JAPAN ON THE NEW INDUSTRIAL REVOLUTION (NIR):

Direction and its global implication for inclusive and sustainable industrial development

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Acronyms and abbreviations

AI	Artificial Intelligence
FY	Fiscal year
I4.0	Industry 4.0
IoT	Internet of Things
IRPF	Integrated Results and Performance Framework
ISID	Inclusive and Sustainable Industrial Development
METI	Ministry of Economy, Trade and Industry
NIR	New Industrial Revolution
PCP	Programme for Country Partnership
SDGs	Sustainable Development Goals
SMEs	Small and Medium-sized Enterprises
UN	United Nations
UNDS	UN Development System
UNIDO	United Nations Industrial Development Organization

1. INTRODUCTION

Since the launch of the German initiative “Industrie 4.0” in 2011, its English translation “Industry 4.0” is becoming a symbolic word for the current trend of the New Industrial Revolution (NIR). Industry 4.0 (I4.0)[1] includes an integration of automated processes of manufacturing via digital technologies such as IoT, AI and robotics. The United Nations Industrial Development Organization (UNIDO) identifies nine characteristics of I4.0: interoperability, visualization, decentralization, real-time capability, service orientation, modularity, convergence, cost reduction and efficiency and mass customization (UNIDO, 2017). Advanced economies have implemented the concept of I4.0 or its relevant technologies in their national policies. United Kingdom launched its new industrial strategy in 2017 with a focus on clean growth. Japan, who often attracts the world with their technologies, captures the larger-scale impacts brought by the NIR under the name of ‘‘Society 5.0’’ aspiring beyond the sole technical advancement.

The trend of establishing industrial policies shows recognition of vital adaption to the rapid shift from the conventional industrial structure. However, developing countries are more likely to be positioned on the edge of being left behind since they face more challenges in the implementation. The adoption of the United Nations (UN) 2030 Agenda for Sustainable Development imposed a universal responsibility towards inclusive and sustainable development. Thus, the UN Member States have been striving to achieve the 17 goals identified in the Agenda, and the whole UN system provides their expertise to support the development of countries in align with these goals. UNIDO has a most direct and relevant mandate in the area of industrialization as a UN specialized agency among the UN Family. Accordingly, UNIDO’s strategic approach to economies at every level of industrialization plays a significant role in shaping the future of industrial development.

This paper explores Japan’s response to NIR, and addresses its global implications to achieve inclusive and sustainable industrial development that UNIDO serves. The significance of this paper is to highlight lessons for UNIDO regarding NIR where developed countries such as Japan are moving forward. The paper is divided into the following sections. Section 2 presents the current situation and direction in Japan over adoption of I4.0. Section 3 provides the needs of developing countries on I4.0. Section 4 illustrates the UN’s interests regarding NIR and UNIDO’s capacity. Section 5 discusses implications for UNIDO’s future path for inclusive and sustainable industrial development. The last section concludes with remarks on the era beyond 2030.

[1] The terms I4.0 and NIR are interchangeably used in this paper.

2. CURRENT DIRECTION TOWARD NIR IN JAPAN

Is Japan a leading country of I4.0? At crossroads of utilization of I4.0

Japan has been a technology-focused country, and it is easy to imagine that Japan can take an advantage of the upcoming NIR since it has developed automation of many manufacturing processes. Japan shows well readiness in the future of production with the strongest Structure of Production among G20 countries (World Economic Forum, 2018). Enterprises share technological development of IoT at an exhibition such as "Smart Factory Japan". However, there is a question if this is enough to presume the country's lead in NIR. Considered Japan's tradition of the business sector to lead its economy, they are less aware of the dynamism of impact by I4.0. They pay less attention to an expected structural change in industry. Deloitte's survey revealed that only 2% of corporate managers discuss the development of human resources, and only 3% recognizes that they will be capable of managing the technology-led impact on organizational structure and employees (Deloitte, 2018). Calvo (2018) mentions that having a competitive advantageous position does not bar reaction to external risks and negative approach toward I4.0 related developments. This incapability entails possibility to miss opportunities for good implementation of I4.0.

Japan has developed national strategies with a new concept "Society 5.0"

The fifth Science and Technology Basic Plan prepared by the Cabinet Office in 2016 proposed "Society 5.0" that moves ahead of the current information society. Society 5.0 is a super smart society where new technologies integrate cyberspace and physical space to bring prosperity to people (The Government of Japan, 2016). All the economic and social activities combined with I4.0 technologies enable to achieve economic development and to provide solutions to social problems. "Investments for the Future Strategy" that the Government of Japan set in 2017 was a progressive vision on I4.0. It clearly recognizes the trend of the NIR, and proposes effective utilization of I4.0. In the end of the same year, the Cabinet decided "New Economic Policy Package", which identifies the three-year intensive investment period for supply system innovation until 2020, for instance (The Government of Japan, 2017).

The latest version of the strategy in 2018 steps forward to the implementation phase of I4.0 to realize Society 5.0 by reconstructing and introducing new measures. Based on challenges and opportunities that Japan faces, it sets out flagship projects in four prioritized areas. The two of them that are the most relevant to industrial development: i) next-generation industrial system and ii) strengthen the productivity, revolution of SMEs and micro businesses.

Regarding the first priority, data coordination is the core of the issue. The Government plans new policy measures to realize data coordination in a society. One measure is to promote data coordination in a supply chain where data coordination occurs among devices in a factory or across companies. As the first process, they plan a verification of coordination among different data-sharing frameworks that companies own individually within the FY2018 (The

Government of Japan, 2018). Another measure is to arrange a policy measure system to ensure safe application of robotics to the society. The Government's ambition for promotion of human-friendly robot system lies in their plan to propose a universal standard in FY2020.

In the second priority, the Government plans to work on the productivity revolution of SMEs and micro businesses by utilization of the strategic platform for productivity of small and medium services established in February 2018 (Headquarters for Japan's Economic Revitalization, 2018:80). In addition, the establishment and launch of the service of one-stop platform for SMEs is expected within FY2018, which enables SMEs to reach necessary support (The Government of Japan, 2018). These measures focus on the arrangement of business environment that encourages SMEs to take opportunities of NIR.

METI's plan for future in 2030s

METI prepared detailed plans for new industrial structure called "Future Vision towards 2030s". It specifies four priorities: mobility, supply chain, healthcare and living. The section of supply chain highlights smart supply chains, and enhanced sophistication and efficiency in manufacturing.

Smart supply chain includes key issues to identify the needs of users and consumers, manufacturing, and agriculture. As to the needs of users AI robots and home appliances are concerned. The vision analysis states that Japan has the advantage in calculation capacity, sensors, carbon fibre composites, small motors for actuator and robotic products in the sense that Japanese companies own nearly a half or more than a half of the market share in these technologies (METI, 2017).

The Japanese recognize the current status of manufacturing is that Japan, Europe and U.S. are on the same line at the verification level in data coordination (METI, 2017). Roadmap in manufacturing contains the launch of smart factory verification projects in order to share fifty cases for data coordination and to establish a real data platform, SMEs' development of skills in data utilization by increasing access to supporters for IoT and robotics introduction, and arrangement of rules for promotion of data sharing and utilization (METI, 2017).

The vision plans six breakthrough projects to accelerate institutional reforms to solve issues regarding supply chain, such as hosting World Robot Summit for technological development. It also plans to arrange the "Center of Excellence" for integration of AI with manufacturing, and the budget of 19.5 billion allocated in FY2016 (METI, 2017). A common format for data communication minimizes the costs of data arrangement. The Government assists to SMEs that have better prospected outcome. They expect to extend these projects to cover different areas of issues.

"Connected industries" is a key concept to boost Society 5.0

To accelerate the implementation of I4.0, METI presented a new concept "Connected industries (CI)" in 2017. The vision identifies five areas to focus in terms of potential economic growth: i) Automated Driving and Mobility Service, ii) Manufacturing and Robotics, iii) Biotechnologies and Materials, iv) Plant/Infrastructure Safety Management, and v) Smart Life. Working groups for these areas were established to discuss necessary projects to realize the vision based on the past experience and current situation. The Act on Special Measures for Productivity Improvement that the Diet approved in June 2018 contains a so-called "CI tax system", which assists collaboration among companies and data utilization(METI, 2018). Sustainable open Innovation Initiative, one of the general incorporated associations in Japan, facilitates subsidy bids for an industrial data sharing project.

Business-sector's readiness

The proposal of Society 5.0 was heavily engaged by the business sector, and large companies are confident in driving the initiative. Mr. Nakanishi, the chairman of Hitachi, has been ambitious for leading Society 5.0. Taking an example of Hitachi's project in UK supplying maintenance service along with trains, he expressed his motivation to spread this Hitachi's business model inside and outside of Japan and to foster the attitudes towards contribution to society with technological solution (Ake, 2018).

There is another concern, if the whole business sector can be a driver towards Society 5.0. Business sector is aware of lack of digital skills in human resources. Andreas Schleicher, Director for Education and Skills of OECD, commented that Japan had many high-skilled human resources but they were not effectively utilized (Keidanren, 2018). Adequate supply of labour with appropriate I4.0 related skills is necessary to apply advanced technologies to the society. SMEs as well as large companies are potential contributors to I4.0 integration to society. However, the readiness of SMEs for NIR seems low. SMEs have not utilized IT widely due to high initial cost, uncertainty of cost effectiveness and scarcity of IT experts (JCCI, 2017).

Japanese Trade Union Confederation (JTUC) has a strong interest in the I4.0 influence to workers since industrial structural change affects labour market. JTUC sets key policies to adopt I4.0 including a plan to establish a framework for I4.0 preparation where employers and workers are involved. Their focus lies in strengthening their support in reskilling the employed and corporate's capacity development triggered by structural change in industry (JTUC, 2018).

Examples of partnerships/frameworks on I4.0 involving Japan

International collaboration has been developed as reflected in the Government's strategy to promote to formulate private sector-led projects of international expansion of Society 5.0 (The Government of Japan, 2018). There are several frameworks around implementation of I4.0.

The Centre for the Forth Industrial Revolution opened in Japan is an example of collaboration between World Economic Forum and the Government of Japan. The centre just opened in July 2018, and is expected to propose solutions for I4.0 related issues especially in the area of data, mobility and health policy (Kiyoshima, 2018). Progressive actors involved in this framework are the keys to realize optimal implementation of I4.0, corresponding to the areas of focus by the Government of Japan,

Industrial value chain initiative (IVI) is a forum established in 2016 in the aim of enabling companies to take equal initiative for designing and driving the society combining manufacturing and IT. The forum arranges the coordination domain of business as a reference model and shares it so that the unique technology of a company is connected to each other. Its membership holders vary from 88 large companies to 68 SMEs, 84 associate members and 22 researchers (Industrial Value Chain Initiative, 2018).

In terms of the manufacturing business revolution, Robot Revolution Initiative (RRI) was launched in 2015 as a private-led organizational platform. As of 2nd March 2017, 152 members are involved in this initiative, mainly from manufacturing companies (Manchu, 2017). This initiative holds expert meetings in collaboration with Germany to propose a standardization model for harmonization of existing models of smart manufacturing. One of the outputs from Japan-Germany collaboration is “secure time-shared type crowd manufacturing”. The system enables different companies to share their own know-hows to operate the same machine through a control network in manufacturing (Manchu, 2017).

3. DEVLOPING COUNTRIES ON I4.0

Concerns on I4.0

Since I4.0 has diverse influences to many countries, global gap is one of the primary concerns for international society. Many of the middle-income countries (MICs) are left behind even in the industrialization attained in the past (Santiago, 2018). MICs have not achieved to frame national strategic policies for I4.0, and they are far from the completion even when they are in the process of formulation (Santiago, 2018). Thus, developing countries face more challenges when they hope to take opportunities to step up development stage. OECD (2017) provides their observations for developing countries in terms of NIR. These include the following points:

1) It is uncertain how different parts of operation of production transform in global value chains (GVCs);
2) I4.0 technologies affect capacity of production regardless of how relevant the automation of process is in a type of industry;
3) There is a scarcity of resources necessary for interconnected production systems, adequate financial and network infrastructure to support introduction of new technologies;

4) Education and training system is important to provide upskilled workforce meeting upgraded needs of labour market due to the revolution in production;
5) Developing countries need to refine their investment policy.

Opportunities to make leaps in development

Nonetheless, it is certain that there are opportunities for developing countries with NIR related technologies. "Developing countries will have access to 4IR technologies applied to enable economic growth while achieving climate change mitigation as prices change similarly to renewable energy with expansion of those technologies" (Nassiry, 2017). Blockchain technology is expected to provide strikingly far more secure international financial transactions and logistics in countries when they have rather underdeveloped financial infrastructure (Menon, 2017). Integration to GVCs is beneficial for SMEs, which developing countries mostly have. Cost reduction can be reached in the coordination of global production as IoT helps to manage how production segments flow in the supply chain (Hallward-Driemeier & Nayyar, 2018). The diverse characteristics of NIR bring developing countries to make leaps in development.

The potential of the NIR caught interests of developing countries in incorporating the concept into their national strategy. China refers to I4.0-related technologies in its action plan "Made in China 2025". Malaysia[2] lately published its national policy titled "Industry 4WRD" in 2018. Many other countries might follow when they are capable.

4. UN ON NIR AND UNIDO'S CAPACITY

The UN strategy on NIR

The United Nations is a key entity to support countries in promoting development. Since the adoption of the UN 2030 Agenda for Sustainable Development, the UN has worked in alignment with SDGs. In September 2018, UN Secretary-General (SG) has set a strategy on new technologies. UNSG António Guterres is ambitiously pursuing UN system reforms. In his view, "without a more deliberate, organized, coherent and ambitious approach across the UN system, we risk providing insufficient support to Member States and other stakeholders to effectively address the international policy, normative and capacity challenges now upon us" (The United Nations, 2018). The UN System Chief Executives Board for Coordination (CEB), who plays a role of coordinating inter-agency relations and guiding the whole UN system, has discussed the future of work, learning and so forth as policy areas affected by NIR through its High-Level Committee on Programmes.

UNIDO's capacity

UNIDO is a specialized UN agency established in 1966 and whose mandate is to

[2] Malaysia is classified into the category of industrialized economies according to UNIDO

promote inclusive and sustainable industrial development (ISID). It has 47 regional and country offices, and it holds 168 Member States as of 2018. The mandate especially agrees with SDG 9 calling to "Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation". The Organization's activities focus on its four strategic priorities: creating shared prosperity, advancing economic competitiveness, safeguarding the environment, and strengthening knowledge and institutions. UNIDO's core functions are technical cooperation, policy analysis and advice, norms and standards, and convening and partnerships. UNIDO's Open Data Platform [3] shows on-going 852 projects in 2018. Approved projects of technical cooperation value US$ 217.9 million in 2017 (UNIDO, 2018: vii). UNIDO holds 64,345,602 euros of the total assessed contributions by the current Member States as of 31 March 2018, and the three largest contributors are Japan, Brazil and China as shown in Figure 1. Japan requested 1,156 million yen for the budget 2019, which decreased by 168 million yen from the previous year (MOFA, 2018:11).

UNIDO has undertaken a wide variety of projects at different industrial sectors through ISID mainly under the first three strategic priorities mentioned before. Their activities are project-based, and a project coordinator in charge has a considerable discretion about his/her own projects. In this sense, it is flexible on the manner of projects. UNIDO's thematic approach is reflected in the cross-cutting service. It includes industrial park, circular economy and industry 4.0. Having these two different dimensions strengthens UNIDO's intervention. Programme for Country Partnership (PCP) is a novel multi-stakeholder partnership for ISID in UNIDO's Member States. Six PCPs are in progress in Africa, Asia and Latin America with different thematic focuses. Private sector's involvement is encouraged since the contribution of private sector is essential in industrial development. UNIDO has successfully expanded partnerships with the private sector.

As its mandate is deeply concerned with I4.0, UNIDO evidently recognizes the capacity of incorporating it with their activities. Their commitment is currently prominent in promoting clean energy by utilizing I4.0 technology from technical assistance and environmental arrangement for adoption and transfer of climate related I4.0 technologies to enhancement of skills and knowledge on clean energy. Partnerships with countries in the area of I4.0 are also emerging. Belt and Road Initiative led by China published a report on the initiative's potential on I4.0 as a part of China and UNIDO partnership. Additionally, in collaboration with the Ministry of Economy of the United Arab Emirates, UNIDO launched Global Manufacturing and Industrialization Summit in 2017.

UNIDO's limitations

On the one hand, UNIDO is active in launching new activities to serve better for ISID,

[3] Open Data Platform available at https://open.unido.org/

but on the other hand there are limitations of the organization.

UNIDO receives limited assistance from western developed countries. Although UNIDO has 168 Member States, major developed countries do not participate in this organization. In the late 1990s, Canada, U.S. and Australia departed, and UNIDO recently had to undergo consecutive withdrawals of developed countries. In 2012, the U.K. assessed that UNIDO had no clear relevant impact on poverty reduction in the 2011 Multilateral Aid Review (Vabulas, 2016). Lithuania, New Zealand, France, Portugal, Belgium, Denmark, Greece and Slovakia followed over the past five years. These countries also expressed similar reasons for their withdrawal. The effective distribution of the limited resources resulted from the national budgetary cut in development aid does not prioritize UNIDO.

The context of development aid seems a determinant of the decisions by western developed countries. UNIDO demonstrates its regional strength in Africa as more than one third of the governmental voluntary contributions reached the region in technical cooperation activities (Figure 2). However, this regional strength does not always attract western donors seeking for poverty reduction in Africa. For instance, U.K. and France, which have closer governmental ties to Africa, do not have to utilize UNIDO particularly but approach other agencies with a wider coverage of issues. In the context of development, industrial development might not be a primary focus to achieve poverty reduction when it leads to eradication of poverty as an effect.

Imbalance among the four core functions due to concentration of technical cooperation activities may impair other services. This results from the organizational structure where the Directorate of Programme Development and Technical Cooperation (PTC) holds all the main sub-departments for implementation of projects. To efficiently run projects a reasonable amount of resources are required, and the resource acquisition directs to the degree of authority that PTC has. The fragmentation of authority eventually affects the consistency of the organizational performance as a whole.

It requires a tremendous effort to ensure the consistency. When UNIDO set the Medium-Term Programme Framework (MTPF) 2018-2021, they upgraded the Integrated Results and Performance Framework (IRPF) to correspond with each other for better performance articulation. The arrangement of the process within the organization towards the new IRPF involves participation in a productive way (UNIDO, 2018:57). The task force for IRPF have conducted discussion with each department to gain understandings about the framework to harmonize the organization's activities. It also takes time to assess the effects of the new framework.

Lastly, UNIDO is facing ongoing UN Development System (UNDS) reform together with other UN organizations. Recognizing overlapping activities among different agencies, repositioning of the organization is necessary to better represent ISID issues. In this regard,

keeping an eye on the progress is essential. However, the geographical location distant from the UN Head Quarters in New York limits access to information about UNDS. Although Mr. Robert Piper, who takes in charge of UNDS, visited UNIDO in Vienna to inform the latest updates on UNDS in September 2018, it is difficult to maintain close communication since most of the discussion takes place in New York.

Linking to the first point, limited budget constraints the number of staffs. Around 660 staff members and 1,590 consultants operate the organization (vii). It is a unique feature of UNIDO to have such a large amount of consultants. Due to the smaller size of resources, the workload per staff increases, and higher competence is required to each staff. There are staffs who work intensively on their tasks for long hours during the busiest period of year.

5. RECOMMENDATIONS

The presented situation above can offer three insights for UNIDO's future approach to perform more effectively and efficiently for ISID:

I. Hub for promotion of sustainable prosperity

The shift of an identification of the organization to a hub for promotion of sustainable prosperity would generate more potential for its effective function. NIR application that not only Japan but also other developed countries proceed demands more fields for its expansion, and it provides mutual benefits for further industrial development. Japan values UNIDO to expand its access to Africa for both economic cooperation and opportunities utilizing Japanese technologies (MOFA, 2018). Capturing and delivering the needs over the world, NIR universality can be a strong core in the role of the hub. This shift does not mean leaving away completely from poverty reduction. As Japan's NIR strategy supports human-centric revolution, it indicates that the aspect of human development can still remain but may rather be enhanced. Under the approach, emerging expansion to other regions such as Middle East and Asia would accelerate UNIDO's collaboration while reinforcing the strength in Africa. The centrality of industrial development along with NIR enables UNIDO to address its capacity for comprehensive development issues.

II. Facilitation of industrial policy-focused communications, norms and standards

NIR urges countries to adapt to a potential radical change to industrial system. Industrial policy plays a significant role in driving the adaptation to impacts that are more dynamic. In this sense, the capacity of policy makers is becoming more and more significant for the effective function of industrial policy with complexities of manufacturing systems at local and global levels (Andreoni and Chang, 2016:499). UNIDO has industrial policy advisory service as its core function to its Member States. Sharing industrial policies and strategies as publication and providing capacity development programmes have contributed to the formulation of industrial policy in Member States such as Viet Nam. To advance this, it would be beneficial to facilitate policy-focused communications or initiatives between developed and developing

countries. Besides, a larger commitment in formulation of norms and standards in Member States would take an effective balance of the services UNIDO provides. Direction around NIR related standards formulation should be tracked. As Japan is expected to provide verification cases regarding application of NIR technologies to society, it is notable to support Member States to align with the standardization of the usage of real-data and other NIR technologies once established. UNIDO can strengthen its capacity by a combined set of core functions in the coming NIR.

III. Inter-agency cooperation for more effective collaboration with other actors

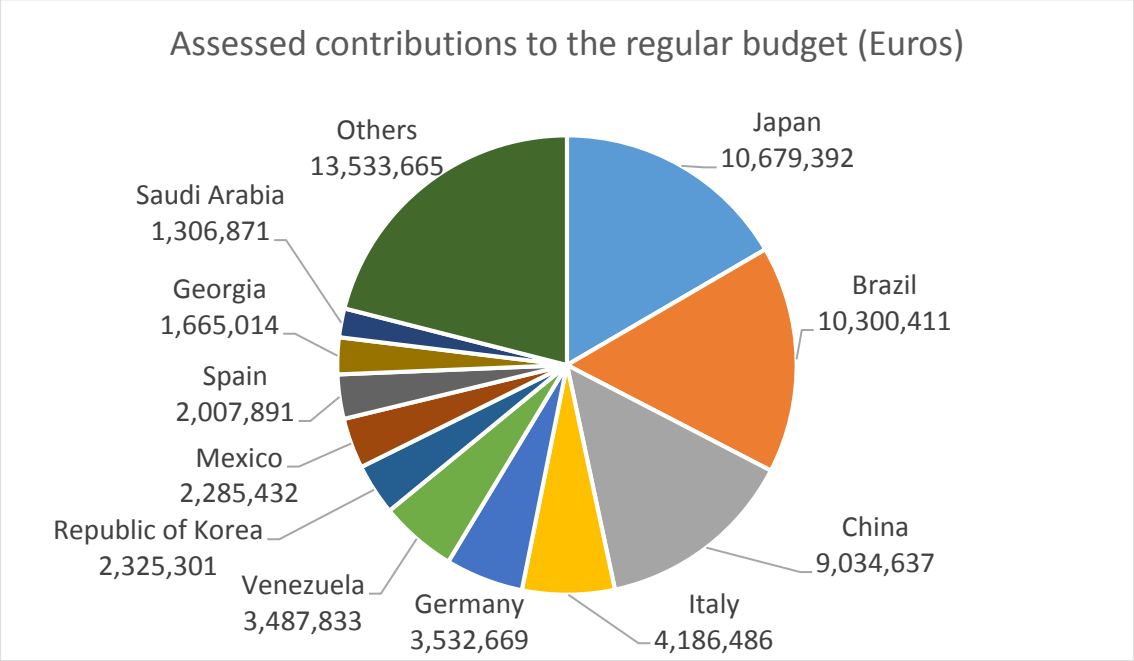
UNDS is a chance for UNIDO or other UN agencies to cooperate in a way that they can collaborate with their Member States and private sector more efficiently. The achievement of SDGs in developing countries demands US$ 2.5 trillion a year, and private sector will need contribute according to the UN (Lloyd, 2018). Partnerships for financial assistance promote effective implementation of projects. Inter-sectoral characteristic as seen in the NIR influence urges smart approach by UN entities to the Member States to solve the issues for sustainable development. UNIDO has already developed partnerships with financial institutions, and it might be desirable to pursue optimization of their collaboration. The strong strategic identification of the organization hereby prevents the organization from blurring its significance for ISID.

6. CONCLUSION

I have developed this paper with the assumption that NIR era is coming. Japan's strategy already foresees the era around 2030 and imagines their society beyond. The adaption to NIR implies the importance of effective approach taken at national and international levels. In relation to UN, it is a curious matter to consider how NIR makes a relevance to 2030 Agenda, which ends in 11 years. It is sufficient to consider NIR's contribution to SDGs in the short term but SDGs might lose its impulse to connect the world altogether in the long term. Since the UN organizations are rarely dissolved, UNIDO has a responsibility to improve its function no matter how small it is. Sharing the direction of Japan in the context of NIR, those implications I raised show the organization's potential pathway. This paper has left much room to analytically discuss the formation of Japan's strategies, the detailed situation in developing countries, and administrative issues of the organization. Moreover, it even raises awareness of post-2030 Agenda. Global inclusive and sustainable industrial development is achieved only when stakeholders take advantage of opportunities with NIR. UNIDO's expertise is capable to help any actors for their involvement.

Figures

Figure 1.



Note: Data for major contributors to UNIDO's regular budget as of 31 March 2018 from 'Financial Situation of UNIDO' (Director General, 2018)

Figure 2.

TECHNICAL COOPERATION NET APPROVALS UNDER VOLUNTARY CONTRIBUTIONS IN 2017 Governmental contributions	
Region	US$ million
Africa	35.5
Arab region	10.1
Asia and the Pacific	8.7
Europe and Central Asia	3.6
Latin America and the Caribbean	5.6
Global and interregional	35.5
Total	99

Note: Recreated from UNIDO Annual Report 2017 Appendix B p13 (UNIDO, 2018b)

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