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A REVIEW OF TECHONOLOGICAL CHANGE AND SUSTAINABLE DEVELOPMENT

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ABSTRACT

The transfer of technology from advanced countries to emerging economies constitutes one of the fundamental ways to pursue progress towards convergence between the two economies in terms of standards of living. The present paper discusses the existing theoretical considerations on sustainability assessments as tuned for a similar exercise on NAMAs by reviewing the relevant literature pertaining to the two bodies of knowledge. The purpose of this paper is to present a comprehensive review of the literature and develop a novel framework in order to tackle the barriers and challenges to operationalize and monitor the implementation of the SDGs.

1. INTRODUCION

The concept of Sustainable Development (SD) was historically coined by the United Nations Commission on Environment and Development's (Brundtland Commission) report, in a document entitled Our Common Future. This concept advocates that development must be planned in order to "meet the necessities of the present generation without harming the future generation's capacity to meet their own" (Brundtland et al., 1987). However, according to Govindan et al. (2013), one of the main challenges for sustainability is to operationalize the resolutions of the Brundtland Commission in order to guide organizational decisions. The current concepts of SD are increasingly more important than they were two decades ago, due to it spanning beyond strictly environmental, economic and social development concerns, towards impacting people's very survival (Kumi et al., 2014). In this context, there is a need for science to serve politics, as well as dealing with the government's and multiple shareholders' requests when they are met with the challenge of attaining sustainable development (Aric_o, 2014).

In the Rioþ20 United Nations Summit of 2012, the idea of creating the SDGs emerged, in which members of states agreed to adopt a set of guidelines towards global development in order to increase the baseline for developing countries and poorer populations (Gupta and Vegelin, 2016), as well as to build a stronger commitment towards people-centered development, human rights, and environmental sustainability (Jayasooria, 2016).

The persisting contradictions between a better life created and supported by technology for the wealthy few, and

increasing environmental degradation and persistent poverty for the vast majority call for a deeper exploration and understanding of the nature of technology and its relationship to society, especially to a sustainable society. In the context of the effort to catalyze a *Great Transition* to a sustainable global society, in which deep changes in culture, values, consumption patterns, governance, business, and institutions are envisaged (Raskin et al., 2002), questions about the role of technology become even more pressing. For example, would a *Great Transition* society require an intensive use of technology to abate the environmental degradation of the ecosphere, or might technology play a much more modest role in such a society? Would that society essentially return to the time before the first industrial revolution when technology offered a limited, incremental extension of human capacity to transform nature? In either of these visions, we must ask how to imagine the development of technologically and economically underdeveloped countries.

In recent years, technology transfer from advanced economies has been put forward as one of the fundamental pillars on which to base the search for alternative routes leading to economic growth in emerging economies, including those of Latin America, through sustainable development. Experience has shown that often the technology transferred and used by transnational companies in emerging economies has caused significant negative externalities in these countries. Nevertheless, on occasion it is these very transnational companies which, given the pressure exerted upon them by the "reputation" factor in a globalized world, aim to be pioneers in the defence of the environment. The focus of this study, however, is not on whether the current path taken by technology transfer is the most appropriate one or the best suited to the interests of emerging economies. Nor do we intended to look in depth at the implications that the globalization of technology could have for these countries. The clear need for emerging economies to obtain new technologies enabling them to increase the yield obtained from their resources is an essential part of the search for an adequate development strategy. Nevertheless, to ensure that this development can be sustained over time, other factors need to be present in addition to the simple transfer of a technology from one place on the planet to another. Numerous Latin American researchers in the social sciences (Caponi and Díaz, 1999; Busso, 1997) have maintained that the path emerging economies should follow in the quest for development is not necessarily the same one as that which was followed by today's advanced economies as they developed. It does not seem to be essential to take a mimetic approach in the field of technology and production in order to achieve a more prosperous economy.The technological innovation system in Latin America underwent a profound change in the nineties. Greater openness, deregulation, privatization of certain productive activities, led many state-owned companies that had set up major R&D and engineering departments during the preceding import-substitution phase in the fifties and sixties to

reduce the scale of these operations after privatization (Katz, 1999). This process has led Latin American economies towards a development model that is less intensive in national R&D and is more dependent on technology "packages" from abroad. Nevertheless, in the case of public and private companies, this technology transfer from abroad often comes up against a somewhat unfavourable environment. Among the key factors identified in various studies (Steenhuis and Bruijn, 2001; Guerin, 2001) as being able to facilitate or hinder the appropriate adoption of technologies by emerging economies, the following stand out: the availability of domestic financial resources; the degree of skills and training of the workforce; import regulations; the quality and quantity of local supplies of inputs; the delivery times of the inputs; basic infrastructure; working conditions; cultural attitudes, etc. Unfortunately, in many emerging economies the behaviour of these factors tends to limit rather than promote technological innovation.

2. PROBLEMS IN THE DIFFUSION OF ENVIRONMENTALLY SUSTAINABLE TECHNOLOGIES

It would seem to be clear that in order to achieve greater environmental quality without limiting productive activity, an effort needs to be made to promote innovation in sustainable technologies. There are numerous economic models which try to evaluate the impact that different environmental policies have on promoting *innovation* aimed at pollution control. Chapter 2 of Kemp (1997), contains an extensive review of these models.

However, there is a growing consensus on the potential for environmental improvement that may be achieved by the *diffusion* of existing sustainable technologies, in particular in terms of greater energy efficiency and the associated reduction in the emissions generated by the use of fossil fuels. Some of the conclusive empirical studies conducted in this field are included in the papers by DeCanio (1998), Krause (1996), and Lovins (1991); or the reports of the *Union of Concerned Scientists and Tellus Institute* (1998), *Interlaboratory Working Group* (1997), *Alliance to Save Energy et al.* (1997), and Sant (1979).

If we accept the validity of these studies, it could be asked what factors limit or hinder the rate of diffusion of these technologies. A second question is to what extent these factors are related to failures of the energy and associated equipment market (Jaffe and Stavins, 1994). To the extent that market failures are responsible, the effectiveness of traditional policies intended to promote the adoption of such technologies by means of economic incentives is placed in doubt. Instead, measures aimed at correcting market failures would appear to be more appropriate.

According to Jaffe *et al.* (2000), the main market failures that can affect the rate and direction of technological diffusion include, in particular:

i) *problems of information* – information being a public good which is not always supplied by the markets. This is an important factor, in that the adoption of a technology by a number of users constitutes of itself an important source for the transfer

of information to other participants, in the form of a positive externality;
ii) *agency problems*, which are also related to imperfect information, may be internal or external to organizations; iii) *Other market imperfections,* such as the difficulty small businesses may experience in accessing the finance required to purchase new technologies, or the barriers to the import of foreign products which may be carriers of technology (Reppelin-Hill, 1999).

There are current obstacles when it comes to the way in which the science is conceived and relates to education that hinder interdisciplinarity. The emerging field in the science of sustainability tries to, among other things, clarify how "a new generation of science" could be conceived in order to promote more integrated ways of thinking to tackle complex matters in society (Aric_o, 2014). According to Kumi et al. (2014), the principles of a neoliberal economic agenda such as mercantilization, deregulation, privatization and various cuts in public spending, may somewhat hamper sustainable development by increasing poverty and inequality. Kumi et al. (2014) also suggest that the economic theories of neoliberalism would have implications for the SDGs, and would come to be part of a cardinal agenda that would guide social, economic and development intervention in the coming fifteen years. Further, provisions for the implementations of the SDGs in the UN Member-States were not elaborated in detail during the negotiation stage of the principles of national sovereignty and subsidiarity. As a result of Agenda 2030 being so broad and extensive, it is harder to define implementation and eventual responsibility processes (Persson et al., 2016).

Moreover, a landscape approach theory - an integrated and multifold strategy which aims to bring together several actors and sectors which transcend the traditional management limits – remains incomplete, and the obstacles to its implementation persist (Reed et al., 2016). According to Koehler (2016), with regards to gender inequality policies amongst other types of inequality, the SDGs are modest, and display no consistency. This is mainly due to the fact that political proposals concerning gender and climate justice are often sparse, gradual and fragmented.

As Van Vuuren et al. (2014) state, there seems to be a huge gap between the conception of a long-term goal and the current shortterm policies implemented by political representatives. Challenging scenarios force political decision-makers to employ different combinations of technological and consumption change measures in order to achieve the desired set of goals for sustainability. It is important for them to show that marginal improvement will not be sufficient to achieve a set of goals in sustainable development, because in order to achieve these goals, transformative change is required (Van Vuuren et al., 2014).Through the analysis of risks and obstacles when it comes to the development of renewable energy in Camar~oes, Mboumboue and Njomo (2016) have identified that corruption and bureaucratic red tape were the main obstacles to the implementation of renewable energy, hampering SD as well as environmental protection. Despite this, Mboumboue and

Njomo suggest that resources must be explored at an optimal level, so as to improve life quality for all and have a positive impact on society in general. Cooperation between sectors, so necessary to achieve synergy in well-being goals, is a distinct challenge. The potential combination of private interests, mechanisms for blaming weaker links, and the lack of transparency mean that these objectives may be implemented without balancing the needs of the natural environment with other well-being objectives (Waage et al., 2015). As far as resources are concerned, the UN system has made provisions for substantial financial support by means of the Sustainable Development Goals' Fund. This has been set-up with the aim of supporting projects, but many organisations encounter problems, especially the lack of specific details on how to submit project ideas and access support.

3. LITERATURE REVIEW

The SDGs represented a top-down approach designed by the political elite based on the objectives created during the United Nations' summits and by conferences in the 90's (Brolan et al., 2014). However, according to Sachs (2012), the path to SD should not follow a top-down approach, and should rather follow a highlypowered problem resolution network which involves universities, companies, NGOs, governments, and - most importantly – the young people of the world. Young people are those who will become the specialists and leaders of a new and deeply challenging age.

Kumi et al. (2014) outlined at least three important matters which should guide operational policies which follow the SDGs: a change of the conventional approach when it comes to poor people from pro-growth to pro-poverty growth; the necessity of taking equity seriously, and lastly, the necessity of tackling power relations and giving poorer people a voice. According to the suggestions of Jayasooria (2016), the global SDG agenda provides Social Workers an opportunity to redefine their relative role to become people of empowerment, socialeconomic development, human rights and the environment. It also creates a positive and holistic intervention framework for practice, allowing SocialWorkers to utilize this approach based on a worldwide commitment during the entirety of the 2030 agenda. The SDGs will provide a wider framework to tackle the concerns of the Bottom 40 group of the socioeconomic gap (B40), ensuring not only equality of access, but also equal results (Jayasooria, 2016). In summary, the objectives of raising the baseline must be complemented by a reduction at the top of the socioeconomic spectrum (Gupta and Vegelin, 2016).

According to Stafford-Smith et al. (2016), more attention must be given to the interconnections between the objectives in three main areas: sectors, agents and countries. Similarly, more consideration ought to be given to time intervals, in order to obtain a systematic overview and an integrated approach for the implementation of the SDGs, ultimately striving for an integrated agenda. Based on science's global perspective and on the practice of sustainability presented by Future Earth, in order to improve these connections, they must encompass seven UN categories of

implementation means in 17 SDGs: finances; technology; qualification; political integrity; partnerships; and finally; data, monitoring and accountability.

Furthermore, Stafford-Smith et al. (2016) suggest seven recommendations that countries must ensure a commitment to: C Legislative and regulatory incentives to the "patient capital" - investment and capital which measures payback throughout decades - particularly in low-income countries; C A partnership approach among countries with lower revenue and resources availability with those with larger ones, in order to co-produce knowledge, technology and processes for sustainability; C A commitment to incorporate systematic thought through all levels of education;

C Integrated SD plans which reinforce ties between fragmented sectors and promote political integrity; C Political leadership on SD, for example in the higher branches of government, such as the President/Prime Minister level as well as high up in the hierarchy of the Executive Branch; C Indicators for integrated SDGs, supported by "essential SD variables" as a common report standard which stimulates or demands that agents work together.

To Stevens and Kanie (2016), the SDGs represent a different approach, and, in order to unfold the global governance practices which may contribute towards a transformation towards sustainability, it is essential to analyze the decision-making processes and the transformative ideas which are captured in these decisions. Therefore, the potential of the SDGs to transform the dominant governance approaches to sustainability remains a significant matter to be addressed (Stevens and Kanie, 2016). Moreover, the assessment of the SDGs is an essential task for the UN and for its member States, and the production and use of quality data is being increasingly recognized as an essential task for the assessment, monitoring and tracking of SDGs. (Choi et al., 2016).

The biggest challenge today is to guarantee an economic development which allows the underprivileged to escape poverty without dooming future generations to an environment which is even more degraded than the current one (Mboumboue and Njomo, 2016).

4. SOCIETAL CONSEQUENCES OF TECHNOLOGICAL DEVELOPMENTS

Seventeenth-century thinkers such as Descartes and Bacon thought that science and technology unlocked the keys to mankind's mastery over nature, which they saw as synonymous with human progress. Since the Enlightenment, the development of modern science and technology has been associated with the triumph of reason and science over superstition and religion. Knowledge based on empirical observations and rational thinking has been the basis on which technological innovation has thrived. Modernization and modernity have been synonymous with technological innovation.

The idea that science reflects reality or even absolute truth has been challenged in many ways, from critics of its reductionism to critics who emphasize that scientific facts are as much socially constructed as a reflection of natural laws (Latour and Woolgar, 1979). In *The Structure of Scientific Revolutions*, in which he argued that theories and facts have only meaning

within a dominant "paradigm", Kuhn (1962) laid the groundwork for challenging logical positivism. Latour and Woolgar (1979) followed by showing in an anthropological study of the modern scientific lab, how scientific facts are "socially constructed" through interpretations by scientists of scientific measurements. Thus, the myth of the "objective scientific fact" was challenged and demystified. This work was followed by the demystification of technology by the SCOT (Social Construction of Technology) theory (Pinch and Bijker, 1987; Bijker, 1995) The idea that technology could have unwanted or unintended consequences is also relatively new. Although the Luddities of the early nineteenth century smashed the machines that were seen as a threat to their employment, and the Romantics decried the dehumanizing march of industrialization, more widespread anxiety about and resistance to technology did not emerge until the mid-1900s. The unprecedented destruction unleashed by the atomic bombing of Hiroshima and Nagasaki spurred many people to question the nature of the individual scientist's ethical responsibility. To what extent is the scientist accountable and responsible for unwanted and often unforeseen consequences of his/her work? From that moment, the assumption of a self-evident linkage between societal progress and technological innovation has been questioned (Carson, 1962).Technology came under increasing scrutiny as a result of the use of Agent Orange during the Vietnam War and the persistence of dioxin contamination and birth defects among U.S. service members and the Vietnamese thereafter. Next came the protests against nuclear energy and the possible health consequences of low doses of radiation from nuclear testing, uranium mining, and nuclear waste. Other environmental and health problems followed: the consequences of air pollution, soil pollution, and water pollution on health, safety, and the environment; the accumulation of DDT, heavy metals, and PCBs in the food chain and in the reproductive organs of animals and humans. With the increase of biochemical knowledge—the possibilities of manipulation of the DNA of microbes, plants, and animals—new hazards were created: man-made mutations and pathogens that created new risks for health, safety, and the environment. The nuclear, biological, and chemical arms race of course contributed to these anxieties. Early questions addressed not only the individual social and ethical responsibility of scientists, but also the structural and even cultural connections between modern science and technology and the economic and political systems. President Eisenhower coined the term "military-industrial complex" to describe the close relationship between the Pentagon and the corporate defense industries and the Cold War ideology, which was used to increase demand for new weapons systems and armaments—a perpetual wartime economy. But the basic alliance between corporations and technology emerged much earlier, in the late nineteenth century when the large chemical, electrical, and automobile companies were created, mainly in the USA and Germany.

Technology and the military merged on a large scale in the Manhattan Project and in the nuclear arms race after the Second World War. Since then, information, communication, biotechnology, energy technology, and medical technology have all developed in "complexes" consisting of universities, large industrial firms and their R&D laboratories, small spin-off firms, and military research and development facilities. Financing is provided by a combination of military and business funding. At least in the "developed" world, citizens benefited from this unprecedented acceleration of innovation, which produced a surge of new products such as radio and color TV, microwave ovens and innovative cars, new medicines and medical technologies, computers and the Internet, and airplanes to take affluent consumers to holiday resorts.

5. INNOVATIVE SOLUTIONS

According to Koehler (2016), by establishing creative connections between goals and targets, there is room for discrete political evolution. The ideas collected in the SDG agenda, along with soft laws - and especially the ICPD Programme of Action (International Conference on Population and Development) - could serve as an inventory for the formulation of sensitive policy towards gender and climate.

The 193 different governments' commitment, which adopted the 2030 Agenda and the SDGs, needs to be solidified, and it must be done in a creative manner, unifying the policies which can be extracted from the resolution itself, as well as from the set of human rights texts. Further, it must be done subversively (Koehler, 2016).

According to Gellers (2016), crowdsourcing is a new and underestimated method of global civil engagement which provides the means to expand participation in an agenda-defining process and in the development of policy. This can be done in a fashion which is quicker and more inclusive than was possible at any other point of human history.

As an attempt to systematize the ways the SDGs are pursued in higher education, the Hamburg University of Applied Sciences in Germany set-up the World Sustainable Development Research and Transfer Centre (WSD-RTC) (https://www.haw-hamburg.de/en/ftznk/ programmes/wsd-rtc.html). WSD-RTC is a multi-stakeholder, academic based research and transfer centre, which congregates the best available knowledge and technologies on sustainable development, in support of the implementation of the SDGs. The philosophy of WSD-RTC is that the holistic implementation of sustainability measures requires not only political decisionmaking, but also concrete research, capacity-building and technology transfer, as well as improved collaboration and information and data exchanges among institutions. It is important that the SDGs explore new paths towards sustainability. The world needs innovative approaches, methods, technologies and new manners of organizing human activity in order to combine life-improvement standards with ecological imperatives (Sachs, 2012).Aggregated and reliable indicators According to Sachs (2012), the SDGs must include precise, timely and available data to managers, political decision-makers and the public at large. Malik et al. (2015) noted that the SDGs

must be "aspirational, universal, communicable and measurable", and must establish the cornerstones for other countries to achieve the global goals between 2015 and 2030. H_ak et al. (2016) state that the indicator framework for the SDGs needs more intense conceptual and methodological work, instead of just producing new social, economic and environmental statistics. More global, integrated and scientifically based information is needed when it comes to SD.

Costanza et al. (2016) highlight that it is necessary to develop aggregate indicators which can evaluate the relative contribution of each SDG and their interaction with each other, in order to evaluate general progress and develop a framework of political reform and social change. This would aid in achieving the SDGs at a national and global level. The achievement of the SDGs needs to be evaluated and followed by goals and indicators, and all of them must be carefully analyzed by specialist scientists in order to reinforce a widely overlooked indicator, which has particular relevance (H_ak et al., 2016).

CONCLUSIONS

In this section, we have developed some future visions of sustainable and more equitable *Great Transition* societies in which technology plays an important, but not dominant, role. We have assumed that technological developments have been fast, but well-monitored and controlled, and that during their development, the "right" decisions have been made as to the direction of their development. As this article has demonstrated, the accomplishment of the Sustainable Development Goals and the targets outlined in "Transforming Our World: The 2030 Agenda for Sustainable Development" is not an easy task. Apart from a review of the literature on the topic, this research presents a novel framework which could help policy-makers, project developers and professionals tackle sustainability challenges. Its implementation will ensure significant contributions towards the achievement of the sdgs.

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