

**ECO-INNOVATION AND FINANCIAL PERFORMANCE IN AFRICA:
EVIDENCE FROM THE PULP AND PAPER INDUSTRY**

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ABSTRACT

Addressing a paucity of research about industrial adoption of environmentally benign technologies in Africa and, more generally, in tropical developing countries, we examined the Nigerian pulp and paper industry as a case study. Qualitative interviews with twenty upper echelon executives representing five Nigerian firms challenge conventional expectations that energy intensive industries in developing markets operate amid highly pollution-intensive conditions, within weak or non-existent formal environmental regulatory frameworks, and with limited institutional capacity. Our findings suggest a strong positive relationship between cleaner technology use and corporate financial performance of African industrial firms. Our study also suggests the adoption of classical ‘win-win’ integrated preventive environmental strategy, eco-efficiency and green productivity which improves industrial efficiency and profitability. Nigerian pulp and paper firms are shown to have moved beyond end-of-pipe technologies and cleaner technologies and adopted industrial ecology and “zero emission” principles with appropriate reuse of the remaining waste streams turning the production system into a sustainable industrial ecosystem.

KEY WORDS

Environmentally Benign Technologies, Environmental Policy, Eco-Innovation, Financial Performance, Pulp and Paper

INTRODUCTION

A number of studies have linked eco-innovation, environment-benign 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 present research was designed to illuminate benign environmental technology adoption in one such economy – Nigeria – in one illustrative industry – pulp and paper.

In developed countries the prevailing regime of environmental policy drives eco-innovation (USEPA, 1992; UNEP, 1993). However, the case might be different, we conjectured, in tropical developing economies where environmental policy usually takes the form of traditional command-and-control. These countries, in particular, are characterised by highly pollution-intensive conditions, weak or non-existent formal environmental regulatory frameworks and enforcement mechanisms, limited institutional capacity, inadequate information on emissions and nearly zero government-imposed “price of pollution”. Hence, decisions for eco-innovation in this context might be motivated by factors other than those that characteristic in developing economies.

In Nigeria, decisive environmental legislation was not enacted until 1988 when hostile media response to the dumping of five ship loads (3888 tons) of toxic wastes' of Italian origin at Koko Harbour and led to the establishment of the Federal Environmental Protection Agency (FEPA), mandated to develop institutional and regulatory strategies for environmentally sustainable development. We conducted qualitative interviews with

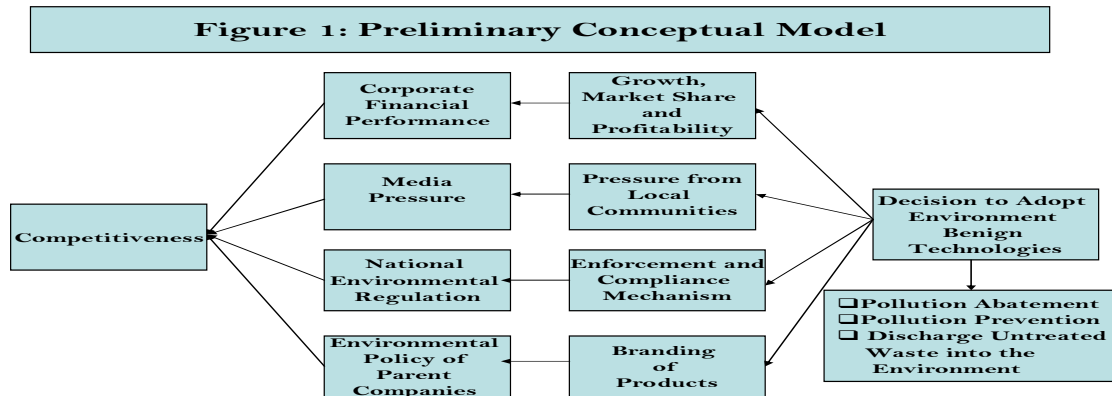
32 leaders of Nigeria's pulp and paper industry to understand the impact of FEPA and/or other potential drivers of eco-innovation on decisions to adopt benign technologies

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 does not need to generate high rate of return or short pay back 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.

RESEARCH QUESTION AND CONCEPTUAL MODEL

What are the drivers for the adoption of environment benign 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, we designed a conceptual model, presented as Figure 1 below, to guide the research.



Several factors that could drive the decision for the adoption of environment benign technologies have been identified (Lall, 1992; Freeman and Soete, 1997). Our model 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 analyse =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).

We conjectured that these decisions might impact firm performance and competitiveness. Our 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 benign technologies may include competitiveness and profitability as in the case of normal technological innovation.

In Nigeria, environmental policy falls within the scope of two regulatory measures developed by the Nigerian Federal Ministry of Environment – basic guides and standards expected in monitoring and controlling industrial and urban pollution and composite law which makes it mandatory for industrial facilities to install pollution abatement equipment or make provision for effluent treatment, and prescribes maximum limits of effluent parameters allowed for contravention (FEPA, 1991).

The S.I.8/S.I.9 law was enacted in August 1991, and industry was given three years (up to December, 1994) moratorium within which to make necessary technical changes for compliance. It specifies technology adoption for firms' compliance with statutorily permissible levels of effluent parameters. Non-compliance with the base law, S.I.8/S.I.9 is expected to be punished by penalties ranging from a stipulated fine to factory closures and/or imprisonment of owners) of a persistently erring factory. Thus, the law did not come into full effect until January 1995 (FEPA, 1995). According to FEPA (1991), the interim guidelines and standards that gave birth to the S.1.8/S.1.9 law was widely circulated and reviewed by relevant government ministries, industries, universities, and individuals in 1990.

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 behaviour 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 behaviour 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

We reviewed literature on the drivers of adoption of environmental benign technologies and its relationship to corporate financial performance. We also reviewed previous work on cases of socially responsible investment in environment benign 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. Our work would 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 benign 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 benign 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 evidences demonstrates that companies that face 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 Benign Technologies

.Most of the existing studies on the drivers of environment benign 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 suggested 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 environment benign 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, Adeoti (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 benign 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 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 labour problems and customers may be more favourably 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 behaviour is considered influences the behaviours 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 environment benign technologies and competitiveness has been argued as a possible outcome in dynamic rivalry models of industrial organisation 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 behaviour 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 environment benign 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 behaviour 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 Benign 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 behaviour.

However, Porter and Linde (1995) argued that the extent to which the adoption of environment benign 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 our leading research questions examined specific cases where the adoption of environment benign technologies has led to positive financial performance and competitiveness in the Nigerian pulp and paper industry.

METHODS

Methodological Approach

This research utilized a qualitative approach. Much social science research has been directed toward the task of testing formal theories. Our 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

Our 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. Letters were sent by the Executive Director of the Paper and Paper Board Manufacturers and Converters Association (PPMCA) to all 19 to facilitate recruitment of interview candidates. The Executive Director of PPMCA made follow up phone calls to the companies a week after dispatching the letters by courier. Follow up visits were made to the companies to confirm acceptance. All of the 19 companies confirmed their willingness to participate. However, 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.

Four of the five firms in the study were located in Lagos, the former capital of Nigeria and the remaining was in Ibadan, the largest indigenous city in Tropical Africa. Over ninety percent of the Nigerian pulp and paper companies are located in Lagos State. Three of the companies had business interests in at least two of the classifications. The remaining two companies operated in only one of the classification.

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 benign technologies. We used a theoretical sampling technique characteristic of grounded theory. Grounded theory has no predetermined guidelines for sample size selection (Locke, 2000). Hence, sample size cannot be predicted. While initial sample selection was based on general inclusion criteria, theoretical sampling is directed by theme emerging from concurrent data collection and analysis (Strauss and Cobin, 1990; Glaser and Strauss, 1967). Sampling continues until data provided a thick rich description of the study phenomenon and no new themes emerges (Glaser and Strauss, 1967).

Hence, seeking to reach theoretical saturation, the data collection evolved from general sampling to relational sampling (that is, seeking to understand relationships) and ended with discriminate sampling (that is, seeking to differentiate relationship) (Strauss and Cobin, 1990).

Data Collection

Data was collected during a five months period from May to September, 2008 in Nigeria. Semi-structured interviews of approximately 50 minutes duration were conducted on the premises of the five companies who participated in the study. Four interviews were conducted at each firm.

The respondents were given the option of a face-to-face interview (the researcher's indicated preference) or a telephone interview. These were set at time and venue convenient to the participant. All the participants opted for face-to-face interviews in an enclosed, private, comfortable office in order to mitigate interruption or ambient noise. A digital audio recording was made of each interview for ease of obtaining information and for accuracy in reflecting the comments. A one-time follow up visit was made on two occasions to clarify some points discussed during the original interview, which was not audio-taped as it was for clarification purposes only. The follow-up visit was made the week following the initial interview and lasted not more than thirty minutes.

Maxwell's (2005) situation specific interview process was adopted to develop the interview protocol used for all the respondents. The guide allowed interviewee's personal experience and stories to emerge as recommended by Spradley (1980). A convergent interview technique was adopted for the interview. A convergent approach was considered appropriate because the research was exploratory and designed to build rather than test theory. In addition, the interview process was also cyclic in nature creating room for continuous streamlining of the research issues and allowing a gradual convergence of the interpretation of the research data (Boyatzis, 1998).

It was explained to all the interviewees that the main focus of the interview was to understand the interviewee's experience on the drivers of the decisions for the adoption of environment benign technologies. The key interview questions included firm characteristics, the technologies adopted in their production processes and waste management and the drivers of the decision for the adoption of environment benign

technologies. Information on conditions under which cleaner technologies was adopted, leading to positive economic performance and competitiveness was also captured. At the conclusion of the interviews, each participant was given the opportunity to provide additional information. This opportunity to expand on earlier commentary often opens up new discoveries. In addition to the digital audio recording of the interview sessions, important comments and references were noted and used as journal and referenced during the data analysis phase. The researcher also observed factory production processes and environmentally benign technologies. Digital audio recordings of answers to questions asked during the factory inspection were made as were hand notes. The interview questions focused on the Nigerian forest resources, policy on recycling and reuse of raw materials, environmental regulation and enforcement mechanism, the evolution of the pulp and paper industry and evidence on adoption of environment benign technologies. The records of the research were kept private. Following the interview, the recorded information was transferred to a password protected computer and the interview was erased from the recorder immediately. Once the follow-up interviews were completed, all identifiers were removed from all records, including but not limited to, the master list. Further, no identifying information was included in the research findings. A transcription of the recording was made by a reputable commercial transcription service that understands and follows the precautions required for human subjects' research. A transcribed word processing file was stored with the associated audio file using the same security approach described above. All transcriptions were then loaded into coding software, *QUALRUS*.

Data Analysis

Data collection was carried out concurrently with data analysis and data collection continued until saturation was reached (Glaser, 1978; Glaser and Strauss, 1967). The interview transcripts and observational notes to be analyzed were read multiple times (Emerson, *et al*, 1995). The interview tapes were also listened to several times. During the period of reading and listening, notes and memos were written on what was seen and heard in the data. Tentative ideas were developed about categories and relationships.

An iterative process of data examination was adopted before formal data analysis was carried out (Maxwell, 2005; Boyatzis, 1998) cycling through the interview data to capture emerging ideas and link them to existing literature. This was followed by multiple iterations of coding of the raw data.

The data was initially subjected to open (inductive) coding to identify “codable moments” (Boyatzis, 1998) using intelligent qualitative analysis coding software, *Qualrus*. A total of 627 codable moments were captured. The codable moments were grouped into 42 sub-themes. Using a simple affinity mapping technique, the sub-themes were then grouped into 18 logically connected themes. Finally, the themes were grouped as described by Boyatzis (1998). Descriptive labels were given to words, phrases and sentences at this stage. The next analytical step was the development of major themes, a rigorous process involving re-examining the data relative to the preliminary conceptual model as well as new insights.

Using a grounded theory approach, categorizing reduces the number of substantive codes generated from the initial data analysis. Codes are constantly compared against each other until they are mutually exclusive (Strauss and Cobin, 1998). The third

phase of the data analysis is theoretical coding. At this stage, second level categories are linked together and theoretical codes emerge. The emerged theoretical codes are compared to existing knowledge in the study domain. Observations made during the interview process were also reviewed, revised and organized as data collection and analysis continued (Maxwell, 2005). . In total, 78 percent (489) of the 627 codable moments grouped into the two key findings discussed in the next section. The allocation of the codable moments across the findings is shown in Table 1 below.

FINDINGS

Our analysis generated the following two key findings:

1. Investment in environment-benign technologies in developing markets is driven by five factors:
 - a. Availability of raw material
 - b. Pressure from local environmental regulators
 - c. Technical knowledge
 - d. Ownership
 - e. Management characteristics

2. There is a strong positive relationship between environment-benign 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 Benign Technologies

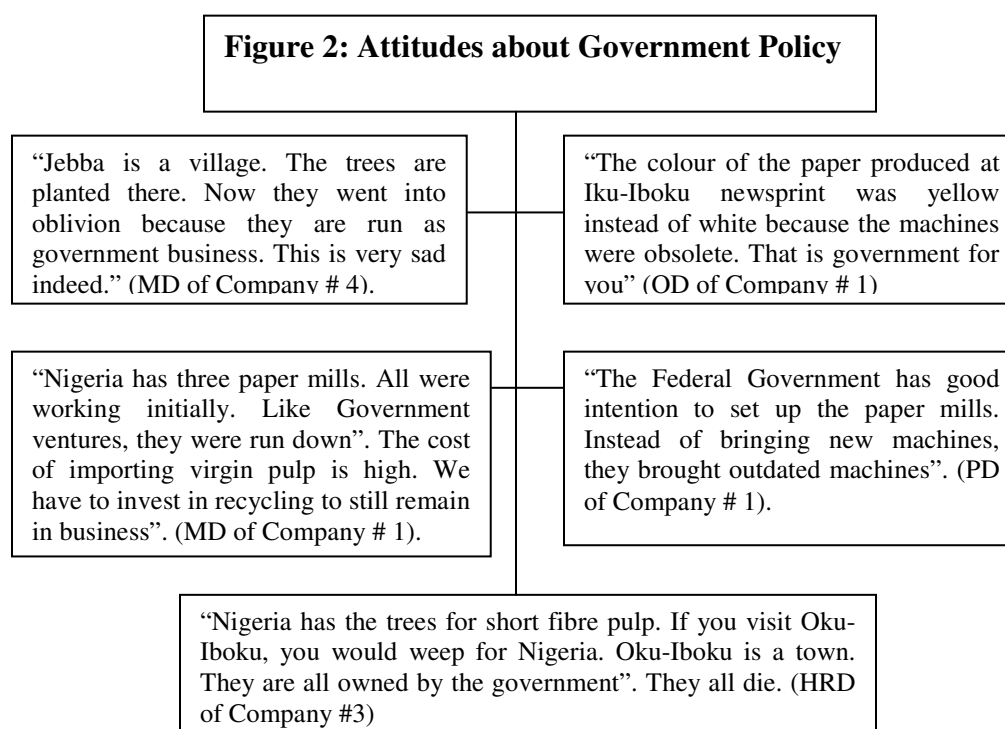
Our data revealed that pulp and paper industry executives in Nigeria appreciate the benefits of eco-friendly technologies and, surprisingly, are investing in them to a degree uncommon in most developing countries. Our executives explained that investment is influenced by five specific factors:

Table 1: Allocation of Codable Moments across the Findings

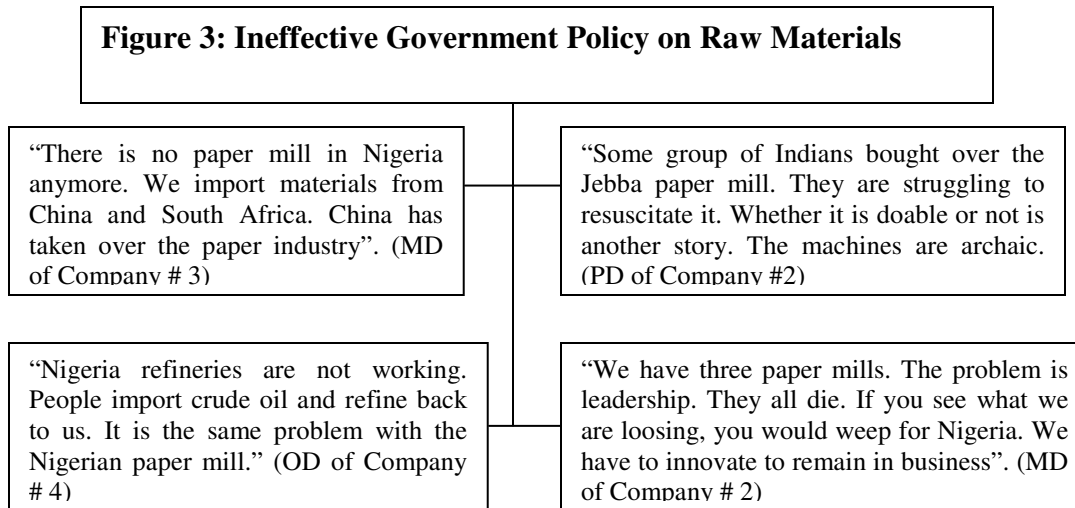
Findings	% MDs	% ODs	% PDs	% HRDs	% Codes
1. Environment-benign technologies drivers					
• Availability of raw material	32%	28%	23%	17%	16%
• Pressure from local environmental regulator	28%	42%	16%	14%	10%
• Technological knowledge	33%	45%	16%	6%	7%
• Ownership	40%	25%	21%	14%	5%
• Management characteristics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

1.1 Availability of Raw Material

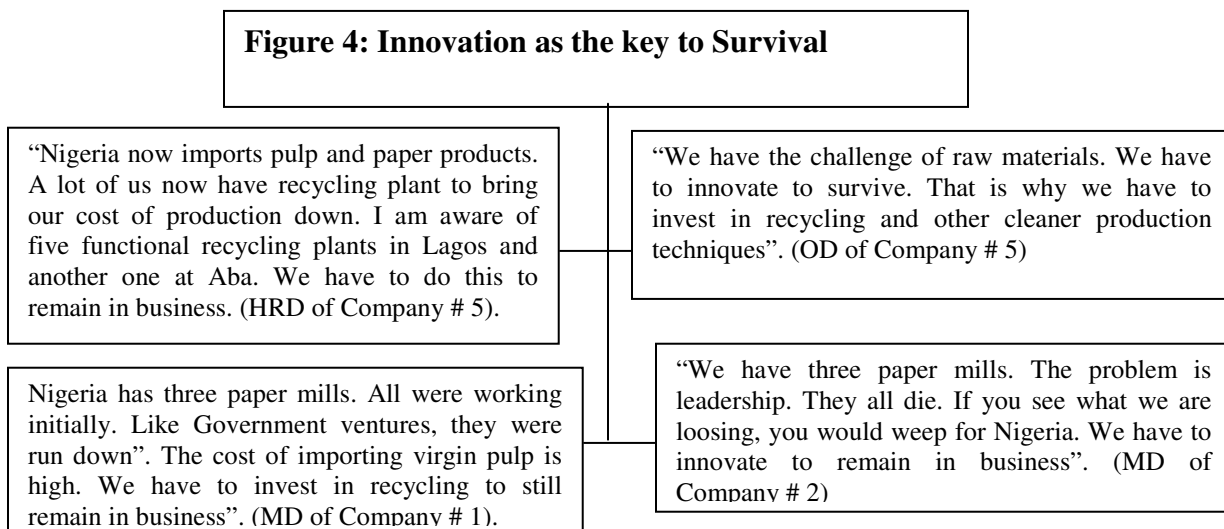
Pulp and paper executives lamented the moribund state of their industry in Nigeria and the reasons for it. As demonstrated in Figure 2 below, respondent's reported disillusionment with pessimism about government policy regarding the industry.



Ineffective government policy, they concurred (as exemplified in Figure 3 below), has fueled foreign importation of supplies to and control of production in Nigeria.



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 Figure 4 below:

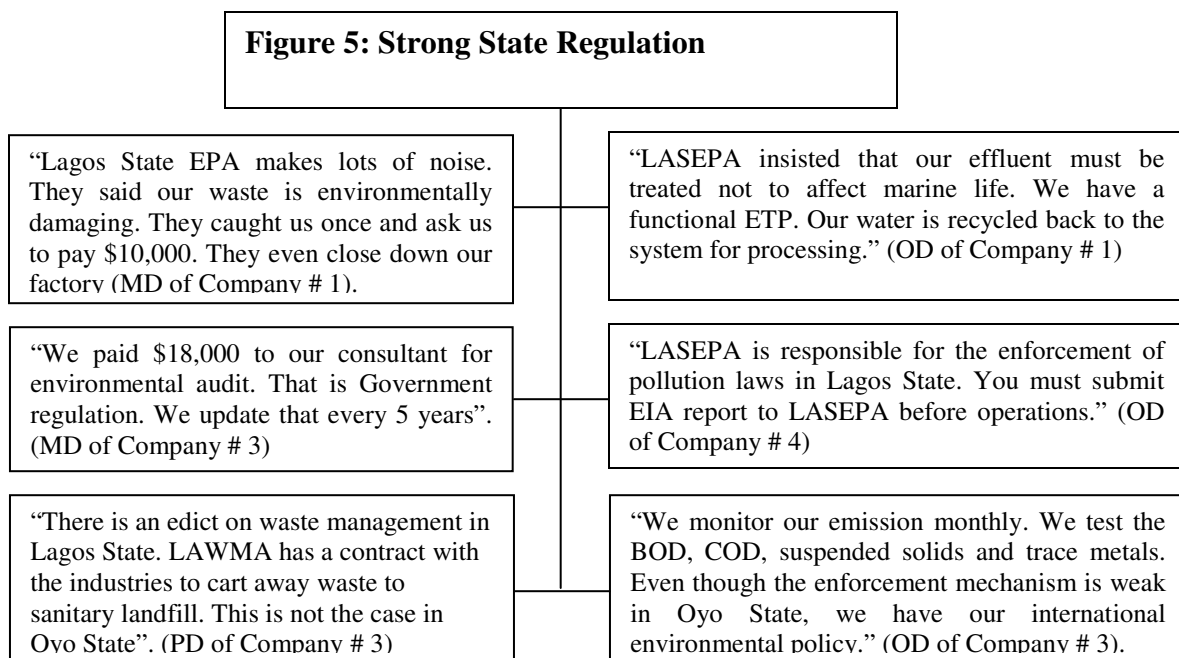


1.2 Pressure from local environmental regulators

Without exception, all interviewees attested to the role of strong state regulation as a driver of firm investment in environment-benign technologies. Sixty three codable moments referenced this finding. In particular, respondents, as indicated in Figure 5, cited 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).

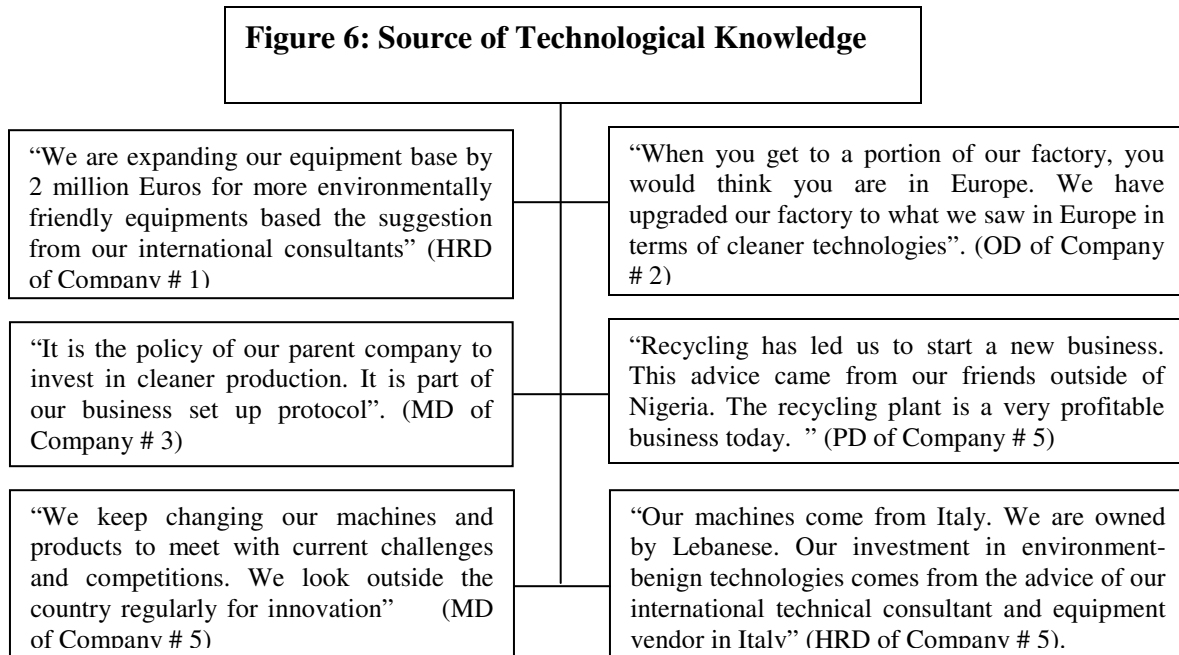
1.3 Technological knowledge

Interviewees unanimously referenced sources of technological knowledge about plants, equipment vendors and international consultants as important in their clean technologies investment decisions as shown in Figure 6 below:



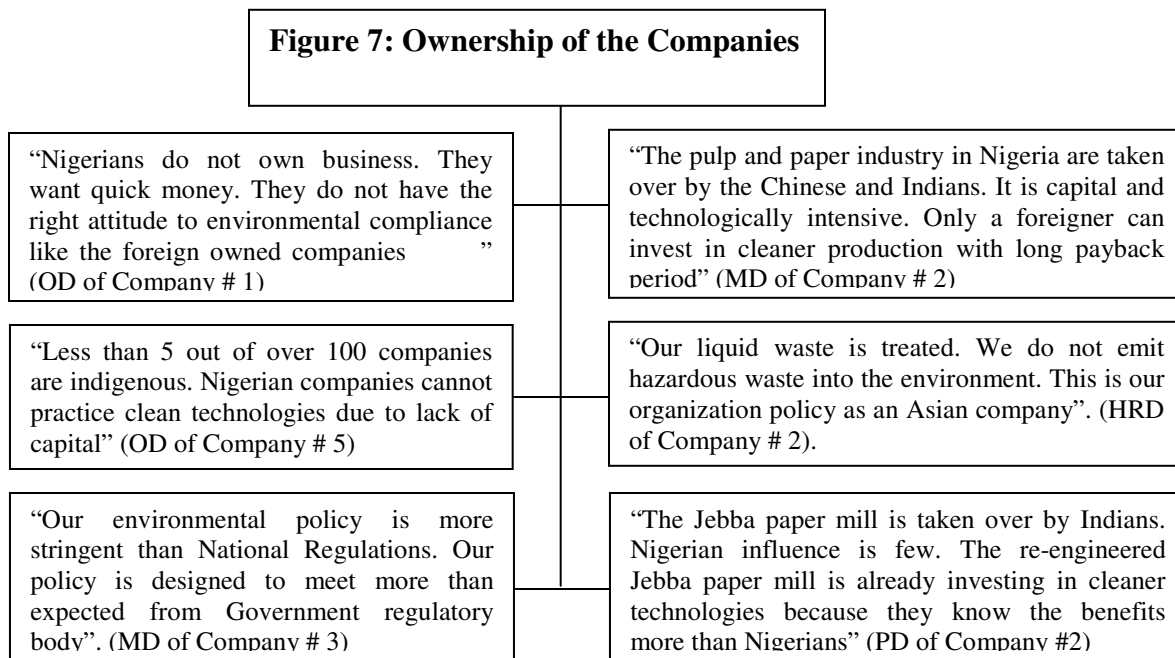
Most of the executives reported that their investment in environment-benign technologies resulted from advice rendered by international consultants and their

equipment was sourced mostly from vendors in Italy and Germany. No eco-innovation, they reported, was Nigeria sourced.



1.4 Ownership

Ownership of the firm whether multinational, foreign or local emerged as a key driver of firm investment in environment-benign technologies as highlighted in Figure 7 below. 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-benign 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.

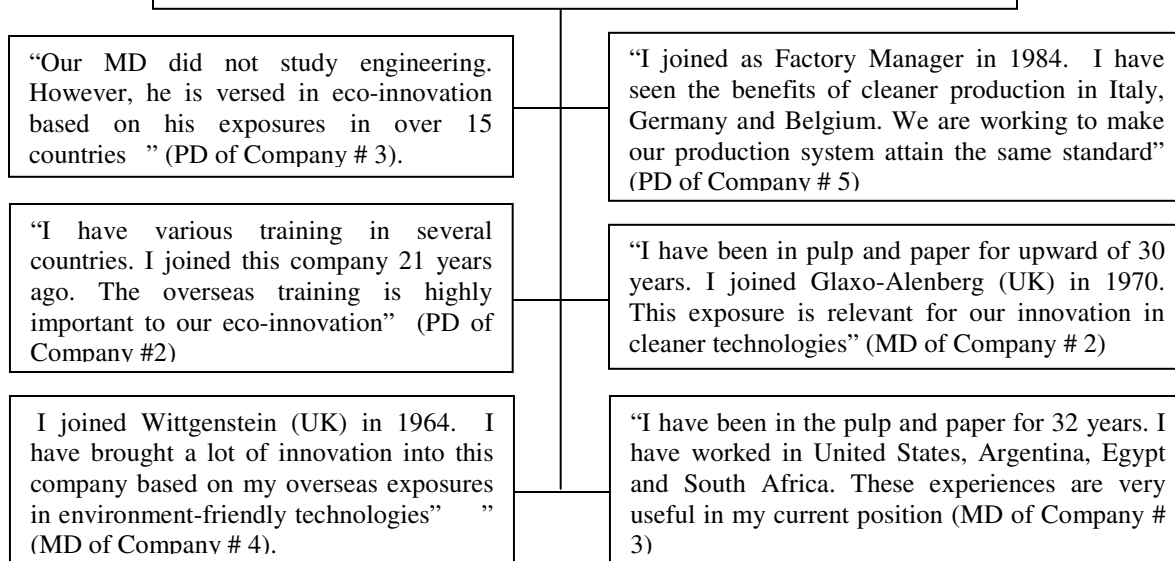


1.5 Management Characteristics

Management education, experience and quality influence the adoption of eco-friendly technology as illustrated in Figure 8. The majority of executives we interviewed had advanced university degrees and an average of 25 years of experience in the pulp and paper industry, typically including international job and/or training experience, mostly in Germany and Italy (considered the forefront of environment-benign 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-benign technologies and management education and experience.

Figure 8: Management education, experience and quality

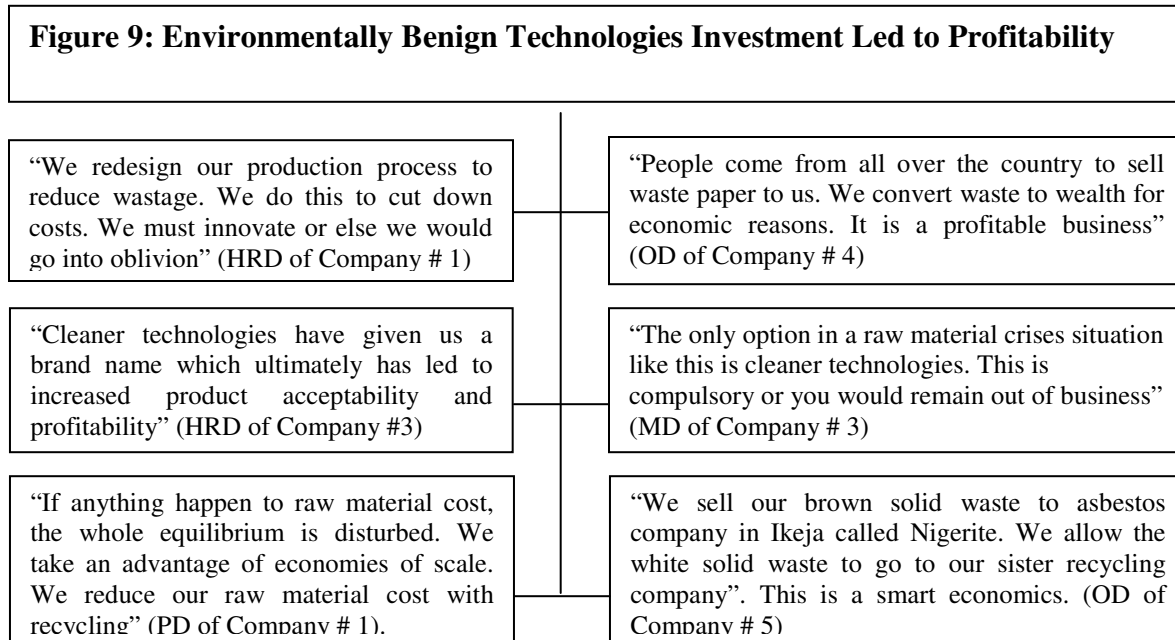


Finding 2: Positive relationship established between environmentally benign technologies and financial performance

Our data provide strong evidence of a positive relationship between environmentally benign technologies and financial performance in the Nigerian pulp and paper industry. Our interviewees 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 our analysis reflected the consensus of our interviewees that cost considerations and economics, in fact, were considered the first and most significant driver of investments in environment-friendly technologies in the Nigerian pulp and paper industry.

Although adopting environmentally benign technologies tapped financial reserves, executives looked upon that investment in terms of cost saving. As illustrated in the quote tree in Figure 9 below, respondents explained production process redesign, for

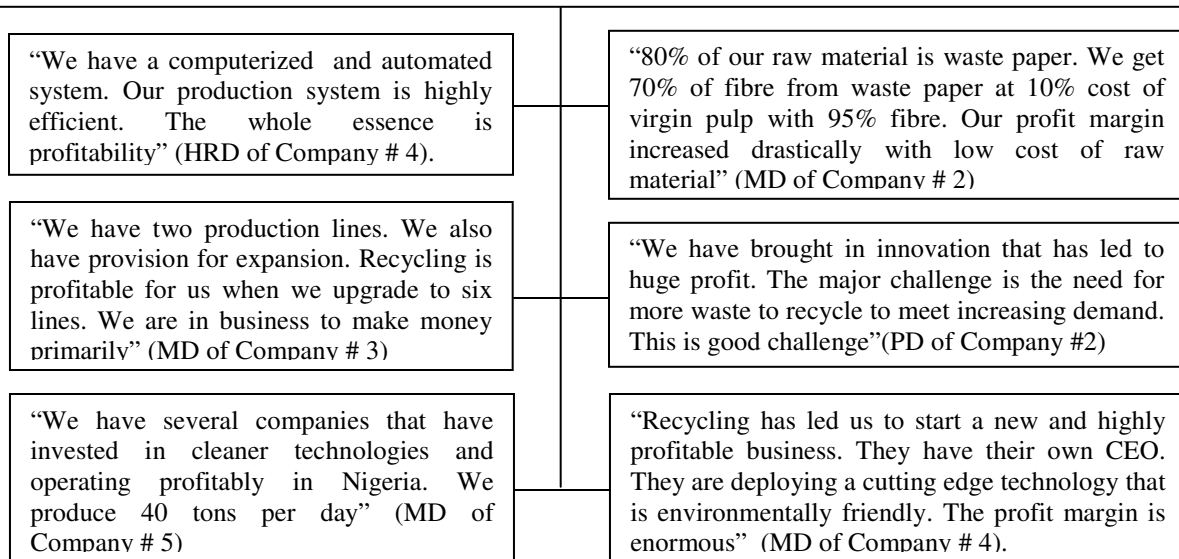
example as intended to reduce wastage and cut cost and engagement in recycling as a requirement to remain in business.



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, as illustrated in Figure 10 below, 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.

Figure 10: Eco-innovation Adoption led to Integrated, Automated and Efficient Production



DISCUSSION

Our findings challenge conventional expectations that energy intensive industries in developing markets operate amid highly pollution-intensive conditions, within weak or non-existent formal environmental regulatory frameworks and enforcement mechanisms, and with limited institutional capacity, inadequate information on emissions and nearly zero government-imposed “price of pollution.” We found the Nigerian pulp and paper industry is fast adopting environment benign and cleaner technologies that are similar to those in developed countries and emerging economies in Asia.

Evidence from our analysis suggests that the adopted cleaner technologies involve continuous application of ‘win-win’ integrated preventive environmental strategy, eco-efficiency, waste minimization, pollution prevention and green productivity to production processes to increase overall efficiency. This has included changes in raw materials, process technology and internal recycling which improves industrial efficiency, profitability, and competitiveness. The companies have also adopted zero-emission

industrial production processes to reduce raw materials and energy consumption, reuse/recycle waste/by-products and reduce waste disposal by recycling/reclaiming waste/by-products for other economic sectors.

Several factors that drive adoption of environment benign technologies in developing countries in several industrial sectors have been previously documented in the literature. (Wheeler, 1992; Lall, 1992; Dasgupta, *et al* , 1988; Dasgupta, *et al*, 2001; Foulon, *et al*, 2002). There is, however, a dearth of literature on the subject focused specifically on tropical developing countries. An exception is the work of Adeoti (2001) and Oyelaran-Oyeyinka (2002) who identified drivers of eco-innovation in the food and beverage and textile industries in Nigeria. The factors identified in their studies include corporate financial performance, media pressure, ownership, scale, sector, trade, local regulatory enforcement, environmental policy of parent companies, manufacturing skills, technical affiliation and competitiveness.

Evidence from our study supports some of these previously noted factors, but our findings include other drivers of eco-innovation that might be sector specific and also peculiar to tropical developing countries. While economic considerations, source of technological knowledge and ownership characteristics, all well demonstrated in our study as drivers of eco-innovation, have been previously acknowledged, raw material availability issues, pressure from local environmental regulators and management quality have not been. Our theoretical framework anchors on a conceptual merger of Institutional theory and Resource-Based theory. Institutional theory acknowledges the role of external forces in technology adoption (Bansal and Roth, 2000; Bansal, 2005) while Resource-Based theory dictates that a company's internal resources can be a source of competitive

advantage. External forces like source of technological knowledge which includes the use of international consultants, overseas equipment vendors and management overseas training emerged as key drivers of adoption of eco-innovation in the Nigerian pulp and paper industry as did internal resources like management education, experience and firms' internal capacity for innovation. Our study confirms the work of others about the positive relationship between environmental innovation and competitive advantage (Hart, 1995; Christmann, 2000). Our work demonstrates that environmental innovations may lower overall company costs, boost long-term competitive advantage and ultimately enhance corporate financial performance.

Pressure from local environmental regulators as a driver of environment-benign technologies has been previously observed (Brunnermeier and Cohen, 2001; Jaffe and Palmer, 1997). Companies that face stronger environmental regulation are more likely to innovate, and to innovate more, than companies operating in weaker regulatory environments. Such is the case of the Nigerian pulp and paper industry which has moved beyond end-of-pipe technologies and cleaner technologies and adopted industrial ecology and "zero emission" principles with appropriate reuse of the remaining waste streams turning the production system into a sustainable industrial ecosystem.

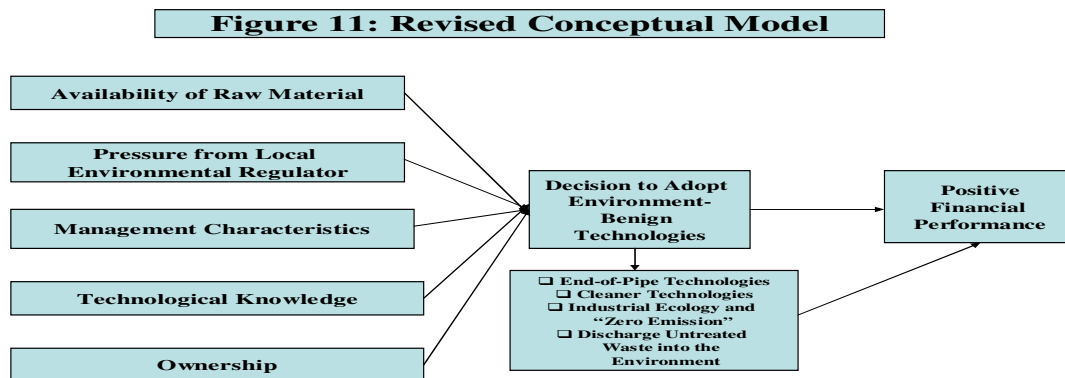
The literature suggests that eco-innovation may result in at least three types of decisions. One is waste disposal in the easiest and cheapest way possible - untreated release into the environment through effluent discharge, emission release and/or dumping of solid waste (Parto and Hebert-Copley, 2007). A second option is pollution abatement which involves using end-of-pipe technologies to treat the 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). A third option is pollution prevention which uses cleaner technologies to analyse the sources of waste and put in place organizational, process and/or equipment changes to eliminate, minimize or otherwise control the volume and hazard of the waste (UNEP, 1994).

Our study demonstrates that the Nigerian pulp and paper industry has adopted both end-of-pipe technologies and cleaner technologies. However, motivation for the adoption of the end-of-pipe technologies is more of pressure from local environmental regulator, ownership and management quality while motivation for the adoption of cleaner technologies includes raw material availability, economic considerations and source of technological knowledge.

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. It has also been argued by those theorizing a negative relationship between social responsibility and economic performance that added costs may result from investment in environment-benign technologies that put a firm at economic disadvantage compared to other less socially responsible firms. (Balabanis, *et al*, 1998). Our findings which ranked raw material crisis and economic considerations at the top on the list of drivers of adoption of environment-benign technologies, agrees with the wealth maximization concept of firm’s equity holders. A firm perceived as high in social responsible investment may create a brand that may well be translated into economic benefits (Mc Guire, *et al*, 1988).

A positive relationship between environment benign technologies and competitiveness has been argued as a possible outcome in dynamic rivalry models of industrial organisation theory (Paulus, 1988). It is argued that, in an attempt to stay ahead of competitors, firms invest in research and development and choose technologies that offer competitive prices after internalizing externalities like pollution control costs (Pradhan and Barik, 1999). This theory is well reflected in our findings. Evidence from our study demonstrates a positive relationship between environment-benign technologies and competitiveness. The firms we studied have invested in technologies that involve the application of ‘win-win’ integrated preventive environmental strategy that offers competitive advantage and profitability. Evidence from the study suggests the need for a revised conceptual model, presented as Figure 11 below. Some of the variables in our original model (sourced from previous empirical studies in other contexts) appear inapplicable to tropical developing countries, while other factors discovered in our inquiry are.



Finally, our work adds a fourth type of decision – sustainable ecosystem design adopting industrial ecology and zero emission concepts –to those options for actions reported in the literature and described earlier in this section.

Evidence from our study suggests that competitiveness does not always imply more profit. A firms' strategy especially with respect to eco-innovations may initially result in less profit (or even loss) in order to acquire longer term market share and attain optimal economies of scale. However, corporate financial performance should be enhanced in the long run. Consequently in our revised model the decision to adopt is shown as proximate to positive performance.

LIMITATIONS

Several limitations to the study are noteworthy:

Our findings were based on a sample that was small, non-random and geographically limited. Our respondents represented only 5 out of a population of 142 paper related firms in Nigeria. 90 percent of them are located in Lagos State. Ownership of the pulp and paper industry in Nigeria is largely foreign which was characteristic of over 90 percent of the firms represented in our sample. Most of the firms were medium and large scale enterprises. Hence, our findings may not be generalisable to micro or small firms.

Environmental regulatory activities in Nigeria are yet to target small-scale enterprises, especially in the informal sector of the economy (Oyelaran-Oyeyinka, 2002). Our findings suggest that the focus of regulation and compliance in Nigeria is on formal sector manufacturing enterprises, particularly those in the medium and large-scale

enterprises categories. This conforms to the generally observed trend in developing countries.

The institutional capacity for environmental regulation is an important determinant of firms' technology responses to the imperatives of environmentally sustainable industrialization (Adeoti, 2001). The institutional capacity for environmental regulation is difficult to quantify, and as such, could not be incorporated into the study.

Our findings appear to be satisfactorily robust and appreciably achieved the study objectives. However, quantitative research is recommended to verify the relationship between the decision of the firms' investment in environmentally benign technologies and financial performance in developing markets.

IMPLICATIONS

Our findings have implications for environmental regulators in tropical developing countries characterized by lack formal regulatory framework and enforcement mechanisms, 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 minima 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-benign technologies and financial performance.

Even in developing economies, environmental sustainability, we conclude, need not conflict with wealth creation. Some forms of socially responsible investment and environment benign 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 benign 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, our study suggests that research and development in alternative raw materials could also contribute to a reduction in global green house 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 benign technologies in tropical developing countries, reflecting investment in these technologies.

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APPENDIX

Interview Protocol

Subject ID # _____

Selected Pulp and Paper Industry

1. Tell me about yourself? How did you get involved with the pulp and paper industry?
2. What are the technologies that you have adopted in your production processes?
3. What are the technologies that you have adopted in the management of the waste (solid, liquid and gaseous emission) from the production processes?
4. Describe the decisions that went into the most recent adoption of the technologies for your production processes and waste management?

The Federal Ministry of Environment and the Federal Ministry of Industries

1. Tell me about yourself? How did you get involved with policy issues pertaining to the pulp and paper industry?
2. Tell me also about three most recent cases of firms' adoption of environment friendly behaviour in the pulp and paper industry?
3. Tell me about three most recent cases of policies and firms response to the adopting of environment friendly behaviour in the pulp and paper industry?

Raw Material Research Council and Federal Institute of Industrial Research

1. Tell me about yourself? How did you get involved with policy issues pertaining to the pulp and paper industry?
2. Tell me about three cases of raw material research that stimulates the adoption of environmental friendly behaviour in the pulp and paper industry?

Manufacturers Association of Nigeria and Paper Converters Association

1. Tell me about yourself? How did you get involved with policy issues pertaining to the pulp and paper industry?
2. Tell me about the three most recent cases of technologies adoption for production and waste management in the pulp and paper industry?