

Review

Sustainable Waste Management Innovations in Africa: New Perspectives and Research Agenda for Improving Global Health

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Abstract: The need for green business practices and green innovations underscores a growing recognition that climate change is now an existential threat not just to population health but also to the survival of businesses that are unable to embrace green practices with a sense of urgency. This paper contributes to the literature on market violence as an inhibitor of green innovations for sustainable waste management to curb the unneeded health effects of wastes in Africa. Our purpose is to problematize received wisdom, unquestioned assumptions, and incorrect diagnosis of the sources and health consequences of various forms of wastes in Africa. Much of the discourse on this issue remains ahistorical, and that risks leaving aside a vital question of exploitative extraction. By including this ‘out-of-the-box’ explanation through major case references, we are able to shed light on the critical issues that have hitherto received limited attention, thus enabling us to propose useful research questions for future enquiries. We propose a framework that delineates the structural composition of costs imposed by market violence that ranges from extraction to e-waste disposal. We advocate for the engineering of policies that create conditions for doing more with less resources, eliminating waste, and recycling as crucial steps in creating sustainable waste management innovations. Additionally, we highlight a set of fundamental issues regarding enablers and inhibitors of sustainable innovations and policies for waste management worth considering for future research. These include programmed obsolescence, irresponsible extraction, production, and consumption, all seen through the theoretical lens of market violence.

Keywords: market violence; planned obsolescence; sustainability; waste management innovations



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1. Introduction

“Plastic waste pollution: in 20 years majority of couples will not be able to have children” [1]. This sounds like a typical sensationalized tale from the newspapers, except that it is not. Rather, it is a report from a meticulous scientific study warning about the effects of pollutants and chemicals in plastics that are endocrine disruptors in humans [2] and are impairing brain development [3]. These same disruptors are responsible for low sperm counts and infertility in males and miscarriages or defective births in females. Between 1973 and 2011, the average sperm count of the average Westerner reduced by 59% [4]. This has been named a “spermageddon” because different chemicals in the environment do not only affect the reproductive systems of humans, but other species as well. Since the 1980s, there has been an exponential increase in childhood diseases such as autism, asthma, attention deficit hyperactivity disorder (ADHD), obesity, diabetes, and various birth defects. Concurrently, over 80,000 new chemicals have been industrially manufactured and circulated into the environment globally [5]. The link between irresponsible industry practices such as the overproduction and disposal of plastics [6,7] and these diseases is self-evident. The sluggish regulatory systems for environmental protection have, in part, contributed to this [8]. The recurrent themes here are environmental sustainability and the roles of

industry and national and regional policies/politics [9–13] in advancing sustainable global health [14].

Against this background, this issue-based paper seeks to contribute to the literature on the health effects of environmental pollution and weakened social determinants of health (<https://www.ban.org/e-waste>; accessed on 4 June 2021); [15]) resulting from the indiscriminate dumping of dangerous wastes [1,16] in order to propose novel directions for future research. Rather than follow a “formulaic research” agenda by seeking a gap in the literature that still submits to established views, we go beyond that by problematizing the current literature [17] regarding the issue at hand. Such an approach led us to reframe discourses on waste differently from being only an environmental, technical, policy or managerial issue but also to consider the historical and political foundations of how they came to represent a form of structural violence (via extractivism) [18,19] perpetuated through market violence (the unjust and brutal impact of commerce) [20,21] where waste is sent to developing nations. The question being answered is: how can the waste problem of Africa be reframed to offer more meaningful research questions and sustainable policy and techno-scientific innovations that create optimal health benefits?

2. Issue-Based Literature on Market Violence and Sustainable Waste Innovations

The Unending Vista of Waste: The Current State of Affairs

“Sustainable manufacturing (SM) or green manufacturing . . . is a method for manufacturing that minimises waste and reduces the environmental impact. Therefore, sustainable manufacturing may be defined as a system that integrates product and process design issues with issues of manufacturing, planning and control in such a manner as to identify, quantify, assess, and manage the flow of environmental waste with the goal of ultimately reducing the environmental impact to that of the self-recovery capability of the Earth could deal with while also trying to maximise resource efficiency” [22].

The global economy is characterized by the migration of polluting industries from high-income nations to developing economies. This occurs via foreign direct investment and trading of goods, which further amplifies the environmental sustainability issues [23]. Green manufacturing (GM) is a growing recognition that climate change is now an existential threat not only to societies, but also businesses that are unable to embrace green practices in ways that keep abreast of the speedily changing times. The potential positive effect of businesses’ operations can be further amplified with green manufacturing. This is necessary for minimizing pollution, water contamination, or e-waste while simultaneously generating new and renewable sources of energy. Nevertheless, most industries remain largely hamstrung by a host of factors.

The world’s population is on track to increase from around 7.7 billion in 2020 to around 10 billion by the year 2050 [24]. This increase will far likely exacerbate the already intense competition for natural resources, exerting further demand for food, renewable energy, and resources. In this regard, environmental sustainability can no longer be regarded as a strategic option but a strategic necessity to curtail CO₂ emissions.

As the world is increasingly becoming a global village [25], global solutions encompassing all countries are needed for this century. The COVID-19 pandemic has elevated the climate issue to the fore as well as propelling new streams of scholarly works on environmental sustainability [11,12,14,26,27]. One of the most pertinent issues facing developing countries is how to usher in green business practices in resource-constrained environments.

Although Africa as a continent contributes less to environmental pollution compared with regions such as Asia, North and South America and Europe, it remains the “the most vulnerable continent to climate change” and the accompanying consequences [28] (p. 21993). This is further exemplified by the fact that the 2015 Climate Change Vulnerability Index observed that seven out of the ten nations (i.e., Chad, Ethiopia, Nigeria, Sierra Leone, South Sudan, Central African Republic, and Eritrea) most vulnerable to climate change risk are situated on the continent [28].

There are potential contributions of sustainable waste management and green manufacturing. That notwithstanding, past studies have largely failed to examine the barriers and challenges in fostering green practices. In this closing editorial, we examine the current challenges and opportunities in leapfrogging to waste management innovations in the post-COVID-19 era. Despite the positive effects of an embrace of environmental sustainability initiatives [29,30], it remains unclear as to how governments can better usher in a culture of environmental sustainability specifically in creating green innovations. Such green innovations will make little difference if systems for proactive environmental awareness and enforcement mechanisms are not put in place to control plastic consumption and disposal. For example, Figure 1 below shows the countries in Africa with the highest importation of plastics. The 230 Mt of imported plastic is a clear demonstration of the gravity of the situation. The same countries are also responsible for a great portion of the ocean littering with plastic [31].

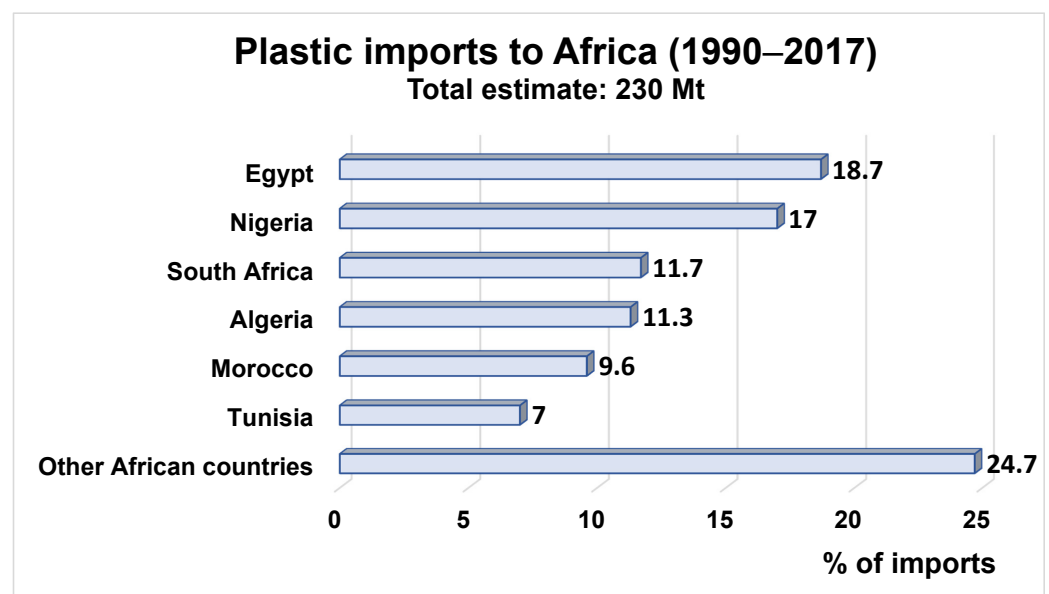


Figure 1. Plastic imports to Africa from 1990 to 2017. The total estimated amount of imported plastics (both in primary form and as products) was 230 megatons, based on extrapolation of available data from 33 selected African countries. Data from reference [32].

In the next sections, we explain the method of the study. We investigate the inhibitors to sustainable innovations and waste management through the theoretical lens of market violence (in the form of e-waste) whilst offering various eclectic research themes worth considering in the quest to further our understanding.

3. Method: Iteration of Cases and Literature

The epistemological and ontological objective of this study is to analyse the issue of waste filtered through the lens of longstanding market violence in the quest to propose novel policies for engineering the necessary conditions for doing more with less resources (saving the environment) and eliminating not only the waste, but the systematic damage wrought on the environment and population health. Thus, our approach is not about gap spotting in the literature, although the literature on waste management innovations within the context of Africa is limited. However, we seek to problematize [17] the current situation of waste management solutions by situating it within a historical context and offering a critical review of the ethical and political side of the management of waste and the extent to which their limitations impinge heavily on the climate, environment and consequently on population health.

We compare two well-known reference cases from empirically significant contexts: Walekale, Eastern Congo, where millions have lost their lives as a result of the globally overlooked exploitation [18] and Agbobloshi electronic waste dumping site in Accra, the capital of Ghana, to explain the historical roots of the problem of extraction, exploitation, waste and the negative health effects they produce. Subsequently, we clarify the conceptual and empirical relationship between sustainable waste and green manufacturing as the way forward. These two cases embody empirical settings with unique histories dating back to colonial times. Nonetheless, these cases have seen little change in terms of exploitation and the subsequent environmental and health effects. The Congo, in particular, has been serving the world with all kinds of mineral resources but in return receives only poverty and underdevelopment [19]. To this day, the pillaging continues unabated. Ghana, on the other hand, enjoys democracy and strong institutional stability. That notwithstanding, the problem of e-waste persists given the absence of sustainable waste management innovations and policies. The question that arises is, what explains the problematics or lack of efficacy in relation to the politics of resource and waste management innovations?

We explain in more detail the sources and causes of e-waste and other wastes by situating the analysis of the extant literature and the two cases from which we present the table showing how resource extraction constitutes the beginning of weakened socio-economic and environmental determinants of health. This seeks to contribute to the literature on market violence.

The research part regards a period of over six months of the observation and documentation of two places in Accra (Madina market and Agbobloshie suburb) in Ghana in 2020, even during the COVID-19 period. Here, the business of on-street innovation produces both self-directed recycling through repairs and the reuse of parts of electronic devices while still not sorting wastes but rather mixing them to be sent to dumping sites mixed with other materials. We could refer to these as confirmatory case studies or case referencing, which bring renewed interest and confirms an ongoing damage that requires immediate attention. Thus, this approach differs slightly from traditional comparative case studies [33] because the issues are well-known/settled and have been publicized extensively; although they are both mis-framed and not problematized (unquestioned underlying assumptions).

4. Market Violence through E-Waste: New Agendas for Future Research

4.1. E-Waste and Industry 4.0: From Eastern Congo to Agbobloshie (Accra, Ghana)

“We are dumping waste at rates beyond nature’s assimilative capacity. Warming temperatures, plunging biodiversity, worldwide deforestation, and ocean pollution, among other problems, are all important. But each is a mere symptom of overshoot”, says William Rees, a population ecologist at the University of British Columbia (in Reference [34]).

The above quote announces some serious and legitimate preoccupations of scholars who look deeper into CO₂ emissions resulting in climate change, among others. For example, going by the current trends, the world could produce up to 417 million tonnes of plastic waste by 2030 [35]. How will we account for the outcomes of sustainable development goals? Can we go on with business as usual? Our current practices are unsustainable and borders on total collapse [34]. Furthermore, the most common and recurrent words used to describe the e-waste phenomenon include ‘dangerous’, ‘toxic’, and ‘hazardous’ [19,36–39] and they fit perfectly into the broader discourse of sustainability. These adjectives are the reasons much attention needs to be paid to the worsening global environmental situation and the attendant [19,40,41] health problems.

We draw attention to two places in Africa, i.e., eastern Congo and Agbobloshie (Accra, Ghana), in the quest to highlight the historical origins of the political, economic, and industrial problems that have led some countries to become suppliers of raw materials [19,40,41], dumping sites of e-waste [36,42], pharmaceutical waste [43], and plastic waste [44]. Emphasis must be put on these place names until the world becomes fully cognizant of those who carry the weight of our prosperity [19,28]. This is because Africa and the rest of the

developing world is disproportionately affected by such deliberate and unsustainable practices as hazardous waste dumping—hence the sense of urgency [19,28]. The limited media and academic exposure and the lack of serious policy intervention towards these two places is not only unsustainable but also criminal. Greater awareness of this waste dumping phenomenon should lead us to pose more profound questions and engage in deeper analyses about the chronic nature of these operations rather than engaging in superficial and low hanging fruit abstractions that hardly speak to the corridors of power and policy making. The Democratic Republic of Congo (DRC) and Ghana (symbolically and literally) represent where the resources for making the electronic devices come from and where the e-waste goes to be disposed of (among many other places in Asia). The people and the soil of these two places do not benefit much. Whether it is a scholar, a politician, a businessperson, or a consumer who depends on these products, the whole world is complicit and part of the problem [18].

Put the following into perspective: Africa produces 9.6% of the global oil output, 90% of platinum supply, 90% of cobalt, 50% of gold, over 60% of manganese, 35% of uranium and 7% of coltan [45]. The youngest continent with respect to the age of the population also holds 30% of global fresh water (mostly around the great lakes of East Africa) and produces close to 70% of global cocoa (mainly Ghana and Ivory Coast). The Sahara Desert also offers vast possibilities for the generation of solar power just like the rest of the continent. Notwithstanding all the above, Africa has the lowest level of industrialization, although she bears the brunt for CO₂ and environmental pollution. This clearly leads to higher disease burden as well [14,46].

There is an air strip in the middle of the Congolese forest. There is no customs office or inspectors, no taxes collected, or miners paid. The workers are sometimes killed for protesting the inhumane conditions, child labour is rampant, and routine violence is maintained with arms to sustain the trade of all the nameable minerals of the earth. Hundreds of young people carry 50 kg of weight on their heads through the forests for days from the dangerous mining sites to the exploitative collection sites only to be paid a pittance or nothing at all [47]. These minerals ensure that tech companies can thrive in the fourth industrial revolution, at the expense of indigenous people who are mainly statistics and distal stakeholders at the mercy of the corporation [48,49]. For more than two decades, the United Nations has deployed over ten thousand troops (Blue helmets) there to monitor the activities of the various rebel factions that operate outside the control of the central government. However, these troops hardly intervene or engage the various factions. The whole world looks on as they hear about this either through brave (but suppressed) journalistic work, some academic work or activists who shed light on the situation, and little seems to have changed over the years [18]. What makes anyone so certain that the world is serious about sustainability? Or is it a mere façade? Who will claim responsibility for the violence, underdevelopment, and unsustainable international business [50]?

Academic articles are typically not as direct, but this should not be normalized when the inventory of issues being studied is already blunt enough and leaves nothing to the imagination. We use this editorial privilege to bring clarity to the issues because being clear adds credence to the message. Faking diplomacy about tragic and unsustainable practices or burning issues misses the opportunity to highlight the truth and rather obfuscate understanding, gaslight us and misdirect our attention from the main problem. Thus, we would like to highlight that the problem of e-waste does not start with the dumping of waste but with the injustice in the extraction of raw materials, which also contributes immensely to environmental degradation while imposing other costs on the nations of Africa [19]. One of the guest editors of this Special Issue visited Agbobloshie, a suburb of Accra, the capital of Ghana, where e-waste is routinely dumped. The sight of the site raises many troubling questions worth analysing. There are those at the bottom of the chain who extract gold, copper, and other things in tiny quantities for resale. This process requires burning these electronic wastes to allow for these people to extract what little they can find. It is this process that causes so much harm to those involved, those

who live around and the environment, as these things end up in the soil and water bodies. The Agbobloshie waste also includes those devices that could potentially be repaired and reused or recycled. While these wastes may contain some valuable parts in the configuration, they also contain hazardous components. The damage this causes to humans and the environment has been well documented (e.g., <https://www.ban.org/e-waste> (accessed on 4 June 2021) [15], and this poses a significant threat to sustainable development in general [51]. A discomfiting question that keeps coming back is why should the very people from whose land the minerals are supplied for manufacturing these electronics wait to access these same minerals in impoverished versions for resale at a very high risk? The research agenda that needs activation here is obvious. What inhibits governments from taking control of resources in ways that create sustainable wealth or from diversifying mineral exportation to production in order to provide jobs and sustainable economic growth?

4.2. Grappling with the Serious Fallout of Health and Environmental Issues

A question that can intrigue any curious mind is: why does e-waste arrive in such mighty volumes and who allows that? There have been several studies and documentaries that discuss the problem in depth and are freely available online (e.g., [52,53]). Therefore, what exactly is stifling the change and why are successive governments not seeing the environmental, health and reputational damage? Young children and under employed/unemployed youth eke a living from such dumping sites but they pay a huge price with their health. Waste electrical, electronic and equipment (WEEE) poses a significant health hazard because it contains toxic metals and organic metals [54]. Each of these poses a different type and degree of risk due to variations in equipment types, the technical make-up and the policies regulating their manufacturing. For example, cathode ray TV exposes the environment to both carcinogenic and non-carcinogenic toxicity while the waste air condition presents the highest level of ecotoxicity from toxic organic chemicals [54].

Currently, the COVID-19 outbreak has increased our reliance on the use of disposable plastics, which in turn has added to the difficulty in managing such waste due to recommended ultra-hygienic daily practices. These include, e.g., personal protection equipment (PPE), grocery plastics and disposable food containers [38]. This new addition of waste seems to have overshadowed the existential threats posed by the problem of e-waste dumped in developing nations.

On the other hand, on the surface, plastic, electronic and medical and non-pharmaceutical waste (e.g., masks and gloves) [43] do not seem too threatening compared to nuclear accidents such as Fukushima Daiichi (Japan) and Chernobyl (Ukraine) [55]. While the former was caused by a natural disaster, the latter was caused by human error. Both nevertheless prompted fears of environmental pollution and health problems caused by radiation. This much is also fuelled by much media coverage. Both accidents have caused serious adverse effects on population health. Although the short-term consequences were mostly political, psychological, and economic and less medical, as Gale (2011) argues, the environmental damage in both cases is incalculable.

Nonetheless, while these former catastrophes are one-off incidents, e-waste dumping entails consistent and increasing volumes of reckless disposal of waste. The effects are slow, but cumulatively they produce serious adverse effects on our oceans, other water bodies, arable soil and cause all forms of environmental pollution whose far-reaching consequences undermine the health of even distant populations [19,39]. In addition, E-waste continuously produces serious health hazards because of the direct contact through inhaling of fumes from the burning of electronic devices in the process of extracting lead, gold, and other substances for resale.

The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal (www.basel.int; accessed on 6 June 2021) is an important first step. However, where it has been signed, there are still many firms that leverage other connections to export e-waste to countries with corrupt officials [56]. The exportation of

millions of tonnes of toxic waste from the US and Europe, where they are banned, happens because it is possible for a firm to work its way around the weak regulatory defences in developing nations. This brings us to the area of policy actions for waste management. Our proposed GM takes time and requires massive capital outlay. Therefore, future research on the extent to which different levels of ecotoxicity affect population health will help advance our understanding of the situation from other parts of the world. Additionally, questions such as “how socio-cultural and educational institutions affect the intensity and efficiency of innovations around waste management” would be worth studying.

Pushing back is easier said than done. However, it can, and must be done. For example, the Philippines returned a shipment of several tonnes of waste to Canada in 2013 and 2014. The shipments had been falsely labelled as plastic recycling according to BBC News (2019). In June 2019, Malaysia also returned five containers of plastic to Spain after it was determined that they were contaminated (BBC News, 2019). As many Asian countries such as Malaysia, China, Taiwan, Thailand, and Vietnam take action to stop the intake of plastic and other wastes, it is apparent that the eyes of unscrupulous exporters of dirty goods will turn to Africa in search of new landfills. Studies that investigate actual government level actions against the inflow of e-waste and other wastes (rather than mere rhetoric) will be a welcome addition.

4.3. How Do the Lack of Data and Political Will Undermine E-Waste Management?

There is a lack of comprehensive up-to-date data on the health impact of those directly involved in operating e-waste sites. This says a lot about where the priority lies. For example, in Agbobloshie, young people, mainly from the North of Ghana, make little income. They get sick frequently; the burning of the hazardous wastes makes the air in the site and surroundings areas un-breathable. The precarious living conditions of the informal waste collectors are very concerning [39]. There is a need for a strong political will to provide alternatives and innovative management practices to curtail the harm. This statement is a repetition because it is exactly what all the articles and documentaries are emphasizing. We argue, however, that there are vested interest groups with financial incentives for keeping this site operational even at the expense of the larger society and the environment.

More disturbingly, the Accra Madina mobile phone market and Kwame Nkrumah Circle market in the capital of Ghana have thousands of young dealers of mobile and other electronic appliances. This, in some way, makes up for the youth unemployment crisis across Africa [57]. Either by necessity or entrepreneurial instincts through improvisation, many in the electronic dealership chains in the developing world attempt to extract what little value there remains in electronic products by extending the life cycle of used devices. In this process, one good component of another device is used to fix the damaged version of another to permit reuse at a lower price. This process comes in many forms, such as repairing damaged ones, repurposing and reconfiguration with ‘added inventions’. An over half a year personal observation in 2020 of mobile phone batteries showed that the average lifespan of some of these street phone batteries was about one month. The street goods are mostly fake, adulterated or knock-off phones and batteries. It is possible to negotiate with the sellers because the items’ lifespans can be as short as the price. The items are not reliable but after they are disposed of, some useful parts are taken out and the rest is dumped among other wastes, which all ends up in different waste collecting sites.

This suggests that it is not only the famous Agbobloshie but there is a national and regional problem of e-waste that is not properly managed because wastes are hardly sorted. It was documented that those useless electronics, batteries and such are all mixed with rejected vegetables and thrown away with used clothes and shoes without any separation mechanism. To our knowledge, successive Ghanaian governments have seriously underperformed in the area of waste management and there is a lot of room for improvement. What forms of public education overhaul are needed to ensure population-wide sensitivity to waste management through sorting and waste management systems? This must be

useful research that brings to light how national waste management practices (including rewards and punishments) in countries such as Sweden, Rwanda and Finland can be transposed and adapted to the African settings. Furthermore, to make facts-based policies, actual data are required. What existing models of governance of data repositories can be transposed into the African settings and how can the data be structured for national policy innovations?

4.4. Unmanaged and Mismanaged E-Waste Dumping as Market Violence

The exploitation of natural resources and the return of wastes to the same place can be viewed with a theoretical framework: market violence [20,21]. There is no epistemic confusion about how ideologies of exploitation through market violence affect society. Market violence refers to the harm or suffering inflicted by the logic of the market [21:1]. In neo-liberal capitalism, violence is employed for the realization of surplus value [20,58,59]. There is an ethical component here. Nevertheless, the violence enacted by corporations [60] is seldom considered in the context of environment, soil life, flora and fauna and water sources although the interdependence between populations and the environment is fundamental for health and survival [19].

There are multiple layers of costs that industrialized economies impose on developing nations owing to the dumping of e-waste (see Figure 2) (this is not to suggest that governments in developing economies are not complicit). These costs begin accumulating already long before the actual production, marketing, and consumption. However, both the obvious and hidden costs far outweigh the gains from e-waste as analysed below. Figure 2 shows how natural resources needed for the manufacturing of electrical and electronic goods are extracted in weaker economies at low prices and in many cases with evaded taxes [40,61]. This is where the problem of market violence starts from. Resources are then sent abroad for manufacturing (value adding) where corporations leverage their economies of scale and scope to produce the goods where labour is cheaper (e.g., China). The cost imposed on developing economies because of extraction, the suffering of indignity of being paid less for resources and exporting them outside so that locals do not get the chance to add value to them has long been analysed in the structural theory of imperialism [41] and as a cause for translocal resistance [62]. These goods are then sold at home and abroad. Here, too, developing nations lose out because local industries cannot compete. In some ways, the costs are offset by access to used/second-hand technologies, but this further weakens the local industrialization.

The Composition of Costs Imposed by E-waste				
<p>1. Loss of economic rents</p> <ul style="list-style-type: none"> • Costs (losses) related to extraction of mineral resources • Undervaluing of resources • Tax evasion • Decreased diversification • Concentration on exports • Dependence on rents 	<p>2. Net exportation of raw materials</p> <ul style="list-style-type: none"> • Loss of competitive advantage • Environmental degradation due to extraction 	<p>3. Manufactured products sold at higher prices and importation of secondhand devices</p> <ul style="list-style-type: none"> • Stagnant industrialization • Weakening of local industries 	<p>4. Loss of national brand and attractiveness</p> <ul style="list-style-type: none"> • Creation of consumer class • Unfavorable media coverage due to environmental pollution 	<p>5. Environmental / health costs</p> <ul style="list-style-type: none"> • E-waste polluting land, water bodies as well as the air.

Figure 2. The structural composition of costs imposed by market violence from extraction to e-waste disposal.

The next phase of the trouble starts when the e-waste then returns to these natural resource-rich developing nations. There is a litany of literature explaining in detail the various components and metals and chemicals that are disposed of along with these devices (e.g., [38,54]). What is known in a nutshell is that they have serious effects on people and the planet because they contribute to environmental pollution that leads to the destruction of biodiversity and increase in costs on healthcare in developing countries. [19,39,63,64]. Above all, being known as the recipient of the world's rubbish is not a good case for national branding [61].

The goal of all this discussion about green manufacturing as a response to market violence is the health and wellbeing of the African population who are disproportionately affected by the environmental issues [28]. If firms and economic agents who are responsible for sending e-waste to developing nations have in most cases not been questioned or sanctioned for the harm they cause, making them accountable now may be interpreted as anti-capitalist or anti-free market. Environmental exploitation, however, does not deviate from the normal strategies of certain firms because self-interest is always at the heart of business. To what extent can comprehensive regulatory effort that sanctions recalcitrant offenders reverse the current situation?

Moreover, there is a chain of neglected responsibilities; from exporters of such electronic devices that create public bad to those who inspect or do not inspect them at the port of entry and those who dump them. In Western countries, consumers do a really good job of sending these discarded objects to recycling centres. However, numerous documentaries and studies have found that somehow, these wastes make their way to Africa, Asia and elsewhere because it is cheaper to send them elsewhere than to recycle them or dump them on home soil due to stringent local regulations. That brings up a new question that creates so much uncomfortable tension. Is it sufficient to send old devices to a recycling centre to be managed by some entity that ends up selling them to a third party who may not be environmentally responsible? This clearly undermines the efforts of responsible consumers. What does it take to change this apart from green manufacturing, recycling and advocacy? Quite clearly, such problems are not solved by simply admonishing perpetrators to cease and desist. They must be required by law to stop, and offenders must be heavily penalized for the infringement of environmental laws. Then again, what if the offenders also include government agencies and bureaucrats? This suggests that there is no one-size-fits-all solution. There are many ways, and the effectiveness will depend on the political, social, and institutional matrix within which these issues unfold. How successfully these laws are implemented in developing nations to reduce social and environmental costs can also be researched in the future. Furthermore, studies into the extent to which green manufacturing and innovative waste management practices affect national place branding will shed light on why proper waste management is more than environmental sustainability concerns [61].

4.5. Planned Obsolescence

Speedy advancements in technological innovations have meant that new configurations of electronic goods quickly become obsolete as marketing communications subliminally inform of the need to seek new versions [65,66] and more advanced applications [67]. While this may be economically justifiable in some cases, quite often it is just sheer over-consumption, addictive purchase or simply, hedonistic excesses [59]. As consumers buy new gadgets, the previously acquired devices are discarded.

The marketing communications that appeal to consumers [66] have a subtle but clear message to convince consumers to own "a little newer, a little better, a little sooner than is necessary" [65]. Programmed, planned, or built-in obsolescence is a term that refers to an artificially short life-expectancy built into a technical device. For Maggiolino (2019) [67], this entails the "market conditions under which an enterprise finds optimal cannibalizing of a version of its durable good with another ... companies can resort to a wide variety of conducts to program the lifespan of their products and to impose their

replacement prematurely.” We can then conceptualize planned obsolescence as a deliberate entrepreneurial decision to shorten the lifespan or limit the durability of a product to induce and increase sales and profitability. Characteristically, new components for revitalizing electronic goods or costs of repairs are higher or not worth it compared to purchasing new ones. This encourages more consumption as a fad, not a necessity, with newer versions always reappearing while old versions lose their value, utility, and appeal. The main sticking point here is that the overconsumption or constrained hedonistic consumption of the unnecessary contributes to the production of more e-waste.

Additionally, the launching of new versions of any product comes with both advantages and undesirable effects. As Maggiolino (2019) [67] argues, in electronic goods especially, it may lead to an increase in R&D spending with new innovations. This in turn can positively affect long-run economic growth. However, here lies the problem. Economic growth is not equivalent to economic development given the environmental costs of such speedy growth. As Maggiolino further argues, planned obsolescence increases the debt levels of consumers (borrowing or being in debt for what they do not really need), makes consumers easily displeased with low quality products, and for our purpose, the constant manufacture of new products drastically increases the use of natural resources [64]. Such hedonistic purchases also displace household spending, savings, and investments priorities. These are clearly the results of creative destruction that not only has an actual impact on the environment but also ethical implications for society and industry [63]. Here, again, to what extent are regulatory frameworks able to force manufacturers to lengthen the lifespan of products and how can consumers resist the urge to prematurely abandon recently acquired devices? Since every sale is also a purchase, how can consumer culture be shifted towards repair and re-use as a personal responsibility in the era of sustainability?

4.5.1. The Abandonment of the Culture of ‘Repair and Re-Use’

The problem with in-built obsolescence is the drastic cultural change in attitude towards the old and durable [65,67]. In other words, we have now moved from a culture of ‘repair and re-use’ to a culture of ‘make–use–throw-away’. However, our irresponsible waste management practices mean that more wastes land in places where they contaminate the environment of mostly those who may not have participated in the consumption but just bear the brunt of the pollution that comes with the wastes [28].

The discouraging anti-repair design by manufacturers and throw-away culture are as political as they are technological and economic in nature. Political—because it is not the fault of those who extract these things but rather the business of policy makers to engineer safer ways of extracting and recycling waste, or not to allow such wastes in their countries in the first place. This requires what we refer to as techno-industrial sustainable policies for green innovations. Technological and economical because a shift away from the throw-away culture to green industry will be profitable, besides being a better trade-off compared to importing wastes without the requisite technology to treat them.

We advocate structural level policy reforms rather than blaming and casting aspersions. Many appliances automatically become waste simply because they lack minor replacement such as batteries for their parts. Within the configurations of many devices, the vital parts that were once replaceable have now been ‘soldered, welded or riveted’, causing the appliances to break during any attempt at opening and fixing them [68]. The solution in Europe it appears is the EU Parliament’s eco-design recommendation to the European Commission to renormalize the tradition of the repair of products by requiring firms to extend warranties, making replacement components easily available and standardizing repair tools [69]. As it turns out, these things are being carried out in Ghana as individuals and small enterprises import parts from China, Dubai and elsewhere to repair phones and computers, giving jobs to thousands. There is always a pool of talents in the informal market who always find a way to lengthen the product lifecycle. How can governments formalize, legitimize and scale this up in a nationally or regionally coordinated manner given the ever increasingly integrated market of Africa?

4.5.2. Unethical Consumption and E-Waste Production

The scope and magnitude of overconsumption is partly the results of marketing and partly consumer irresponsibility or unethical consumption that does not take the environment into consideration. The statistics from Eurostat (2020) are staggering. “From 2016 to 2017, the amount of electrical and electronic equipment put on the market in the EU increased by 7.4 % from 8.4 million tonnes to 9.0 million tonnes.” Access to more consumer goods in the modern day projects a sign of wealth and fulfilment, but what are the ethical and sustainability implications of such display of opulence? There are several components to overconsumption and unethical marketing which cannot be studied in silos. Therefore, a multidisciplinary study from diverse theoretical foundations that will advance our understanding will be a welcome approach towards redirecting research efforts and attention to what really matters. Given the practical utility of such studies, it would be ideal to borrow terminologies from activists and others who are already influencing industry and policy making [70,71]. These include ‘green consumption’, ‘ethical consumption’, ‘consumer activism’, ‘inhibitors and enablers of consumption’, and ‘disposal of fast fashion and electronic goods. The psychological analysis of how integrated marketing communications affect purchasing behaviour can also be used to conscientize consumers about their power to change the direction of unsustainable production and consumption. The disposal of pharmaceutical wastes is equally troubling. For example, the Pharmacy and Poisons Board (PPB; [72], cited in [43]) defines pharmaceutical waste as waste containing medicines that are expired, contaminated, split, unused and no longer needed, including items containing or contaminated by pharmaceuticals such as bottles, boxes, vials, ampules, gloves, and masks. To what extent are such wastes properly managed by hospitals, pharmacies, and municipalities and how effective are the educational programmes in convincing consumers about the effects of haphazard disposal of such wastes and encouraging them to follow, for example, national or WHO guidelines? The next section examines the current challenges and opportunities in leapfrogging to waste management innovations via green manufacturing or sustainable innovations.

5. Green Practices: Drivers for Change

Encompassing green manufacturing (GM) or environmentally conscious manufacturing are manufacturing matters related to pollution control, waste recycling, conservation, environmental protection and fulfilling legal and regulatory obligations [37,42]. GM revolves around lessening the “environmental impact by reducing toxic waste, pollution, optimizing use of raw material, and energy by applying end of life (EOL), cradle to cradle and close loop approach” [37] (p. 20). It broadly seeks to ensure the minimization of adverse effects on the environment in designing and delivering in the production process [37].

Past studies have demonstrated that GM represents a combination of a set of actions and initiatives that can lead to the mitigation of adverse environmental effects of firms’ activities [37,73]. By incorporating the green design of products, and the use of recyclable materials and packaging, GM can pave the way for firms to enhance their competitiveness via cost saving from waste [73]. Indeed, with resource conservation, effective and robust waste management, and environmental protection measures coupled with pollution control, firms can mitigate the negative or bad press stemming from the lack of attention to the negative effects of their production activities. This also helps firms to adopt superior processes and standards in their industry that enhance their market competitiveness.

5.1. Green Manufacturing

Manufacturing is viewed as one of the panaceas to fostering rapid industrialization and economic development not only in Africa, but across the global south. It has historically played a pivotal role in the development of many advanced nations and newly industrialized nations in Asia, including South Korea and Japan. In recent decades, manufacturing production across the African continent has surged and in West, East, Central and southern Africa increased in value from USD 73 bn in 2005 to around USD 157 bn in

2014 [74]. However, manufacturing as a share of GDP declined from 19% in 1975 to 11% in 2011 [74]. Accordingly, there is a need for the greening of industries to develop and enrich the manufacturing base to combat unemployment and foster industrialization. Indeed, GM can emerge as a means to combat social problems such as youth unemployment and environmental depletions in both urban and rural areas in Africa. In responding to recent “calls to action” for combating climate change, there has been a growing emphasis on GM [75].

The African Continental Free Trade Area (AfCFTA), which came into effect in 2021, seeks to foster and boost intra-African trade by easing barriers between signatory countries (Economic Commission of Africa, 2020). Africa accounts for mere 1.3% of the globe’s USD 3.4 trillion-dollar ecommerce ecosystem and thereby presents opportunities for countries to expand and develop this sector [76]. Although the transition to GM remains a major challenge for an emerging Africa, the current literature offers very little insight on the GM regulatory framework, opportunities and constraints facing small and medium enterprises (SMEs) and their capacity to transition to green practices.

Drivers of Green Manufacturing

GM has emerged in recent years as one of the effective mechanisms to deliver sustainable development [77] (p. 1554). This entails the use of renewable sources of energy such as biomass, solar, geothermal and wind in tandem with the adoption of new efficient processes and technologies to reduce material use, waste and emissions by businesses. By using renewable resources, processes and eco-friendly approaches, GM or the “greening” of manufacturing has the potential to reduce levels of natural resources depletion, pollution, and waste [75,78] and thereby ushering potential green revolution in the developing world. Eco-manufacturing and low-tech manufacturing firms seek to achieve energy-saving via designing factory floors that allow natural lights and using renewable energy sources [79]. By seeking to develop a carbon-neutral factory, firms also enhance their corporate image, which helps in attracting environmentally conscious consumers and investors. GM also has the potential to help mitigate global warming and cater for the pressing need for new green jobs to combat youth unemployment [80]. This is pivotal given that youth unemployment accounts for around 60% of the entire continent who are jobless [57].

Given that by 2050, Africa’s population is expected to reach 2.2 bn, thrice that of Europe, which represents a major surge from the 1950s, when West, East, Central and southern Africa accounted for only 180 m, which was at the time a third of Europe’s population [81], there is a need to create new jobs to absorb this surging youthful population and GM appears essential. Besides the increasing pressure from stakeholders such as environmental groups and governments for firms to adopt green initiatives, there are also compelling economic incentives for firms to opt to become green [29,75,82]. Given the abundance of natural resources in Africa, there remains an untapped opportunity to transition to GM via harnessing renewable power and adopting green practices. Indeed, structural and infrastructural deficiencies such as roads and power supply often hamper firms’ ability to capitalize on the ample opportunities on the continent. Inefficiencies inherent in transportation infrastructure also often hamper the development of this sector.

5.2. Impediment of Transition to GM

For many developing nations such as Ghana, Nigeria and Kenya, manufacturing firms’ growth are often curtailed by intense competition from cheap imports, a lack of access to finance and erratic power supply [83]. Many African nations have generally failed to capitalize on the relatively low labour rates to compete with rivals domiciled in Southeast Asia due to “very low levels of output per hour” [84] (p. nd). Another issue is the lack of size/scale to build large factories with the potential to accrue synergetic benefits and ultimately be able to compete with imports [84]. However, the success of GM might be predicated on skills development and the application of latest manufacturing technologies. From a public policy standpoint, ECOWAS and EAC countries: Ghana and Nigeria, and

Kenya, focusing on green has potential for these to become hubs for GM on the continent. The Switch Africa Green project that Ghana, Nigeria and Kenya have ratified is another channel to realizing their green economic goals.

Past studies investigating constraints faced by green SMEs or firms striving to become green suggest that access to technologies that could allow them to reduce their carbon emissions remains a major challenge, irrespective of compelling motives for doing so. Although many such firms view environmental innovation as a cornerstone in enriching their market competitiveness, technology access stemming from resource constraints have often halted their drive to achieve market competitiveness. Firms in emerging economies in Africa particularly face this challenge, but many overcome this through forging collaboration with other resource-rich firms from other emerging economies from outside the continent.

In the wake of growing global concerns to combat climate change, firms are increasingly being forced to adhere to stringent environmental standards and regulations via the adoption of green manufacturing practices [85]. However, many SMEs lack access to technology and technological know-how that could equip them to embrace practices to reduce emissions and waste of their production processes. Some studies suggest that SMEs fundamentally differ from MNEs in terms of access to financial and human resources needed to access latest technologies and resources needed to usher in green business initiatives. Green manufacturing practices require access to the latest and most efficient technologies. However, often, many SMEs are operating with obsolete technologies due to resource constraints which curtails their ability to compete.

Despite the potential of economic contributions, policy makers' attention remains targeted at attracting only Western multinationals. In recent years, emerging markets have put little emphasis on cultivating and fostering the development of domestic firms to enter the renewable energy sectors. Government incentives and subsidies often needed to power such firms into the future are often lacking, leaving many to rely on potential foreign collaborations that have often borne little or no fruit. Taken together, research is needed on different mechanisms for achieving effective green manufacturing and sustainable waste management.

6. Conclusions and Limitations

This study sought to problematize the received wisdom, unquestioned assumptions and incorrect diagnosis of the sources and health consequences of various forms of wastes in Africa. Based on two case references from Congo and Ghana and through the theoretical lens of market violence, we propose a framework that delineates the structural composition of costs imposed by market violence that ranges from extraction to e-waste disposal. These include: (i) loss of economic rents and initial environmental cost due to exploitative extraction, (ii) net exportation of resources, (iii) stagnation of local industries, (iv) loss of national brand attraction due to being a dump site for other nations' wastes and (v) the final environmental and health costs resulting from the unsustainable management of waste.

We explore the need for green manufacturing as a solution to the on-going waste problem. However, this may be inadequate unless the initial problem of exploitation and structural inefficiencies are made to accommodate sustainable innovations. As matters stand, it no longer seems possible to deflect the main arguments about responsible production and consumption or the accompanying individual and collective responsibilities in managing waste. As markets rise, there also seems to be a fall in the quality of health [58,59] and a weakening of other determinants of health [86]. The policy interventions are few, inconsistent, and not sufficiently radical to fix the problem with urgency despite the scale. The lack of repair resulting from planned obsolescence and high costs of spare parts/components should now receive serious regulatory and research attention. The suggested green manufacturing agenda must be met with a change in attitude towards green consumption, increased investments in technical education and other incentives, without which the sustainability agenda will not succeed.

As with all papers, there are limitations which we try to make up for in one way or another in order to meet the goal of the study. Notwithstanding our efforts, the major limitation of the study is that it provides more questions than answers. However, that in fact fulfils the original end goal of the paper, although we are unable to provide an exhaustive list of topics. We hope that the proposed future research questions highlight new areas that require focus on the fundamentals rather than offer more ‘me-too’ topics.

Other limitations of the paper are that although one of the authors was on an observation and confirmation tour at the Agbobloshie dumping site and recorded and documented activities at the Kwame Nkrumah Circle and Madina markets (street electronic dealerships and repairs in Accra), there are various limitations of the research which need to be confronted and spelled out as we suggest themes for future research. We did not set out to conduct a full-scale comparative case study, hence the lack of interview data and the dependence on documentaries and literature. The subject of waste dumping in Africa has been in the news and documentaries by almost all global TV networks and several news agencies, but the omission has been the structural and historical causes to it. On the other hand, there is the need for future research to dig deeper into the problematic(s) related to the unending exploitation and environmental degradation. These are important initial phases of the problem that leads to both adverse health and environmental effects on populations across Africa.

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