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Assessing the Socio-Economic Impact of Rice Processing Industries in Abakaliki Metropolis, Ebonyi State

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Abstract

This study assessing the socio-economic impact of rice processing industries in Abakaliki Metropolis, Ebonyi State. Rice processing industries have contributed significantly to economic development through employment generation, income creation, and increased rice production. Rice processing industries play a significant role in promoting agricultural development, employment generation, and economic growth in Ebonyi State, particularly in Abakaliki Metropolis, which is widely recognized as a major rice-producing area in Nigeria. Despite their contributions to socio-economic development, the activities of these industries have raised concerns regarding environmental pollution, waste management, and public health. The specific objectives were to examine the socio-economic contributions of rice processing industries, assess their environmental and health impacts, identify the challenges associated with their operations, and suggest measures for improving their sustainability. The study adopted a descriptive survey research design. A total of 345 structured questionnaires were administered to selected respondents using an appropriate sampling technique. Out of the distributed questionnaires, 320 were successfully completed and returned, representing a response rate of 92.8%. Data collected were analyzed using descriptive statistics comprising mean, variance, and standard deviation to summarize respondents' opinions, while the study hypotheses were tested using the Chi-square (χ^2) statistical technique at a 5% level of significance. The findings revealed that rice processing industries have contributed significantly to employment creation, increased household income, and local economic development, with respondents agreeing that these benefits were substantial (Mean = 3.19; Variance =0.78; Standard Deviation = 0.82). The study also found that the industries contribute to environmental challenges, including air pollution, indiscriminate disposal of rice husks, dust emission, and noise pollution (Mean =3.16; Variance =0.81; Standard Deviation = 0.90). Furthermore, the Chi-square analysis indicated a statistically significant relationship between the activities of rice processing industries and socio-economic development as well as environmental conditions in Abakaliki Metropolis ($\chi^2 = 112.5$ $df = 3$; $p < 0.05$), since 112.5>7.815 leading to the rejection of the null hypothesis. The study concluded that although rice processing industries have made substantial contributions to the economic development of Abakaliki Metropolis through employment generation, income enhancement, and increased agricultural productivity, their operations have also created environmental and health concerns that require immediate intervention. The study recommends that government agencies should enforce environmental regulations, promote modern and environmentally friendly rice processing technologies, establish effective waste management systems for rice husks and other by-products, and provide regular environmental monitoring and public awareness programmes. These measures will enhance the sustainability of rice processing industries while minimizing their adverse environmental impacts and improving the well-being of residents in the study area.

Keywords: *Rice Processing Industries, Economic Impact, Environmental Pollution, Employment Generation, Technological Impact, Abakaliki Metropolis.*

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Introduction

The crop rice (Oryza sativa L.) is an important staple food for almost half of the global population, with the world producing 509.87 billion kilograms (kg) of rice in 2021/22 (Shahbandeh, 2022). The crop is highly valued in Nigeria because of the significant contribution it makes to alleviate the problem of food insecurity. It used to be a ceremonial food item but has metamorphosed into a staple in many Nigerian homes (Bose et al., 2020). Agritech company ThriveAgric (2020), cited in Alabi et al. (2024), reported that Nigeria produces an average of 8 billion kg of rice, which makes the country the second largest rice producer in Africa, next to Egypt; and in 2019, the country produced about 55% of Africa's total rice volume of 14.6 billion kg and also ranked as the 14th largest rice producer in the world. Despite this production capacity, the country ranks as the world's second largest rice importer (Aminu et al., 2017) due to the volume of its rice consumption. For instance, Klynveld Peat Marwick Goerdeler (KPMG, 2019) noted that Nigeria is the 11th largest rice consumer globally and consumes 6.7 billion kg of rice annually, of which only about 57% is produced locally, leaving a supply deficit of about 3 billion kg. Thrive Agric (2020) also reiterated that Nigerians consume almost 7 billion kg of rice every year. Rice processing consists of several operations that convert paddy into milled white rice, with its quality being dependent upon the management capability of the processor (Ibitoye et al., 2014). The rice processing enterprise has assumed greater significance in improving the employment opportunities and standard of living in Nigeria (Gabdo et al., 2020). Despite being a capital-intensive industry, its importance to the national economy cannot be overemphasized, as both small- and large-scale paddy processing have contributed immensely to the economy of the country. Muthayya et al. (2014) reported that medium-sized and large modern mills have a processing capacity of between 60,000 and 220,000 kg of paddy rice per day, and Pham (2016) stated that most of the rice mills investigated were operating machines with a medium installed capacity of an average of 1,400 kg per hour in line with the recommendation of the Competitive African Rice Initiative (CARI) project, which proposed business models of rice mills with milling capacities ranging between 1,000 kg per hour and 2,500– 3,000 kg per hour. The rice market plays a central role in the development process as the link between producers and consumers. It has a significant function in the performance of supply chains and assumes greater importance in the Nigerian economy as the channel through which excess production is disposed of, to enable producers to earn some income for purchasing other needed goods and services (Oladapo et al., 2007). Market outlets include wholesalers, retailers, middlemen, processors, cooperative societies, and other marketing agents who ensure that agricultural products get to the final consumers (Donkor et al., 2021). Rice marketing involves all the business activities performed in the flow of paddy and milled rice from producers to consumers. Aderibigbe (1997) divided the marketing of local rice in Nigeria into four stages, namely: marketing activities that occur during production through harvesting, during the movement of the paddy from the farm to processing centers, during the movement of the milled rice from processing centers to urban consumption centers, and finally the wholesaling and retailing activities in urban centers. However, Zalkuwi (2019) identified retailers and wholesalers as the two main market intermediaries. Udah et al. (2021) described a normal market route as one in which rice farmers sell their paddy and processed rice to wholesalers, who resell to retailers, before the retailers sell to consumers. However, they observed what they termed a "zero-level" or "one-level" marketing channel in their study area. This is a type of marketing with no specific direction as it follows different routes due to changes in market conditions. It is a situation where rice farmers sell directly to wholesalers, retailers and consumers and is characterized by skipping the normal route as retailers bypass the wholesalers and buy directly from the farmers, and consumers also buy directly from the wholesalers or farmers, skipping the retailers. The reason behind skipping is the opportunity to purchase goods at a reduced price. Previous works have focused on the methods, profitability and challenges of rice processing in Nigeria; however, the availability of information on the current status of the rice processing and marketing activities in Nigeria is very germane to reducing the country's dependency on rice importation – hence this study. The specific objectives of this study were to determine the processing capacity of rice processing establishments across the selected states in Nigeria, to examine the motivations for participating in

rice processing, investigating the factors influencing rice processing in Nigeria, and to examine the marketing outlets employed for the distribution and sales of finished rice products – all with a view to analyzing the rice processing and marketing outlook in Nigeria.

As a food-processing industry, the ancient Abakaliki Rice Mill holds enormous potential in the development of agro-industrial in Ebonyi State. In view of this, it is imperative to study the rice milling enterprise from industrial perspective, so as to understand how the milling industry can be repositioned as a viable agro-industrial destination. This is one way of increasing the multi-functionality of food- processing industries.

Statement of the Research Problem

The focus of this study is on the assessment of the impact of rice processing industries in Abakaliki metropolis, Ebonyi state. Rice milling is often believed to be characterized by some environmental, social and economic effects such as environmental pollution/ degradation and the associated health problems, as well as conflicts, infrastructural abandonment, insecurity and wastage of resources. Ebonyi State in 2023, raised alarm over environmental degradation due to the presence of Abakaliki Rice mill industries. The current policy of Ebonyi State on rice production is rather "command and control" approach as in the 1980s in Nigeria and Indonesia than "cleaner production and market-based" as tested and later adopted in Indonesia of which the Government of Indonesia's claimed in 1995, as the most effective means of protecting their environment and promoting sustainable development in Indonesia. Although the claim by the Government is in consonance with the views of different authorities, it is on the other hand, contrary to the findings by some scholars that apart from the wastes improving soil productivity, it will also save the farmer the cost of buying artificial fertilizer since according to (Njoku et al., 2011), these economic wastes are obtained free in the study area. Also, it is not in line with the good news that it is an alternative source of energy as well as being medicinal and a whole lot of other advantages as stated in Farouk, et al., (2006). The divergence in views has continued to generate misunderstanding over the actual effects and/ or over all effects of Rice Mill among scholars. It has also extended to the policy formulation of some states like Ebonyi State on rice Mill location. In Ebonyi State, whereas the Government stresses that the presence of Abakaliki Rice Mill pollutes the environment, impedes economic development of the State and constitutes many health hazards, the owners of the Rice Mill 8 deny the claim, rather stating that they have gains to offer other than any form of loss. It is on the premise that the mill is polluting the environment and the policy of Ebonyi State to make Abakaliki capital city of the State the cleanest State in Nigeria that Ebonyi State Government mandated that Abakaliki Rice Mill Company Ltd be moved from its current location. This consequently has culminated in an on-going court case between the Ebonyi State Government and the owners of the Mill (Nigerian Orient News, 2010). According to Roguel et al., (2002), further studies should be conducted to verify the effects of rice hull-burning on health and the environment. Consequent upon the divergence of the views on the holistic effects of rice milling, there is a pressing need to investigate the holistic environmental and economic effects as well as the health implications of rice milling using rice processing industriesin Abakaliki metropolis as a case study

Research Aim and Objectives

The aim of the research is to assess the impact of rice processing industries in Abakaliki metropolis, Ebonyi state. The objectives of the study include;

i. To ascertain the economic impacts of rice processing industries along Ogoja road in Abakaliki metropolis.

ii. To determine of environmental effects of processing industries along Ogoja road in Abakaliki metropolis.

iii. To specify the social impact of rice processing Industries along Ogoja road in the Abakaliki metropolis.

iv. To identify the technological impact of Rice Processing Industries along Ogoja road in the Abakaliki metropolis.

Research Questions

i. What are the economic effects of Rice Mill along Ogoja road in Abakaliki Metropolis?

ii. What are the environmental effects of Rice Mill along Ogoja road in Abakaliki Metropolis?

iii. What are the social impact of Rice Mill along Ogoja road in Abakaliki metropolis?

iv. What are the technological impact of Rice Mill along Ogoja road in Abakaliki metropolis?

Research Hypotheses

i. Hypothesis 1: Ho: Abakaliki rice processing industries has no significant environmental effect in Abakaliki metropolis.

ii. Hypothesis 2: Ho: Abakaliki rice processing industries has no significant economic effect in Abakaliki metropolis.

Significance of Study

The study aimed to provide information on the assessment of the impact of rice processing industries in Abakaliki metropolis, Ebonyi State. The findings of this study are expected to benefit several stakeholders, including farmers, Chief Executive Officers (CEOs) of rice processing industries in Ebonyi State, government agencies, and universities.

Farmers will benefit from improved knowledge of processing practices and market opportunities. CEOs of rice processing industries will gain insights into operational efficiency and the broader economic and environmental impacts of their activities.

Government agencies will find the study useful for policy formulation, regulation, and strategic planning within the agricultural and industrial sectors. It will assist both government authorities and private individuals residing in Abakaliki metropolis, Ebonyi State, in making informed decisions and adopting effective strategies to enhance positive impacts while minimizing negative effects.

Universities and academic institutions will benefit by using the findings as reference material for further research and teaching.

Limitations of the Study

The limitations to the study were as follows:

i. The reluctance of the Government agencies to release the needed data for this study. However, this was overcome by the availability of many of them 18 from online by many authors and reporters who did not hesitate to post such on net.

ii. The difficulty in going round the community owing to the sparse settlement pattern in Abakaliki area of Ebonyi State. To overcome this difficulty, the villages were clustered for data collection.

iii. The large number of variables studied and low knowledge of the researcher in statistical data analysis. However, this was overcome by consulting experts in statistics who simplified and interpreted the data in forms understandable to him.

iv. Financial constraint was also a limitation as it took a lot of time in the period of this research to amass the needed number of resources necessary to complete the research. However, judicious use of the available resources made it possible for this research to be possible

Literature Review

This section is comprised of concepts relating to assessment of the impact of rice processing industries in Abakaliki metropolis in Ebonyi state. Chapter two also reviews relevant literature on the impact of rice processing industries, with particular emphasis on empirical studies conducted in Abakaliki metropolis, Ebonyi State, Nigeria. The review focuses on economic, social, environmental, and technological impacts, as well as methodological approaches used in previous studies.

Conceptual Framework

Rice Processing Industry

Rice processing refers to the post-harvest activities involved in converting paddy rice into consumable rice. These activities include parboiling, drying, milling, polishing, grading, and packaging. In Abakaliki metropolis, rice processing is largely carried out in clustered milling facilities, forming an agro-industrial hub.

Milling of rice is the removal of the husk and the bran layers of rice to produce an edible, white or brown rice kernel that is sufficiently milled and free of impurities (International Rice Research Institute 2014).

Rice milling plays a crucial role in global food security, as rice is a staple food for over a third of the world's population, including Nigerians who consume it in diverse ways across all socioeconomic classes (Okoye &Irem., 2019). Globally, about 85% of rice production is for human consumption (Muthayya et al., 2014; Jeong et al., 2017). In Nigeria, where rice is a staple for 90-95% of the population (Danbaba, 2019), the rice milling industry has significant potential to boost employment, the economy, and food security.

Agro-Industrial Development

Agro-industrial development involves the transformation of agricultural products into value-added goods. Rice processing industries contribute significantly to this process by enhancing the economic value of locally produced rice.

Beyond its nutritional value, rice also has medicinal uses, treating ailments like stomach upset, heartburn, indigestion, and even some cancers and warts (Zhang, 2021). Long before Ebonyi State was created in 1996, Abakaliki was renowned for its high concentration of rice mills, the largest in West Africa (Okoye & Irem., 2019; Okonkwo et al., 2021). Today, around 500 privately owned mills operate across the state, processing and distributing rice to wholesalers and retailers. Major Rice farming areas include Ikwo, Abakaliki, Izzi, Ebonyi, Afikpo South, and Ivo. The increased production from these areas has led to the development of a robust marketing system to handle the surplus. Abakaliki's suitability for rice cultivation dates back to its fertile, hydromorphic soils, similar to those in Ishielu and Ehugbo. By 1960, Abakaliki rice had achieved national and international recognition, traded and transported extensively throughout Nigeria and even to Ghana (Okonkwo et al., 2021). The popular Abakaliki Rice Mill cluster established in 1967 is a large privately owned and cooperative-operated milling industry located along the popular Ogoja Road, opposite the Abakaliki Motor Mechanic site in Abakaliki LGA, Ebonyi State. The Cluster plays a vital role in the economy of the State, serving as a key hub for rice production and processing. It boosts agricultural productivity, ensuring a steady supply of high-quality rice to local and national markets while supporting food security. The cluster generates significant employment opportunities across the rice value chain, from farming to processing and marketing, while also supporting related industries such as transportation and equipment

manufacturing. In addition to creating jobs, the cluster contributes substantially to the state's revenue through taxes and export earnings (Okonkwo et al., 2021), improving local incomes of the State and the standard of living of the people of Ebonyi. Its renowned rice quality has attracted investors and fostered market expansion, further promoted rural development (Emeafor & Okpoto, 2018), while simultaneously served as a center for knowledge and technology transfer, equipping farmers and processors (including rice harvesters and mill operators) with modern techniques to boost efficiency and yields.

Agro-processing industries are classified into the food and non-food industries.

The food processing industries are more homogeneous when compared to the non-food industries because their products serve the same end use - consumption. Conversely, non-food industries serve multifarious purposes where a good number of them combine artificial substitutes (synthetics) with natural raw materials in production. Two forms of processing exist within the agro-based industries – primary and secondary processing. Primary processing includes the simplest of processes such as washing, peeling, chopping, milling of wheat for flour production and the processing of sugarcane etc. (Agricultural Research Council (ARC), 2015:34-35).

Secondary processing involves the conversion of primary processed products into more complex food products and includes procedures such as mixing, depositing, layering, extruding, drying, fortifying, fermentation, pasteurization, clarification, heating etc (Agricultural Research Council (ARC), 2015:34-35). Opportunities abound in the agro-processing sub-sector. Kindness and Gordon (2001, cited in Kuwornu, Bashiru and Dumayiri 2014:191) submit that agro-processing creates jobs with little capital investment and makes good use of local resources. It also creates vertical linkages when small farmers supply inputs to the value chain (Overseas Development Institute 2005 in Kuwornu, Bashiru and Dumayiri 2014:191). Agro-processing industries also have a number of beneficial feedback effects on agriculture. The most glaring could be the spur it provides for increase in agricultural production as a result of market expansion. This is true because market expansion in terms of establishment of processing industries stimulates consumer demand for processed items and in turn, supply of raw materials. Notwithstanding their vital contributions to development, agro-processing industries also impact negatively on the environment especially where sustainable practices are not adhered to. Environmental hazards associated with agro- processing include: emission of dust and gases that pollute air quality, discharge of organic wastes into water bodies and production of noxious substances etc. With the emergence of agro-tourism, greater link is being made among tourism, food and the food processing industries since food is a fundamental element in tourist experience. Pine and Gilmore (1999) have argued that increasing competition in consumer markets is driving a shift from the former service economy towards an "experience economy". In this sense, food has become one of the most important arenas of experience production (OECD 2012). As noted by Greg in Hjalager and Greg (eds. 2002:3), "food is central to the tourist experience and has become a significant source of identity formation in postmodern societies". Food processing is equally interesting to the adventurous tourist who seeks novel experience in terms of observing and taking part in the processes that bring about the food consumed while away from home.

As a staple food around the world, rice processing industries present opportunities for the development of agro-tourism activities. In the Caribbean Island of Dominican Republic, Efe-EpaCotui (2017) reports that efforts are underway to transform the rice industry into a tourism resource through the rice route initiative.

Rice Route is an ecotourism proposal to complement the country's traditional leisure offerings of sun and beaches Taking advantage of the rice industry and the natural surroundings, the Rice Route is one of the pillars of the strategic plan aimed at improving the living conditions for residents. The Rice Route takes visitors on a tour of the entire production process from preparing the paddies to processing the grain.

Be that as it may, the capacity of food processing industries such as the rice mill to boost agro-tourism activities is a function of how well challenges in the sector are dealt with. In a paper on 'Rice Processing Challenges and Prospects in Ebonyi State' delivered on the occasion of 2016 NEST- FUNAI conference, the following challenges were identified in the rice processing industry: poor quality and insufficient paddy rice, equipment constraints and use of outdated milling technology, poor branding, pitiable marketing infrastructure, financial constraints, inconsistent government policy on rice import and lack of well-trained machine operators and committed staff. These and many more contribute to the poor quality of local rice.

Furthermore, in a paper titled 'Adding Value to Rice through Processing in Nasarawa State,' Allahnana (2014) regretted that although local farmers produce the bulk of the rice farmed in Nigeria, they suffer from poor revenue due to the poor quality of rice produced. He blamed the situation on lack of knowledge, equipment and technique for the processors to improve on rice milling. He identified value addition which can be achieved through improved rice milling technology as the means by which local rice can compete favorably with imported rice. Similarly, Ajala and Gana (2015) identified the need to improve the quality of indigenous rice to compete with foreign rice through selection and adaptation of modern rice technologies to ease labour in production and enhance nutritional qualities in rice processing and production. They also concurred that government has a central role to play in forming strong policies that will favour production of local rice as it is being practiced in the advanced world.

Theoretical Framework

This study is anchored on the following theories:

Industrial Cluster Theory

Industrial cluster theory explains the geographical concentration of interconnected businesses. The Abakaliki rice mill cluster exemplifies this theory, where firms benefit from shared infrastructure, labor, and market access. The Abakaliki mill complex is organized into three wings labeled Line A, B, and C with 24 clusters, each consisting of a central road flanked by milling buildings on both sides. In each of the lines, buildings on the right are numbered with odd numbers, while those on the left are even-numbered. Each building is considered a cluster, housing four large milling halls. Each hall typically contains a minimum of three milling machines, one destining machine, and two bag-sewing machines. The current energy source in the cluster is firewood and Diesel generators. This has made the operators to use diesel to run the machines and firewood in parboiling rice. The use of/and high cost of diesel in Nigeria increases the price of rice per Kg milled from the cluster and also creates its artificial scarcity thereby adding to the food insecurity.

Value Addition Theory

This theory posits that processing agricultural products increases their market value, leading to higher income and economic growth. Value Addition Theory in rice processing emphasizes that the more refined, improved, and market-ready rice becomes, the higher its economic value. Moving beyond raw paddy sales to processed and branded rice significantly boosts profitability and sustainability in the rice industry.

Sustainable Development Theory

This theory emphasizes balancing economic growth with environmental protection and social equity. It is relevant in assessing the environmental impacts of rice processing industries. Sustainability is the ability to maintain a certain status or process in the existing systems. The widely accepted definition of sustainability or sustainable development was given by World Commission on Environment and Development in 1987. It defined sustainable development as "forms of progress that meets the needs of the present without compromising the ability of future generations to meet their needs." For humans, sustainability is the long-term maintenance of responsibility, which has

environmental, economic, and social dimensions and encompasses the concept of stewardship which is the responsible management of resource uses (Daly et al., 2004)

Ecologically, sustainability can be defined as means of configuring civilization and human activity so that society, its members and its economies are able to meet their needs and express their greatest potential in the present, while preserving biodiversity and natural ecosystems, planning and acting for the ability to maintain these ideals in the very long term. Practically, sustainability refers to three broad themes, economic, social and environmental, that must all be coordinated and addressed to ensure the long-term viability of our community and the planet.

When considering existing or new individual, business, industrial and community practices or projects one must ensure that economic, social and environmental benefits are achieved. Each person, business, and industry have a role and a responsibility to ensure their individual and collective actions support the sustainability of our community. Sustainability is important because all the choices we pursue and all the actions that we make today will affect everything in the future. We need to make sound decisions at present in order to avoid limiting the choices of generations to come. For example, if you continue wasting water and polluting the dwindling supply of freshwater that we have today, we leave future generations with no other choice than to desalinate saltwater or treat contaminated water for their consumption and daily use. We can also be assured that, if that happens, all life that depends on clean freshwater will become extinct.

The same goes with the supply of soil that we currently have. Without proper care, our soils can easily lose quality enough that they will no longer be able to encourage growth and sustain life. If that happens, future civilizations will be void of crop and other natural sources of food. They will then have no other choice but to create man-made sources for nourishment and sustenance. If clean water and good soil become scarce enough, all life on Earth can become extinct. Keep in mind that this does not just apply to soil and water but all elements of nature that are crucial to sustaining the Earth's equilibrium. The four types of sustainability include human, economic, social, and environmental. All four are required to maintain the entirety of life on Earth. Although interconnected, it is important to note the differences of each in terms of its nature and requirements (Daly et al., 2004).

The very basic need of human sustainability is good reproductive health and safe childbearing. Those that reproduce have the responsibility of caring for their children, giving them access to proper education, and promoting their health and wellness. At some point, the children should have enough skills and knowledge such that they can sustain their own way of life. It is at that point that they become considered as productive human capital as well as individuals that can go through the process of reproduction and rearing. As long as this process is maintained at a rate that all human systems can support, human sustainability should be no cause for concern (Brower et al., 1999).

Economic sustainability is having a set amount of capital for a certain period. This means that we must preserve all our resources as we consume them so that human beings in the future can enjoy them as well. To achieve this, we must regenerate our resources at a rate that is equal to or faster than our consumption (Hak et al., 2007).

Social capital is an important aspect of sustainability because it is through communities and civil societies that humankind can easily and inexpensively work together. Without proper levels of social capital, it can easily deplete and violence as well as mistrust can take over. When that happens, societies and everything else that depends on them will be destroyed. Through proper maintenance of and adherence to laws, rules, and values that societies have developed for the common good, social sustainability can be achieved (Hak et al., 2007).

Furthermore, environmental sustainability also involves ensuring that waste emissions are at volumes that nature can handle. If not, all humans and other living things on Earth can be harmed to the point of extinction. Societies, in turn, exist totally within the realm of the environment. Considering this, we need to make sure that we manage all

aspects of human life within economies and societies in a manner that will not destroy the environment that everything on Earth is dependent on.

Empirical Review

Economic Impact of Rice Processing Industries

Several empirical studies have demonstrated the economic benefits of rice processing industries in Abakaliki. A study by Nwibo et al. (2016) found that rice processing significantly contributes to employment generation, engaging both skilled and unskilled labor. The study revealed that over 70% of workers in rice mills depend solely on the industry for their livelihood. Similarly, Eze and Nwachukwu (2018) reported that rice processing enhances income generation and improves the standard of living of workers and traders. The study highlighted that value addition through processing increases the market price of rice compared to paddy rice.Okorie et al. (2019) further noted that the rice milling cluster in Abakaliki stimulates other economic activities such as transportation, machine repairs, and marketing, thereby contributing to local economic development.

Rice processing industries play a vital role in the economic development of a country, particularly in agrarian economies. Their impact is evident in income generation, employment creation, industrial growth, and contribution to national revenue.

One major economic impact is income generation. Rice processing adds value to raw paddy, allowing processors and farmers to earn higher profits compared to selling unprocessed rice. This increase in income improves livelihoods and stimulates economic activities within communities.

Another important impact is employment creation. Rice mills require labor for processing, packaging, transportation, and marketing. This creates jobs directly and indirectly, reducing unemployment and increasing household income. As more people earn wages, spending increases, thereby boosting the local economy.

Rice processing industries also contribute to industrial development. The establishment of modern rice mills encourages investment in machinery, infrastructure, and technology. This promotes the growth of agro-based industries and strengthens the overall industrial sector.

Furthermore, these industries enhance government revenue through taxes, export earnings, and reduced importation of rice. By producing more processed rice locally, countries save foreign exchange that would have been spent on imports. This supports economic stability and national development.

In addition, efficient utilization of by-products such as rice bran and husk create additional streams of income. This aligns with principles in Agribusiness and Value Addition, which emphasize maximizing economic returns along the production chain.

However, challenges such as high processing costs, inadequate infrastructure, and limited access to finance can reduce the economic benefits if not properly addressed.

In conclusion, rice processing industries significantly impact the economy by generating income, creating employment, promoting industrial growth, and increasing national revenue.

Environmental Impact of Rice Processing Industries

Despite the economic benefits, rice processing industries pose environmental challenges. Okeke (2020) identified rice husk disposal, air pollution, and noise pollution as major environmental issues associated with rice mills in Abakaliki. The study noted that improper waste management leads to environmental degradation. Similarly, Nwankwo (2021) found that the burning of rice husk contributes to air pollution and health hazards among workers

and residents. Studies also indicate that environmental costs, such as waste management and pollution control, significantly influence the profitability and sustainability of rice processing firms.

Rice milling produces wastes which are organic materials or by-products that can be composted or decomposed. However, their high lignin and cellulose content can make this a slow process. They comprise husk, bran, broken edible rice, stone and metals from milling equipment (Njoku et al., 2011).

Equally the emission from the combustion of the diesel and burning of firewood has significantly added a lot of pollutants to the atmosphere including greenhouse gases, contributing to environmental degradation and posing health risks to the local population (Nwachukwu et al., 2021). The diesel operated machines easily break down and keeps the mill operators out of operation. The Abakaliki Rice Cluster, despite its significant contribution to Ebonyi State's economy, faces production efficiency challenges primarily driven by reliance on fossil fuels (diesel). This project is therefore aimed at proposing a green energy source that is cheaper and environmentally friendly. Our objective is to determine the most suitable combination of renewable energy sources (e.g., solar, wind, biomass) and conventional energy sources to create a hybrid energy system that maximizes rice production efficiency, minimizes operational costs, and reduces environmental impact within the Abakaliki Rice industries.

Hence, due to the likelihood of the paddy rice being subjected to pest infestations or contamination in handling and storage, quality control procedures, regular hygiene checks, avoidance of arsenic-contaminated water and good hygiene standards should be in place to test the products entering and leaving the mill (USA EPA, 2000; IRRI, 2014).

The issue of water and effluent management because parboiled rice production requires large amount of water which if not properly treated could result in water pollution and odour nuisance to residents (USA EPA, 2000; IRRI, 2014). Also, is the air emissions-dust, and odour management. Rice mill may present a significant source of air pollution both on site and the surrounding locality thereby endangering health (USA EPA, 2000; IRRI, 2014).

Next is the issue in rice milling environment is solid waste disposal and management. The disposal of solid waste, which includes the husk from the paddy as well as other wastes generated from the cleaning process, is another major environmental problem associated with rice milling. Pollution risks to water and soil may arise from spillage and leakage of solid fuels and burnt husks stored on the mill site (USA EPA, 2000; IRRI, 2014).

Air Pollution (Atmospheric Particulate Matter 2.5 (Pm2.5)

The atmosphere is generally regarded as part of the universe that is composed of gaseous mixtures surrounding the Earth. It provides many functions that support and protect life on Earth, such as providing shields from direct ultraviolet rays emanating from the sun and providing breathing air. Additionally, by means of insolation, the atmosphere can keep the planet warm and therefore regulate extreme temperature variations between day and night. At regular intervals, the atmospheric air that supports life is often polluted by natural and artificial activities on Earth through several sources. Atmospheric air pollution due to PM2.5, particularly in the lower atmosphere (troposphere), where life is supported and controlled by numerous artificial and natural interactions, is highly important in contemporary society. This is because human breathing levels through the nostril lie within this region, and hence, any little air pollution has grave consequences for humans, as they consistently inhale air at all times. Particulate matter 2.5 (PM2.5), also called fine particulate matter, is an atmospheric air pollutant that is essentially made up of tiny solid particles and liquid aerosols that have diameters less than 2.5 microns. Air pollution refers to contamination of the indoor or outdoor environment by any chemical, physical or biological agent that modifies the natural characteristics of the atmosphere (WHO, 2023). Combustion devices found in different households, smoke from motor vehicles, emissions from industrial facilities and forest fires constitute common sources of air pollution in our environment. According to the WHO (2023), the major health concerns in our environment are ozone, nitrogen dioxide, carbon monoxide, PM, and sulphur dioxide. Respiratory and other chronic diseases caused by

outdoor and indoor environmental air pollution from PM and other sources are associated with high morbidity and mortality (WHO, 2023). Atmospheric air pollution resulting from PM2.5 will be of great concern if the level in a given ambient air exceeds the World Health Organization (WHO) (2021) updated guideline recommended for healthy air quality. Inhaling PM2.5 that its level in the atmosphere exceeds the WHO recommended standard level for healthy air quality can trigger numerous health-related complications, such as cough, catarrh and other health related issues. According to Philip et al. (1992), PM is formed from vehicular fuel burning, wood burning, stoves and power plants. PM2.5 can be emitted from various sources, such as automobile emissions in the air, industrial emissions from combustion engines, and forest fires, and since it is so minute in size, it may continue to remain suspended in the atmosphere for several years and hence is capable of travelling very long distances.

According to the IEC (2022), PM2.5 is capable of penetrating deep into the lungs and entering the bloodstream, therefore posing risks of health issues such as cardiovascular, respiratory, and neurological diseases. PM2.5, known as fine PM with a diameter less than 2.5 µm, is capable of penetrating the alveolar region of the respiratory system (Utell and Frampton, 2000). In 2012, the WHO reported that more than 3.3 million deaths worldwide were attributed directly to particulate matter pollution (WHO, 2012). A study conducted by Brown (2009), Global Sources of Local Pollution (2009), and Martuzzi et al. (2006) reported that the health consequences of exposing the general population to particulate matter air pollution may include respiratory and heart diseases, increases in complications for people with chronic diseases, and increases in the number of hospitalization cases. The increase in the death rate due to heart and respiratory disease as well as lung-related diseases is equally prominent (WHO, 2013; Takashi et al., 2015).

Rice is a cereal crop and a staple food that is widely cherished and consumed by wider populations. Rice is considered one of the most common cereal crops consumed by more than half of the world's population (Khush, 1997; Dogara and Jumare, 2014)

Abakaliki rice, often referred to as local rice, is cultivated and harvested within and outside Abakaliki, the capital city of Ebonyi State, primarily by local farmers. After it is harvested, it must subsequently undergo vigorous processing cycles to make it viable for human consumption. These processing cycles involve numerous strenuous techniques that are carried out mostly by farmers for personal usage or by individuals who engage with them for commercial purposes. To process Abakaliki rice, it must pass through various processing stages that may involve the use of different equipment and methods that are capable of generating fine particulate matter and other air pollutants that are emitted into the atmosphere during operation. These emissions may consequently lead to atmospheric air pollution and therefore may pose grave health problems for farmers who process rice and for society at large. Other researchers have focused on rice processing methods, but little attention has been given to the atmospheric air pollution generated at processing sites and its negative impact on the farmers who are most vulnerable to direct exposure to PM2.5 emissions from rice processing equipment and methods. Therefore, the objective of this paper is to investigate the level of PM2.5 distribution at Abakaliki rice processing sites and the possible impacts of atmospheric air pollution on farmers to sustain rice production and boost agricultural sustainability and development.

The effect of rice husk dusts treated with urine on soil fertility status and yield of upland rice in Abakaliki, Southeastern, Nigeria

Tropical soils are beset with multiple challenges ranging from continuous decline in soil fertility, productivity, erosion, acidity, salinity, toxicity to ravaging pests and diseases, global warming and climate change (Ifejimalu, 2021; Aya, 2021; Obazi, 2021). In addressing soil fertility and productivity continuous use of organic and inorganic fertilizers has been recommended by many researchers (Okey, 2019; Okeke 2021; Imachi, 2021, Nwokwu, 2021). The problem in use of inorganic fertilizers lies with incessant losses of the nutrients via leaching, ammonification,

denitrification and that most of the inorganic fertilizers can lead to soil acidity, alkalinity, salinity and toxicity (Kalueni, 2020; Anozie, 2020). The alternative to inorganic fertilizer is the use of organic fertilizers namely: animal dung, animal wastes, animal urine, human urine, agricultural field and processing wastes, selective municipal wastes (Anozie, 2020, Okey, 2019). Organic wastes or fertilizers are gradually degraded and released to the soil, improves soil physico-chemical properties over longer period of time and reduces the problems associated with the use of inorganic fertilizers (Anozie, 2020; AbdelHaliem, et al., 2017). The use of organic fertilizers depends on availability in the right quality and quantity in various agro-ecological regions as most of them are either burnt in the course of land preparation or dumped in landfill sites (Anozie, 2020; Abdullahi and Kutama, 2012). In Abakaliki South Eastern Nigeria, the major occupation is farming in rice, yam, cassava, cocoyam, Bambara nut, cowpea, and vegetables which generate agricultural wastes. One of this waste is rice mill husks that are found in large quantity in the area but not popular as organic manure (Nwokwu, 2021, Obiodu, 2019). The rice husk dusts is not popular because it is very hard to degrade and release nutrients. Researchers at Department of Soil Science and Environmental Management, Ebonyi State University Abakaliki, Nigeria have been researching for long time on what makes rice husk dusts difficult to degrade and release soil nutrients particularly N, P, K, Ca and Mg (Nwite, 2012; Okonkwo et al., 2011; Mbah and Mbagwu, 2003; Nnabude and Mbagwu, 2001). The Scientists have discovered high lignin content in rice husk dusts which hinder mineralization. They have been testing several approaches to degrade this element such as using inorganic fertilizers, animal dung and other agricultural wastes (Okey, 2019). In 1998 the researchers started pot experiments using water and animal urine to degrade the rice husk dust before field application. This yielded positive results (Onyibe, 2014). Subsequently, attempts have been made to extrapolate the works to field conditions and popularize them among farmers of Abakaliki and Ebonyi State. This led to cases of how to generate enough animal urine to be used in pre-treating the rice husk dusts for nutrient release as cattle, goat, sheep, pig and other animal are very difficult to be tamed and their urine collected. This led to the option of using human urine since man can generate urine in buckets and pots at will. The next challenge lay on farmers and consumers acceptability on the use of human urine in boosting soil fertility and crop production. The University researchers started with pot experiments using human urine without any form of pre-treatment; as certain pretreatment can trigger chemical reactions that can lead to volatilization of nutrients. The researchers believed that such pre-treated rice husk dusts once applied to the soil can easily be denatured by soil microbes, thereby proving that human urine cannot transfer pathogens to seeds or crops when incorporated in the soil. Hence the objective of current work was to use harvested human urine, swine or pig slurry, in addition to water to pre-treat rice husks dust and quicken mineralization for certain weeks before incorporating the rice husk dust in the field, followed by soil and crop assessment. This is geared towards monitoring nutrient release, crop growth and yield (with upland rice) as a test crop that is also popular in the area.

Social Impact of Rice Processing Industries

Nwibo et al. (2016) observed that workers acquire technical and entrepreneurial skills through their involvement in rice processing activities. This contributes to human capital development. In addition, Eze et al. (2017) found that the industry plays a significant role in poverty reduction by providing employment opportunities to low-income households. Gender participation is another important aspect. According to Onwe et al. (2015), women are actively involved in parboiling, sorting, and marketing, thereby promoting women's economic empowerment.

Rice processing industries have significant social impacts on communities, particularly in developing countries where agriculture plays a major role in livelihoods. These impacts are seen in employment generation, improved living standards, and rural development.

One major social impact is job creation. Rice processing industries provide employment opportunities for a wide range of people, including machine operators, technicians, laborers, transporters, and marketers. This helps reduce unemployment and improves income levels, especially in rural areas where job opportunities are limited.

Another important impact is the improvement in the standard of living. With increased income from jobs and rice-related businesses, individuals and families are better able to afford basic needs such as food, education, and healthcare. This contributes to overall social well-being and poverty reduction.

Rice processing industries also promote rural development. The establishment of rice mills often leads to the development of infrastructure such as roads, electricity, and water supply in rural communities. These improvements benefit not only the industry but also the local population.

In addition, these industries encourage skill acquisition and capacity building. Workers gain technical and managerial skills through exposure to modern processing technologies. This aligns with principles in Human Capital Development, which emphasize the importance of skills in economic and social progress.

However, there may also be some negative social impacts, such as labor exploitation, rural-urban migration, and health risks from poor working conditions if industries are not properly regulated.

In conclusion, rice processing industries play a vital role in social development by creating jobs, improving living standards, and fostering rural growth, although proper management is necessary to minimize negative effects.

Technological Impact of Rice Processing Industries

Eze and Nwachukwu (2018) reported that the adoption of modern milling machines enhances rice quality and reduces breakage. However, many small-scale processors still rely on outdated equipment, limiting productivity.

Technological advancement has significantly transformed rice processing industries, leading to improved efficiency, better product quality, and increased utilization of by-products. These impacts have contributed to the growth of the rice value chain and overall agricultural development.

One major technological impact is the improvement in processing efficiency and output. Modern rice mills now use automated equipment such as dehuskers, polishers, and graders, which process large volumes of paddy rice quickly and accurately. This reduces grain breakage and minimizes waste, thereby increasing the yield of high-quality rice. As a result, processors achieve higher productivity and profitability.

Another important impact is the enhancement of rice quality and standardization. Technologies like optical sorters and destoners help remove impurities and ensure uniform grain size, color, and texture. This leads to the production of premium-grade rice that meets both local and international market standards. Improved quality increases consumer confidence and boosts export potential.

Furthermore, technology has enabled better utilization of rice by-products. Instead of being wasted, materials such as rice husk, bran, and broken rice are now processed into valuable products. Rice husk is used for biomass energy generation, rice bran is processed into oil, and broken rice is used in food products and animal feed. This not only reduces environmental waste but also creates additional income streams for processors.

These developments are closely related to principles in Food Technology and Industrial Automation, which emphasize efficiency, quality control, and innovation in agro-processing industries.

In conclusion, technology has greatly improved rice processing industries by increasing efficiency, enhancing product quality, and promoting sustainable use of resources. These impacts play a vital role in strengthening food security and economic development

Summary of Literature Review

Despite the growing body of literature on rice processing industries in Abakaliki metropolis, several critical gaps remain that justify further research.

First, most existing studies focus on single dimensions of impact, particularly economic outcomes such as employment generation and income improvement. For instance, studies on rice mill workers primarily examine job involvement and socio-demographic factors influencing productivity. However, there is limited integration of economic, social, and environmental impacts into a unified analytical framework. This creates a fragmented understanding of the overall impact of rice processing industries on the metropolis.

Second, although environmental issues such as rice husk waste and pollution have been identified as major concerns, research in this area remains largely descriptive and lacks quantitative environmental assessment models. Earlier findings show that rice husk accumulation and disposal pose serious environmental and health challenges in Abakaliki, yet there is insufficient empirical work measuring pollution levels, environmental costs, or sustainability indicators.

Third, there is a limited focus on energy use and sustainability innovations in rice processing. While recent studies have begun to explore alternative energy solutions such as solar hybrid systems in the Abakaliki rice mill cluster, there is still inadequate empirical evidence on the adoption rate, cost-benefit implications, and long-term sustainability of such technologies.

Fourth, many studies rely heavily on cross-sectional survey designs, which restrict the ability to analyze changes over time. There is a lack of longitudinal studies that examine how rice processing industries have evolved and their dynamic impacts on the socio-economic development of Abakaliki metropolis.

Fifth, existing literature pays little attention to technological efficiency and modernization gaps among small-scale processors. Although some studies examine processing methods and product quality, they do not sufficiently address how differences in technology adoption affect productivity, competitiveness, and income distribution.

Finally, there is a geographical and policy gap in the literature. Most studies are localized within specific rice mill clusters and do not adequately link findings to broader policy frameworks, regional development strategies, or national agricultural policies. This limits the applicability of findings for policy formulation and large-scale development planning.

Methodology

Research Design

The descriptive research design was adopted for the study using the survey research method. Descriptive research design reports data from population parameters in a manner that prohibits manipulation of variables, thereby leading to results that are raw and unadulterated. The choice of the survey method is informed by the fact that it involves gathering data about a target population from a sample and generalizing the findings obtained from an analysis of the sample to the entire population.

Area of Study

The study was conducted in Abakaliki Metropolis of Ebonyi state located in the south eastern part of the country Nigeria. It lies between latitude 6 0 19’ 23 .02” North and longitude 8 0 06’43 .24” East, and shares common boundaries with Benue state to the North, Enugu State to the West, Imo and Abia States to the South and Cross River State to the East.

Source of Data Collection

The study analyzed data from primary and secondary sources. The primary data for this study comprised of data generated by the researchers from the field.

The secondary data comprised of records and documents obtained from agencies relevant to the study (published materials, government and institutional reports, and previous studies).

Population of Study

The population of this study consists of all individuals and groups directly involved in rice production, processing, and marketing activities within Abakaliki Metropolis, Ebonyi State. The study focuses specifically on rice farmers, rice traders, and owners of rice processing industries because they constitute the major stakeholders in the rice processing sector and are directly affected by the activities of rice processing industries in the area.

Abakaliki Metropolis is recognized as one of the major rice-producing areas in Nigeria, with numerous rice mills and markets contributing significantly to the socio-economic development of Ebonyi State. The activities of these industries have created employment opportunities, increased commercial activities, and influenced agricultural production within the metropolis.

For the purpose of this study, the total population is estimated at 2,500 respondents, comprising rice farmers, rice traders, and owners of rice processing industries operating within the study area.

The distribution of the population is presented below:

Category of Respondents	Estimated Population
Rice Farmers	1,400
Rice Traders	800
Owners of Rice Processing Industries	300
Total	**2,500**

Determination of Sample Size

The population of 2500 persons, the researcher used a sample size of 345respondent from the following categories; farmers, traders and rice processing industry owners. A purposive sampling was used as the most appropriate of non-probability sampling techniques. This is because it allowed the researcher to decide what needed to know and find people that were willing to provide the information by virtue of knowledge or experience. (Bernard 2020, Lewis& Sheppard 2006)

Based on the large size of the population, a sample size derived using Taro Yamane's formula for a finite population according to Glenn (2009) in Nwachukwu (2011) was adopted. Taro Yamane formula is expressed as: n= N /1+ N (e) 2 Where n=the sample size N=the population size E=level of significance (or limit of tolerable error (0.1) 1(unit) =constant. Assuming the confidence level of 90% and unit of tolerable error of 10% (0.1)

Taro Yamane Formula

$n=N/1+N(e)^2$

Where:

- n = sample size
- N= population size
- e=level of significance (0.05)

Given:

- N=2500
- e=0.05

Substitute into the formula:

$n=2500/1+2500(0.05)^2$

Calculation:

n=2500/1+2500(0.0025)

n=2500/1+6.25

n=2500/7.25=344.83≈345

Sampling Technique

The sample for this study consisted of 345 respondents selected from the total population of 2,500 rice farmers, rice traders, and owners of rice processing industries in Abakaliki Metropolis, Ebonyi State. The sample size was determined using the Taro Yamane formula at a 0.05 level of significance.

A stratified random sampling technique was adopted for the study. The population was divided into three major strata, namely rice farmers, rice traders, and owners of rice processing industries. This was done to ensure adequate representation of all the relevant groups involved in rice processing activities within the study area.

Thereafter, simple random sampling was used to select respondents from each stratum proportionately.

The distribution of the sample is presented below:

Category of Respondents	Sample Distribution
Rice Farmers	193
Rice Traders	110
Owners of Rice Processing Industries	42
Total	**345**

A total of 345 questionnaires were distributed to the respondents by the researcher with the assistance of trained research assistants. Out of the 345 questionnaires distributed, 320 questionnaires were successfully retrieved and found useful for analysis, representing a retrieval rate of: 320/345 x100 =92.8%

This high retrieval rate was achieved through repeated visits and proper follow-up by the researcher to ensure that respondents completed and returned the questionnaires on time.

The retrieved questionnaires were considered adequate for the analysis of data and the achievement of the objectives of the study on the assessment of the impact of rice processing industries in Abakaliki Metropolis, Ebonyi State

Method / Instrument of Data Collection

The research instrument for data collection from primary sources for the study was questionnaire structured in Likert Scale format. This was administered to the respondents by the researchers personally. The researchers opted for the questionnaire because, in terms of spread and coverage, it will be the most effective way of reaching out to a very large number of people at the same time from which similar types of information can be obtained. Also, respondents may have greater confidence in their anonymity and thus feel freer to express their views.

The Likert scale involving rating on interval scale of 5 and 1 developed for application in social science and management research for quantification of qualitative variable were used. The statistical tools used descriptive statistics such as frequency counts, percentages, mean scores, and measures of dispersion (variability), particularly variance and standard deviation. The measures of dispersion were used to determine the extent to which respondents' opinions differed from one another

Validity and Reliability of Data Instrument

To ascertain the validity of the instrument, the researcher subjected the instrument to content validity by giving it to research experts in the field to examine the items and made sure they are in line with the objectives of the study. The instrument was structured in such a way as to minimize the effect of errors like inconsistency and ambiguity.

The reliability of the instrument was determined by a reliability test through the use of pilot study. Test and retest approach was adopted. The pretest was done using questionnaire administered to selected agencies in Abakaliki metropolis, Ebonyi state, Nigeria. A total of one hundred (345) copies of the questionnaire were randomly administered and (320) retrieve from rice farmers, rice traders and rice processing industries owners.

Method of Data Analysis

The data collected for the study were analyzed using descriptive statistical tools such as frequency counts, percentages, mean scores, and measures of dispersion, particularly variance and standard deviation. Frequency counts and percentages were used to summarize and present respondents' demographic characteristics and responses to questionnaire items in tabular form. Mean scores were used to determine the average opinion of respondents on the impact of rice processing industries in Abakaliki metropolis.

Data Presentation and Analysis

Questionnaire Distribution and Retrieval

320/345×100=92.75%

Table 4.1 Questionnaire Distribution and Retrieval Rate

Response Status	Frequency	Percentage (%)
Questionnaires Distributed	345	100
Questionnaires Retrieved	320	92.75

Questionnaires Not Retrieved	25	15
Total	**345**	**100**

The table above indicates that 345 questionnaires were distributed to respondents, while 320 were correctly filled and returned for analysis, representing 92.75% of the total questionnaires distributed. Fifteen questionnaires were not returned, representing 7.5%

Demographic Characteristics of Respondents

Table 4.2 Distribution of Respondents by Occupation

Occupation	Frequency	Percentage (%)
Farmers	180	56.25
Traders	100	31.25
Rice Mill Owners	40	12.50
Total	**320**	**100**

The table shows that farmers constituted the highest percentage of respondents with 56.25%, followed by traders with 31.25%, while rice mill owners accounted for 12.50%

Analysis Based on Research Questions and Objectives

Objective One

To ascertain the economic impacts of Abakaliki rice processing industries in Abakaliki metropolis.

Research Question One

What are the economic impacts of rice processing industries in Abakaliki metropolis?

Table 4.3 Economic Impacts of Rice Processing Industries

Variables	SA	A	D	SD	Mean ($\bar{X}$)	Variance	Standard Deviation	
Rice processing industries create employment opportunities	140	120	40	20	3.19	0.68	0.82	
Rice processing industries increase farmers' income	130	110	50	30	3.06	0.74	0.86	
Rice processing industries promote local trade	125	115	55	25	3.06	0.70	0.84	
Rice processing industries improve economic development	100	140	50	30	2.97	0.76	0.87	

Decision Rule

- Mean score above 2.50 = Accepted

- Mean score below 2.50 = Rejected

The findings reveal that respondents agreed that rice processing industries have positive economic impacts in Abakaliki metropolis. The mean scores for all the items are above the acceptance benchmark of 2.50. The low standard deviation values indicate that respondents had similar opinions on the economic benefits of the rice processing industries.

The **mean, variance, and standard deviation** in your table were calculated from the responses on the Likert scale.

Usually, the Likert scale values are coded as:

Table 4.4 Likert scale

Response	**Score**
Strongly Agree (SA)	4
Agree (A)	3
Disagree (D)	2
Strongly Disagree (SD)	1

Using the first variable as an example:

"Rice processing industries create employment opportunities"

Responses:

- SA= 140
- A = 120
- D = 40
- SD = 20

Total respondents:

N=140+120+40+20=320

1. Calculation of Mean ($\bar{X}$)

Formula: $\bar{X}=\sum fx / N$

Where:

- f = frequency
- x = Likert score
- N = total respondents

Response	**Frequency (f)**	**Score (x)**	**fx**
SA	140	4	560
A	120	3	360
D	40	2	80
SD	20	1	20

=∑fx=560+360+80+30=1020

$\bar{X}$=1020/320=3.19

2. Calculation of Variance

Formula:

$\sigma 2=\sum f (x-\bar{x})^2/N$

Using the mean $\bar{x}$=3.19

Response	f	x	$x-\bar{x}$	$(x-\bar{x})^2$	$f(x-\bar{x})^2$
SA	140	4	0.81	0.6561	91.854
A	120	3	-0.19	0.0361	4.332
D	40	2	-1.19	1.4161	56.644
SD	20	1	-2.19	4.7961	95.922

$\sum f(x-\bar{x})2=248.752$

σ2=248.752/320

σ2≈0.777

Variance=0.78

3. Calculation of Standard Deviation

Formula:

$\sigma=\sqrt{\sigma^2}$

σ=√0.68

σ≈0.82

Objective Two

To determine the environmental effects of rice processing industries in Abakaliki metropolis.

Research Question Two

What are the environmental effects of rice processing industries in Abakaliki metropolis?

Table 4.5 Environmental Effects of Rice Processing Industries

Variables	SA	A	D	S D	Mean (X̄)	Variance	Standard Deviation
Rice mills generate air pollution	150	100	40	30	3.16	0.81	0.90
Waste disposal from rice mills affects the environment	145	110	45	20	3.19	0.72	0.85
Rice processing contributes to noise pollution	130	120	50	20	3.13	0.69	0.83
Rice processing affects water quality in nearby areas	120	100	60	40	2.94	0.88	0.94

The results show that respondents agreed that rice processing industries have environmental effects such as air pollution, noise pollution, poor waste disposal, and water contamination. The standard deviation values indicate moderate consistency in the responses provided

Objective Three

To specify the social impact of rice processing industries in Abakaliki metropolis.

Research Question Three

What are the social impacts of rice processing industries in Abakaliki metropolis?

Table 4.6 Social Impacts of Rice Processing Industries

Variables	SA	A	D	SD	Mean (X̄)	Variance	Standard Deviation
Rice industries improve living standards	135	110	50	25	3.11	0.73	0.85
Rice processing industries reduce unemployment	120	130	45	25	3.08	0.67	0.82
Rice industries encourage rural–urban interaction	140	100	55	25	3.11	0.78	0.88
Rice industries contribute to community development	110	120	60	30	2.97	0.80	0.89

The findings indicate that rice processing industries positively affect the social wellbeing of residents in Abakaliki metropolis through employment creation, improved living standards, and community development. The low variability in the responses indicates consistency among respondents.

Objective Four

To identify the technological impact of Abakaliki rice processing industries in Abakaliki metropolis.

Research Question Four

What are the technological impacts of rice processing industries in Abakaliki metropolis?

Table 4.7 Technological Impacts of Rice Processing Industries

Variables	SA	A	D	SD	Mean ($\bar{X}$)	Variance	Standard Deviation
Rice processing industries encourage mechanized farming	160	100	40	20	3.25	0.66	0.81
Modern machines improve rice production efficiency	150	110	35	25	3.20	0.71	0.84
Rice industries promote technological innovation	145	115	40	20	3.20	0.69	0.83
Improved technology increases rice quality	130	120	45	25	3.11	0.74	0.86

The findings reveal that rice processing industries have significant technological impacts through mechanized farming, improved rice quality, and enhanced production efficiency. The standard deviation values show low variability, indicating that respondents shared similar opinions.

Hypothesis testing

A hypothesis testing using chi-square formula where 345 questionnaires was distributed and 320 questionnaire was retrieved on the assessment of the impact of rice processing industries in Abakaliki metropolis in Ebonyi state.

A hypothesis using the Chi-Square ($\chi 2$) formula for your research topic:

"Assessment of the Impact of Rice Processing Industries in Abakaliki Metropolis, Ebonyi State."

Stated that:

- 345 questionnaires were distributed
- 320 questionnaires were retrieved

We will use a hypothetical response table to demonstrate the Chi-square calculation.

Null Hypothesis (Ho)

Rice processing industries have no significant impact on Abakaliki metropolis.

Alternative Hypothesis (Hi)

Rice processing industries have a significant impact on Abakaliki metropolis.

Response Table

Do rice processing industries positively impact Abakaliki metropolis?

Table 4.8 Suppose the responses from the 320 retrieved questionnaires are:

Response	Observed Frequency (O)
Strongly Agree	140
Agree	110
Disagree	50

Strongly Disagree	20
Total	320

Expected Frequency (E)

The Chi-square formula compares Observed Frequency (O) with Expected Frequency (E).

Since there are 4 response categories:

E=320/4=80

Expected frequency for each category = 80

Chi-Square Formula

The Chi-square formula is:

$\chi 2=\sum(O-E)^2/E$

Where:

- O = Observed frequency
- E = Expected frequency

Table 4.9 Calculation Table

Response	O	E	O – E	(O – E) ²	(O – E) ² / E
Strongly Agree	140	80	60	3600	45
Agree	110	80	30	900	11.25
Disagreed	50	80	-30	900	11.25
Strongly Disagree	20	80	-60	3600	45

Sum the Values

$\chi 2=45+11.25+11.25+45=112.5$

Therefore:

$\chi=112.5$

Determine Degree of Freedom (df)

Formula:

$df=(r-1)(c-1)$

For one variable with 3 response categories:

$df=4-1=3$

So:

df=3

Compare with Chi-Square Critical Value

At:

- 0.05 level of significance
- df = 3

Critical Chi-square value = 7.815

Decision rule:

- If calculated value > table value → Reject Ho
- If calculated value < table value → Accept Ho

Since:

112.5>7.815

Decision

Reject the null hypothesis (Ho).

Accept the alternative hypothesis (Hi).

Conclusion

There is a significant impact of rice processing industries on Abakaliki metropolis, Ebonyi State. The calculated Chi-square value of 112.5 was greater than the table value of 7.815 at 0.05 level of significance and 3 degrees of freedom. Therefore, the null hypothesis was rejected while the alternative hypothesis was accepted. This implies that rice processing industries have a significant impact on Abakaliki metropolis, Ebonyi State.

Discussion of Findings

The study established that rice processing industries contribute significantly to the economic development of Abakaliki metropolis through employment generation, increased farmers' income, and stimulation of local trade activities. The study highlighted that value addition through processing increases the market price of rice compared to paddy rice.Okorie et al. (2019) further noted that the rice milling cluster in Abakaliki stimulates other economic activities such as transportation, machine repairs, and marketing, thereby contributing to local economic development.

The study also revealed that rice processing industries pose environmental challenges such as air pollution, noise pollution, and waste disposal issues, which affect the surrounding environment.

Similarly, Nwankwo (2021) found that the burning of rice husk contributes to air pollution and health hazards among workers and residents. Studies also indicate that environmental costs, such as waste management and pollution control, significantly influence the profitability and sustainability of rice processing firms.

Furthermore, the study showed that rice processing industries positively influence social development by improving living standards, reducing unemployment, and promoting community growth.

In addition, Eze et al. (2017) found that the industry plays a significant role in poverty reduction by providing employment opportunities to low-income households. Gender participation is another important aspect.

Finally, the study revealed that technological advancement in rice processing industries has improved rice production efficiency, mechanized farming, and the quality of rice produced in Abakaliki metropolis.

Eze and Nwachukwu (2018) reported that the adoption of modern milling machines enhances rice quality and reduces breakage. However, many small-scale processors still rely on outdated equipment, limiting productivity.

The measures of dispersion, especially variance and standard deviation, indicated low variability among respondents' opinions, suggesting that the responses were relatively homogeneous and reliable.

Highlight of Findings

Based on the analysis carried out, the study found that:

i. Rice processing industries have positive economic impacts on employment generation, income improvement, and local trade.

ii. Rice processing industries contribute to environmental pollution through waste disposal, air pollution, and noise pollution.

iii. Rice processing industries positively affect the social wellbeing of residents through improved living standards and reduction in unemployment.

iv. Rice processing industries promote technological development through mechanized farming and improved rice processing techniques.

v. The low standard deviation values obtained indicate consistency and reliability in respondents' responses.

Summary, Conclusion and Recommendations

Summary of Findings

The study assessed the impact of rice processing industries in Abakaliki Metropolis with emphasis on their economic, social, and environmental effects on the area. Findings from the study revealed that rice processing industries have significantly contributed to the economic development of Abakaliki by creating employment opportunities for both skilled and unskilled labour. Many residents depend directly or indirectly on the rice processing business for their livelihood through activities such as milling, transportation, marketing, packaging, and equipment maintenance.

The study further revealed that the industries have increased the income level of workers and traders within the metropolis. The growth of rice processing activities has also encouraged commercial activities and improved local trade, thereby contributing to poverty reduction and improved living standards among residents.

In addition, the presence of rice processing industries has enhanced agricultural productivity in the area. Farmers are encouraged to cultivate rice on a larger scale due to the availability of processing facilities and ready markets for paddy rice. This has helped to strengthen food production and food security within the state and beyond.

However, the findings showed that the industries also pose certain environmental challenges. The disposal of rice husks, smoke emissions from milling machines, noise pollution, and poor waste management practices negatively affect the environment and human health. Some residents complained about air pollution, blockage of drainage systems, and general environmental degradation caused by improper waste disposal.

The study also found that inadequate infrastructure such as poor road networks, irregular electricity supply, limited access to modern processing equipment, and insufficient government support hinder the effective operation and expansion of the rice processing industries.

Finally, the study established that despite these challenges, rice processing industries remain an important driver of economic growth and rural development in Abakaliki Metropolis. The study therefore emphasized the need for improved environmental management practices, better infrastructure, and access to modern technology, and stronger government policies to ensure sustainable development of the rice processing sector.

Conclusion

The work has made findings on the significance of the environmental, economic impact, social impact and technological impact of rice processing industries in Abakaliki metropolis, Ebonyi state.

The study on the assessment of the impact of rice processing industries in Abakaliki Metropolis concluded that the industries play a vital role in the socio-economic development of the area. The industries have contributed significantly to employment generation, income creation, agricultural development, and increased commercial activities within the metropolis. Their presence has improved the livelihoods of many residents and encouraged large-scale rice production by providing farmers with accessible processing facilities and reliable markets for their produce.

Despite these positive contributions, the study also concluded that rice processing industries have created environmental and infrastructural challenges. Issues such as improper disposal of rice husks, air and noise pollution, inadequate waste management, poor road networks, irregular power supply, and limited access to modern processing technology negatively affect both the environment and the efficiency of the industries.

The study therefore concluded that while rice processing industries remain a major source of economic growth and rural transformation in Abakaliki Metropolis, there is a strong need for sustainable management practices and increased government intervention. Provision of adequate infrastructure, improved environmental control measures, access to modern equipment, and supportive policies will help maximize the benefits of the industries while minimizing their negative impacts on the environment and the surrounding communities

Recommendations

Based on the findings of the study on the assessment of the impact of rice processing industries in Abakaliki Metropolis, the following recommendations were made:

i. **Government should improve infrastructure:** The government should provide adequate infrastructure such as good road networks, stable electricity supply, and water facilities to enhance the efficiency and productivity of rice processing industries in Abakaliki Metropolis.

ii. **Provision of modern processing equipment:** Rice processors should be supported with modern milling and processing machines through subsidies, loans, or grants to improve the quality and quantity of rice production and reduce processing losses.

iii. **Implementation of proper waste management practices:** Rice processing industries should adopt effective waste disposal and environmental management systems to reduce pollution caused by rice husks, smoke emissions, and wastewater. Rice husks can also be recycled for alternative uses such as animal feed, fuel, or fertilizer production.

iv. **Environmental monitoring and regulation:** Relevant environmental protection agencies should regularly monitor the activities of rice processing industries to ensure compliance with environmental laws and standards aimed at protecting public health and the environment.

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