

SUSTAINABILITY = SURVIVAL

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ABSTRACT - Introduction to Sustainability

I was asked to review an abstract that addresses research and industrial adoption of environmentally advanced technologies in Africa, more generally, in tropical developing countries. The report examined the Nigerian pulp and paper industry as a case study. It started with qualitative interviews with twenty senior executives representing five Nigerian firms challenging conventional expectations that energy intensive industries in developing markets operate amidst highly pollution-intensive conditions, within weak or non-existent formal environmental regulatory frameworks, and with limited institutional capacity. The findings of this report suggest a strong positive relationship between cleaner technology use and corporate financial performance of these African industrial firms. The study also suggests an adoption of classical ‘win-win’ integrated preventive environmental strategy, eco-efficiency and green productivity which improves industrial efficiency and profitability. This group of Nigerian pulp and paper firms have moved beyond end-of-pipe technologies, implemented cleaner technologies, adopted industrial ecology and “zero emission” principles with appropriate reuse of the remaining waste streams turning the production system into a sustainable industrial ecosystem.

The economics of clean technologies differ from one industry to another. In particular, the pulp and paper industry is a sector where cleaner production would significantly affect future economic performance. Recent research in Vietnam indicates significant environmental and financial benefits (UNIDO, 2005). In principle, cleaner technologies do not need to generate a high rate of return or a short payback period to be considered successful because most pollution prevention technologies are cheaper than conventional end-of-pipe technologies (US Congress, 2004).

Hence, a greater emphasis on prevention can reduce environmental compliance costs, regardless of the economic benefits in countries with emerging environmental regulatory framework such as Nigeria.

Keywords: advanced environmentally technologies, environmental policy, eco-innovation, financial performance, pulp and paper

INTRODUCTION

Green Investment and Business Performance: The African Experience

In today’s market everyone is looking at the world in both a financial and sustainability perspective. A number of studies have linked eco-innovation, environmental technologies and financial performance in developed countries and several emerging economies in South-East Asia (Hart and Ahuja, 1994; Cohen, et al, 1995; Russo and Fouts, 1997) We know little, however, about their association in tropical developing countries. The research was designed to illuminate advanced environmental technology adoption in one such economy –Nigeria– in one illustrative industry – pulp and paper.

Research Question and Conceptual Model

What are the drivers for the adoption of advanced environmental technologies in the Nigerian pulp and paper industry? What are the conditions under which a decision to adopt cleaner technologies is reached, leading to firm competitiveness? Informed by the literature and by preliminary interviews with government and industry leaders in Nigeria, the authors designed a conceptual model, presented as Fig. 1 below, to guide the research.

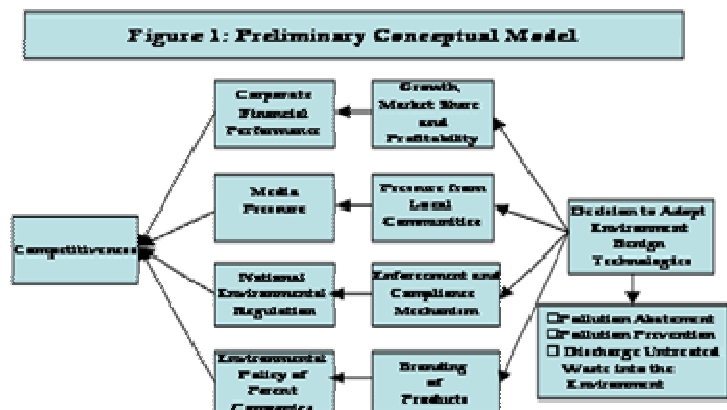


Fig. 1. Preliminary Conceptual Model

Several factors that could drive the decision for the adoption of advanced environment technologies have been identified (Lall, 1992; Freeman and Soete, 1997). The model chosen suggests that the decisions may be influenced by a variety of factors including corporate financial performance, media pressure, and environmental policy of parent companies as well as national environmental regulation. These factors

may influence at least three types of decisions:

1) Dispose of waste in the easiest and cheapest way possible, i.e., untreated release into the environment through effluent discharge, emission release and/or dumping of solid waste (Parto and Hebert-Copley, 2007).

2) Use pollution abatement which involves end-of-pipe technologies to treat waste prior to release into the environment thereby bringing hazardous constituents to within legally acceptable levels through dilution, neutralization, solidification or incineration (any “innocuous” waste can be landfilled) (Yap, *et al.*, 2007); and.

3) Rely on pollution prevention which includes implementation of cleaner technologies to analyze sources of waste and the adoption of organizational, process and/or equipment changes to eliminate, minimize or otherwise control waste. Cleaner technologies are based on the simple principle of “continuous application of an integrated preventive environmental strategy to reduce risks to humans and the environment,” (UNEP, 1994).

The report conjectured that these decisions might impact firm performance and competitiveness. The preliminary fieldwork indicated that a number of environmental factors including government policies and emerging environmental regulations could moderate the relationships between investment drivers, decisions and outcomes. A significant outcome of the adoption of environment advanced technologies may include competitiveness and profitability as in the case of normal technological innovation.

However, competitiveness is defined as growth, market share and profitability. Though the ultimate objective of competitiveness is profitability, it may or may not be linked to that of competitiveness (Adeoti, 2001). It is recognized that competitiveness does not always imply more profit, especially in the contemporary world of imperfect competition and strategic behavior of industrial firms. A firm’s strategy to acquire market share in order to attain optimal economies of scale may initially result in less profit (or even loss). Such a strategy may include eco-innovations that may boost consumer acceptance of products. Market share may be gained at less profit to the firm.

Competitive firms are generally known to be innovative firms (Tidd, *et al.*, 1997; Porter and Linde, 1995). The capacity of a firm to adopt environment-friendly behavior may depend on the competitive nature of the firm, every competitive one being more prone to recognize opportunities for eco-innovation than a less competitive one.

Literature Review

The researchers reviewed literature on the drivers of adoption of environmental advanced technologies and its relationship to corporate financial performance. They also reviewed previous work on cases of socially responsible investment in advanced environmental technologies that has led to competitiveness. Most of the literature reviewed was based on studies in developed countries and developing

countries of Asia. There is an acute dearth of literatures on the subject in Africa. This work will contribute to the growing body of emerging literatures in the field in tropical developing countries.

Several theoretical frameworks have been used to offer insights about adoption of environmental advanced technologies, among them Institutional theory and Resource-Based theory. Institutional theory acknowledges the role of external forces in technology adoption (Bansal and Roth, 2000; Bansal, 2005) while the Resource-Based theory dictates that company’s internal resources can be a source of competitive advantage (Khanna and Damon, 1999).

However, Berrone, *et al.* (2007) suggests that the adoption of environmental innovation might be advanced by a conceptual merger of both theoretical frameworks.

Institutional theory has been used extensively since 1930 (Bansal and Clelland, 2004; Hoffman, 1999; Jennings and Zandbergen, 1995) as a lens for understanding corporate responses to increasing pressures for environmental management. Given increased social awareness of organizational wrongdoing and the explicit environmental demands, institutional theory predicts that companies can gain legitimacy by reducing their impact on the environment and exhibiting socially responsible performance (Bansal, 2005; Bansal and Clelland, 2004).

On the other hand, Resource-Based theory, perhaps the most influential framework in environmental management (Hart, 1995) views the capacity to innovate as a source of competitive advantage since innovations are knowledge-based. Accordingly, environmental innovations may lead to more complex, environmentally advanced technologies, processes and products. These in turn might lower overall company costs, boost long-term competitive advantage and ultimately enhance corporate financial performance (Christmann, 2000). Empirical evidence demonstrates that companies facing stronger environmental regulation are more likely to innovate more, than companies operating in weaker regulatory environments (Brunnermeier and Cohen, 2001; Jaffe and Palmer, 1997).

Drivers of Environmentally Advanced Technologies

Most of the existing studies on the drivers of environment advanced technology adoption are limited to developed countries (Dasgupta, *et al.*, 2001). Developing countries, particularly those in Asia, are fast adopting industrial pollution control standards similar to those in developed countries (Foulon, *et al.*, 2002).

Progress has been greatly hampered, however, by the absence of clear and legally binding regulations, limited institutional capacity, lack of appropriate equipment and inadequate information on emissions (Wheeler, 1992). Studies in Asia suggest many factors, including ownership, scale, sector, trade and other business relationships and local regulatory enforcement among others (Dasgupta, *et al.*, 2001; Foulon, *et al.*, 2002).

Few studies on environmentally advanced technologies from Nigeria have been conducted. Evidence from the work

of Oyelaran-Oyeyinka (2002) on the innovation response of private Nigerian brewing firms to a state-induced crisis suggests that size, ownership, manufacturing skills and technical affiliation were decisive factors in the innovation success of firms that survived and prospered in a decidedly-turbulent environment. In addition, Adcoti (2001) indicates that the firms in the food and beverage and textile sector are actively involved in adoption of cleaner technologies that may enhance water use economy and process-related innovations that may reduce or eliminate the generation of wastewater at the source.

The determinants of pollution abatement by twenty-six pulp and paper plants in four Asian countries: Bangladesh, India, Indonesia and Thailand were investigated by Dasgupta, *et al* (1988). Evidences from the study shows that the level of pollution abatement is positively associated with scale and competitiveness, negatively associated with public ownership and unaffected by foreign links.

Socially Responsible Investment and Financial Performance

While socially responsible investment has figured in commercial life for centuries, corporations in recent years have been increasingly pressured to play a more explicit role in the welfare of society (Wartick and Cochran, 1985; Wood, 1991) and in particular to demonstrate environmental sensitivity. But traditional economic arguments suggest that managers should make decisions that maximize the wealth of the firm's equity holders by making decisions that enhance the present value of the firm's future cash flows and it has been argued by those theorizing a negative relationship between social responsibility and economic performance that added costs may result from investment in environmentally advanced technologies putting a firm at an economic disadvantage compared to other less socially responsible firms. (Balabanis, *et al*, 1998).

An argument provided by Tuzzolino and Armandi (1981) provides a Motivational Theory of Organizational Social Response based on Maslow's hierarchy of needs. This postulates that corporate social responsibility is the fulfillment of a firm's "internal and external self-actualisation needs" which are located on the top of their organizational needs pyramid. The theory argues that firms adopt corporate social responsibility after they have satisfied three earlier layers of needs (which includes physiological or survival needs fulfilled by corporate profits; safety needs such as dividend policy, conglomeration and competitive position and affiliate needs such as participation in trade associations, lobby groups and so on) (Epstein, 1987).

On the other hand, some business scholars have argued that firms have a duty to society that goes beyond maximizing the wealth of equity holders (Swanson, 1999; Whetten, *et al*, 2001). A firm perceived as high in social responsible investment may face fewer labor problems and customers may be more favorably disposed to its products. In addition, social responsible investment might improve a firm's

reputation and relationship with bankers, investors and government officials. Improved relationship with them may well be translated into economic benefits (Mc Guire, *et al*, 1988). Socially responsible behavior is considered and influences the behaviors of investment decisions by banks and other institutions (Graves and Waddock, 1994). Hence, a high social responsible investment profile may improve a firm's access to sources of capital (Pava and Krausz, 1996).

A positive relationship between environmentally advanced technologies and competitiveness has been argued as a possible outcome in dynamic rivalry models of industrial organization theory (Paulus, 1988). It is argued that in an attempt to stay ahead of competitors, firms do invest in research and development and choose technologies that offer competitive prices after internalizing the externalities like pollution control costs (Pradhan and Barik, 1999). The relationship between competitiveness and environment-friendly behavior is grounded by several studies using econometric estimation (Birdsall and Wheeler, 1993; Wheeler, *et al*, 1995). A positive relationship between scale and profitability (as competitiveness variables) and environment-improvement has been documented (Hettige, *et al*, 1996).

Evidence suggests that some forms of socially responsible investment and environmentally advanced technologies may actually improve the present value of a firm's future cash flows and thus, may be consistent with the wealth maximizing interests of the firm's equity holders. For example, socially responsible behavior can enable a firm to differentiate its products in its products (McWilliams and Siegel, 2001), enable a firm to avoid costly government-imposed fines and reduce a firm's exposure to risk (Godfrey, 2004). All of these socially responsible actions can increase the present value of a firm's future cash flows and are therefore consistent with maximizing the wealth of the firm's equity holders.

Environmentally Advanced Technologies and Competitiveness

The Porter hypothesis of environmental innovation and industrial competitiveness (Porter, 1990; Porter and Linde, 1995) argued that environmental regulations can stimulate growth and competitiveness through a dynamic process of innovation.

A stringent well-designed environmental regulation not only leads to social benefits and improved environmental quality, but may *very often* also result in increased competitiveness for the regulated companies. The benefits lie within the effects that well-designed environmental regulations may have in stimulating innovation, leading to private benefits for regulated companies by increasing productivity or product value (Porter and Kramer, 2002).

The empirical results from the work of Pradhan and Barik (1999) on cleaner technologies identified the pulp and paper sector as one of the most polluting industries in India, indicates that competitiveness improvements, have positive influence on environment-friendly behavior.

However, Porter and Linde (1995) argued that the extent to which the adoption of environment advanced technologies can contribute to a firm's economic benefits would be different among industries, depending on the character of the products. That is the reason why one of the leading research questions examined specific cases where the adoption of environment advanced technologies has led to positive financial performance and competitiveness in the Nigerian pulp and paper industry.

Methodological Approach

This research utilized a qualitative approach. Much social science research has been directed toward the task of testing formal theories. The objective, however, was to generate a grounded theory, that is, one "grounded" in the data (Spradley, 1979; Glaser and Strauss, 1967). Qualitative research is an appropriate methodology when the objective is to generate grounded theory (Glaser and Strauss, 1967), a methodological approach employed in a variety of disciplines to describe and interpret the "lived worlds" of subjects (Glaser, 1978; Schatzman and Strauss, 1973).

A major function of theory is to provide a model (Strauss, 1995; Maxwell, 2005). Grounded theory does not refer to any particular level of theory, but to theory that is inductively developed during a study (or series of studies) in constant interaction with the data from the study (Glaser and Strauss, 1967). This theory is grounded in the actual data collected, in contrast to theory that is developed conceptually and then simply tested against empirical data. In qualitative research, both existing theory and grounded theory are legitimate and valuable (Clarke, 2005).

Sample

The study sample consisted of twenty upper echelon executives representing five pulp and paper firms operating in Lagos State and Oyo State, Nigeria. The five firms were selected from a population of 19 such companies invited to participate in the study.

Five companies representing the existing ownership structure and the classifications of the Nigerian pulp and paper industry comprising pulp and paper products, printing and publishing and sanitary towers, diapers and napkins were selected for an in depth study involving four executives from each of the companies to allow for diversified opinion on corporate strategy, operations, finance and human capital. Respondents included Managing Directors, Operations Directors, Human Resources Directors and Procurement Directors.

The ownership structure of the five companies cut across multinational, foreign ownership (Lebanese, Chinese and Indian) and one was fully owned by a Nigerian. All of the five companies employed over 200 persons and could be classified as large scale enterprises according to Lall, et al. (1994) and Oyelaran-Oyeyinka (1997).

The companies had been operating between 20 to over 30 years. The respondents were all male, aged between 50 to 65 years. All had extensive work experience in the pulp and

paper industry ranging from 25 to 40 years and all were university educated with a minimum of undergraduate degrees. Most had graduate degrees. All were well versed in adoption of environmental advanced technologies. We used a theoretical sampling technique characteristic of grounded theory. Grounded theory has no predetermined guidelines for sample size selection (Locke, 2000).

Findings

The team analysis generated the following two key findings:

1. Investment in environmentally advanced technologies in developing markets is driven by five factors:
 - a. Availability of raw material
 - b. Local environmental regulatory pressures
 - c. Technical knowledge
 - d. Ownership
 - e. Management characteristics
2. There is a strong positive relationship between environment-advanced and cleaner technologies and corporate financial performance.

The table below summarizes the allocation of the codable moments across the findings and between the executives interviewed (Managing Directors (MDs), Operations Directors (ODs), Procurement Directors (PDs) and Human Resources Directors (HRDs)).

Finding 1: Drivers of investment in environmentally advanced technologies

The data revealed that pulp and paper industry executives in Nigeria appreciate the benefits of eco-friendly technologies and, surprisingly, are investing in them to a degree uncommon in most developing countries. The executives explained that investment is influenced by five specific factors:

Table 1. Allocation of codable moments across the findings

See below Table

Table 1: Allocation of Codable Moments across the Findings

Findings	% MDs	% ODs	% PDs	% HRDs	% Codes
1. Environment-benign technologies drivers					
• Availability of raw material	32%	28%	23%	17%	16%
• Pressure from local environmental regulator	28%	42%	16%	14%	10%
• Technological knowledge	33%	45%	16%	6%	7%
• Ownership	40%	25%	21%	14%	5%
• Management characteristics	28%	24%	22%	16%	9%
2. Positive relationship between environment-benign technologies and corporate financial performance	41%	31%	17%	11%	31%
Total					78%

obsolete. That is government for you” (OD Company #1)

1.1. Availability of raw material

Pulp and paper executives lamented the moribund state of their industry in Nigeria and the reasons for it. As demonstrated in comments below, respondent’s reported disillusionment with pessimism about government policy regarding the industry.

Ineffective government policy, they concurred (as exemplified in comments below), has fueled foreign importation of supplies to and control of production in Nigeria.

Attitudes about government policy

“Nigeria has the trees for short fibre pulp. If you visit Oku-Iboku, you would weep for Nigeria. Oku-Iboku is a town. They are all owned by the government. They all die.” (HRD of Company #3)

Ineffective Government Policy on Raw Materials

“We have three paper mills. The problem is leadership. They all die. If you see what we are losing, you would weep for Nigeria. We have to innovate to remain in business”. (MD Company # 2)

“Jebba is a village. The trees are planted there. Now they went into oblivion because they are run as government business. This is very sad indeed” (MD of Company # 4).

“Nigeria now imports pulp and paper products. A lot of us now have recycling plant to bring our cost of production down. I am aware of five functional recycling plants in Lagos and another one at Aba. We have to do this to remain in business.” (HRD Company #5)

“Nigeria has three paper mills. All were working initially. Like government ventures, they were run down. The cost of importing virgin pulp is high. We have to invest in recycling to still remain in business” (MD Company #1)

“There is no paper mill in Nigeria anymore. We import materials from China and South Africa. China has taken over the paper industry”. (MD Company #3)

“The federal government has good intention to set up the paper mills. Instead of bringing new machines, they brought outdated machines.” (PD Company #1)

“Some group of Indians bought over the Jebba paper mill. They are struggling to resuscitate it. Whether it is doable or not is another story. The machines are archaic.” (PD Company #2)

“The colour of the paper produced at Iku-Iboku newsprint was yellow instead of white because the machines were

Innovation as a key to survival

“We have the challenge of raw materials. We have to innovate to survive. That is why we have to invest in recycling and other cleaner production techniques.” (OD Company #3)

Strong state regulation

“LASEPA insisted that our effluent must be treated not to affect marine life. We have a functional ETP. Our water is recycled back to the system for processing.” (OD Company #1)

“LASEPA is responsible for the enforcement of pollution laws in Lagos State. You must submit EIA report to LASEPA before operations.” (OD Company #4)

“Lagos State EPA makes lots of noise. They said our waste is environmentally damaging. They caught us once and ask us to pay \$10,000. They even close down our factory.” (MD Company #1)

“We paid \$18,000 to our consultant for environmental audit. That is regulation. We update every 5 years.” (MD Company #3)

“There is an edict on waste management in Lagos State. LAWMA has a contract with the industries to cut away waste to sanitary landfill. This is not the case in Oyo State.” (PD Company #3)

“We monitor our emission monthly. We test the BOD, COD, suspended solids and trace metals. Even though the enforcement mechanism is weak in Oyo State, we have our own international environmental policy.” (OD Company #3)

In this difficult environment, pulp and paper executives looked to innovation as the key to survival. Innovation, they reported, included investment in clean technologies as indicated in comments by the participants:

“We have the challenge of raw materials. We have to innovate to survive. This is why we have to invest in recycling and other cleaner production techniques” (OD of Company #5)

This very issue came up during a recent audit in the US Mill where water usage per ton of paper in a facility was addressed by our auditing team. The reply by the mill manager was simple when water usage becomes a cost factor then we will address this issue. Knowing water is a valuable resource but the fact that currently water is abundant meant he did not have to innovate.

In other countries where resources are scarce innovation and environmental performance is a determining factor to reaching for sustainability.

1.2. Pressure from local environmental regulators

Without exception, all interviewees attested to the role of strong state regulation as a driver of firm investment in environmentally advanced technologies. Sixty three codable moments referenced this finding. In particular, respondents, indicated under comments by those interviewed environmental legislation including guidelines and standards for the abatement and control of pollution and environmental impact assessment, audit, monitoring and compliance regulations for their investments in effluent treatment plants for liquid waste and for cleaner technologies (including reducing, reusing and recycling of solid wastes).

1.3. Technological knowledge

Interviewees unanimously referenced sources of technological knowledge about plants, equipment vendors and international consultants as important in their clean technologies investment decisions.

Most of the executives reported that their investment in environmentally-advanced technologies resulted from advice rendered by international consultants and their equipment was sourced mostly from vendors in Italy and Germany. No eco-innovation, they reported, was Nigeria sourced.

Source of technological knowledge

“When you get to a portion of our factory, you would think you are in Europe. We have upgraded our factory to what we saw in Europe in terms of cleaner technologies”. (OD Company #2)

“Recycling has led us to start a new business. This advice came from our friends outside of Nigeria. The recycling plant is a very profitable business today.” (PD Company #5)

“We are expanding our equipment base by 2 million Euros for more environmentally friendly equipment’s based the suggestion from our international consultants.” (HRD Company #1)

Ownership

Ownership of the firm whether multinational, foreign or local emerged as a key driver of firm investment in environmentally advanced technologies as highlighted in Executives acknowledged that foreign firms (mainly Indian, Chinese and Lebanese) own and operate most of the pulp and paper facilities in Nigeria and hence most of the investment in environment-advanced technologies is motivated by foreign firms. Most of the foreign firms have cleaner production in place, often featuring the same technology that operates in their parent companies abroad.

“The pulp and paper industry in Nigeria are taken over by the Chinese and Indians. It is capital and technologically intensive. Only a foreigner can invest in cleaner production with long payback period” (MD Company #2)

“Our liquid waste is treated. We do not emit hazardous waste into the environment. This is our organization policy as an Asian company”. (HRD Company #2)

“Less than 5 out of 100 companies are indigenous. Nigerian companies cannot practice clean technologies due to lack of capital.” (OD of Company #5)

“Our environmental policy is more stringent than National Regulations. Our policy is designed to meet more than expected from government regulatory body.” (MD of Company #3)

“The Jebba paper mill is taken over by Indians. Nigerian influence is few. The re-engineered Jebba paper mill is already investing in cleaner technologies because they know the benefits more than Nigerians.” (PD Company #2)

“Nigerians do not own business. They want quick money. They do not have the right attitude to environmental compliance like the foreign owned companies” (OD Company #1)

1.5. Management characteristics

Management education, experience and quality influence the adoption of eco-friendly technology. The majority of executives interviewed had advanced university degrees and an average of 25 years of experience in the pulp and paper industry. Typically these managers came with international job experience and/or training, mostly from Germany and Italy (who are considered to be in the forefront of environment-advanced technologies).

Typical was a Procurement Director who joined his organization in 1984 and had extensive local and overseas training in Italy, Germany and Belgium where he had seen the benefits of cleaner production and subsequently tried to mimic it in Nigeria. A Managing Director of another firm and a lifelong veteran of the pulp and paper industry reported bringing innovation into this company based on his overseas exposure. Hence, evidence from the study provides a link between adoption of environment-advanced technologies and management education and experience.

Management education, experience and quality

“Our MD did not study engineering. However, he is versed in eco-innovation based on his exposures in over 15 countries” (PD Company #3)

“I joined as Factory Manager in 1984. I have seen the benefits of cleaner production in Italy, Germany and Belgium. We are working to make our production

system attain the same standard.” (PD Company #5)

“I have been in pulp and paper for upward of 30 years. I joined Glaxo-Alenberg (UK) in 1970. This exposure is relevant for our innovation in cleaner technologies.” (MD Company #2)

“I have various training in several countries. I joined this company 21 years ago. The overseas training is highly important to our eco-innovation.” (PD Company #2)

“I joined Wittgenstein (UK) in 1964. I have brought a lot of innovation onto this company based on my overseas exposures in environmental friendly technologies.” (MD Company #4)

“I have been in the pulp and paper for 32 years. I have worked in United States, Argentina, Egypt, and South Africa. These experiences are very useful in my current position.” (MD of Company #3)

Positive relationship established between environmentally advanced technologies and financial performance

The data provides strong evidence of a positive relationship between environmentally advanced technologies and financial performance in the Nigerian pulp and paper industry. Those interviewed stressed the salubrious bottom line effect of eco-friendly technology adoption. As expected, all respondents stressed the impact of economic conditions on their investment decisions. More than 194 of the 627 codable moments representing 31 percent captured in the analysis reflected the consensus of the interviewees that cost considerations and economics, in fact, were considered the first and most significant driver of investments in environmentally advanced technologies in the Nigerian pulp and paper industry.

Although adopting environmentally advanced technologies tapped financial reserves, executives looked upon that investment in terms of cost saving. As illustrated in the quotes by the respondents explained production process redesign, for example as intended to reduce waste cut cost and engagement in recycling as a requirement to remain in business.

Environmentally advanced technologies investment led to profitability

“The only option in a raw material crises situation like this is cleaner technologies. This is compulsory or you would remain out of business” (MD of Company #3)

“People come from all over the country to sell waste paper to us. We convert waste to wealth for economic reasons. It is a profitable business” (OD of Company #4)

“Cleaner technologies have given us a brand name which ultimately has led to an increase in the products

acceptability and profitability.” (HRD Company #3)

“If anything happens to raw material cost, the whole equilibrium is distributed. We take an advantage of economics of scale. We reduce our raw material cost with recycling.” (PD Company #1)

“We sell our brown solid waste to an asbestos company in Ikeja called Nigerite. We allow the white solid waste to go to our sister company. This is smart economics.” (OD Company #5)

Conveying the spirit of the majority of the respondents, the Operations Director of one company called it “smart economics” to sell the firm’s brown waste to an asbestos ceiling company to “make more money” and the Managing Director of a multinational company said the only option in a raw material crises situation like Nigeria’s is cleaner technologies which made investment in them compulsory.

In addition, the Managing Director of one company (consistent with the views of most of the respondents) reported how eco-innovation adoption has led his firm to establish a highly profitable recycling subsidiary and acknowledged that several pulp and paper industries in Nigeria were operating profitably after investing in similar cleaner technologies.

Implications

The findings of this study have implications for environmental regulators in tropical developing countries characterized by lack of a formal regulatory framework and enforcement mechanism, limited institutional capacity and inadequate information on emissions. The data suggest that environmental education about the economic benefits of cleaner technologies could enhance compliance with minimal cost to regulators. The findings also have implications for the shareholders of the pulp and paper industries in Nigeria. The study indicates a positive relationship between environment-advanced technologies and financial performance.

Even in developing economies, environmental sustainability, they conclude, need not conflict with wealth creation. Some forms of socially responsible investment and environment advanced technologies have been identified that may actually improve the present value of a firm’s future cash flows, consistent with the wealth maximizing interests of the firm’s equity holders ^{(Mc Guire, et al, 1988; Pava and Krausz, 1996).}

The study suggests that a firm might stay ahead of competitors by investing in research and development and choosing technologies that offer competitive prices after internalizing the externalities. By installing cleaner technologies—which allow companies to reduce, reuse and recycle waste, manufacturing industries can reduce waste emissions by at least 25 percent without any investment in end-of-pipe technologies.

One of the primary drivers of environmentally advanced technologies identified is raw material availability. This has implication for global greenhouse gas emission and climate change because trees in tropical forests typically hold, on average, about 50 percent more carbon per hectare than trees outside the tropics. This means that an investment in cleaner technologies in the form of reduction, reuse and recycling of waste could potentially reduce tropical deforestation. Land-use change contributes to 20 percent of world global greenhouse gas emission ^{(Stern, 2006).} In addition, the study suggests that research and development in alternative raw materials could also contribute to a reduction in global greenhouse gas emission. A demonstration project by the Nigerian Federal Institute of Industrial Research suggests that “*Kenaf*”, a weed like sugar cane available in abundance in savannah area of Nigeria could be a potential raw material for the Nigeria pulp and paper industry. These are green areas for future research. Other areas include empirical analysis of the determinants of environmentally advanced technologies in tropical developing countries, reflecting investment in these technologies of the research findings.

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