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To cite this article: P.F. Tunji-Olayeni *et al* 2021 *IOP Conf. Ser.: Earth Environ. Sci.* **655** 012068

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**240th ECS Meeting** ORLANDO, FL

Orange County Convention Center **Oct 10-14, 2021**



Abstract submission due: April 9

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# Climate Change Mitigation Strategies: A Case of Manufacturing Companies in Ota, Nigeria

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## Abstract.

Carbon emissions (CO<sub>2</sub>) from manufacturing companies contribute significantly to the volume of atmospheric Greenhouse Gases (GHGs) that trigger climate change. Mitigating climate change has become necessary because of the effects it has on social, economic and environmental outcomes. The minutest action taken against climate change can reduce its devastating impacts. Hence, this study assesses the strategies used by manufacturing companies in mitigating climate change. The study location is Ota, Nigeria. In this paper, a quantitative research approach was adopted with questionnaires distributed to participants at a climate change workshop, which is analysed using statistical techniques. The results show, among others, that all the respondents are aware of climate change and the most common source of climate change knowledge is the mass media. Moreover, most of the respondents describe climate change as a rise in global temperatures. Waste reduction, waste recycling, and waste reuse are the most common climate change mitigation strategies adopted by the manufacturing companies. Other mitigation strategies include: use of energy-saving bulbs in offices and factories and switching off electrical appliances when not in use. Although the findings indicate that the manufacturing companies are taking some steps to mitigate climate change, a lot still has to be done in reducing carbon emission levels, particularly during the manufacturing process. It is also essential that manufacturers use renewable energy sources as alternative power instead of diesel generators so that the volume of atmospheric carbon in the region



can be reduced considerably. The role of government in driving emission reduction is also emphasised. The study provides baseline data that can be used in the development and implementation of policies on regional climate change mitigation strategies.

Keywords: global warming, sustainable manufacturing, renewable energy, sustainability, sustainable development

## 1. Introduction

Manufacturing companies constitute one of the major engines of social and economic development in many countries. This is due to the unique features of manufacturing sectors such as the use of high capital outlay, adoption of state-of-the-art technology, enormous employment potentials and strong linkages with other industries [1]. Manufacturing companies also enhance economic growth by contributing substantially to Gross Domestic Products (GDP). For instance, in Nigeria, the manufacturing sector contributed about 26.75% to GDP in 2018 [2]. However, manufacturing companies are one of the major producers of atmospheric Greenhouse Gases (GHGs). These gases trigger climate change which results in extreme weather conditions, drought, melting of ice caps, rise in sea level and other humanitarian crises. According to [3], manufacturing companies contribute significantly to global anthropogenic greenhouse gases. Two-thirds of the global CO<sub>2</sub> are generated by manufacturing companies, including manufacturers of coal, oil, natural gas and cement [4]. Apart from CO<sub>2</sub>, manufacturing companies also produce large quantities of other substances such as atmospheric aerosols. Some studies [5,6,7] provide empirical evidence of the effects of atmospheric aerosols on climate change.

Moreover, improper disposal of waste from manufacturing companies constitute a threat to environmental sustainability. [8] noted that poor waste management practices lead to eco-imbalance of the earth's systems and also triggers chemical reactions which pollute the environment [9,10].

The upsurge in climate change knowledge and awareness globally has increased government, consumers and public pressure on producers of greenhouse gases to cut down on CO<sub>2</sub> emission, thereby forcing manufacturing companies to rethink their processes. With a forecast of CO<sub>2</sub> emissions increasing by 50-150% in 2050 [11], mitigating climate change becomes a crucial step in minimising the incidence of fatalities associated with climate change.

Although many initiatives have been taken by the government and carbon-intensive firms in developed countries to reduce climate change, little evidence exists about the state of climate change awareness, knowledge and mitigation in developing countries. The awareness and knowledge of climate change, particularly among managers of carbon-intensive firms such as manufacturing companies is the first step towards climate change mitigation. The dynamics of climate change, in that its effects have no borders, makes its mitigation crucial. This is particularly so for developing countries where institutional frameworks are weak, and funding is generally inadequate [12].

This study examines the climate change awareness and perceptions of managers. It also assesses the mitigation strategies used by manufacturing firms. The study location is Ota, Ogun State, which has the third-highest concentration of manufacturing companies in Nigeria [13].

## **2 Brief Literature Review**

### *2.1 Climate Change*

Climate change is induced by the accumulation of GHGs in the atmosphere. GHGs prevent the heat of the sun from being reflected into space, thereby trapping it within the earth and causing a rise in global temperature, otherwise known as global warming. GHGs are naturally occurring gases such as Carbon dioxide (CO<sub>2</sub>), Nitrous oxide (N<sub>2</sub>O), methane (CH<sub>4</sub>) and water vapour (H<sub>2</sub>O).

Nevertheless, industrial activities increase the concentration of atmospheric GHGs. This situation alters weather conditions and leads to climate change. According to [14], the most common carbon-intensive industries are steel, chemical, cement, food and drink. Manufacturing companies generate CO<sub>2</sub> during the use of fossil fuel as a source of power, chemical processing and in the manufacture of carbon-based substances such as cement and limestone [15].

### *2.2 Awareness, Knowledge and Perceptions*

Climate change awareness, knowledge and perception are crucial for developing effective mitigation strategies. However, it is not unlikely to find significant differences in climate

change awareness, knowledge or perceptions among people from different regions of the world. For instance, [16] surveyed Biosphere Reserve (BR) managers from different countries and assessed their climate change perceptions. The survey indicated significant differences between the perceptions of BR managers in emerging economies and developed countries. Specifically, BR managers in emerging economies perceived climate change has been less relevant than other forest issues such as poaching.

In the United States, it was found that forest service managers (range managers, pest managers and climate change coordinators) all had an idea of climate change. However, there were differences in their perception regarding climate change effects on natural resources [17].

[18] examined climate change awareness and perceptions from different countries over the last 25 years. The study revealed two conflicting results. Firstly, that concern for climate change is decreasing because the ruling class in some countries has an adverse ideology against climate change. Secondly, there is an increasing concern about climate change in regions experiencing various adverse weather conditions.

Apart from political ideologies, socio-economic status has also been found to influence climate change awareness, knowledge and perceptions. For instance, [19] noted that persons with higher economic and educational status were more informed about climate change in Bangladesh.

Moreover, knowledge about climate change is positively associated with the reduction of climate change. The study of [20] about the perceptions of managers in the Australian energy sector showed a positive correlation between knowledge of climate change and the relevance of climate change mitigation.

Awareness of climate change is on the increase, and this will pressurise stakeholders to take appropriate mitigation measures. [21] noted that 60% of people surveyed in the United States believe that climate change is risky and is an occurrence that can have negative impacts on their families in years to come if not tackled now.

The review of the issues in the literature shows that many of the study respondents were knowledgeable about climate change. However, their perceptions of climate change and the impacts vary. The differences in views about climate change may be due to several factors such as economic conditions, social status, educational level, religious beliefs, frequency of adverse weather conditions, the political ideology of the ruling class, security levels, and

professional orientation among other things. These factors have implications for the design and execution of climate change mitigation strategies. Moreover, there is scanty evidence from developing countries such as Nigeria about the perceptions of managers in manufacturing companies on climate change.

### 2.3 *Mitigation Strategies*

Climate change mitigation strategies have been highlighted in the literature. [15] reviewed climate change mitigation strategies in the industrial sector and predicted the potential of manufacturing companies in mitigating climate change. Their study projected that the most significant and cost-effective method of mitigating climate change would be through the use of energy-efficient systems and policies.

The European Union (EU) is one of the regions actively driving climate change mitigation. [3] assessed 158 carbon-intensive manufacturing companies in the (EU) and identified emissions trading, process emission reduction, combustion emission reduction, external measures and lowering product output as the standard climate change mitigation strategies used by manufacturing companies in the EU. Moreover, [22] recommended the use of industrial clusters, review of agricultural practices especially meat production, conservation of natural resources, direct digital manufacturing, and use of colours to code products as climate change mitigation strategies for manufacturing companies.

[23] further identified carbon governance, carbon reduction and carbon competitiveness as CO<sub>2</sub> reduction strategies in manufacturing companies. The study also revealed that the government and other stakeholders' pressure have positive effects on CO<sub>2</sub> reduction initiatives.

After sampling 247 manufacturing firms in the EU [24] it was concluded that EU companies were making efforts towards mitigating climate change but that significant reductions of GHG by manufacturing companies will be enhanced by market pressures, regulatory pressures and environmental strategies.

The review shows climate change mitigation strategies and technologies recommended for use by manufacturing companies in combating climate change. Nevertheless, limited knowledge about climate change mitigation strategies of manufacturing companies in Nigeria is a noticeable gap which this study seeks to fill.

### 3 Research Method

This paper adopts a survey research design to address the objectives of the study. Structured questionnaires were distributed to managers of manufacturing companies in Ota, Ogun State Nigeria, who attended a climate change workshop in February 2019. The questionnaire had four sections. The first section was on awareness of climate change. The second section had questions relating to respondents' sources of climate change knowledge. The third and fourth sections consisted of five-point Likert scale type questions of strongly disagree to agree strongly. Section three focused on respondents' perception about climate change, while section four was on climate mitigation strategies used by their companies. Mean scores were used to rank respondents' perception of climate change and the strategies used for mitigation.

### 4 Results

#### 4.1 Awareness of Climate Change

Table 1 indicates that all respondents are aware of climate change.

Table 1 Awareness of climate change

Awareness	Frequency
Yes	30
No	0
Total	30

#### 4.2 Source of Climate Change Knowledge

The sources of climate change knowledge are presented in table 2. The most common source from which the respondents obtained climate change knowledge was the mass media (14 respondents), followed by the internet (9) and through seminars (7).

Table 2 Source of climate change knowledge

Source	Frequency	Percent
Mass Media	14	46.67
Internet	9	30.00
Seminars	7	23.30
Total	30	100

### 4.3 Perception of Climate Change

Table 3 shows the managers' perceptions of climate change. The most common perception of managers about climate change is a rise in global temperatures (4.77), this is followed by extreme weather conditions (4.63), depletion of the ozone layer (4.43), frequent occurrence of eclipse (3.27) and the end of the world (2.60).

Table 3 Perception of climate change

Perception	N	Mean
Rise in global temperatures	30	4.77
Extreme weather condition	30	4.63
Depletion of the ozone layer	30	4.43
Frequent occurrence of an eclipse	30	3.27
The end of the world	30	2.60

### 4.4 Climate Change Mitigation Strategies

Table 4 indicates the climate change mitigation strategies commonly used by the manufacturing companies surveyed. The most common climate change mitigation strategies in use are reduced waste, recycle waste and reuse waste. The least commonly used climate change strategies are phase out diesel-powered vehicles, the use of solar panels as a partial replacement for generators and the use of solar panel powered inverters.

Table 4 Climate change mitigation strategies

Mitigation Strategy	N	Mean
Reduce waste	30	4.67
Recycle waste	30	4.67
Reuse waste	30	4.63
Use of energy-saving bulbs in offices and factories	30	4.57
Switching off power sources when not in use	30	4.50
Use of energy-efficient ACs	30	4.43
Provision of company bus	30	3.43
Encouraging car sharing for staff living in the same area	30	3.22
Use of e- facilities for communication	30	3.00
Use of environmentally friendly energy sources	30	2.70
Use of solar panel powered inverters	30	2.42
Use of solar panels as a partial replacement for generators	30	2.31
Phase-out diesel-powered vehicles	30	2.20



## 5 Discussions

The findings of the study show that all the managers surveyed had an idea about climate change.

It reinforces the fact that people are becoming more knowledgeable about climate change, and it corroborates with [25] who found a high degree of climate change awareness among corporate managers in Malaysia. The findings are also similar to those of [17], which showed that forest service managers in the United States were very aware of climate change. Climate change awareness is critical in the design and execution of climate change mitigation strategies. The awareness of climate change enhances preparedness of the public, experts and government towards climate change-induced disasters. It predicts the response of people during an environmental crisis [26]. Climate change awareness is also beneficial for effective management and planning of environmental resources [27].

The findings also show that the mass media is an effective platform for climate change awareness as it was the most common source of climate knowledge. The results also resonate with the findings of [25], which revealed mass media as the primary source of climate change awareness among corporate managers in Malaysia. The mass media is a vital tool for disseminating climate change knowledge because it creates a platform for informing people about climate change [26]. The study also revealed that seminars did not deliver as much information on climate change, making it the least source of climate change knowledge. Even though all the managers in this study were aware of climate change, the use of seminars can be a vital medium for transferring industry-specific knowledge about climate change mitigation strategies.

Furthermore, the rise in global temperatures and extreme weather conditions were the most common perceptions of climate change among managers of manufacturing companies. [19] also found that most community dwellers in Bangladesh described climate change as excessive temperature and extreme weather events.

Climate change mitigation strategies were also analysed. The most common strategies used by the manufacturing companies were reducing waste, recycling waste and reusing waste. Improper disposal of urban waste from both domestic and industrial sources poses a significant challenge to environmental sustainability. For instance, the burning of waste releases CO<sub>2</sub> and other GHGs which contribute to the concentration of atmospheric GHGs

that trigger climate change. Hence manufacturing firms use waste reduction, recycling and reuse strategies to mitigate climate change. The application of techniques, such as lean manufacturing can significantly reduce waste and production costs. Moreover, recycling waste also helps to reduce waste management problems. Common waste recycling efforts of manufacturing firms include recycling of used papers to tissue papers, turning waste from breweries to animal feed and recycling used PET bottles into the same bottles for reuse.

Also, the respondents appear not to associate the provision of company bus and car-sharing (pooling) with climate change mitigation. Their opinion was hinged on the fact that though most of the manufacturing companies provide buses for their staff, there is some form of car-sharing for staff living around the same area. The provision of company bus and encouraging car sharing for staff living in the same area ranked as the 7th and 8th climate change mitigation strategies.

The use of solar-powered inverters, solar panels as a partial replacement for generators and phasing out of diesel-powered vehicles were the least climate change mitigation strategies used by the manufacturing companies. The above implies that the manufacturing firms surveyed were still heavily dependent on fossil fuel. One of the ways by which manufacturing firms generate CO<sub>2</sub> is by the use of fossil fuel as a source of power [15]. However, the use of renewable and cleaner sources of power, such as solar will reduce GHG and ultimately mitigate climate change. Also, electric cars will significantly reduce carbon emissions, but it is yet to be used in Nigeria.

Apart from the mitigation strategies identified in this study, there are other more advanced and efficient strategies that manufacturing companies in developing countries can adopt to mitigate climate change. Some of these strategies include the use of direct digital manufacturing, the use of alternative materials or materials with less carbon content and a review of manufacturing processes. Nonetheless, these strategies will require intensive research and funding which are lacking in developing countries. Moreover, the government's role in the process cannot be undermined. Its exemplary commitment will chart the course for the much-desired climate change mitigation. Strategies such as carbon governance will require active government regulation and legislation for fruition.

## **6 Conclusion**

The study examines the climate change mitigation initiatives of manufacturing firms in Ota, Nigeria. All the managers surveyed were aware of climate change. Awareness of the managers about climate change may suggest their likelihood and support for other climate change mitigation initiatives. Sustainable waste management practices such as waste reduction, waste recycling and waste reuse were the most common climate change mitigation strategies adopted by the manufacturing companies. Research and development will enhance the adoption of other advanced and more effective climate change mitigation strategies.

The government plays a fundamental role in driving climate change mitigation. The government can become an active player in the process by: increasing climate change awareness; formulating climate change policies; coordinating the adoption of climate change policies; providing funding or making efforts to attract climate change mitigation funds; ensuring judicious allocation and use of climate change mitigation funds; and. engaging manufacturers to adopt alternative and more environmental-friendly energy sources during the production process.

## **Acknowledgements**

The authors are grateful for the support from Covenant University Centre for Research Innovation and Discovery (CUCRID).

## **Funding**

This research was not funded by any agency in government, private organisation or charity.

## **Conflict of Interest**

There is no conflict of interest.

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