December 8th,2019

A Comprehensive Framework on Appropriate Technology Choice for Sustainable Development

1. The Unsustainability of The Modern World and The Need for Comprehensive Framework

1-1. Technologies Appropriate to the Purpose Have to Be Chosen

Today, Sustainable Development Goals (SDGs) have become the target widely approved by people/organizations across various sectors in both developed and developing countries. However, despite presenting goals to work towards, it is still not clear what kind of economic systems, social systems, and technologies should be developed and applied to achieve these targets.

From a technological viewpoint, recent developments such as artificial intelligence, autonomous vehicles, space development, and advanced medicine are considered to be remarkably promising, and major R&D resources are allocated towards them. Although these technologies may be attractive and useful, it is doubtful if development of these technologies is consistent with the attainment of SDGs. If we consider the primary problems facing the world today; including poverty and inequality, global and local environmental problems, a shortage of natural resources, and dehumanization and alienation; the current choices modern societies are making, both when using and developing technology, are at odds with those they need to become sustainable.

Here, the term “technology” will be defined as per common parlance, namely: the means or skills to accomplish a predefined purpose whilst carrying out a purpose-oriented action. In this commonly understood definition, technology is defined solely as the means for attaining a certain purpose. However, technology often finds itself being positioned as the purpose itself, not the means in modern society, commonly leading people to become subservient to technology. The choice to use or develop technologies with the aim of creating new products and services, in order to in turn expand consumption and drive economic growth in the name of obtaining more profits, or to open new “frontiers” for the future, often lead to the direction of society deviating considerably from what can be considered sustainable.

To achieve SDGs, technologies appropriate to the goals should be chosen, developed and used.

1-2. The Significant Role of Appropriate Technology and Its Revitalization in Modern Society

In order to consider what kind of technologies are necessary for the future, appropriate technology movements, which were primarily active between the middle of 1960s to the middle of 1980s, provide significant hints and inspirations. Various definitions of the term 'appropriate technology' have been used across the decades, giving it a rather broad and vague meaning. In general, the term implies technologies appropriate to local socio-economic and cultural conditions, which match well with the needs of local people, and create job opportunities whilst remaining environmentally friendly in nature. At the same time, the term has also been used as alternatives to modern technologies. That is, based on the perception that modern technologies have been bringing about serious problems such as global/local environmental ones, depletion of natural resources, and dehumanization, the term appropriate technology has come to be associated with technologies that resolve these issues. Therefore, the targets that are aimed for with 'appropriate technologies' are generally consistent with those of SDGs.

However, after the middle of the 1980s, appropriate technology movements became less active. This implies that there might have been something lacking in these movements. Therefore, it is vital to investigate what the movements lacked, and then develop these areas in order to revitalize the movements. This process is believed to be one of the most effective way to create a system of technologies capable of attaining sustainable development.

When looking back at the history of appropriate technology movements, numerous reasons for decline can be identified, such as the dominance of capitalism and modern technology that arose with the end of the Cold War, an absence of practical business management, a shortage of related human resources, and a lack of political support. However, the very nature of appropriate technologies as an ambiguous concept and the lack of framework which can be approved and supported widely by people and organizations across various sectors in our society can be considered as the essential and most basic reason. Based on this perception, here it is aimed to develop a Comprehensive Framework on Appropriate Technology Choice for Sustainable Development.

*The term "Appropriate Technology Choice" is intentionally chosen instead of "Appropriate Technology" for this framework, as the term "Appropriate Technology" evokes a wide range of definitions including limited and stereotyped ones. Also, the term is potentially misleading, hinting at a group of technologies which are inherently 'appropriate' due to a special property they possess rather than being heavily dependent on the context of their usage.

1-3. Our Unsustainable World

In order to consider the required technologies for sustainable development, it will be reasonable and effective to view problems of today's world in three categories; that is, poverty and inequality problems, environment and natural resource depletion problems, and dehumanization problems. These problems are derived from the same root and linked one another to make the world unsustainable. Therefore, it is not effective to attempt solving only one of them separate from the others. For example, if we can solve poverty and inequality problems but environmental problems remain unsolved, the basic infrastructure of our life can be destroyed by climate change related disasters. If the poverty problems and environmental problems are solved, but dehumanization problems prevail, our life may become devoid of meaning. What is more, dehumanized people are not able to be as creative when resolving the problems that face them. It is necessary to investigate the root of these problems, explain the dynamic relationships between related factors, consider measures to overcome the problems, and then effectively implement these measures.

1-4. Poverty and Global Inequality Crisis

In 2017, 2.2 billion people lacked access to safely managed drinking water services and 4.2 billion people lacked access to safely managed sanitation services(*1). About 1 billion people lived without access to electricity(*2) and 1.6 billion people lived in inadequate housing(*3). On the other hand, in 2018, the richest 26 people in the world owned the same wealth as the 3.8 billion people who make up the poorest half of humanity(*4).

(*1) UNICEF/JMP/WHO, 2019, *Progress of household drinking water, sanitation and hygiene 2000-2017*

(*2) OECD/IEA, 2018, *World Energy Outlook 2018*

(*3) UN-HABITAT,2017, *Dialogue on the special theme for the twenty-sixth session of the Governing Council*

(*4) OXFAM, 2019, *Public Good or Private Wealth ?*

Poverty conditions should not be defined statically as only a matter of daily income, but more dynamically and practically by focusing on the conditions that assure people's freedom to pursue the life they wish.

If we consider the causes of poverty and inequality, and investigate the mechanism which brings about the problems, we find that it isn't the matter of

"backwardness" in developing countries, but factors that occur when traditional society gets caught up in the global wave to modernize. Issues also occur when movements in the private sector aim to increase production efficiency in order to gain more profit despite there being limited room for economic growth in the local context. In other words, poverty and inequality problems can be attributed to the development of industrialized society with capitalism and modern technologies as essential drivers.

As the trickle-down theory has continued to lose credibility in the middle of a global inequality crisis, policy makers seek solutions for poverty via measures such as redistribution of wealth, job-training, and education. Although these measures make sense and are effective in certain contexts, the problem is that most of these solutions assume that technologies are a fixed background, rather than something that can be chosen by people.

1-5. Environmental Problems and Natural Resources Depletion — Lessons not Learned

In the early 1960s and early 1970s, very important warnings regarding the problems with modern industrialized society were issued in the form of "Silent Spring" (Rachel Carson, 1962), and "The Limits to Growth" (Donella H. Meadows et al.,1972). "Silent Spring" outlined the harmful effects on the natural ecosystem from indiscriminate use of pesticides, showing how a wide range of animals and plants dynamically interact in the system, meaning not only insects but also other living things were impacted by using pesticides. "The Limits to Growth" instead raised a significant warning regarding industrialized societies, which were seeking never-ending growth of economy as an unquestioned assumption. The report used a computer simulation to demonstrate that if the growth is not subject to proper control, our society will face various limits in the foreseeable future, which will result in a sudden and uncontrollable decline in both population and industrial capacity.

However, many are yet to recognize these important warnings, and the associated lessons remain unlearnt. Today, a wide range of waste, including plastics, chemicals, radioactive matters, and heavy metals are being discharged and accumulated in much larger amounts in our environment. Most countries are still seeking limitless economic growth, and climate change has become reality. Phenomena such as super typhoons, catastrophic floods, heat waves, large scale forest fires, and glacier melts are now providing the same warnings as "The Limits to Growth" in a far blunter manner. Yet there still exists a significant gap between the very serious risks we are now facing and our society's general climate that is rather reluctant to take necessary measures in required speed and intensity.

1-6. Dehumanization

During the time that appropriate technology movements were active, the issues associated with dehumanization were also actively discussed. However, as the attention paid to appropriate technology fell away, so too did the attention given to dehumanization. It appears this came about not because dehumanization problems were being solved, but because the problems increasingly became the norm in our daily lives. This issue not only make our work worthless, it also threatens to disturb the development of harmonic human relationships in our society, including those amongst family.

Fundamentally, human beings are capable of fulfilling our desires in various dimensions and attaining our welfare through their work, via which we produce necessities of our lives, develop our potentials and creativity, be of help to others, develop cooperative relationships with others etc. In modern society however, work has moved to a means through which to receive wages, with no or very limited human capacities being developed, and only poor human relationships established. The compulsive motivation for industrialized society to seek higher efficiency of production often forces laborers to work harder for lower wages.

Very rapid development of information and communication technologies in recent years have made it possible to communicate without restriction of distance of space and differences of time. It has also enabled extremely high-speed data processing and new services in fields such as consumption, transportation, medicine, education, and finance. However, these technologies may bring about new types of dehumanization problems: namely, a lack of direct human relationships, transfer of human abilities to machines, causing human subordination to them, and the emergence of strictly controlled totalitarian society. Furthermore, the reduction of labor caused by increased production efficiency using the ICT technologies can bring about severe unemployment problems, especially when the space for further economic growth is limited.

Problems such as poverty and environment are related to the basic conditions necessary for our lives. On the contrary, dehumanization creates issues that devalue human life, and make it less worth living. Moreover, it contributes heavily to our ability to solve the problems that face our society.

1-7. Necessity of Multi-Sector Dialogue among “Developed” and “Developing” Countries

It is clear that the development pattern attained so far by “developed” countries has already reached various limits, and as such it is not sustainable one.

However, many developing countries are still pursuing the same development pattern taken by developed countries. If people in developed countries insist on alternative development patterns from existing one, it is likely that people in developing countries consider the attempt as egoistic because it seems like those who have already enjoyed the benefit of modern industrialized society prevent the people in developing countries to do so.

This impasse can only be settled by creating a way forward for each side, wherein the welfare of people in each country can be realized. When creating technologies required for these new paths of development, it is effective to make use of certain factors of modern technology and modify it to fit the local conditions. Simultaneously, people from developed countries can look at and relearn what they have lost in the process of modernization from societies of developing countries; such as traditional technologies, an understanding of how much humans can do through their own abilities, harmonic way of living with nature, and human relationships amongst communities. Furthermore, reasonable critiques of developed countries will be necessary in order to drastically reform technologies in developed countries. The above-mentioned framework should be developed and brushed up through multiple sector dialogue between developed and developing countries.

Through such dialogue, it is hoped that a concept of future can be developed, in which people are share the same purpose of creating harmonic, inclusive and sustainable societies, but at the same time recognizing diversity in a concrete form.

2. Appropriate Technology Choice for Sustainable Development

Now is the time to make appropriate technology choices, develop those chosen and utilize them widely in order to attain sustainable development. Such technologies will be characterized and/or oriented as follows:

§ To Solve Poverty and Inequality Problems

P-1. Appropriate to Local Conditions and Contribute to Poverty Reduction Directly

In general, technologies used in developed countries are difficult to be directly transferred in sustainable ways to developing countries where socio-economic, as well as cultural conditions are quite different from those of developed countries. It is necessary to choose or develop technologies which fit local conditions, and effectively fulfill basic needs of people such as clean water, sanitation, electricity, housing and food.

Related SDGs

P-2. Create Job Opportunities Properly

Redistribution of wealth, as the most common measure being taken for poverty alleviation, is necessary and important in certain conditions. However, if the underlying structure causing poverty and inequality itself is unchanged, the poor will remain poor, and they will continuously depend on the help of others. Pioneering the concept of "Intermediate Technology" as precursor of "Appropriate Technology", E.F. Schumacher defined the concept based on "equipment cost per workplace". The essential solution of the poverty problems is to create worthwhile job opportunities, whilst properly adapting to the context of individual cases, and using technologies suited to that purpose.

Related SDGs

§ To Solve Environment and Natural Resource Depletion Problems

E-1. Limited Things Should Be Treated as Limited Things

E.F. Shumacher's "Small is Beautiful" begins with the description: "One of the most fateful errors of our age is the belief that "the problem of production" has been solved." With this phrase, Shumacher severely criticized modern industrialized society, as it had been consuming "capital", or limited non-renewable resources, such as fossil fuels, as if it had been "earnings", or unlimited renewable resources. It goes without saying that non-renewable resources will exhaust if we keep using them. Similarly, it is obvious that environment will become disordered or even destroyed if we continuously discharge waste, waste water, and exhaust gas without proper treatment. Instead, if "Limited Things Should Be Treated as Limited Things" becomes a guiding principle of technologies, most environmental and natural resource depletion problems will be resolved. This principle can be divided into two sub-principles: that of natural resource depletion, and that of waste management.

E-1.a Refrain from using non-renewable resources as much as possible, and get rid of using fossil fuels.

E-1.b Refrain from discharging wastes, wastewater and exhaust gas without proper treatment, and avoid greenhouse effect gas emission.

Note: Nuclear power plants are often evaluated as an energy source with little greenhouse effect gas emission. However, the recognition is based on limited perspectives. Considering the issues of potential catastrophic damage caused by severe accidents, issues with radioactive waste that can potentially threaten people tens of thousands of years into the future with radiation exposure, and the danger of operators/workers being exposed to radiation, the technology is inappropriate in all situations.

Related SDGs

E-2. Develop a Society Based on Resources Which Can be Supplied in Sustainable Way

Modern technologies have been developed based on the assumption that fossil fuels can be always supplied abundantly. Contemporary movements for the promoting of renewable energy primarily focus on replacing a part of the existing energy supplied by fossil fuels. However, the current excessive use of fossil fuels is extremely unsustainable, as it will see these natural resources that have formed over several hundreds of millions of years used up within a few centuries. Therefore, the fact that replacement implies that the use of fossil fuels is the default, and thus an unreasonable viewpoint. On the contrary, we should plan and develop our society, industries, technologies as well as our life based on the quantity and quality of resources that can be supplied in sustainable way from the beginning of the process.

Related SDGs

E-3. Do Not Disturb the Balance and Cycling Process of Natural Ecosystem

Materials which can be safely returned to natural ecosystems (referred to as "N") and artificial materials which cannot be (referred to as "A") must be distinguished

strictly. N should be recycled or reduced to nature after use, whilst A should be used in systems separated from the nature so as not to disturb the balance and cycle of the natural ecosystem, and then recycled or disposed safely after use. The complex products which are composed of both N and A should be designed and produced so that N and A can be separated easily.

Related SDGs

E-4. Give Priority to Small Scale Decentralized System

Natural energy, which will be the major energy resource of the sustainable world is characterized by its' low energy intensity that is spread everywhere. Therefore, it is suited to small scale decentralized energy supply systems. In harmony with the renewable energy supply, development of decentralized socio-economic and technological system which is highly self-sufficient in basic needs supply such as energy, water and food, and at the same time open to interact widely with other regions and countries, will significantly contribute to attain sustainability of our society. In such decentralized systems, technologies which are controllable, create job opportunities properly, are environmentally friendly, and lead to unique and attractive production activities and lives, are more likely to be used than large scale centralized systems. Moreover, under today's conditions where the world faces serious risks from various aspects, securing the ability of local regions to provide their basic needs will significantly increase the safety of society as a whole.

Related SDGs

E-5. Recognize the Limits of Modern Science and Technology and Respect Nature

Modern Science and technology are based on a mechanical view of the world mainly developed in 16th and 17th century. The mechanical view of the world is based on the following principle: reduce an object to certain factors, then define verifiable laws that these factors obey. The scientific knowledge obtained through this principle can be systematically accumulated in large quantities and added to exponentially. Through the

advancement of this science and technology, the accumulation of knowledge has led to a tendency to misunderstand that human beings have clarified a large part of the world, and those things we do not understand will also be elucidated in the future. The reality is however, that the world is unfathomably complex, and though we may make attempts to understand it, new questions and old, such as the creation of the universe and the origin of life, are constantly arising, pushing ultimate understanding further and further away. Additionally, non-verifiable matters, such as the nature of human consciousness, emotions, and the arts and religions remain prevalent in society. Furthermore, no one knows what lies beyond the bounds of human perception. Things humans have no hope of perceiving let alone understanding may exist, preventing us from ever even asking questions about them.

When the arrogant assumption that human beings have understood most matters in the world mixes with a worldview that justifies human dominance, there arises an attitude of looking down on nature, and viewing it as an object to be made use of. This attitude can be considered as the basic factor that has brought about today's environmental and natural resource problems and must be changed. We should recognize that what we know about the nature is very limited and human beings' capability is also limited. We need respect nature as the mysterious and incomprehensible thing it is, something with deep and irreplaceable value, which we must refrain from disturbing or harming.

Related SDGs

§ To Solve Dehumanization Problems

D-1. Appreciate and Extend Non-Commercial Production/Work

We are now living in a society in which most productions/services and related works are conducted as commercial productions/services and wage labors. However, originally people could fulfill their basic needs such as water, energy, food, and housing by themselves. People were also able to handle a wide variety of jobs and carry out various ceremonies and festivals by themselves through cooperative and direct human relationships in a community. Through the development of the commodity economy, people became to be related indirectly mediated by money, which was furthered as the rise of capitalist economies pushed more and more goods and services to be supplied as

commercial ventures in order to seek a never-ending increase in profit. These processes led to a lot of capabilities which had been developed by self-sufficient activities being lost, whilst making people increasingly more dependent on commercial goods and services.

For attaining sustainable development, it will be important to promote the principle of "Do It Myself/Ourselves" in order to recover our own initiative, and to develop our creativity in our productive activities and lives. That means non-commercial production/work are appreciated and extended properly.

Related SDGs

D-2. Make Use of Controllable Technologies by People

In general, the introduction of technology to certain production/consumption systems means the transfer of what belongs to human capability/skill to tools, machines, facilities and systems. The process usually brings about an increase of production efficiency and an improvement of convenience. On the other hand, human beings inevitably become more dependent on things or systems not belonging to themselves. The process is not as simple as just a loss of human owned skills, but more complex as new skills based on the use of the technologies and/or monotonous works might appear. However, at least the new skills are more dependent upon the outer things/systems than the ones without the introduced technologies. The best technology choice should be made considering these dynamic changes. In principle, however, as our happiness and welfare arise from the work which is carried out with our own initiatives and by our own free will, those technologies which can be better controlled by people should be given priority.

Related SDGs

D-3. Make Use of Technologies Which Develop Human Resources

Work gains value and significance when it enables people to demonstrate and develop their capabilities. This kind of work is worthwhile and rewarding as it can be creative and likely to develop cooperative relationships with other people. Therefore, we

should make much of technologies which bring out and develop human resources.

Related SDGs

3. Epilogue

A technology system based on above mentioned comprehensive framework should form the mainstream of future technology system of the world. The principles and direction described will act as a foundation for more concrete and practical proposals regarding technology choice depending on the local/specific conditions in each individual case and the following implementation.

For the development and the implementation, multi-sector and international cooperation including international organizations, governments, private sectors, universities and NGOs is indispensable. Development aid so far conducted has been based on the concept that "developed countries" lead "developing countries" due to the perception that the developed countries are "advanced". However, it is the development pattern of "developed countries" that has made today's world unsustainable. Therefore, the existing development pattern of "developed countries" cannot simply be a model to be pursued by "developing countries". The "developed countries" must change their socio-economic structures and technologies drastically towards those of sustainable ones. At the same time, "developing countries" must pursue alternative development patterns different from the existing ones followed by "developed countries". Hope for attaining sustainable development will be found where effort for drastic change towards sustainability by "developed countries" and challenges for alternative development towards the same goal by "developing countries" proceed cooperatively.

Drafted by APEX (Asian People's Exchange)

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