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**Commentary**

# ECOLOGICAL PERSPECTIVES IN TECHNOLOGICAL DIFFUSION IN DEVELOPING COUNTRIES: A SUSTAINABLE APPROACH

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## ABSTRACT

A review is written on the ecological perspectives in technological diffusion in developing countries using a sustainable approach. Although technology diffusion is the process by which innovations are adopted by a population or economy, some technological products have been kept at bay due to safety and ethical considerations. The article discusses succinctly, the ecological perspectives in major technological diffusion, their local and global impacts and concludes that there is the need for biosafety programmes that would serve as a guide for technology diffusion in order to sustainably manage the overwhelming effects of technological products after adoption in developing countries.

**Keywords**: Ecology, Technology diffusion, Developing countries, Sustainable development, Ethics, Biosafety.

## INTRODUCTION

Technology diffusion can be defined as the process by which innovations are adopted by a population (PHM, 2015). From the perspective of economic growth and development, technological diffusion is the process by which innovations (whether be it new products, new processes or new management methods) spread within and across economies (World Bank, 2008; Stoneman, 2015). Technology diffusion involves the dissemination of technical information and know-how and the subsequent adoption of new technologies and techniques by users that embodies diverse products and processes (Tassey, 1992; Rogers, 2003). Classic models of technological development suggest a simple linear path from basic research and development to technology's commercialization and adoption, however, in practice technology diffusion is more often a complex and rhythmic process (Edquist and Jacobsson, 1991). Technology can diffuse in multiple ways and with significant variations, depending on the particular technology, across time, over space, and between different industries and enterprises (Shapira and Rosenfeld, 1996). Whether diffusion occurs and the rate at which it occurs is dependent on several factors including the nature and quality of the innovation, how information about the innovation is communicated, and the characteristics of the population into which it is introduced (PHM, 2015).

Throughout the developed industrial economies and increasingly in developing industrial countries like Nigeria, there has been a great increase in recent years in policy and programme initiatives to promote the diffusion of technology (Shapira and Rosenfeld, 1996). The effective utilization of technology has been associated with industrial competitiveness, productivity and efficiency, economic development, business growth, business flexibility, quality, the maintenance of high-wage jobs, and the propulsion of further feats of innovation (Edquist and Jacobsson, 1991). Attention has been paid not only to specific policy measures that might accelerate technology diffusion and tighten links between technology developers and users, but also to the creation of models and nurturing of supportive systems and infrastructures for technology diffusion (Comin and Hobijn 2008).

Although new technologies take the form of new production processes, new tools, and new and higher quality goods and services, potential ecological impacts on the environment have often been ignored (Rogers, 2003). Such ecological impacts often have deleterious effects on humans and the environment both in the short-term and long-term durations. Hence, there is the need to explore such impacts with a view of mitigating them. The aim of this article therefore is to discuss the ecological perspectives associated with technological diffusion in developing countries.

### Ecological perspectives on major aspects of technological diffusion

The ecological perspectives associated with technological diffusion can be grouped into innovative concerns for biotechnology products and core-technological products.

### Biotechnology products

Under this category are genetically engineered crops and animals also known as genetically engineered foods. Through bioengineering techniques such as the selective breeding of plants and animals, hybridization which involves reproduction between different strains or species and recombinant

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deoxyribonucleic acid (DNA), genetically modified organisms can be created and possibly patented (Microsoft Encarta, 2008). However, environmental concerns about the deleterious effects of these organisms and their products on the ecosystem have lead to widespread bans and restrictions in most countries thereby restricting their technological diffusion impact. For instance, in early 2000, 130 countries devised the Protocol of Biosafety, which was formally approved in June 2003 (Chosewood and Wilson, 2007). This treaty requires exporting nations to notify importers when products contain genetically modified organisms, including seeds, food crops, cattle, and fruit trees.

Although already addressed, concerns had been raised in some cultures in the past about some vaccines possibly having long-term negative impacts on the reproductive ability to procreate in some developing countries. These bioethical issues have contributed in large measure in the diffusion of many technological innovations.

**Core-technological products**

For the purpose of this article, core-technological products are hereby categorized into most recent products such as personal computers, cellphones, MRIs and internet; and older technological products like planes, trucks, cars, electricity, railway and ships. There has been rapid technological diffusion of the most recent technological products listed above with the outfall of highly toxic electronic wastes (e-wastes) due to limited capabilities in recycling and reuse technology in most developing countries (Don-Pedro, 2009) . Such electronic wastes (e-wastes) consist of discarded television sets, cell phones, computers and other electrical and electronic devices (Miller and Spoolman, 2010). E-waste is a source of toxic and hazardous pollutants that may include polyvinyl chloride (PVC), brominated flame retardants, lead, cadmium and mercury. E-wastes have the potential of contaminating air, surface water and groundwater, as well as soil which can adversely affect animal and human health leading to early deaths of those exposed to the toxic substances (Tyokumbur, 2010a,b). This is particularly a major problem in big cities where these e-wastes are disposed of in waste dumps and landfills very often through incineration that gives off a plethora toxic gases that includes PCBs (Polychlorinated biphenyls), dioxins and polycyclic aromatic hydrocarbons (PAH) which may act as a mutagen (gene distorter), carcinogen (cancer-causing agent) or teratogen in living tissues and organs.

Older technological products like planes, trucks, cars, railway and ships are well known for their active and passive roles in climate change through the emission of the greenhouse gas carbon dioxide. This is because the engines of these technological products consume cheap fossil fuels. Although lately, there has been a great effort in shifting towards biofuels and renewable energy sources, it will take some time before major shifts are attained.

In a review by Tyokumbur (2015) on potential ecological effects of onshore and offshore wind farms for electricity generation in Nigeria, the major constraints and benefits of adopting the technology were succinctly discussed as it affects the human environment. The article concluded that potential impacts of wind farms are diverse and in order to implement, install and mitigate the effects on the ecosystem in developing countries with limited capacities, a broad-based approach has to be used that will involve ecologists, wind energy engineers, policy makers and other relevant professionals.

As a result of climate change, there has being a growing consensus in scientific literature that in the coming decades the world will witness higher temperatures and changing rainfall patterns and levels (Tyokumbur, 2014). The major effect of this will be low agricultural products yield as evidenced in many countries (IPCC, 2007; Deressa and Hassan, 2010). This is particularly true in low-income countries, where weather is the primary determinant of agricultural productivity and adaptive capacity is very low (Apata *et al.,* 2009). Many African countries, which have their economies largely based on weather-sensitive agricultural productions systems, are particularly vulnerable to climate change (Deressa *et al.,* 2008). It can therefore be asserted that the high efficiency in the technological diffusion of these older innovations have greatly affected the human environment in recent times.

Electricity is another older technological innovation that continued to evolve into more complex systems that impacts the ecosystem through its rapid diffusion. More traditional ways of generating electricity through hydroelectric power stations have had the impact of obstructing the migratory routes of some fishes that usually spawn upstream. Modern dam design nowadays include fish ladders or bypass to allow such fish species the freedom to move upstream and downstream of the water turbine infrastructure to breed and mature without interrupting their natural biological cycles (Tyokumbur, 2015).

The other electricity generating sources like nuclear and coal-fired power stations have remained environmentally controversial to be allowed to technologically diffuse to the shores of most developing countries due to the health threats posed by them to humans and the environment. Thus, they have been restricted through deliberate policy initiatives. For instance, radioactive wastes produced by nuclear power stations are hazardous because prolonged exposure to the emitted ionizing radiation often leads to adverse effects in living organisms especially humans causing mutations, cancers, organ malformations and sometimes instant death after exposure to very doses (Burgher and Hirschberg, 2008; Tyokumbur, 2010a). Some of the radioactive substances may persist in the environment over long periods of time depending on which radioactive isotopes are present. Although, proponents of nuclear energy contend that nuclear power is a sustainable energy source that reduces carbon emissions and increases energy security by decreasing dependence on fossil fuel sources, its generation of low-level and high-level radioactive wastes portends great danger to human health (Markandya and Wilkinson, 2007).

In addition, the ash that is left from coal-burning power plants has been shown to be highly toxic to man and the ecosystem. The burning of coal like other fossil fuels releases carbon dioxide into the atmosphere, which is the second

most abundant greenhouse gas in the atmosphere, after water vapour (Microsoft Encarta, 2008).

## CONCLUSION

Technology diffusion has greatly enhanced the quality of life globally and specifically in developing countries. However, safety, bioethical and environmental ethical considerations remain relevant in influencing the acquisition and use of some technological innovations, which must meet the cultural and developmental yearnings of developing countries. For instance, nuclear meltdown and impact of radiation to human health remain the greatest obstacles for the adoption of nuclear energy in most developing countries despite its relative efficiency. Perhaps emerging nuclear fusion technology presumed to be safer in contrast to the current fission technique remains the promising direction for the technology diffusion of nuclear energy in developing countries. Ecologically, renewable energy remains the best source of power supply. It can be concluded that there is the need for biosafety programmes that would serve as a guide for technology diffusion in order to sustainably manage the overwhelming effects of technological products after adoption. This overwhelming effect has been shown through the upsurge of electronic wastes (e-wastes) resulting from the influx of used, disused, non-serviceable and even new electronic and electrical products into the country without the requisite know-how for recycling and reusing them.

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