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Review of research on environmental impact of ICT and human rights bifurcation of Green ICTs

O. TURSUNOV, J. DOBROWOLSKI, J. SZPYTKO
AGH UNIVERSITY OF SCIENCE AND TECHNOLOGY, A. Mickiewicza Ave 30, PL 30 - 059 Krakow, Poland
EMAIL: obidtursunov@gmail.com

ABSTRACT
This paper attempts to provide a review of the recent and current state of the art of Information and Communication Technology (ICT) affects the environment and human rights bifurcation of green ICT's. The review has revealed that currently dominant approach is either a micro-level case study approach or a micro-level statistical approach. It is inferred that a more predictive and empirical model, which could be applied within a sector of society, ought to be more beneficial in the long term. Moreover, there is growing enthusiasm for the benefits of 'green' ICT's, but a general oversight among environmental activists and conscionable consumers, not to mention policymakers, is the assumption that usage of a product is the only segment of that item's lifecycle with environmental impacts. Post-disposal and re-manufacture challenges tend to be forgotten in state or corporate boosterism about 'green' technologies in telecommunications, with the costs being suffered by human beings and ecosystems far away from consumers. Consequently, human rights are at stake, with a conflict brewing among contemporary conceptions of human rights concerning development, telecommunications, telematics and environmental protection. AGH-UST Open University contributes to partnership in this field of experts and knowledge-based society.

Keywords: environment, ICT, human rights, recycling, consumers

1. Introduction

Virtualization of products (e.g. CDs to mp3s), dematerialization of transport (e.g. flights to teleconferencing), digitization of information (e.g. catalogues to websites), diminishing of warehouses/office spaces and shortening of supply chains are all, at first glance, positive impacts. In fact these developments can be seen as the catalyst to achieve integrated social development, economic growth and environment protection is the ultimate goal to sustainable development.

The information and communication technology (ICT) revolution may have not only positive but also negative impacts on the environment. This paper attempts to address this question, via a review of recent and current literature. To achieve this objective, the paper attempts to present a critical chronological summary of previous work. Journal papers, articles, project reports and websites produced so far are covered. Positive contributions, methodologies and limitations applied are covered, with an emphasis on various aspects such as energy consumption, transport, waste, pollution, material efficiency, etc.

A search of recent literature in telecommunications and telematics policy easily reveals blue-sky visions of the environmental benefits of 'green' information and communications technologies (ICTs). Contemporary research and development into wireless networks and nanotechnologies in personal communications devices herald dramatic improvements in sustainable production and energy efficiency. Policymakers in Europe have prognosticated that by 2020, green ICTs can foster a 15% reduction (equal to 7.8 billion tons) in greenhouse gas emissions through optimized freight transport, telecommuting/teleconferencing, reduced paper usage, and various categories of energy efficiency [1]. Advanced cellular telephone companies like Samsung and Motorola are

unveiling 'eco-friendly' phones that feature recycled materials and reduced power usage [2].

Despite this burgeoning enthusiasm for the benefits of green ICTs, a common supervision among conscientious consumers and environmental activists, not to mention policymakers, is the assumption that usage of a product is the only segment of that item's lifecycle with environmental impacts. A modern 'green' technology with a demonstrably positive impact on the environment (such as decreased power usage) may only be beneficial during its use by the consumer, and there are little-appreciated negative impacts during raw materials extraction and product disposal. Citizens and their leaders frequently overlook the impacts of these other segments of the item's lifecycle, specifically if those impacts are absorbed by ecosystems and peoples in other regions of the world.

Cellular handsets, smart phones, laptop computers, and other modern ICT devices require manufacturing with often and rare toxic minerals that must be extracted from the Earth, and often in an environmentally hazardous fashion in remote Third World locales. Meantime, rapid-moving technological innovations and expansionist state telecommunications policies inevitably lead to fast obsolescence in ICT devices. Accordingly, great quantities of such devices are discarded with those same toxic minerals extant. The usually noble endeavor of recycling becomes hazardous when retrieving these valuable and reusable substances – a task that is frequently handed to exploited workers in undeveloped nations. Non-recycled ICT devices can also cause serious toxic pollution problems at landfills.

These pre-manufacture challenges tend to be forgotten in the state or corporate boosterism surrounding not just ICTs in general but also 'green' ICTs. Human rights are at stake as well. The world's growing dependence on contemporary telecommunications devices and networks can be framed as a matter of both the human right to networked communications and the human right to a healthy environment – categories within the international human rights regime that are untested but growing in efficacy among activists. Particularly, environmental human rights, while seemingly unenforceable and esoteric, become an important issue when most of the world's nations are advocating ICT driven development as a matter of security and prosperity, with some doing the same for 'green' ICTs.

The most significant for modern society is active contribution in trans-disciplinary cooperation of experts focused on more efficient prevention against different environmental risk factors of incurable diseases of civilization as well as congenital malformations, cancer and leukemia incidence [3-5].The are new methods useful both for early detection of environmental risk factors including application of artificial intelligence, cell monitoring of elements as well as integration of human ecology, sustainable design of indoor environment as well as eco-toxicology and innovative biotechnology for better prevention against health hazard for consumers [4-8].

2. Environmental impact of ICT

Heinonen et al. described a concept which they termed Information Society Assessment (ISA) in a paper published in 2001, entitled The ecological transparency of the information society. The Fifth Framework Program of the European Union had largely replaced the terms 'information and communication technologies' and 'telematics' with the broader term: Information Society Technologies (IST). Thus proposed ISA as an assessment tool to examine activities and approaches, to evaluate the implications of IST. They developed a few criteria, scenarios and indicators as tools for identifying various environmental impacts inherent in the information society. They also proposed that differences among countries could be considerable, so they felt that the establishment of reliable and internationally comparable data required analysis, monitoring, treatment and checking on a continuous basis. Heinonen et al. also made what they considered to be a critical point, i.e. that indicators were only a tool for evaluation, linking the indicators more closely to the established purposes and commitments was the ultimate challenge [9].

In 2003, a group of researchers attempted to model the costs and benefits of policies to manage 'e-waste'. They focused on a large component of the electronic waste stream, computer monitors. Environmental concerns in this matter were associated with disposal of the lead embodied in cathode ray tubes (CRTs) used in many monitors. It was revealed that the benefits of avoiding possible negative health effects associated with CRT disposal appeared far outweighed by the costs, for a wide range of policies. This study suggested Computer Monitor Policy Simulation, or COMPS, allocated retired CRTs across the various end of life (EOL) discard options based on a cost minimization algorithm. The algorithm precisely accounted for the heterogeneity of the costs connected with each of the different options for different classes of CRT users [10].

In 2006, Hilty et al. published a paper entitled 'The relevance of information and communication technologies for environmental sustainability - A prospective simulation study'. The summary of the principal results of the project accredited by the Institute for Prospective Technological Studies (IPTS) of the European Commission [11]. In the simulation study described in this article, they modelled all known relevant effects on all three levels applying a System Dynamics approach in combination with expert consultations and scenario techniques. Nevertheless, they felt that some limitations of System Dynamics became apparent during the project. They indicated that the results should not be interpreted as forecasts of the development of the environmental indicators, because their stark values in 2020 greatly depend on the three scenarios chosen and on majority uncertain model parameters. Therefore they believed that this project contributed to the common understanding of the environmental impacts of ICT and provided a useful basis for policy-making in the fields of environment and ICT.

2.1. Methodologies for impact of ICT on environmental sustainability

As the major methodology used by the IPTS project — Impact of ICT on Environmental Sustainability, scenarios are qualitative planning and communication tools rather than predictive tools. The project proposed that scenarios were particularly well suited to this area of research since they precisely acknowledged the uncertainty and complexity that characterized any assessment

of the relationship between the development of ICT and environmental sustainability in 2020. It aimed to provide policy-makers and other decision-makers with numerious perspectives on key areas of uncertainty and allow them to develop robust strategies that could deal with multiple outcomes [12]. As we as applied in Digital Futures project as the main methodology, scenarios were considered as communication and planning tools to explore complex, uncertain and sometimes disputed futures.

Life cycle assessment (LCA), being one of the most traditional methods and systematic approach to measure the impacts of particular products/services on the environment, in terms of the energy, raw materials consumption, and final waste in the complete process of production, transport, delivery, consuming and disposal, etc., is the most favorable methodology in assessing the environmental impact of ICT in academics. Considering the experiences of researchers in applying this method and long established history, LCA is so far the most reliable method, too. However, due to the complicated nature of the ICT technology, it is rather complicated to define the boundary of the life cycle and the unrecognized/uncertain factors involved. Numerous studies are based on quite a few assumptions, bounded in certain narrow field and lack generic application to other sectors [13].

Frey and his colleagues discussed whether the Ecological Footprint methodology could be applied to electronic products. The Ecological Footprint (EF) methodology, developed by Wackernagel and Rees, has often been suggested as a sustainability indicator for the human impact on earth. EFs, expressed as area, sum up the complete productive area of land and water ecosystems required to sustain the resources, wastes, and emissions of a population wherever that land may be located. Thereby, EFs can be established on a global or other geographic level. Frey et al. proposed that the Ecological Footprint could not compete with other assessment tools, but should rather be seen complementary [14].

Utilizing Geographical Information System (GIS) in identifying the environmental impacts of e-commerce or comparing the online system with the traditional system. GIS is particularly good at route planning in the home delivery in the e-commerce system from the author's point of view, such as how to optimize the route for online deliveries within a geographic area in order to minimize the frequency of delivery and fuel usage, etc. Some industries have started implementing and designing the more systematic GIS based Intelligent Transport System (ITS) for freight transport and to refine the overall supply chain system. The potential of this tool for decoupling the environmental impacts remains to be seen and further researched [15].

3. Environmental issues in ICT recycling

According to a European researcher in green computing, 'ICT is becoming an increasingly essential component of the world's energy consumption, carbon emissions, and waste stream' [16]. The ICT sector creates what can be more than its fair share of toxic waste. In addition to the hazards caused by raw materials, quick technological advancement in the industry results in devices being discarded long before the end of their useful lives. The same can happen due to government policy decisions (or non-decisions) as well.

Cellular telephone handsets, at least in developed nations, are basically discarded after two years or less even though the average modern handset has been constructed to remain operational for ten years or more [17]. The initial reason for this inefficiency is the structure of service plans by leading cellular firms. For instance, the typical service plan in the United States requires that the customer sign up for a two-year contract in return for a reduced price for a handset. At the expiration of the contract, the service provider might entice the customer to stay on with the promise of a new handset which, due to the industry's research and development efforts, is probably significantly more advanced than the older phone that the customer purchased just two years previously. The same enticement is used by service providers to lure customers away from their competitors, so customers also obtain a new handset when they switch companies [18].

Prompt obsolescence is a problem for electronics in general, as advancements in product quality or new features entice consumers to replace older products that could still fulfill their functions for years to come. Television sets, for which some manufacturers (Samsung, for instance) are now touting 'green' energy-saving benefits, illustrate a peculiar policy-induced obsolescence and waste problem. The US Environmental Protection Agency estimates that Americans have nearly 100 million discarded TV sets in their homes, majority of which are still functional but have been replaced by newer or updated models. These devices contain the toxic contaminants cadmium, barium, and chromium, and up to six pounds of lead [19]. In 2009 the United States government made hundreds of thousands more operational TV sets obsolete through a policy decision, in which broadcasters were required to switch from analog to digital signals. This made old sets obsolete before their time for American viewers who chose not to receive a digital converter box (itself subsidized by taxpayer funds) or satellite service or purchase cable [20]. Many of the other nations in the world are enacting similar transitions to digital television, with varying levels of interest in managing the large numbers of television sets suffering from policy-induced obsolescence [21].

Computers are also discarded in huge numbers well before the end of their useful lives. Units that are just a few years old, but still well within their operational timeframes, are condemned by users as too dilatory or lacking the functionality for rapid advancements in software, multimedia applications, or websites. Computers share many toxins in common with TV sets; the US Environmental Protection Agency claims that tens of millions of old computers become 'hazardous household waste' every year in America [22], and the US National Safety Council has analyzed that 75% of all computers are discarded before the end of their useful lives [23]. An American recycling expert estimates that Americans throw away approximately 130,000 computers every day (60 Minutes, 2008).

All of these discarded electronic devices comprise many potentially dangerous chemicals and minerals, and recycling programs for such products are in their infancy. In the United States and Europe, many local jurisdictions suggest special recycling operations for electronics, but such services are typically by special arrangement or by delivery of

the items to inconvenient locations [20]. Cellular telephone handsets introduce their own recycling challenges by quantity alone. In the United States, a few institutions and private businesses, reacting to consumer discomfort over the trashing of large amount of functional devices, offer to collect handsets. Some of these are forwarded to refurbishers or charities but most become part of the general recycling stream in which there are few provisions for handling toxicity [24, 25]. The European Union has regulated the recycling of cellular telephone handsets (by assigning responsibility to manufacturers) via the 2002 Waste Electrical and Electronic Equipment Directive, but this also does not solve the basal problem of toxic waste entering the environment no matter who performs the recycling.

For all of these devices, many conscionable consumers will reveal that recycling programs are nonexistent or inconvenient. Those who do make the effort to send their obsolete electronic devices into the recycling stream may be unpleasantly wondered by how these devices are actually recycled. Due to the functional design of electronic devices, reusable materials are not easily removed and have to often be extracted by hand. This is a poisonous and laborious process for those who are employed to do it. Here is the one of the most troublesome human rights implications of 'green' ICTs that are discarded because of early obsolescence, as caused by either government policies or business decisions.

4. The human rights to environmental protection

The idea of a human right to a healthy environment has gained popularity on the international stage as the basic human right to existence is increasingly integrated philosophically to an environment that can provide pure air, water, and food [26]. The Universal Declaration of Human Rights does not specifically mention the environment, though it does have one provision that has inspired subsequent generations of environmentalists: 'Everyone has the right to a standard of living adequate for the health and well-being of himself and of his family, including food'. Modern environmentalists have inferred that 'food' and 'health' are dependent upon a clean environment [27]. Starting in the 1960s, activists also began to frame Article 3 of the UDHR – 'Everybody has the right to life' – as advocating a clean environment as a requirement for 'life' [28].

The United Nations first proposed environmental protection as a human right in a 1968 resolution, and officially recognized that right for the first time in the Stockholm Report of 1972. Subsequent resolutions have declared the right of persons to demand protection of the environment and the right not to be exposed to manmade toxins and pollutants [29]. Various declarations and resolutions in these areas were consolidated in the Draft Declaration of Principles on Human Rights and the Environment of 1994. Included in this document were the statements 'All persons have the right to a secure, healthy and ecologically sound environment' (Part I(2)) and 'All persons have the right to freedom from pollution, environmental degradation and activities that adversely affect the environment' (Part II(5)). The document also regularly combines environmental protection to the already established human rights of 'life' and 'health'.

Regardless of their enforceability or acceptance on the international stage, environmental human rights can be a matter of great significance in the promotion of ICTs, particularly those that are deemed to have 'green' benefits. Communications related human rights, as described above, cannot be so easily divided from environmental human rights. In brief, perhaps the peoples of the world have the human right to ICTs that do not damage the environments in which they live while they use them for interpersonal communications. If this is the case, then these ICT consumers should not disregard the damage done to environments far away from their own homes.

There is likely to be a basal conflict between these two possible human rights when someone other than the consumer is considered. In a globalized ICT marketplace, consumers are never involved in the manufacture of their devices, they are not involved in the extraction of raw materials and they are unlikely to live near the locations where these activities take place. The human rights of labourers and local residents, from mining to manufacturing to recycling, should be be taken into account. Most significantly for this article, and for the promotion of green ICTs, the environmental implications extend far beyond the usage patterns of consumers and into the human rights of people who live and work far away.

Worldwide awareness of human rights violations in not perfect, with news services tending to report on the most blatant cases of ethnic cleansing, political repression, or systematic injustice – a headline-grabbing pattern that is repeated by policymakers and researchers [30]. Therefore, the possible human rights violations related to the manufacture of ICTs are unlikely to inspire widespread outrage beyond the community of human rights activists. Nevertheless, these violations should not be ignored by consumers or telecommunications policymakers.

Conscionable consumers may be dismayed to learn of the conflicts that are fueled (directly or indirectly) by their use of supposedly ethical ICT devices, like the environmental and human debacle that has been documented in the Democratic Republic of the Congo [31]. These consumers, armed with greater knowledge of how 'green' their devices really are, might be inspired to take action against human rights violations [32]. On the political and policymaking stage, human rights violations are increasingly cited in calls for costly humanitarian interventions or military operations that have ironical human rights implications of their own [33, 34]. In a globalized economy in which raw materials are extracted from unstable nations and consumer products are disposed of in places far from the homes of consumers, human rights violations are likely to increase, bringing about further strife and expense for the world at large.

5. Conclusion

This paper has attempted to provide a review of the recent and current state of the art of how ICT affects the environment. It is claimed that the research examined has captured the most essential and important work to date, either for a common knowledge of this

new area or for background study by experts carrying out future research.

It is can be inferred that traditional assessment approaches are insufficient to accommodate the digital technology revolution and cannot accommodate the challenge of measuring the impacts of ICT on environmental sustainability. New up today innovative methods need to be created to fill this gap. An artificial neural network based more empirical and predictive model was proposed to extend the traditional impact study methods.

This article has also argued that two emerging human rights will come into conflict as the world's dependence on information and communications technologies grows. Policymakers who promote the environmental benefits of 'green' ICTs, and consumers who use them for that reason, must acknowledge that there are consequences stretching far beyond someone's daily use of a laptop computer or mobile phone. Concerned ICT firms and policymakers should strive not just for energy efficiency, but should also strive for improved and modified operations throughout product lifecycles with a focus on cradle-to-grave environmental benefits and costs. Transnational solutions should include human rights agreements among the nations involved in the transport of ICT raw materials and used devices. Individual nations could consider more closely the environmental and human rights bifurcations of policy decisions like the transition to digital television broadcasting, or policy non-decisions like allowing cellular service providers to encourage the unnecessary obsolescence of millions of devices for business reasons rather than technical reasons.

Conscionable consumers can assist the situation by considering more closely the human rights and environmental bifurcation of the entire lifecycles of the devices they use in an effort to make a difference. Environmentalists and ethicists should not continue to fall for the fallacy that their own usage of 'green' products can automatically lead to sustainability when the true environmental costs are suffered by peoples and ecosystems that are out of mind and out of sight. In conclusion, it must be noted that contemporary information and communications technologies really have made advancements in energy efficiency and sustainable consumer behavior, and the environmental benefits thereof are beginning to be realized. However, concerned policymakers and consumers should not rest on their laurels by assuming that the battle against environmental degradation is over, especially when the human rights of disadvantaged peoples are still at stake.

In a final conclusion, the authors would also like to emphasize that efficient interdisciplinary cooperation among experts require new problem-solving training. Partnership among experts and knowledge-based society is a subject of 25 years activity of AGH-UST Open University including consultative meetings with representatives of administrative bodies at regional and national level.

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