Technology and its Implications toward Sustainable Development

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Abstract: The current mode of production and consumption in the context of technological development has brought devastating effects on the environment and its ecosystems. As various issues on sustainable development were raised, several discourses in literature emerge which provide conceptual and philosophical approaches on the notion of sustainable development. This paper presents a philosophical framework on technology and its links to the current views of sustainable development. It highlights that the current view of sustainability supports the development of technology as substitute capital of natural resources for generations to come. This stimulates philosophical questions regarding our view of technology and natural resource. It is maintained that fundamental change is prescribed on two significant areas: our behavior towards technology and our perspectives on sustainable development. The contribution of this work lies in providing an approach that promotes sustainable development by way of changing our perspectives on the development of technology and its use.
Keywords: Technology; sustainable development; philosophical framework

1 INTRODUCTION

In this postmodern society, technological development is inevitable. Electronic gadgets, modern modes of transportation and communication, fast-paced production and consumption are all but few of several evidences on the dynamics of this techno economic system. Sachs and McArthur [1] and Ranis [2] argue that technological innovation brings long-term economic growth. Agricultural production, for instance, is enhanced by the use of tractors, commercial fertilizers and pesticides. Fast-paced societies in highly urbanized cities are run with a system of technologies that has played a substantial role in supporting communities. For example, communities with faster modes of transportation with excellent farm-to-market roads are capable of shortening market transactions; thus, enabling efficiency and productivity of delivering commodities from source to market. The rise of information technology has brought solutions to distance-related challenges arising from globalization. Complex technologies such as in aviation industry require consumers to succumb themselves to the capabilities of technology. Hence, we entrust our activities, comfort, leisure, and even our lives to the technologies that we created. Advancements in biotechnology, nanotechnology, geographical information system, virtual reality, etc. have brought significant breakthroughs to humankind and have radically changed almost everything we have. Development in specific technological areas such as computing, communication and transportation, entertainment and information technology has been highly dynamic over the past few decades. Such control to these advancements may seem impossible due to the demands of the techno economic society, the

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patterns of production and consumption, cultural upbringings, and individual preferences and choices.

While this technological development improves many areas of concerns, there are negative consequences coupled with this kind of development that include environmental degradation, climate change, resource depletion, human toxicity caused by harmful chemicals, loss of biodiversity, degradation of rivers, lakes, seas, oceans and forests, and the altered pattern of land use. These are all direct effects on human activities needed to support the modern pattern of production and consumption together with a close to seven billion human inhabitants on the planet. These problems, when projected, can wipe out all life forms on Earth including those unborn generations [3]. Aside from threatening ecological systems that support life, these environmental crises pose potential threat on human understanding of himself and its place in the world [4]. Redirecting this pattern of development to minimize ecological crises is not only environmental and generational preservation but also is a form of self-preservation. In its very sense, it is important to know that we are transforming our world through our intellectual creativity and then we attempt to reflect this creativity in the world we want it to be. We are presenting vast, highly advanced technological devices to the world as evidence of our creative potential and in the process, we treat our environment as mere means to achieve our best design for the world. Substantial evidence claims that current patterns of human activity globally exhibit an unsustainable path [5].

The current discourse on sustainable development offers a promising reform framework through equitable development of intra-generational and inter-generational capital [6]. The seminal work of Beder [7] provides a discussion on the relationships of technology to sustainable development. Beder [7] emphasizes the importance of redesigning our technological systems to support sustainable development. Ashford [8] expands the necessity of technological change in advancing pollution reduction initiatives. Keoleian and Menerey [5] claim that environmental issues must be integrated in the design of technology in order to achieve sustainable development. Yan der Gaast and Begg [9] address the challenges the challenges that involve sustainable development and technology transfer. Although, philosophical and conceptual discussions were presented in literature, providing a comprehensive framework on sustainable development however remains a challenge. This paper provides further insights on how our choices regarding creation, use and development of technology affect sustainable development from a philosophical point of view. It discusses how technology development must be directed in order to promote sustainable development. The contribution of this work is in presenting a framework that offerss another view of sustainable development from the perspective of philosophy of technology.

2 SUSTAINABLE DEVELOPMENT AS OUR RESPONSIBILITY

The highly cited definition of sustainable development across literature came from the report of the United Nations' World Commission on Environment and Development, popularly known as the Brundtland Commission in 1987, entitled The Common Future which defines sustainable development as a kind of development that meets the needs of the present without compromising the ability of future generations to meet their own needs [10]. This language has evolved into a powerful, international policy framework [11]. The term first appeared in the UN Stockholm Declaration in 1972 and the following Coyococ Declaration on Environment and Development in 1974. It was not until 1980 that this idea of sustainable development became central to development discourses [10]. It has also been a central topic of dialogues in business, academe and political discourses and often becomes an "attractive label" to several projects. Its central idea implies that current development pattern in all activities that demand Earth's resources could not be sustained unless we take into consideration the welfare of future generations. The Brundtland report perceived that the Earth has an exhaustible amount of supply of natural resources and to a certain point in time these resources will be depleted such that it needs another tremendous amount of time so that the Earth can provide these resources again [4].

The foundation of sustainable development rests upon the consensus efforts of governments globally. Despite of its prominence, sustainable development suffers from a lack of unified meaning. Davison [11] and Williams and Millington [12] observed that literatures on sustainable development provides individual definition based from their orientation. For instance, Ragas et al. [13] defined sustainable development as "*a process of change in which the exploitation of resources, the direction of investments, the orientation of technological development and the institutional change are in harmony and increase the present, as well as the future, possibility to accommodate human needs. The relation between society and its physical environment should be as such that a natural carrying capacity is ensured for future generations*".

Clift [14] described it briefly as "*a way of living such that, in ten or twenty generations' time, people living on the Earth can have a satisfactory existence*". Eighty various definitions of sustainable development exist in the literature which are often contradictory [15]. Redclift [16] argues that sustainable development forges a number of discursive interpretations. Glavic and Lukman [17] published an article in the Journal of Cleaner Production which provides definitions of sustainability and sustainability-related terms. Robinson [18] elaborates the idea of sustainable development including its criticisms and concerns and provides strategies available to move forward from a conceptual to action-based approach. Sneddon et al. [19] underline the progress and challenges of sustainability in the post-Brundtland world and they emphasize plurality of perspectives in achieving sustainable development. Robert et al. [20] underscore how tools and approaches toward sustainable development relate to and build on each other when used for planning sustainability.

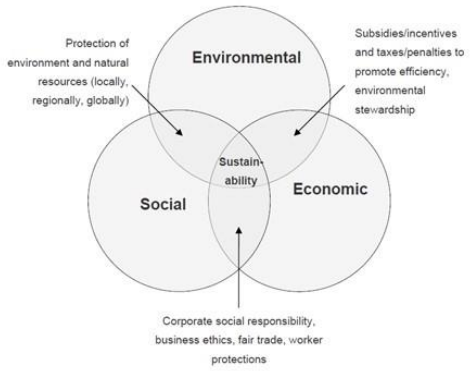

Fig. 1. The triple-bottom line approach (adopted from Rosen and Kishawy [25])

Most, if not all, of these definitions agree on the concept of the "triple-bottom line" as a way to represent sustainability [21]. The term was first coined by Elkington [22]. This approach highlights the three dimensional nature of sustainable development – economic growth, environmental stewardship and social well-being. These dimensions consist of various levels of hierarchy of categories which may be general or specific depending upon a specific application or perspective. A comprehensive review of literature of the triple-bottom line can be found in Joung et al. [23]. Sustainable development is regarded as the intersection of these three dimensions as shown in Fig. 1. The framework implies that economic approaches such as efficiency, growth, and development which were of concern in the past five decades could not be sustained without taking into account the environmental issues that were traded off in the process and the social impacts they have posed. As the rate of the depletion of the environment and natural resources becomes steeper, then it must become our responsibility to redirect our activities in order to promote sustainable development. Although this is widely pronounced in literature, other scholars take on another stance. For instance, Banerjee [24] argue that sustainable development is rarely a paradigm shift, but is only based on economic rationality.

3 PHILOSOPHICAL RELATION OF TECHNOLOGY AND SUSTAINABLE DEVELOPMENT

From the perspective of technological development, technology assumes at least two aspects. First, technology is one of the underlying causes of the problems that impact natural ecosystems [20]. Secondly, technology could be used in reshaping society into a sustainable pattern – a relatively new framework in addressing human activity and its responsibility to the society and nature [21]. The first aspect involves unsustainable development, use, management and maintenance of technology which harm nature and its ecosystems. The pattern of production and consumption which require resources and processes that produce CO_2 and CH_4 emissions which cause global warming is an example of various human activities that yield devastating effects to natural ecosystems. One must realize that the carrying capacity of the Earth to provide resources that support all life forms and its ability to absorb emissions from human activities is finite [26]. In fact, many geographical and industrial places we have today already exceeded the carrying capacity of the planet [26]. On the other hand, the second aspect of technology highlights a perspective that promote harmony of technological advances and various issues that concern society, nature and economy. This agenda is not relatively new. From Beder [7], various works highlight several approaches that integrate technology and sustainable development. Ashford [8] pointed out that necessary technological changes must be in place which include: (1) material input substitution, (2) process redesign, and (3) final product reformulation. These initiatives on technological change must address pollution at various media and reflect fundamental shifts in the design of products and processes. These new approaches are known as pollution prevention, source reduction, toxic use reduction, or clean technology [8]. van der Gaast and Begg [9] discuss the key role of technology development and transfer in low-emission and climate-resilient development. Ahmed and Stein [27] explores viewpoints at a global level on the state of science, technology and sustainable development. They claim that science and technology can contribute solutions to the inter-relationships of

natural, governmental, economic and social dimensions of sustainable development.

Finding this path of harmony between technology and sustainable development, however, could not be established from a single source. It requires active collaboration among engineers, scientists, social scientists, economists, philosophers, lawyers as well as the government. In fact, Beder [7] himself emphasized that although sustainable development relies on technological change, governments must take tough steps to force radical technological innovation. Appropriate policies must be established as guide on the development and use of technologies. Moreover, Ashford [8] highlights fundamental cultural shift as a requirement for technological change. Redclift [16] points out that "sustainable development" today must be linked to new material realities, the product of our science and technology, and associated shifts in consciousness. Today, industrial sectors are critical in technology development which ensure that these technologies preserve environment and society. Furthermore, governments are pushing on policies and regulations, creating institutional committees on environmental protection, and developing various programs on how to achieve a sustainable Earth. These collaborations are expected to support long-term environmental objectives and short-term goals.

Now, we shall discuss how does technology become a destructive or a constructive tool for sustaining our world. We shall proceed with the thoughts of Albert Borgmann in providing us with a philosophical understanding on the issue. In his book Technology and the Character of Contemporary Life, Borgmann [28] argues that technology has two main functions: role of satisfying its promise and its enrichment role. Truly technology has saved humanity by removing the misery and turmoil man faces. Technology reduces or eliminates darkness, cold, heat, hunger and confinement. For instance, to support an environment conducive for learning, air conditioning units have been installed in classrooms to help facilitate professors and students do their teaching and learning activities. With this, instead of getting distracted by a humid environment, technology in the form of air conditioning unit fulfills its promise. On the other hand, technology also liberates and disburdens us from demanding activities associated with our desire of comfort. Instead of students bringing fan inside the classrooms which is a burden, air conditioning units provide them the comfort they want without having them burdened. Borgmann [28] contends that it is this enriching role that technology disengaged us with our environment. Technology in the form of devices has been proliferating in a faster rate ever than before. It provides convenience at the highest form of efficiency. It transforms the entire activity into pure consumption without contemplating on the environmental burden during production. Convenience which is a commodity is in the form of mere ends without considering the burden of means [4]. By taking pure consumption into account, people tend to forget that various things were treated as "mere means" in the process and environmental repercussions became negative results. The complex origins of these highly advanced technologies presented to in the form of countless resources are exhausted and used up in the process. This liberation and prosperity offered to us through technology enabled us to be technologically dependent. We rise to bed, we take a bath, we drink, we eat, we go to work, we fulfill our tasks in our offices, we entertain ourselves, and we communicate others through specific forms of technology. Now the fundamental question is: Are all these technologies necessary to dwell and fulfill our desires? Let's use Borgmann's framework to answer this question. Borgmann [28] encourages us to turn away from this irresponsible consumption to realization of focal things and practices. Focal things are those things which demand us commanding presence, continuity with the world and centering power [28]. These are the things which enhance our communal experience with other people and affirm directions of our lives. For example, going up to two or three floors in a building can be supposedly done by walking instead of using the elevators. Walking is a focal thing in this case. It demands commanding presence on us and connects our ends by this means. This is described as Borgmann's device paradigm [28]. This framework provides us insights in controlling this current mode of unsustainable production and consumption through reflective thinking on focal things. The distraction which potentially harms the environment, therefore, does not come from the device; rather it comes from how we think about them and our behavior that governs them.

Scholars also provide modern perspectives on technology. For instance, by describing a "good technology" we usually refer to it as novel, convenient and efficient [4]. Davison [11] identifies two ill-conceived misconceptions of technology which blinded us to see its role on our modern world: instrumentalism and determinism. Instrumentalism is the "*understanding of technology as a collection of neutral devices that exist as mere means to human ends and they may be put down any time we want*" [11]. This misconception underestimates the underlying truth of technology that as we shape it, it also shapes us. For example,

take the use of social networking sites as a form of entertainment. This technology fulfills its promise of entertaining us and connecting us with our peers. In this process, our personal information and privacy are deliberately waived in the form of presenting to the open public who we are and what we are doing. Furthermore, many could not get themselves off to these sites by paying so much time looking photos of our peers or hearing their updates. As a result, work productivity is at stake. Thus, this technology shapes our lives into something what we want to manifest. Determinism, on the other hand, regards technology as independent of human intention [4, 11]. Modern technological theorists suggest that resisting technological progress is not possible in this modern time. This misconception takes out human input in the process of developing technology. The alluring form of technology makes human attracted to it and through this misconception, we are then placed into a situation where we could hardly control its development.

4 WEAK AND STRONG SUSTAINABILITY

In this section, we attempt to evaluate how technological development could provide solutions to unsustainability. Most practitioners of sustainable development have one focal point in common, though they have diverse meanings on sustainability. They claim that there is an inconsistency between what is demanded on Earth and what the Earth is capable of supplying of [12]. Thus, what we need is a set of solutions which either decreases our demands on Earth (demand-side sustainability) or increase its supply to offset the demand (supply-side sustainability) in the form of development of renewable energy source, for instance. Through this modern economic system, our demands are often converted in a form of a technology using the natural resources of the environment. Since Earth's supply is finite, it is not possible to exhaust these resources whenever we want. This inconsistency of demands on and supply of the Earth has brought diverse and contested discourses on sustainability.

There are two groups of sustainability enthusiasts that can be drawn out from these two possible approaches of sustainable development: weak sustainability and strong sustainability [12]. The former holds that in order to promote sustainability, Earth's supply must be increased using further development of solutions using human intelligence in the form of technology. It also holds that any problems that will arise can be solved using technological development. In this view, the current technological development and demands on Earth do not necessarily require fundamental change. What is needed is to provide environmental management agencies, efficient use of resources, expanded use of renewable energy, taking into account environmental costs. The difficult part of this view is to hold that nature is merely a collection of natural resources that can be used by humans [12]. Strong sustainability, on the other hand, holds that Earth is finite and argues that no habitable future is possible unless the demands on Earth are altered by reviewing our views on nature and development. Holders of this view prevail that the notion of weak sustainability is on "sustaining development" rather than sustaining the environment and ecosystems. Strong development theorists propose that the demands on Earth should be reduced by making ourselves self-reliant [12]. This holds that we should rethink all our desires of efficiency and comfort by putting into consideration the use of Earth's natural resources. For instance, those working in highly urbanized areas usually use thread mills to support their desires of a healthy body. In a form of technological device, this desire of sustaining human health is supported, without realizing the potential damage and natural resource depletion brought about by production and use of these thread mills which could have been equally achieved by running in a park or a hill.

Now, where are we in these two sustainability stances? According to Brundtland [10], "*sustainable development is the development that meets the needs of the present without comprising the ability of future generations to meet their own needs*". This is considered as the most satisfying definition by economists since it does not promote a "zero growth" while maintaining sustainability [29]. However, the definition implies two forms of capital, namely: inter-generational capital and intra-generational capital. Note that the term capital here represents two forms. One is the natural capital and the other is a man-made capital in the form of technology. The definition applies the word "development" which means here that there must be no "non-diminishing level of transformation from one generation to the other generation" [29]. This suggests that the present generation can use more natural resources today provided that this must be substituted with a corresponding technology – a man-made capital. This implies that there is no issue when future generations use fewer natural resources provided that man-made capital suffices their needs. It also holds that if present generation can provide new technological innovation to minimize the need of future generations on the use of natural resources, then we are still complying with the requirements of sustainable development. Daly [30], however, highlights the problem of what is the proper mix of man-made and natural capital, which in turn raises

the question of whether man-made and natural capital are substitutes or complements in production.

Following this view, our concept today on sustainable development thus lies mostly on weak sustainability. The evidence of this claim is the use of cleaner production technologies in manufacturing processes, more research and development activities in biofuels and renewable energy, expanding more researches in eco-efficiency, etc. These approaches truly comply with the definition of the United Nations World Commission on Environment and Development in 1987. We are expanding our supply of resources; substituting natural source with a man-made source. We are using more technologies to correct the harmful effects of previous technologies. However, this pattern has some drawbacks. For instance, Binswanger [31] claims that resource-saving or energy-saving technological progress is not sufficient to make the economy sustainable because of the induced feedback in energy or resource demand. This implies that as we develop more clean and eco-efficient technologies, there exist a feedback component to the environment which is ultimately undesirable.

5 DISCUSSION AND CONCLUSION

In this work, we have presented a framework on how technology development be directed in order to support sustainable development using Borgmann's [28] device paradigm. Building upon this framework, Davison [11] suggests that one must consult first his fears and the moral questions underlying the development and use of technology. While we are stunned by the perceived benefits of such technologies, we fail to realize that we promote the culture of materialism - collecting devices and keeping in touch with their latest advancements. Modern technologies transform our lives of consumerism without first consulting ourselves with the destruction it may bring forth to the environment and how it will affect our lives and the focal things around us.

The current trend of sustainable development implies a weak sustainability stance. The substitution of natural resources into man-made capital for future generations seems to equate technology with the natural resource. One must realize that technology is discontinuous and does not provide us perfect solutions. Ultimately, they will be replaced by new emerging technologies and this cycle goes on. Technology depreciates both on its economic value and on its aesthetics. Equating technology with natural capital tends to reduce entire situation into an optimal allocation problem. This problem will just seek which of the two capitals will have a return of greater value. In this case, the concept of sustainable development becomes redundant. For instance, if greater value will result from transforming all environmental resources into technological forms, does it mean to say that future generations must enjoy man-made capital? There must be a balance on strong and weak sustainability approaches in this regard. The choice of technological development to pursue can provide us insights on this balance. It is beneficial to have a fundamental reform on our present contentions on sustainable development. The recent trajectory of technological development is faster than how we review them in their environmental and social contexts.

It is shown that the current mode of sustainable development today leads us to a realization that technology is used as substitute to support the depleted natural resources. The fundamental change must first be seen on our own personal perspectives through contemplation on the moral questions embodied with our technologies at hand. Second, we should redefine our current discussions on sustainable development in order to settle issues on equivalence of technology and natural resource. Finally, we should provide a framework on which technologies to be prioritized so that we are not sustaining the current development but sustaining the environment and its ecosystems.

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