improving physical connectivity, incorporating digital and green initiatives, maximising the potential of

AfCFTA, and ensuring inclusive growth, through a phased approach requires significant costs and time.

On the other hand, Cilliers (2025) points out that leapfrog strategies using digital technology and renewable energy may surpass traditional physical infrastructure development. The rapid spread of mobile communication and the internet, in particular, transforms the informal economy into the formal economy. In fact, impacts on income improvement and poverty reduction have been reported in several countries, including Ghana.

Based on this recognition, this section proposes a leapfrog economic corridor development strategy that prioritises border facilitation (including OSBP), the deployment of skill-development SEZs through digital education, the development of gateway ports, and the reduction of non-tariff barriers to strengthen connectivity with Asia and Europe, while postponing intra-regional road development. Regarding border facilitation, it has been reported that the introduction of OSBP and the training of specialised personnel in customs and clearance fields in the North-South Transport Corridor have contributed to the reduction of clearance time and the promotion of trade (JICA, 2022). In the context of Africa's supply chain, the introduction of ICT and smart borders accelerates trade facilitation, effectively eliminating bottlenecks and reducing transaction costs (Grater and Hoffman, 2021). The spread of mobile communication and the skill development of the younger generation contribute to improved connectivity and productivity in economic corridors (Bhalla and Chaturvedi, n.d.). Additionally, the development of digital education and vocational training SEZs aligns with the ICT education support and skill transfer that Japan has implemented in African countries, suggesting that these efforts lead to economic diversification and industrial enhancement (JICA, 2022). Furthermore, the reduction of non-tariff barriers through the efforts of individual countries and regional communities (EAC, COMESA) and the harmonisation of electronic customs and SPS regulations may simultaneously facilitate intra-regional trade and strengthen the foundation for connectivity with Asia and Europe. This approach opens the path to more immediate economic integration and economies of scale compared to traditional development focused on physical infrastructure. The triad approach of OSBP development and electronic procedure promotion, SEZ design centred on ICT education, and systematic reduction of non-tariff barriers to enhance global connectivity is extremely rational as a new corridor development model in Africa.

Even without road development, this strategy, which combines improved connectivity and industrial development while considering intra-regional and extra-regional economic interconnections, can be defined as a new economic corridor development model. Moreover, the approach and scenarios in this section do not advocate for measures limited to digital and institutional reforms but also emphasise the importance of physical infrastructure improvements at borders and ports. In fact, delays in development at borders and ports not only hinder trade but also become bottlenecks in the advancement of digitalisation (Almeida and Okon, 2025; World Economic Forum, 2022; World Bank Group, 2023).

To analyse these aspects, we will examine the impact of economic corridor development initiatives in Sub-Saharan Africa on the economies of various countries and regions. Using the Geographical Simulation Model (IDE-GSM) developed by the Institute of Developing

Economies, the Japan External Trade Organization (IDE-JETRO), we will evaluate how traditional phased economic corridor development approaches and leapfrog economic corridor development approaches each promote economic growth and mitigate regional economic disparities. Comparing the traditional phased economic corridor development approach with the leapfrog economic corridor development approach is effective in assessing whether the latter can achieve high economic effects in a short period.

IDE-GSM is a computable general equilibrium (CGE) model based on spatial economics, and its development began in 2007 as a joint research project between JETRO's Institute of Developing Economies and the Economic Research Institute for ASEAN and East Asia (ERIA). IDE-GSM is a useful tool for analysing international economic corridors and has been utilised by ERIA, the World Bank, and the Asian Development Bank (ADB) to analyse the economic effects of international infrastructure development. The first advantage of IDE-GSM is that it has regional-level data for multiple countries. This allows policymakers and researchers to understand how economic corridors spanning multiple countries affect different regions within those countries and to formulate effective policies accordingly. Secondly, IDE-GSM responds to changes in economic structure. Unlike models with fixed input-output structures at the national or regional level, IDE-GSM includes firms and consumers within the model, whose behaviour changes. For example, when transport infrastructure is developed, firms and consumers change their sales and purchasing patterns, which alters the overall economic structure. This is effective for scenario analysis involving significant structural changes, such as connectivity with Asia. Thirdly, IDE-GSM can analyse and compare the economic impacts of various policy measures related to international economic corridors, such as the effects of individual infrastructure projects (e.g., the construction of individual bridges and roads), tariff reductions, and trade facilitation. These aspects make IDE-GSM a highly useful tool for analysing international economic corridors.

The main data used in IDE-GSM includes economic geography data (such as sector-specific regional GDP, population, and area) and multimodal route data. Industries are divided into primary industries (agriculture, mining), manufacturing (automobiles, electronics and electrical equipment (E&E), textiles and apparel, food processing, other manufacturing), and services. Route data includes roads, sea routes, air routes, railways, and high-speed railways, with information on routes, speeds, border crossing times, and costs. Economic geography data is constructed according to official statistics, but if regional GDP is not available, other data such as economic censuses or night-time light and land cover from satellite images are used. For African route data, IDE-GSM incorporates cross-border transport data compiled by NX Research Institute and cross-border transport data based on the OSBP Status Report (AUDA-NEPAD & JICA, 2024).

2. Scenario

In the analysis scenarios, we focus on Sub-Saharan African countries, identifying major corridors and considering the impacts of road development, border facilitation, SEZ development, and the reduction of non-tariff barriers (Table 1).

[Table 1]: Components of Each Scenario

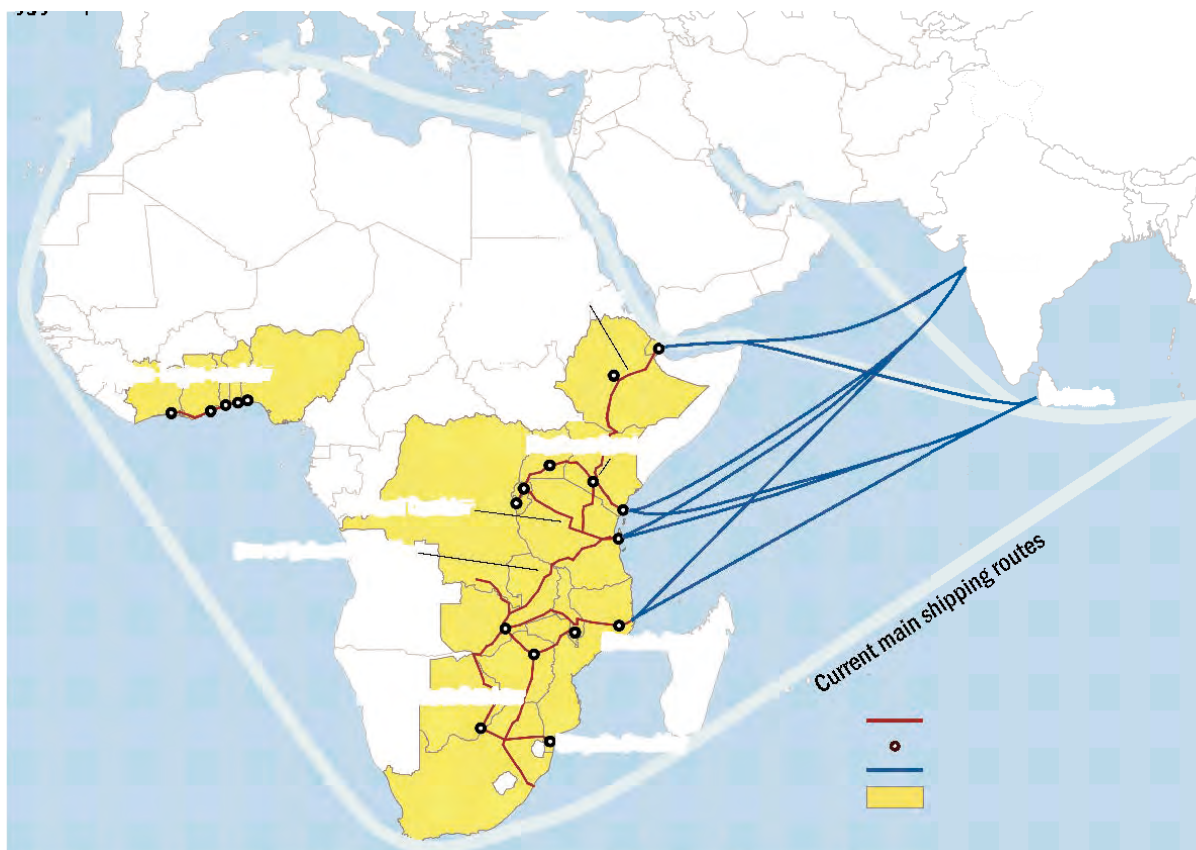
	Road improvement	Border facilitation	SEZ	Connection with South Asia	NTB reduction	Connection with Japan & EU
Traditional corridor-based development strategy						
Scenario 1	✓	✓	(Northern and Central Corridors only)			
Scenario 2	✓	✓				
Scenario 4m (minus)	✓	✓		✓		
Scenario 3	✓	✓	✓			
Scenario 4	✓	✓	✓	✓		
Scenario 5	✓	✓	✓	✓	✓	
Scenario 6	✓	✓	✓	✓	✓	✓
Leapfrog development strategy						
Scenario 7		✓	✓	✓	✓	✓

(Source: IDE-GSM team.)

3. Traditional Economic Corridor Development Scenario

In Scenario 1, we consider road development and border facilitation for the ring section consisting of the Northern and Central Corridors. In Scenario 2, we expand the geographical scope to include road development and border facilitation for major corridors in Sub-Saharan Africa. We will improve road infrastructure and reduce border crossing times and costs as indicated in the "Road improvement" section of Figure 1. Scenario 3 assumes productivity improvements in cities designated as "SEZ" in Figure 1, in addition to the elements of Scenario 2. Before Scenario 3, we set up Scenario 4m (minus), which assumes sea route development with Mumbai and Colombo without developing SEZs. Scenario 4 includes sea route development with Mumbai and Colombo in addition to Scenario 3. Specifically, it connects the ports of Djibouti, Mombasa, Dar es Salaam, and Nacala with the ports of Mumbai in India and Colombo in Sri Lanka. Scenario 5 involves reducing NTBs through institutional reforms in countries designated in the "NTB reduction" section of Figure 1, in addition to Scenario 4. Scenario 6 adds improved connectivity to East Asia via Singapore from Sri Lanka and to Europe from West Africa to Scenario 5.

[Figure 1]: Scenario Analysis Content (Scenarios 1-5)



(Source: IDE-GSM team.)

For road development, it is assumed that trucks will be able to travel at an average speed of 60 km/h. This requires dedicated roads for vehicles in areas other than sparsely populated regions. At borders, the time and cost required for customs clearance will be halved, both where OSBP exists and where it does not. This includes not only the establishment of OSBP but also the development of transshipment facilities and the elimination of congestion before entering border CIQ facilities. For sea route development, it is set on the region's main routes, improving port operation performance and halving the time and cost incurred at ports.

In SEZs, the productivity parameters of the region will be increased by 10%. This involves not only setting up SEZs but also completing infrastructure such as electricity, water supply, and wastewater treatment within industrial parks, and improving access to major corridors.

Non-tariff barriers in IDE-GSM refer to all barriers other than tariffs and difficulty in accessing transportation. This includes not only policy-related non-tariff measures but also the lack of capacity of government agencies handling imports and exports, lack of transparency, and the lack of capacity of individual companies handling imports and exports. Therefore, the reduction of non-tariff barriers in the scenarios specifically includes the promotion of single-window customs clearance, reduction and standardisation of required documents, abolition of paper document submission and presentation, establishment of systems such as AEO, advance rulings, and

deferred payment of customs duties before and after transportation, improvement of transparency, and development of digital trade platforms. Additionally, it includes not only the improvement of the capacity of personnel but also the improvement of the capacity of logistics companies and customer companies using the services.

4. Leapfrog Economic Corridor Development Scenarios

In Scenario 7 of leapfrog economic corridor development, as shown in Table 1, only the road development part is excluded from Scenario 6. Although intra-regional road development is excluded, it includes the reduction of time and cost at borders and improvement of port operation performance.

The development of SEZs continues with the scenario of increasing the productivity parameters of the region by 10%, but instead of traditional industrial parks assuming manufacturing, it assumes SEZs targeting ICT education, skill development, DX, and IoT.

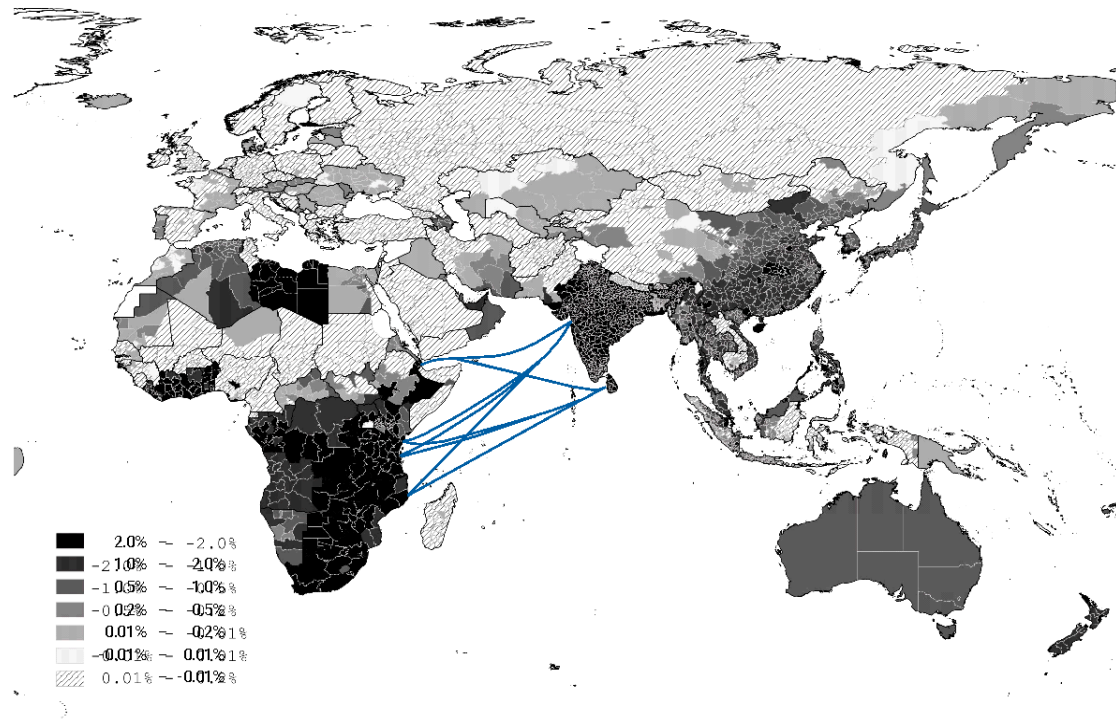
5. Results

Based on these scenarios, the impacts on countries and regions are evaluated. The findings derived from the simulation results of the traditional economic corridor development scenarios are as follows:

- Infrastructure development and border facilitation initiatives in Sub-Saharan Africa have a significant positive impact on the economies of many countries and regions.
- The strategic combination of road development, OSBP, SEZ, reduction of non-tariff barriers, and connectivity with Asia is crucial.
- Enhancing connectivity with South Asia without regional infrastructure development and human resource development on the African side leads to negative impacts in some African countries close to Asia. This is partly due to the influx of a large amount of goods from India, which hampers the growth of African manufacturing, and partly because people tend to live in cities closer to Asia, reducing the influx of population into the largest economic cities. African countries already have a very high proportion of the service sector, so both manufacturing and service sectors, which generate high-wage employment, cannot absorb employment. The establishment of such undesirable forms of international division of labour indicates risks to the promotion of African industries.

The reduction of NTBs also brings positive effects to the African region, but there are regions that experience negative impacts (Figure 2).

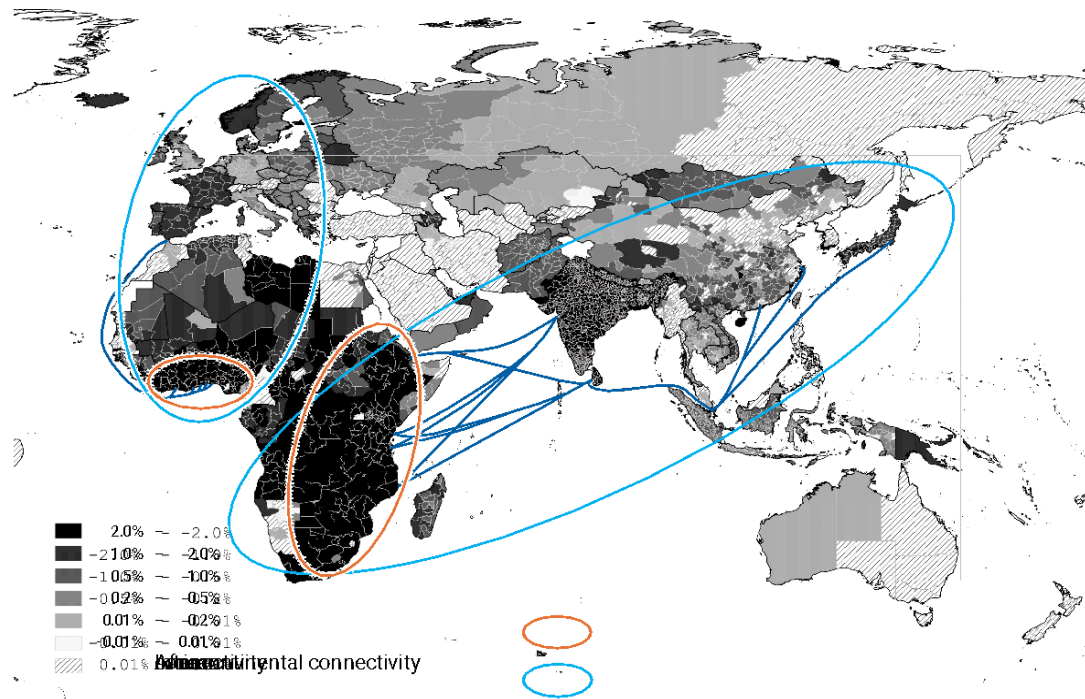
[Figure 2]: Economic Effects of Scenario 5 (All Scenarios: Road Development, OSBP, SEZ, Reduction of Non-Tariff Barriers, Connectivity with South Asia)



(Source: IDE-GSM simulation result.)

Furthermore, in Scenario 6, by adding improved connectivity to East Asia via Singapore from Sri Lanka and to Europe from West Africa to Scenario 5, positive effects will spread to many regions in Africa, and significant positive impacts will be seen in Japan, Europe, and India (Figure 3). As geopolitical trends change, production systems concentrated in specific countries, sales strategies dependent on specific consumer countries, and systems reliant on traditional major transport routes are becoming increasingly difficult. Strengthening connectivity within Africa and linking it to intercontinental connectivity can expand positive effects in many regions worldwide and contribute to enhancing the resilience of the global economy.

[Figure 3]: Economic Effects of Scenario 6 (Connectivity within Africa and Intercontinental Connectivity)

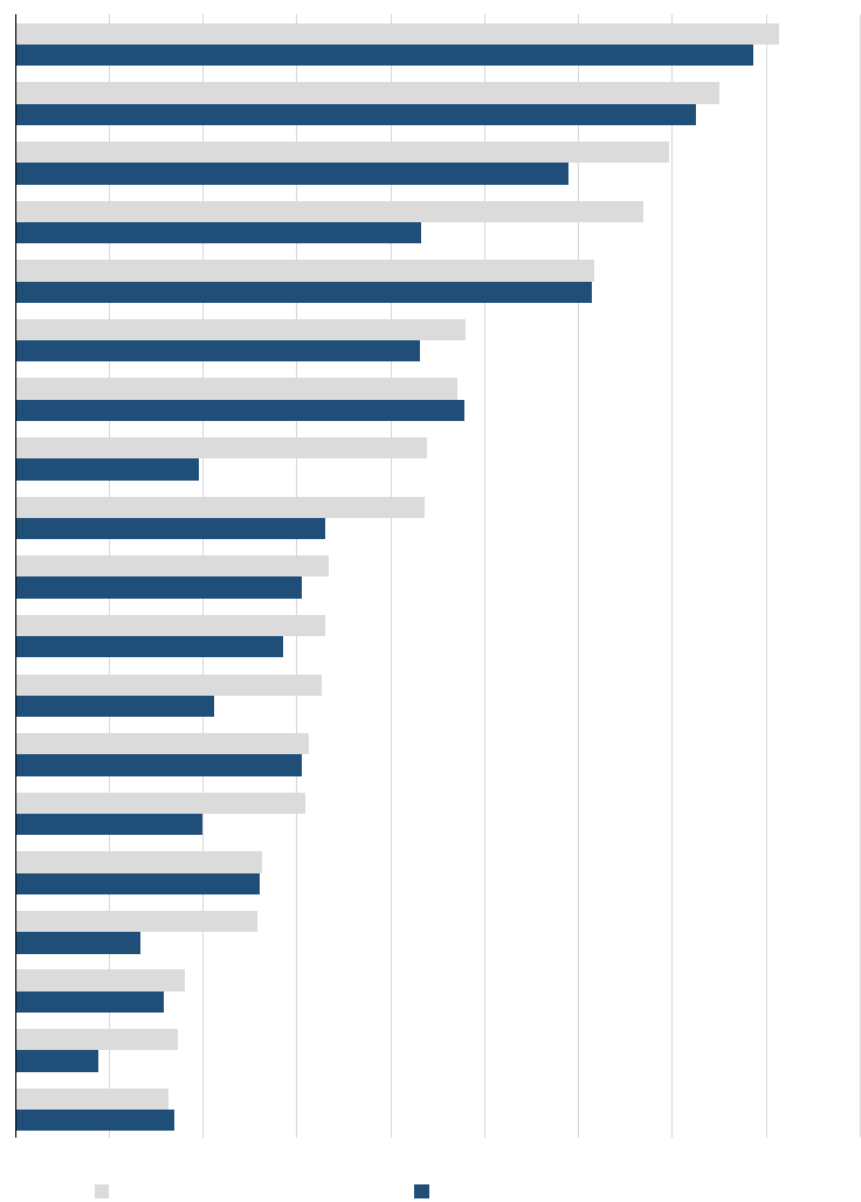


(Source: IDE-GSM simulation result.)

In Scenario 7 of leapfrog economic corridor development, road development is excluded compared to Scenario 6, which considers all aspects. Therefore, it is generally expected that the economic effects will be lower than Scenario 6. The critical question here is the extent to which the difference is decisive.

The comparison between Scenario 6 and Scenario 7 is shown in Figure 4. Scenario 6 exhibits a maximum economic effect of 16.3% in various countries but achieving this requires large-scale investments and long-term efforts in road development and physical infrastructure installation. On the other hand, Scenario 7 postpones intra-regional road infrastructure development and prioritises border facilitation measures such as OSBP, the establishment of skill-development SEZs accompanied by digital education, and the electronic reduction of non-tariff barriers to strengthen connectivity with Asian and European markets. This achieves high-level positive effects in a shorter period. This clearly demonstrates that even when physical infrastructure development is concentrated at borders and ports, significantly reducing time and costs, many regions can still achieve comparable economic outcomes.

[Figure 4]: Comparison between Scenario 6 (Traditional Phased Approach) and Scenario 7 (Leapfrog Approach)



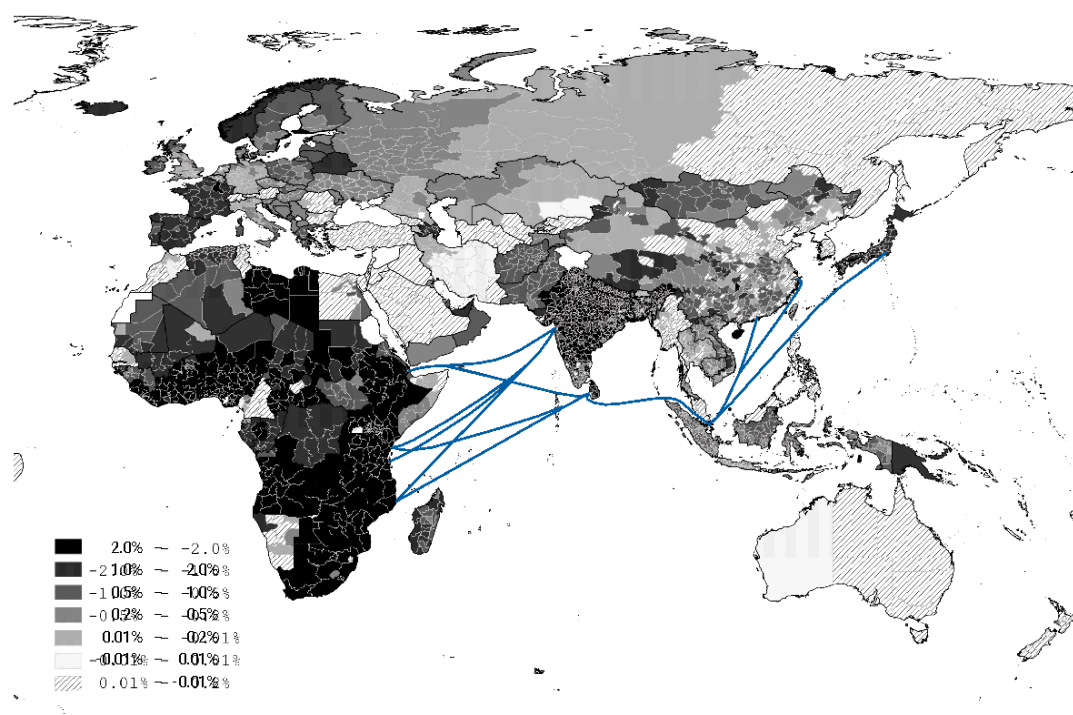
(Source: IDE-GSM simulation result.)

These results are consistent with the continental-level leapfrog + large-scale infrastructure scenario model results by the Institute for Security Studies (ISS Africa) (Cilliers 2025). Here too, it is emphasised that the leapfrog strategy leads to faster progress by prioritising the development of non-physical infrastructure areas (electricity, ICT access, digitalisation of institutions, etc.).

Figure 5 illustrates the economic effects of leapfrog economic corridor development in Scenario 7. It shows that even without intra-regional road development, the geographical spread

of regions that can achieve positive economic effects within the region is ensured, and the risk of leaving rural areas behind is minimal.

[Figure 5]: Economic Effects of Leapfrog Economic Corridor Development (Scenario 7)



(Source: IDE-GSM simulation result.)

6. Conclusion

The development of economic corridors in Africa is essential for deepening regional economic integration, promoting trade, and achieving sustainable growth. In particular, the success of the African Continental Free Trade Area (AfCFTA), which came into effect in 2019, hinges on the establishment of efficient and reliable economic corridors.

Analysis using the IDE-GSM has shown that, in the traditional economic corridor approach, combining road development, border facilitation, SEZ development, reduction of non-tariff barriers, and strengthening connectivity with Asia in a phased and strategic manner promotes economic growth in Africa and mitigates regional economic disparities. However, if productivity improvements, such as adequate human resource development, are not achieved on the African side, there is a risk of undesirable forms of international division of labour, which could pose risks to the promotion of African industries. Therefore, accumulating successful cases and realising the optimal development path is essential for sustainable development.

Furthermore, even in the leapfrog economic corridor development scenario, which intentionally excludes road development from the traditional economic corridor approach, it has been shown that countries can maintain high economic effects and ensure the geographical spread of regions that can achieve positive economic effects within the region. This scenario still includes infrastructure development at borders and ports, indicating the necessity of modernising these ports and facilitating logistics. Although SEZs are assumed to be skill-development SEZs rather than traditional industrial parks, similar to the analysis results of the traditional economic corridor approach, it is emphasised that improving connectivity with South Asia without securing sufficient skills could lead to undesirable forms of international division of labour, hindering the promotion of African industries.

As policy recommendations, a strategic deployment based on the following three pillars is appropriate. First, prioritising the introduction of OSBP and the digitalisation of customs as border facilitation measures to eliminate trade bottlenecks. This can achieve a reduction in customs clearance time and optimisation of transaction costs. Secondly, in skill-development SEZs, making digital education a mandatory requirement and introducing IT and digital-related vocational training as a set. This allows for simultaneous endogenous human resource development and industrial diversification. Thirdly, promoting the reduction of non-tariff barriers through digitalisation and strengthening cooperation with AfCFTA and COMESA to enhance integrated market access with Asia and Europe. By comprehensively implementing these measures, African countries can achieve maximum economic effects in a short period with minimal cost and time. This analysis demonstrates that the leapfrog corridor strategy, as an alternative to the traditional corridor model, excels in policy effectiveness and cost performance.

Regarding leapfrog development in Africa, there are also sceptical and critical perspectives in the literature. Alzouma (2005) and Tan and Taihagh (2020) point out that there are limitations to the introduction of technology without understanding the structural constraints of society and the economy (education, institutions, market size). Awoleye (2021) highlights that as long as technology is dependent on foreign capital, there are issues of data sovereignty. These suggest that without the design of digital governance systems, such as data protection, the effects will be limited.

Asian countries are expected to strengthen their connectivity with Africa and contribute to the construction of sustainable trade networks. It is particularly important to promote trade facilitation through the digitalisation of logistics systems and the enhancement of sea route connections. In addition to infrastructure development support, it is desirable to contribute to human capital development through technology transfer and support for educational institutions.

From a long-term perspective, it is desirable to optimise large-scale logistics infrastructure investment in the African region in parallel. The difference in economic effects between traditional economic corridor scenarios and leapfrog economic corridor development varies by country, indicating that domestic road infrastructure investment remains important. It is crucial to select key corridors such as the Northern Corridor, Central Corridor, and Nacala Corridor, and to develop roads, ports, and railways. Furthermore, to strengthen inter-regional cooperation, it is

necessary to establish coordinating bodies among AfCFTA member countries and formulate infrastructure investment plans.

Japan should strengthen international cooperation and actively contribute to the development of economic corridors in Africa. It is important to continue infrastructure development support through JICA and deepen cooperation with local communities. Additionally, it is necessary to formulate economic corridor development strategies and promote sustainable projects in collaboration with African countries. Furthermore, actively transferring technology and knowledge to contribute to the improvement of local industrial competitiveness is essential. In terms of trade and investment environment development, it is worth considering strengthening policies to promote the entry of Japanese companies into Africa (such as risk management support and tax incentives). Moreover, it is desirable to deepen business exchanges between Japan and Africa and promote economic cooperation through public-private partnerships.

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Chapter 8

Development Strategy

Chapter 8: Development Strategy -- The Developmental Strategy for Digital Logistics and Circular Economy in the Global South Based on Field Research in Ethiopia, the African Union, and Kenya

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1. Research Topics

The Musashino Institute for Global Affairs (MIGA) held the 'Africa Master Plan Formulation Project Study Group' in fiscal year 2025. This group undertook the 'Master Plan Formulation Project for Resource Circulation Formation through Enhancement of Digital Connectivity in Regional Logistics in Africa.' The main theme of this project is to establish a circular economy system by enhancing digital logistics connectivity. While this may appear to focus narrowly on the industrial sector, its implementation requires the formulation of a new perspective on developmental strategies that the Global South should adopt to achieve long-term and sustainable economic growth.

This, in turn, raises issues related to the evolutionary path of the modern civilization. This chapter will organize and discuss these issues.

Musashino Institute for Global Affairs (MIGA) has been conducting a series of seminars since fiscal year 2024 to examine the content of developmental strategies that the Global South should adopt in the future, within the broader framework of the evolutionary path of modern civilization. The findings of this work have been compiled in the report titled 'Path Diversity for 'No One Left Behind'' (MIGA, November 2024). This report was distributed to all sherpas at the G20 Sherpa Meeting held in Rio de Janeiro in November 2024 and was also presented at the G20 Social Summit (November 14th, 2024), which was held in conjunction with the G20 Summit, thereby disseminating information to the world. This chapter examines the approach to advancing the construction of a circular economy system through the enhancement of logistics digital connectivity, in line with the content of the report regarding the potential developmental strategies that the Global South should adopt in the era beyond the mid-21st century.

2. Challenges in Establishing a Circular Economy System through the Enhancement of Logistics Digital Connectivity

Based on the discussions conducted in the study group and field surveys, it can be said that to practically establish a circular economy system based on digital logistics connectivity requires tackling the following challenges.

The first challenge is to establish a comprehensive Cyber Physical System in the target region.

Logistics digital connectivity is based on the premise that it is possible to completely track the location and status of materials subject to logistics at any given time. Based on this, it is necessary to implement the control measures necessary for efficient logistics. In other words, a system that enables complete digital tracking and control of materials is required, which is possible through a comprehensive Cyber Physical System.

In addition, in the construction of a circular economy system, it is necessary to completely track and control all resources that have the potential to be recycled, beyond the scope of resources that have traditionally been considered as resources for production activities. This includes many items that have traditionally been considered waste (garbage). Furthermore, to reintroduce these new "resources" into the production process, it is necessary to accurately track and control the capacity of production facilities, in addition to tracking and controlling the new "resources". Furthermore, to appropriately predict the generation and availability of new "resources" soon, it is necessary to grasp extensive information beyond industrial sectors, including information related to people's daily lives.

In other words, it will be necessary to track and control comprehensive information not only in industrial and logistics sectors but also in all aspects of people's lives in the target region, and the means to achieve this will be the construction of a comprehensive Cyber Physical System. The greatest challenge in practically promoting the construction of a circular economy system through the enhancing logistics digital connectivity is the construction of a comprehensive Cyber Physical System in the target area. Conversely, it is extremely difficult in practice to promote the construction of logistics digital connectivity and a circular economy system without first constructing a comprehensive Cyber Physical System.

It is important to note that the necessity of construction being emphasized here is not for Cyber Physical Systems specialized for industrial use, but for comprehensive Cyber Physical Systems. The concept of Cyber Physical Systems was first proposed by Germany in the 2010s as part of its Industrie 4.0 initiative. Since then, Germany has introduced the RAMI 4.0 data architecture and the GAIA-X conceptual model for industry and is promoting the development of data integration systems such as CATENA-X for the automotive industry.

In contrast, this study argues for the construction of a comprehensive Cyber Physical System that encompasses all human actions within the scope of the target area, not limited to the industrial or logistics fields. This is because human behaviour not only directly triggers economic movements as consumption behaviour but also forms the foundation for the creation of new value required for the construction of a circular economy system, as described below. Here, we will distinguish between specific Cyber Physical Systems tailored to specific industries, such as GAIA-X and CATENA-X, which we refer to as specific-purpose Cyber Physical Systems, and the comprehensive Cyber Physical Systems described in this study, which we refer to as general-purpose Cyber Physical Systems.

The second challenge is to develop methodologies to promote the creation of new value in relation to the new philosophy of a circular economy system that has emerged in the history of the modern civilization.

Since the first industrial revolution, which is said to have begun in the mid-18th century (Note 1), industrialization has been understood as consisting of three types of human behaviour:

production, logistics, and consumption. After consumption, waste (garbage) is generated, which is considered economically worthless because it must be disposed of at a cost and cannot be used as input for new production activities. Furthermore, since disposal incurs costs, waste is regarded as having negative value.

On the other hand, a circular economy system involves reintegrating waste (garbage) generated from the three types of human activities—production, logistics, and consumption—into the supply chain as resources for new production. This requires a fundamentally different philosophy from the traditional industrialization paradigm. To implement such a new system in society, it is necessary to construct a fundamentally different way of thinking from the traditional notion that the three types of human activities unfold sequentially and that industrialization comes to an end with the cessation of consumption. Since waste (garbage) becomes a resource for new production activities and is incorporated into the supply chain, it must be recognized as having positive value, and a new supply chain system must be constructed based on this premise.

In other words, to fully operationalize a circular economy system, it is insufficient to merely revise certain aspects of traditional industrialization concepts or add new factors partially. Instead, it is necessary to comprehensively evolve the concept of industrialization within modern civilization and develop new wisdom regarding the nature of a productive (artery) industry and circular (venous) industry integrated developmental strategy. Based on the various research findings on "wisdom creation" methods currently being pursued, it is considered necessary to systematically aggregate the wisdom of the world in a decentralized (democratic) manner in order to generate such new wisdom. The only feasible method for achieving this is to establish a new methodology for promoting value creation through an interoperability platform for Cyber Physical Systems, as described in. In other words, the construction of Cyber Physical Systems also serves as an indispensable intellectual infrastructure for value creation to address entirely new challenges in the industrialization of modern civilization, such as the construction of a circular economy system.

The third challenge is digital human resource development (d-HRD).

To implement digital logistics systems in most of the Global South, it is necessary to have digital human resources in place in all regions where such systems are required. Furthermore, the construction of Cyber Physical Systems will require digital human resources of an extremely high standard in the local areas of the Global South. Additionally, digital human resources of a high standard will be necessary to construct and operate Cyber Physical Systems that enable the excellent wisdom located in the local areas of the Global South to participate in global activities that promote value creation through the interoperability platform.

From the above, it is clear that the construction and operation of Cyber Physical Systems is indispensable for promoting the construction of a circular economy system through the enhancement of logistics digital connectivity, and that it is therefore necessary to cultivate digital human resources of sufficient quality and quantity in each region of the Global South.

The need to cultivate a large number of digital human resources in a short period of time in rural areas of the Global South has already been recognized by many governments in the Global South, and measures are being taken to address this issue. In some of the Global South countries, digital human resource development has been successful in capital cities, leading to rapid economic growth through connection to global outsourcing networks. However, in rural areas, the promotion of new industries has not progressed. The resulting expansion of regional economic

disparities is a concern from the perspective of national integration, as noted by some countries.

To address the challenge of rapidly producing a large number of digital human resources in rural areas of the Global South, the "The Global South d-HRD Initiative" promoted by APEN (Asia Professional Education Network), an international network established by the Advanced Institute of Industrial Technology (AIIT) (Tokyo Metropolitan) targeting East Asian countries, serves as a reference. This is a distance learning program for the training of junior and intermediate digital human resources, where registered students watch videos remotely, take regular exams, and receive support for connecting to a global outsourcing network upon graduation. Of course, there are various methodologies for digital human resource development, but in any case, the implementation of a globally scalable remote education system and the connection of graduates to a global outsourcing network are key.

As we have seen, in order to promote the establishment of a circular economy system through enhancement of logistics digital connectivity, it is necessary to address the following three issues: first, the establishment of Cyber Physical Systems; second, the establishment of methodologies for promoting new value creation related to a circular economy (interoperability platforms for Cyber Physical Systems); and third, the development of digital human resources. Conversely, without appropriately addressing these challenges, it will be practically difficult to promote the construction of a circular economy system through the enhancement of logistics digital connectivity.

The argument of this chapter is that since the strategy of constructing a circular economy system through the enhancement of logistics digital connectivity requires appropriate responses to the above challenges, the construction of such a system must rely on a "leapfrog-type" developmental strategy that differs from conventional thinking regarding the developmental strategies of the Global South. The construction of a circular economy system through the enhancement of logistics digital connectivity compels a fundamental shift in thinking regarding the developmental strategies that the Global South countries should adopt.

3. The "Leapfrog-type" Developmental Strategy ('Path Diversity for 'No One Left Behind')

Two Pathways

At present, the so-called "aid community" (advanced country governments, international organizations, and other entities that "provide" development assistance) generally understands that developing countries in the Global South should adopt the following developmental strategy in the future. That is, regardless of the era, there is only one form of developmental strategy that developing countries should adopt to achieve long-term, sustainable economic growth, and that is the strategy adopted in East Asia in the latter half of the 20th century.

Specifically, this refers to a developmental strategy that begins with the promotion of labor-intensive manufacturing. In the first stage, labor-intensive manufacturing is promoted, and once this yields results, the second stage involves advancing manufacturing, i.e., promoting capital-intensive manufacturing. Once this also yields results, the third stage involves promoting knowledge-intensive industries and digital transformation (DX). Such a

- ① labor-intensive manufacturing

⇒② Advancement of manufacturing (promotion of capital-intensive manufacturing)

⇒③ Promotion of knowledge-intensive industries (promotion of DX)

is referred to here as the traditional developmental strategy.

In contrast, MIGA has been conducting research on the possibility of the following developmental strategy. This strategy prioritizes the promotion of knowledge-intensive industries and DX before the promotion of all manufacturing industries, including labor-intensive manufacturing industries. Specifically, the first stage involves promoting the development of knowledge-intensive industries and DX. Once this achieves results, the second stage involves applying those results to promote manufacturing, and the third stage involves applying those results to infrastructure development. This is referred to as

①DX promotion (promotion of knowledge-intensive industries)

⇒② (Utilizing the outcomes of DX) Revitalization of manufacturing

⇒③ (Infrastructure development leveraging DX outcomes)

is referred to here as the "leapfrog-type" (reverse) developmental strategy.

The construction of a circular economy system through the enhancement of logistics digital connectivity, which is the subject of this study, requires the development of generic Cyber Physical Systems and the cultivation of digital human resources for its practical implementation. Therefore, efforts must first be made to establish these foundations. As such, the promotion of this system constitutes an example of the "leapfrog-type" developmental strategy discussed here.

Throughout the 20th century, the international regime based on a strict distinction between developed and developing countries, as described above, demonstrated high effectiveness in many areas despite containing numerous issues. However, we believe that the following changes, in particular, have significantly impacted the effectiveness of the international developmental regime, and as a result, the once-effective structure of distinction is becoming increasingly meaningless today.

Characteristics of the "leapfrog-type" developmental strategy (in contrast to the traditional "Kaizen-based approach")

The characteristics of this "leapfrog-type" developmental strategy are clearly evident when contrasted with traditional developmental strategies. Here, we will compare this strategy with the "kaizen" (improvement) approach" to manufacturing promotion, which is a representative traditional developmental strategy implemented by Japan in Africa.

Manufacturing industry promotion support using "Kaizen-based approach" as a method has been implemented by the Japanese government in East Asian countries since the 1980s and has historically yielded significant results. The Japanese government made the policy decision to extend this approach to Africa at the TICAD 4 (Tokyo International Conference for African Development) in 2008. The background to this decision can be summarized as follows.

With the end of the Cold War, major Western European states faced the challenge of integrating Eastern Europe and were forced to raise enormous amounts of funds for this purpose. As a result, they drastically reduced the amount of aid they had been providing to African countries during

the Cold War era. Many African countries, which had fallen into severe fiscal crises, turned to Japan, whose economy was booming at the time, for assistance. In response, TICAD was launched in 1993. At the TICAD 1 in 1993 and the TICAD 2 in 1998, many African leaders visited Japan and appealed to the Japanese government for aid, significantly enhancing Japan's status on the African continent.

Meanwhile, the following developments between the TICAD 2 and TICAD 3 in 2003 had a major impact on the status of TICAD thereafter.

First, China, which sought to expand its influence over African countries, launched the Forum on China-Africa Cooperation (FOCAC) in 2000, a summit meeting similar in format to TICAD. As a result, African countries gained the option of requesting assistance from China in addition to Japan through the TICAD platform as a means of compensating for the decline in aid from Western European countries.

The second factor was the creation and adoption of the NEPAD (New Partnership for Africa's Development) by the African Union in 2001. This was a plan for the future development of Africa, formulated by Africans themselves. A similar movement followed in 2013 with the adoption of 'Agenda 2063', subtitled "The Africa We Want" (adopted in 2015), which outlines a long-term plan for the entire African continent through 2063. At the TICAD 1 and the TICAD 2, the Japanese government took the position that Japan could offer not only aid but also the knowledge gained from its successful economic growth. However, with these developments, Africans came to take the position that they would base their thinking on their own ideas, and as a result, competition with China came to be based on the "amount" of aid and investment.

At the TICAD 3 in 2003, African countries requested a fundamental shift in support from aid to trade, including agricultural products, which are major exports of African countries. In response, a TICAD Trade Ministers' Meeting was held in Makuhari (Japan) in 2004, where intensive discussions were held on how to address this request.

During this period, China successfully held the FOCAC 2 in Addis Ababa in 2003 and the FOCAC 3 in 2006.

The TICAD 4 was held in 2008. Although the Japanese government sought to expand new yen loans, many African countries were unable to do so due to issues related to IMF signaling (Note 2). Against this backdrop, the policy that was formulated was the expansion of "Kaizen-based approach" technical cooperation, which Japan had previously implemented in East Asian countries, to Africa. The common theme of TICAD was also set as "Bringing East Asia's Success Experience to Africa." This common theme directly stated that African countries should adopt the same developmental strategy as East Asian countries, with the content focusing on traditional, labor-intensive manufacturing as the starting point.

Subsequently, according to Ooka (2025) (Note 3), "Kaizen-based approach" technical cooperation in Africa has been implemented as follows:

The first "Kaizen-based approach" technical cooperation was implemented by JICA in Tunisia following the TICAD 4 in 2008. Inspired by the achievements in Tunisia, the pioneering introduction of "Kaizen-based approach" technical cooperation was advanced in Ethiopia between 2009 and 2011. At the request of then Prime Minister Meles Zenawi, the Japanese government responded by implementing the first technical cooperation project (Quality and Productivity Improvement Plan Survey Phase 1) from 2009 to 2011. At the same time, a Kaizen

Unit (KU) was established within the Ethiopian Ministry of Industry, and in 2011, the Ethiopian Kaizen Institute (EKI) was established (later renamed the Kaizen Excellence Center, or KEC).

Subsequently, JICA implemented technical cooperation projects in nine countries, including Ghana, Kenya, Tanzania, Zambia, Cameroon, and South Africa, in 2018, and the number of countries receiving support increased to 35 by 2024. Additionally, in April 2017, JICA and the African Union Development Agency (AUDA-NEPAD) launched the "Africa Kaizen Initiative (AKI)," a 10-year initiative spanning from 2017 to 2027.

The "Kaizen-based approach" technical cooperation is progressing smoothly under these circumstances, and it has already begun to yield significant results in many African countries. There is no doubt that it will continue to make a significant contribution to Africa's long-term and sustainable economic growth.

However, our concern is whether this alone is sufficient, and whether we should consider entirely new approaches with different perspectives to achieve long-term, sustainable economic growth in Africa.

To begin with, achieving long-term, sustainable economic growth across the entire African continent, and more broadly across the Global South as a whole, is an extremely challenging task. It is unlikely that any single approach alone will be effective in achieving this goal, and we believe that multiple approaches with different content should be pursued simultaneously.

While "Kaizen-based approach" technical cooperation has already yielded significant results in Africa, it is a typical traditional developmental strategy and therefore inherently limited by the principles of such strategies.

According to workshops on "Building a Circular Economy System through Enhancement of Logistics Digital Connectivity" held in Ethiopia from May to June 2025 by MIGA in collaboration with major universities in Ethiopia (Note 4), traditional developmental strategies are likely to contain the following fundamental problems.

The first issue is the adoption of a linear evolutionary perspective on developmental strategies, and more broadly, on the evolutionary path of the modern civilization. Based on this perspective, it is argued that all countries in the world must adopt the same developmental strategies that were previously followed by leading nations.

The biggest problem with this linear evolutionary perspective is that, as long as it is followed, African countries that were late in starting modernization (long-term, sustainable economic growth) will be unable to escape their position at the bottom of the global hierarchy, at least until the middle of the 21st century.

Such a logical conclusion is intolerable for many Africans, and there are already those among them who express a strong desire to adopt a new developmental strategy that is completely different from that of East Asian countries. A representative example of such a new developmental strategy is the "leapfrog-type" developmental strategy, which is based on a multilinear perspective that fully acknowledges the possibility of multiple developmental strategies (evolutionary paths of the modern civilization) on Earth under the modern civilization. The "leapfrog-type" developmental strategy must be grounded in a multilinear perspective. It is expected to promote economic development in ways that no one in the world has ever attempted before.

This simply means a "leapfrog-type" developmental strategy based on a multilinear perspective. In fact, the Southern African Development Bank and Advanced Institute of Industrial Technology (the Tokyo Metropolitan) jointly launched a "Workshop on the "Leapfrog-Type" Developmental Strategies in Africa" in 2015.

Additionally, during discussions held in June 2025 between MIGA and the Kenyan Ministry of Industry, the following remarks were made: "In the digital field, we are seeing rapid growth, such as MPESA. Therefore, Kenyans today are beginning to feel that, in addition to the traditional approach of starting with labor-intensive manufacturing, it is necessary to consider new policies." (Stanley Koske Sawe, Director of Industry, Ministry of Industry, Kenya, 10 June 2025).

The second issue is that traditional developmental strategies are based on a sector-targeted approach.

The sector-targeted approach assumes that aid is provided only to the targeted areas, and that all systems outside the scope of aid are assumed to be identical to those in developed countries. For example, looking at "Kaizen-based approach" technical cooperation, in its most basic interpretation, this refers to support provided solely within the manufacturing plant domain, excluding systems outside this domain, as well as the broader social systems that encompass it.

However, in the Global South, it is entirely unrealistic to assume that systems outside the manufacturing factory, such as enterprises, supply chains, logistics, economic systems of the national economy, social systems of the state, and cultural systems, are similarly developed as in developed countries. Under these circumstances, even if Japan's assistance improves production processes within manufacturing plants, the fact that the structure of surrounding businesses, logistics, and economic systems differs significantly from those in Japan means that such improvements are not necessarily likely to lead to fundamental improvements in the national economy or industrial conditions.

Therefore, in providing assistance from advanced countries, it is strongly recommended not only to implement assistance in the targeted specific sectors but also to take necessary measures regarding external systems that have "institutional complementarity" with the targeted sectors.

In this way, we refer to the methodology of providing assistance not only to targeted specific sectors but also to external institutions that are "institutionally complementary" to them, as the institutional complementarity approach (as opposed to the sector target approach). This concept is based on the "combined approach" proposed by the Addis Ababa University of Science and Technology.

Incidentally, regarding "Kaizen-based approach" technical cooperation as noted in the "most basic interpretation," the problems with the sector-targeted approach are already well understood by JICA and other relevant parties. The "Kaizen" concept has evolved over many years of research and is now widely applied not only to production processes within manufacturing plants but also to corporate management methods and even to the governance functions of social systems. In other words, while the "Kaizen" concept was initially constrained by the sector-targeted approach, it has since evolved over time to promote an institutional complementarity approach.

However, such success stories are difficult to find outside of "Kaizen-based approach" technical cooperation.

As outlined above, the characteristics of the "leapfrog-type" developmental strategy can be summarized as follows in contrast to traditional developmental strategies.

The first characteristic is that it is based on a multilinear perspective of the evolution of the modern civilization rather than a linear perspective.

The second characteristic is that the implementation method is based on an institutional complementarity approach rather than a sector-targeted approach.

The feasibility of the "leapfrog-type" developmental strategy

The next question is whether the "leapfrog-type" developmental strategy can realistically bring about long-term, sustainable economic development for the Global South. In contrast to the traditional developmental strategy, which has already been sufficiently proven by the success of many East Asian countries, there are still no concrete examples worldwide that demonstrate the effectiveness of the "leapfrog-type" developmental strategy.

This issue was examined in the study on the "Leapfrog-type" developmental strategy included in 'Path Diversity for "No One Left Behind"' (MIGA, November 2024) (Note 5, hereinafter referred to as Ambashi et al. (2024)).

According to this study, the promotion of labor-intensive manufacturing in East Asian countries led to long-term, sustainable economic growth because it facilitated the accumulation of human capital (high-quality labor), physical capital (private machinery, equipment, and buildings), infrastructure (public capital such as roads, railways, ports, and airports), social capital (efficient contractual systems and trust relationships), and intellectual capital (scientific, technological, and managerial knowledge) required for industrial development were accumulated over an extended period. On the other hand, in the current global context where DX is advancing, it is argued that the benefits of DX enable the Global South countries to achieve long-term, sustainable economic growth without going through the lengthy process of accumulating these stocks, i.e., the "leapfrog-type" is possible.

The key to this is said to be the development of modern service industries and innovation through digitalization. In other words, the technological gap between today's advanced countries and the Global South can be bridged by the Global South utilizing cutting-edge digital technology, and the institutional inefficiencies that are currently hindering economic development in the Global South can also be improved through the use of digital technology.

Furthermore, specific methodologies for putting the "leapfrog-type" developmental strategy in the Global South into practice are proposed. These include, first, the promotion of small and medium-sized enterprises (labor-intensive IT industries) utilizing digital technology; second, the "heavy industrialization" of digital services (large-scale corporate organization); and third, the participation of existing manufacturing industries in renewed supply chains.

In conclusion, under the premise that the conditions of accumulating human capital and social capital through the promotion of digital education targeting a wide range of society, and the promotion of the penetration of modern institutions into countries and societies are met, the "leapfrog-type" developmental strategies are possible without going through manufacturing if digital services are activated in accordance with each country's social issues" (Ambashi et al. (2024): p. 77).

In other words, the "leapfrog-type" developmental strategy is feasible for the future Global South, and the construction of a circular economy system through enhancement of logistics digital connectivity is expected to be realized as a typical attempt at the "leapfrog-type" developmental strategy by advancing it in a manner that addresses the considerations and prerequisites outlined in the aforementioned paper.

4. Regional Revitalization in the Global South

(1) Regional Revitalization in the Global South

As described above, promoting the construction of a circular economy system through enhancement of logistics digital connectivity, based on the framework of a typical "leapfrog-type" developmental strategy, is expected to bring significant new developmental opportunities to the regional areas of the Global South centred on Africa.

Prior to DX, when traditional manufacturing industries dominated the economy, adopting a "leapfrog-type" developmental strategy was practically impossible, leaving the Global South with no choice but to follow traditional developmental strategies. On the other hand, traditional developmental strategies are labor-intensive manufacturing-led, and therefore, it was extremely difficult to envision a scenario in which the rural areas of the Global South, which had limited population concentration, inadequate logistics infrastructure for large markets, and low technological standards, could achieve steady economic growth. In fact, there are very few examples of such steady economic growth in these regions.

However, with the arrival of the full-scale DX era, the adoption of so-called "leapfrog-type" developmental strategies has gained practicality. In this current situation, the possibility of adopting entirely new developmental strategies has opened up significantly for these regional areas. Today, the barriers to local regions in the Global South utilizing cutting-edge digital technologies developed in advanced countries are relatively low. The adoption of such technologies can bridge the technological gap between advanced countries and local regions in the Global South, as well as improve institutional inefficiencies. As a result, disadvantages in population concentration, logistics, and technological standards no longer constitute decisive obstacles to achieving steady economic growth.

Such a "leapfrog-type" developmental strategy will powerfully promote the development of rural areas in Africa, which has been difficult to achieve through conventional developmental strategies that focus on promoting labor-intensive manufacturing. The fact that rural areas in the Global South can promote substantial economic development through global connectivity based on DX can be seen as a real-world example of Richard Baldwin's concept of the "Third Unbundling".

Furthermore, by leveraging interoperability platforms in Cyber Physical Systems to disseminate the unique wisdom of regional areas in the Global South to the world, these regions—which have traditionally been mere "recipients" of development strategies—can assume the role of "donors" that share their wisdom with the world, at least from a technological perspective. Such information dissemination by local regions in the Global South could be seen as a catalyst for guiding the evolutionary history of modern civilization toward a genuine multilinear evolutionary model.

The arrival of a new era of regional revitalization in the Global South is upon us.

(2) The role of universities/research institutions as "nodes of wisdom" (SEZs)

Finally, we will examine the role of universities/research institutions in rural areas of the Global South when promoting the construction of a circular economy system through enhancement of logistics digital connectivity as a typical "leapfrog-type" developmental strategy.

To summarize the challenges of promoting the construction of a circular economy system through enhancement of logistics digital connectivity as a typical "leapfrog-type" developmental strategy, the following points can be identified.

First, it is necessary to address three challenges specific to the construction of a circular economy system through enhancement of logistics digital connectivity. The first is the construction of Cyber Physical Systems, the second is the construction of methodologies to promote new value creation related to the circular economy (interoperability platforms in Cyber Physical Systems), and the third is the development of digital human resources.

In addition to these, the unique challenges of adopting the "leapfrog-type" developmental strategy include the accumulation of human and social capital through the promotion of digital education targeting a wide range of society, and the promotion of the penetration of modern institutions into the country and society. Based on this, the first challenge is the promotion of small and medium-sized enterprises utilizing digital technology (labor-intensive IT industry promotion), second, the "heavy chemical industry" transformation of digital services (large-scale corporate organization), and third, the promotion of participation in renewed supply chains by existing manufacturing industries.

It is expected that universities and research institutions in rural areas of the Global South will play a particularly important role in enabling these regions to appropriately address the aforementioned challenges.

Universities and research institutions possess the necessary capabilities to address the aforementioned challenges effectively. First, universities and research institutions with engineering and information science departments are well-positioned to advance the development of Cyber Physical Systems and interoperability platforms for such systems in rural areas of the Global South countries. In fact, such institutions are the only entities capable of fulfilling this role.

Regarding digital human resource development, universities are institutions of higher education, their educational content is higher education, and their students are university students. On the other hand, the main targets of the digital education promotion and the rapid development of a large number of digital human resources, which are the issues raised here, are at a lower level than higher education. In other words, in rural areas of the Global South, the biggest challenge is to connect a large number of people to the global outsourcing network as digital human resources in a short period of time. Developing cutting-edge AI through higher education is not particularly required. However, as long as universities exist and their systems are in operation, it is not difficult to provide secondary education-level education programs separately from the regular education of universities as higher education. Ambashi et al. (2024) cites examples of investments in human capital for the revitalization of manufacturing in Japan, such as the establishment of training centers, vocational training schools, and higher vocational schools. The same applies to the development of digital human resources under the "leapfrog-type" developmental strategy, where

vocational training targeting a wide range of social strata and the expansion of secondary education are necessary, in addition to higher education.

To achieve this, while establishing entirely new educational institutions as Japan did (Note 6) to promote manufacturing industry revitalization is an option, from a cost perspective, it is more practical to provide special educational programs within universities. While it is impossible for secondary education institutions to offer higher education programs, universities, as higher education institutions, are fully capable of providing secondary education or vocational training programs.

Third, regarding the challenge of promoting the penetration of modern systems into countries and societies, in regional areas of the Global South, universities often have close ties with local governments, and their policy recommendations are often adopted by local governments. Therefore, it is reasonable to place sufficient expectations on universities in this regard.

As described above, when promoting the establishment of a circular economy system through enhancement of logistics digital connectivity in rural areas of the Global South as a typical "leapfrog-type" developmental strategy, universities are strongly required to go beyond their roles as higher education institutions, and research institutions are required to go beyond their roles as research institutions tasked with conducting research on assigned topics, in order to address the above issues.

The "leapfrog-type" developmental strategy is one that prioritizes the development of knowledge-intensive industries from the outset, rather than following the traditional sequence of labor-intensive manufacturing, capital-intensive manufacturing, and then knowledge-intensive industries. Naturally, this strategy places significant demands on the level of intellectual activity. In regional areas of the Global South, universities and research institutions are the only entities capable of demonstrating such a high level of intellectual activity.

Thus, universities and research institutions that go beyond their originally assigned roles of providing higher education and conducting research to contribute to the implementation of the "leapfrog-type" developmental strategies in regional areas of the Global South are required to undertake new tasks related to "wisdom" that transcends the conventional concepts of physical capital and human capital.

In the modern civilization, only specific forms of "wisdom" derived from the utilization of specific brain functions have been employed, and these specific forms of "wisdom" have also been utilized in developmental strategies. On the other hand, it is widely recognized in Eastern philosophy that "wisdom" exists not only in the form used in the modern civilization but also in various other forms obtained by utilizing different parts of brain functions. According to "Brain Functional Analysis of Civilizations (BFAC)" (Note 7), examples of civilizations other than the modern civilization that utilize these various forms of "wisdom" in the construction and operation of their civilizations can be found in several cases.

Drawing on these examples, the tasks required for implementing the "leapfrog-type" developmental strategy can be understood as activating various brain functions in humans, identifying forms of "wisdom" that differ from the conventional ones based on these functions, and mapping them onto actual economic developmental activities.

The act of mapping such "wisdom" obtained through the activation of brain functions that are different from the usual ones onto actual society can be called "epistemic." From this, I consider

it appropriate to capture the role of universities/research institutions that play a role in promoting the "leapfrog-type" developmental strategies in the local areas of the Global South using the new concept of SEZ (Special Epistemic Zones).

During the field survey conducted by MIGA in Ethiopia from May to June 2025, all local universities that participated in the workshops expressed a strong desire to fulfill the role of SEZ, and the establishment of global collaborative organizations was strongly requested. This fact concludes this chapter.

[Note]

(Note 1) The evolutionary path of the modern civilization, including the process of industrialization (Industrial Revolution), is analyzed in detail in Applied Infosocionomics. See Kumon, S., and M. Maeda, (2021). *Applied Infosocionomics: A Manifesto of Informatized Society Building in Developing Economies*. ERISE Press.

(Note 2) The IMF Signaling System classifies countries as Signal Green if, under the assumption that current conditions remain unchanged, they are deemed capable of repaying their debts even after stress tests are conducted, such as a significant decline in international prices for major exports (e.g., specific agricultural products) and a significant increase in international prices for major imports (e.g., crude oil). Countries expected to maintain debt sustainability under current conditions but likely to face problems under stress tests are classified as "yellow," while those already facing sustainability problems are classified as "red." "New loans should be strictly limited to countries classified as "green." The Japanese government is strictly adhering to this system, and new yen loans are limited to countries with a green signal. New yen loans are not provided to countries with a yellow (or red) signal.

(Note 3) Akira Ooka, "The Trajectory of Kaizen in Africa: From the Origins of Japanese-Style Kaizen in Ethiopia to the Ambitions of the Entire Continent (2009–2025)," Global Association of Civilizational Diversity, 2025.

(Note 4) Addis Ababa University of Science and Technology (May 28, 2025), Dire Dawa University (May 30, 2025), Jimma University (June 2, 2025), Adama University (June 3, 2025), Addis Ababa University (June 4, 2025).

(Note 5) Ambashi, M., F. Iwasaki, R. Fujioka, and K. Oikawa (2024). "Policy Proposal IV: 'Leapfrog-Type' Development Strategy," in 'Path Diversity for "No One Left Behind"' (MIGA, November 2024), pp. 72–80.

(Note 6) The Japanese government established Technical College (Kosen) in 1961 as new higher industrial human resource education institutions in response to demands from industry. The Technical College (Kosen) Act, enacted in 1961, is a special provision under the Basic Education Act. It is important to note that while Technical College (Kosen) are not recognized as higher education institutions internationally under the Washington Accord, they are classified as higher education institutions within Japan.

(Note 7) Mitsuhiro Maeda, (2022). *The Civilizational Diversity and the Evolution of the Modern Civilization -Towards the Brain Functional Analysis of Civilizations*, ERISE Press.

Profiles

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Director, Musashino Institute for Global Affairs (MIGA); Specially Appointed Professor, Musashino University; Supreme Advisor to the President, Economic Research Institute for ASEAN and East Asia (ERIA)

Graduated from the Faculty of Law, the University of Tokyo and obtained a Master's Degree in International Development and Economics from Yale University. Joined the Ministry of International Trade and Industry in 1976. Has assumed numerous positions, Vice Governor for International Affairs of Ehime Prefecture, Director-General of the Business Support Department of the Small and Medium Enterprise Agency, Executive Managing Director of the Japan-China Economic Association. Assumed position of founding ERIA Executive Director in 2008 and subsequently was appointed as ERIA's first President in 2015, and was reappointed as President of ERIA until 2023. Haiku Poet as Gania Nishimura. Editor of The Matsuyama Declaration 1999. Representative of Haiku Magazine TEN I.



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Born in 1962. Graduating from Department of Law, University of Tokyo, Prof. Maeda has stepped up so-called 'a Revolving Door Career Path' between the Government and Academia. In the Government of Japan, he served as Director for International Finance, and Director of Financial Cooperation Division, Ministry of Economy, Trade and Industry. In Academia, he served as Associate Professor of University of Saitama, Visiting Professor of Graduate Institute of Policy Studies (GRIPS), Visiting Fellow of the Royal Institute of International Affairs (Chatham House, UK), Visiting Fellow of Johns Hopkins University School of Advanced International Studies (SAIS, USA) and Visiting Fellow of University of Cambridge. He is now serving as Professor of Advanced Institute of Industrial Technology (AIIT), President of ERISE (Epistemic Research Institute of Social Ethics), Vice President of the Global Society of Applied Infosocionomics (GloSAI), and Visiting Professor of Musashino University.



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Graduated from the University of Tokyo, Faculty of Economics in 1982, and joined the Ministry of International Trade and Industry (now the Ministry of Economy, Trade and Industry) in the same year. He has been serving for many positions in the field of international energy and climate issues including Counselor, Permanent Delegation of Japan to the OECD (energy advisor), Head, Country Studies Division at the IEA and Director, International Affairs Division, Agency of Natural Resources and Energy (ANRE), METI. From 2008 to 2011, he served as Deputy Director-General in charge of global environmental issues at the Minister's Secretariat, and from 2011 to 2015, he served as Director of the London Office of the Japan External Trade Organization (JETRO) and as a Special Researcher on Global Environmental Issues. Since August 2015, he has been Professor, Graduate School of Public Policy, the University of Tokyo. Together with Professorial position, he is also Consulting Fellow, Research Institute of Economy, Trade and Industry (RIETI), Senior Fellow, Asia-Pacific Research Institute (APRI); Senior Policy Fellow on Energy and Environment, Economic Research Centre for ASEAN and East Asia (ERIA), lead author of the IPCC Sixth Assessment Report. He has participated in COPs 18 times.



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He was graduated from the Faculty of Computer and Information Sciences, the Hosei University in 1973. After graduation, he started to work for Century Research Center Co. (CRC), one of Japanese think tanks and became manager of Economic Group, Research Institute of CRC in 1988. He joined the Energy Data and Modelling Center (EDMC), the Institute of Energy Economics, Japan (IEEJ) as head of Statistics Information Office in 1993 and became Senior Research Fellow in 2005. He has been engaged in preparation of energy statistics in APEC region as coordinator and energy modeling work applying econometrics and input-output approaches for a long time. Using these expertise, he has been conducting capacity building on energy statistics and energy outlook modelling in Association of Southeast Asian Nations (ASEAN) region for more than 10 years. He has been also in charge as a leader of Working Group for Preparation of Energy Outlook and Analysis of Energy Saving Potential in East Asia, Economic Research Institute for ASEAN and East Asia (ERIA) from 2007. From August 2013, he has been in charge of Special Adviser to Executive Director on Energy Affairs of ERIA additionally. He retired IEEJ in September 2015 and moved to ERIA completely keeping same position. He retired from ERIA at the end of March 2025 and became a Visiting Researcher at Musashino University in September 2025.



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Doctor in Engineering from the Graduate School of Engineering, Osaka University. 1982 joined Komatsu Ltd. and conducted research and development of spatial understanding and cognitive technology at the Production Technology Research Laboratory, and promoted the development of applications for automation systems, etc. In 1993, he established LEXER RESEARCH Inc. and became its president and CEO. In 2022, he founded the Green CPS Consortium, which promotes GX/DX activities for a carbon-neutral society. In 2016, the company announced the "CPPS Technology Concept and 2040 Manufacturing Vision (Japan Society of Mechanical Engineers)," which sets out guidelines for manufacturing in Japan, and was featured in the Ministry of Economy, Trade and Industry's Manufacturing White Paper. In 2022, he established the Green CPS Consortium, an incorporated association promoting GX/DX activities towards a carbon-neutral society, and became its representative director. In addition to promoting proposals for new social systems with members from industry and academia, he has been focusing on GX/DX human resource development, and has developed human resource development courses not only in Japan but also in collaboration with industry, academia and government in ASEAN countries, focusing on activities to enhance Japan's international appeal.



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- Structural Changes in Africa: Accounting for rural-urban wage gap
- Skill Mismatch of Vocational Trainees in Ethiopia
- Displacement Effects of Educational Expansion: Vocational Secondary Education in Ethiopia

<Publication>

- Kiyoyasu Tanaka, Takahiro Fukunishi 2022. "Rules of origin and exports in developing economies: The case of garment products," *Journal of Asian Economics*, Volume 82.
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- Takahiro Fukunishi and Tatsufumi Yamagata eds. 2014. *The Garment Industry in Low-income Countries: An Entry Point of Industrialization*, Palgrave Macmillan.



- Takahiro Fukunishi ed. 2014. *Delivering sustainable growth in Africa: African farmers and firms in a changing world*, Palgrave Macmillan.

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He holds an MSc in Global Market Economics from the London School of Economics and Political Science and a Master in Media and Governance from Keio University. Most significantly, Mr. Kumagai was awarded the prestigious 40th Masayoshi Ohira Memorial Prize in 2024 for his groundbreaking work with Dr. Nakamura on Malaysia's economic development strategy, specifically addressing solutions for overcoming the middle-income trap. This recognition underscores the significant impact of his research on understanding economic development in Asia.

His major publications on Malaysia include:

"Economic Development Strategy Learning from Malaysia: Hints for Overcoming the Middle-Income Trap" (with M. Nakamura, Sakuhinsha, Nov 2023)

"How Politics and Economy Changed in Post-Mahathir Malaysia" (with M. Nakamura, IDE-JETRO, 2018)

"The Middle-Income Trap from the Viewpoint of Trade Structures: Are the Geese Trapped or Still Flying?" (Journal of International Commerce, Economics and Policy, 6(3), 2015)

His other influential works on Asian economic integration and development include:

"The Economics of East Asian Integration: A Comprehensive Introduction to Regional Issues" (with M. Fujita and I. Kuroiwa, Edward Elgar, 2011)

"Economic Integration in East Asia: Perspectives from Spatial and Neoclassical Economics" (with M. Fujita and K. Nishikimi, Edward Elgar, 2008)

"Economic Impacts of the US-China Trade War on the Asian Economy: An Applied Analysis of IDE-GSM" (with T. Gokan, K. Tsubota, et al., Journal of Asian Economic Integration, Jul 2021)

His research uniquely combines theoretical frameworks with practical policy implications, making it valuable for both academic researchers and policymakers. Mr. Kumagai's expertise in using the IDE Geographical Simulation Model (IDE-GSM) has provided crucial insights into regional economic development and integration patterns across Asia.

Mr. Ikumo ISONO

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Mr. Isono was educated in Japan and received a bachelor's degree in economics from Saitama University in 1998. He has a master's degree in economics from the University of Tokyo in 2000. He joined the Institute of Developing Economies, JETRO (IDE-JETRO) in 2005 as a research fellow. He was a research fellow in the Bangkok Research Center, JETRO from 2009 to 2011. He was seconded to the Economic Research Institute for ASEAN and East Asia (ERIA) from 2011 to 2013 as an economist and from 2020 to 2024 as a senior economist. He was seconded to European Commission, Joint Research Centre (JRC-Seville) as a visiting researcher from 2017 to 2018. He was appointed director of the economic geography studies group at IDE-JETRO in 2024 and was appointed director of the economic integration studies group at IDE-JETRO in 2025. His expertise is in spatial economics and connectivity aspects of economic integration in ASEAN and East Asia, including infrastructure development, economic corridors, logistics, trade and transport facilitation, free trade agreement (FTA), and digital connectivity. He has participated in several ERIA's flagship projects, such as the Comprehensive Asia Development Plan, Mid-Term Review of the Implementation of AEC Blueprint, and ASEAN Vision 2040.



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Select publication:

1. Hayakawa, K., Keola, S., Sudsawasd, S., & Yamanouchi, K. (2025). International bridges and informal employment. *Journal of Comparative Economics*.
2. Andersson, M., Hayakawa, K., Keola, S., & Yamanouchi, K. (2025). Impacts of international transport infrastructure: Evidence from Laotian households. *Journal of Asian Economics*, 97, 101876.
3. Hayakawa, K., Keola, S., & Urata, S. (2022). How effective was the restaurant restraining order against COVID-19? A nighttime light study in Japan. Hayakawa, K., Keola, S., &

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4. Tanaka, K., & Keola, S. (2017). Shedding light on the shadow economy: A nighttime light approach. *The Journal of Development Studies*, 53(1), 32-48.
 5. Keola, S., Andersson, M., & Hall, O. (2015). Monitoring economic development from space: using nighttime light and land cover data to measure economic growth. *World Development*, 66, 322-334.
 6. Kumagai, S., Hayakawa, K., Isono, I., Keola, S., & Tsubota, K. (2013). Geographical simulation analysis for logistics enhancement in Asia. *Economic Modelling*, 34, 145-153.

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He graduated from the Faculty of Economics at Hosei University. He joined Nissin Corporation in 2001 as a licensed customs specialist, responsible for customs clearance operations related to apparel, miscellaneous goods, food products (including alcoholic beverages), and machinery, handling both import and export procedures. In 2004, he participated in practical training at Shanghai Gaosin International Logistics Co., Ltd., gaining hands-on experience in local export and import declarations, customs duty payments, and refund procedures. In 2005, he joined Macnica Inc. and was assigned to the Product Marketing Department, where his responsibilities included managing marketing and sales of semiconductors and electronic components to major electronics manufacturers. Since 2007, he has been working at NX Logistics Research Institute and Consulting Inc. (formerly Nittsu Research Institute and Consulting, Inc.), actively engaging in a wide range of logistics consulting projects. These include promoting modal shifts, supporting joint logistics distribution, and conducting domestic and international logistics research. Additional responsibilities encompass trial transportation support and feasibility studies for local business entry.



He possesses extensive experience as a lecturer at various institutions and organizations, including Sampo Japan Insurance Inc., Waseda University Social Logistics Research Institute, Ryutsu Keizai University Special Lectures, Japan International Freight Forwarders Association (JIFFA), and Japan Customs Brokers Association. He has also published articles on international logistics research, including contributions to “*Transportation and Economics*” (2017, Institute for Transport Economics), sharing insights and research findings on international logistics.

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After graduating from the Faculty of Law at Chuo University in 1978, he joined Nippon Express Co., Ltd. After graduating from the Institute for International Study and Training (IIST) in 1983, he was sent to Nippon Express U.S.A., Inc. (NEU) and Union Pacific Railroad for training. Since then, he has traveled back and forth between Japan and the US three times, working in the US for a total of about 17 years. In 2005, he was appointed GM, Chicago Ocean Cargo Branch of NEU. In 2008, he returned to Japan as GM, Logistics Consulting Division of Nittsu Research Institute and Consulting, Inc., the predecessor of the current NX Logistics Research Institute and Consulting, Inc. He was appointed Executive Managing Director of the company in 2014. And then he was appointed Research Fellow of the company in 2018. He is currently active as an academic member of the National Land and Infrastructure Development Special Committee of the Japan Chamber of Commerce and Industry, and a visiting lecturer at Kyoto University Business School, the Japan International Freight Forwarders Association, the Japan Institute of Logistics Systems, etc.



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Graduated from the Faculty of Law at Kokugakuin University in 2005. Joined Misawa Home Co., Ltd. in 2005. Joined Aichi Co., Ltd. in 2008 and worked as a preschool teacher at Ishigami Kindergarten, affiliated with the Kenchu Welfare Association, a social welfare corporation, from 2019. October 2023: secretary to the Supreme Advisor to the President of the Economic Research Institute for ASEAN and East Asia (ERIA), supporting various research projects, including the Global South Research Group. December 2024: Became a Visiting Researcher of Musashino University. Supported the establishment of the Global South Research Society and engaged in network-building activities. Participated in the research project “Urban Development to Strengthen Water Ecosystems,” jointly promoted by MIGA and the Japan Disaster Risk Reduction Platform (a general incorporated association). April 2024: Presented at the “Global Environmental Issues Countermeasure Seminar” at Da Nang Dong A University (Da Nang) on the topic “Enhancing Urban Development through Water Ecosystems” (co-presented with Professor Mitsuhiro Sanada of the Institute of Industrial Technology, Tokyo Institute of Technology). November 2024: Supported the presentation of the Global South Research Society's policy package “Path Diversity” at the T20 Brazil Side Event themed “No One Left Behind.” December 2024: Contributed to the signing of a contract for the “Master Plan for Strengthening Resource Circulation through Enhanced Digital Connectivity in Logistics in Africa” under the Ministry of Economy, Trade and Industry (METI)’s “2023 Supplementary Budget 'The Global South Future-Oriented Cooperation Project (Formulation of a Strategy to Strengthen Economic Partnerships with Africa and Promotion of Overseas Expansion of Japanese Companies, etc.)’.”



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