



# Recommendation System for Carbon Reduction

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**Abstract.** Nigeria is one of the country's most vulnerable to carbon emission (CO<sub>2</sub>). A basic understanding of public perception on vulnerability, attitude and the risk in relation to Carbon Emissions and health provide strategic directions for government policy, adaptation strategies and development of guidelines. The aim of this research was to collect data on people's knowledge and perception about Carbon Emissions and their impact on health. A cross-sectional survey was conducted online from 20th to 31 August 2021. A structured questionnaire was used to collect data among 129 people online. This research revealed that respondents had a low and inconsistent understanding of climate change and its impact on health. To reduce carbon emission, we built a carbon emission recommender system, which would calculate carbon emitted by individuals and industries and then suggest alternative resources that can be used to reduce or mitigate carbon emission.

**Keywords:** Carbon emissions · Footprint · Awareness

## 1 Introduction

Nigeria is a country in West Africa bordered by Cameroon, Nigeria, Chad, and Benin [1]. Nigeria is the most populous country in Africa, with a population of over 211 million. This huge population has also contributed hugely to the greenhouse gases emitted in Nigeria. According to [2] F gases, Nitrous oxide (N<sub>2</sub>O), Methane (CH<sub>4</sub>) are non-CO<sub>2</sub> gases emitted while Land-use (LULUCF), Non-Combustion, Building, Transport, Industry and Power & heat are CO<sub>2</sub> emitted in Nigeria. Furthermore, industries have also contributed to the emission of gas in Nigeria. Lack of stable electricity has also pushed the majority of the population to depend on fuel, coal and other high carbon emitted processes of generating power.

At this point let's look at carbon emission: which was defined by [3] as the release of carbon into the atmosphere. Carbon emission refers to greenhouse gas emissions. Additionally, carbon emission is a major contributor to climate change, which is also increasing global warming. Climate change has effect Nigeria in several ways such as high temperatures, floods, drought and changes in weather.

Human activity happens to be a huge contributor to climate change [3]. Human activities comprise greenhouse gas emissions. In addition, the major greenhouse emission is the emission of carbon dioxide. The emission of CO<sub>2</sub> is major caused by fuel-burning

activities. Human activities such as deforestation, transportation activities and industrial sector activities have increased carbon emission.

Climate changes affected both the humankind and environment; however, human health is impacted by the ecological condition. Climate changes affected human health in many ways such as Asthma, vector-borne diseases, repository disease. Evidence shows that human health and climate change are interrelated.

As a populous country, Nigeria is one of the countries that are vulnerable to climate change because of its geographical location [12]. The result in [12] shows that carbon emission is a major contributor to carbon dioxide and the use of dirty fuel. The huge populations' density, rely on agriculture for food and fuel, wood/coal for energy [2]. Drought, landslides and flooding are types of climate change hazards that have harmed Nigeria. Nigeria's carbon emission has increased by 270%. However, not all hope is lost as the Nigerian government pledged to reduce carbon emission by 20% by 2030 [2].

Pledging and promising to reduce carbon emission, is not the only and final solution. To speed up the process, there is a need to fully engage the citizens of Nigeria. Engaging the citizens will only be fruitful by knowing their level of knowledge and understanding of carbon emission. A survey is one of the methods used in understanding people's knowledge and understanding.

To develop an artificial intelligence solution for carbon reduction in the energy sector. We designed and developed a recommender system for carbon reduction. To achieve that we started by conducting a cross-sectional survey online. The result of the survey is presented in Sect. 3.

Our recommender system would help in monitoring individual/industries' carbon emissions. The system would now suggest to the individual and industries methods/alternative resources to utilize for reducing carbon emission. The contribution of this work can be summarized as follows:

- We ran an online survey to understand people's knowledge/awareness about carbon emission.
- We built an awareness website, where individuals and industries can learn more about causes, effects and solutions for mitigating carbon emission.
- We designed a recommender system for carbon reduction, the goal is to have a system that would track and suggest methods of reducing carbon emission to industries and individuals.
- We finally developed a recommender system for carbon reduction; the system will track industries/individual carbon emissions and hence recommend the necessary materials and equipment that would reduce carbon emission

The rest of this paper was organized as follows: Sect. 2 discusses the related work. Section 3 presented the survey. Section 4 presents the online survey result. Section 5 presents the proposed recommender system. Finally, Sect. 6 concludes the paper.

## 2 Related Work

According to [2] in 2015 Nigeria was the world's 17<sup>th</sup> largest greenhouse gas emitted. Moreover, it is Africa's largest oil producer and the world's 9<sup>th</sup> largest exporter. It is

projected that Nigeria will overtake China in the nearest future to become the world's second-most populous country. Unfortunately more than a 3<sup>rd</sup> of Nigerians lack access to electricity and rather depend on wood, charcoal etc.

The aim of the paper [4] was to gather data on people's knowledge and perception about climate change and its effects on health. They conducted a cross-sectional survey among 7 vulnerable districts of Bangladesh. 6720 people participated who are from 224 rural areas. They used a structured questionnaire method with an observational checklist in collecting data from households. The research shows that 54.2% had some knowledge of climate change, however, 45.8% do not. The research also shows that educational qualification and monthly income, occupation and age is also associated with knowledge about climate change. The research concluded to emphasize the need for policy maker to introduce a climate change child centre education and training for health workers.

Paper [5] ran a cross-sectional study to understand the knowledge and awareness of adolescent people in Yogyakarta. The survey results show that the youths have less knowledge and awareness about climate change. Hence, the recommended that there is a need to improve adolescent knowledge of climate change. From the survey, they find out that only less than 15% of respondents believe that climate change is a very important problem. The majority of the respondents do not see climate change as an important problem. 50% of the respondents feel the climate change argument is not convincing. Participants do not also know that climate is caused by human activities. The above outcome suggested that there is a need to incorporate climate change in the curriculum of high education. This is to close the knowledge gap and also enhance adolescent knowledge about climate change.

Paper [6] also conducted a survey to investigate health risks in Nigeria caused by climate change. The research pointed out that climate change has greatly caused a serious health problem in Nigeria. These health risks are malaria, high blood pressure, skin cancer, cardiovascular respiratory disorder and other health issues. The research recommended that government should raise awareness of the adverse effect of climate change. The impact is among vulnerable groups such as children, women and people in rural areas.

According to [7] the China government adopted public awareness and understanding method to promote the development and deployment of Carbon dioxide Capture, Utilization and Geological Storage (CCUS) technology. This public awareness and understanding were done via a national survey. The aim of the survey is to understand the public awareness and understanding regarding the environmental impact & management of CCUS technology. The result indicated that the awareness of the high environmental impact of the technology by the public has negatively encouraged lower acceptance of the system by the public. It has also indicated that there are high expectations from the government department to play a major role in managing the environment. Finally, the ability to communicate and inform the public about the importance of CCUS technology via open lectures, traditional and media channels and government agencies can reduce the high negative assumed risk by the public, thus enhancing public acceptance of the technology.

The building sector has posed a lot of issues and challenges when it comes to the reduction of carbon emission [8]. The work presented solutions that can be adapted to control the urbanization of cities. These solutions include introducing standard policies, impact assessment of building processes and adopting low carbon technology and the reduction of energy utilization.

The work done by [9] explored whether using a health framework can encourage behavioural reductions of greenhouse gas in the US. To promote behavioural reductions of greenhouse gas emissions and adaption measures. The feels using the health frame will really motivate citizens to reduce the amount of carbon they emit. Using random digit dialing they conducted a cross-sectional survey in United State. The health threat from a personal perspective was explored. The data were analyzed via logistic regressions and path analysis. 771 people participated in the survey. 81% acknowledged that climate change was happening. Participants stated that they are ready to reduce energy consumption if they are convinced that climate change could affect their way of life.

In Nigeria to understand the awareness of climate change and sustainable development among undergraduates in two major universities in Oyo state Nigeria. Paper [10] primary aim was to improve the knowledge of climate among undergraduates. 300 undergraduates were selected randomly from these two universities. The data collected was analyzed using a simple percentage and T-test. The research presented that there is a high level of awareness on the concept of climate change. Education, personal experience and access to information were great influencer factors to the awareness. However, there is still a gap in awareness; the study recommended that climate education needs to be structured and integrated into school curricula at all levels.

To ascertain the level of awareness regarding climate change among tertiary institution students in Taraba state Nigeria. In [11] a descriptive survey was conducted among 225 students. A structured questionnaire was conducted among participants. The survey outcome indicated that 18.2% have never heard of climate change. While 81.8% heard about climate change, 89% do not even know what climate is all about, its causes, effects and mitigations measures. The study suggested that there is a need for a climate change awareness club in Jalingo tertiary institutions.

In [13] pointed out that with the huge amount of data and information on the internet. It is difficult for users to select or decide on what to buy. Hence, a recommender system is an intelligent computer-based system that predicts based on user usage and adoption and helps to suggest an item from a huge pool of items. Their major work centred on providing comprehensive research on recommender systems. They presented the approaches, associated issues and techniques used for information retrieval.

### 3 Survey

In this study, an online survey was conducted. Responses were collected from 20 August 31 August 2021. We used to google form to create an online survey term: Carbon Emission Awareness in Nigeria. The survey was divided into 3 sections, which are Sect. 1 basic information, section Climate change awareness and Sect. 3 Attitude towards climate change.

In Sect. 1 majority of the responders are male, and the majority are of age 15–20. Furthermore, the majority of the responders are residing in the north-central geopolitical

zone, and generally, they stay in the federal capital. Finally, people with BSc-HND have the highest responders.

In Sect. 2, 97.7% believe climate change exists which is a good number. For the question that asked how well people understood what carbon emission is and how it affects the environment. The majority of responders have a piece of average knowledge about carbon emission and its effect. That means there is a need for more awareness and sensitization. 82.9% understand the causes of global warming. Finally, in Sect. 2 we have an open-ended question, which answers displayed in Fig. 1.

In Sect. 3, we asked about the attitude towards climate change, 30.7% of people are extremely concerned about climate change. While 29.9% are average concerned about climate change, which is a huge number. For mitigation, 72.4% agreed they would contribute to mitigating climate change if they had the information. We also have three open-ended questions which comments were shown in Fig. 2.

### 4 Result

This section presented the result pulled out from our survey. Due to limited time, we had to stop the survey. As stated, the above section comprises basic information, Sect. 2 awareness while Sect. 3 was the attitude towards climate change.

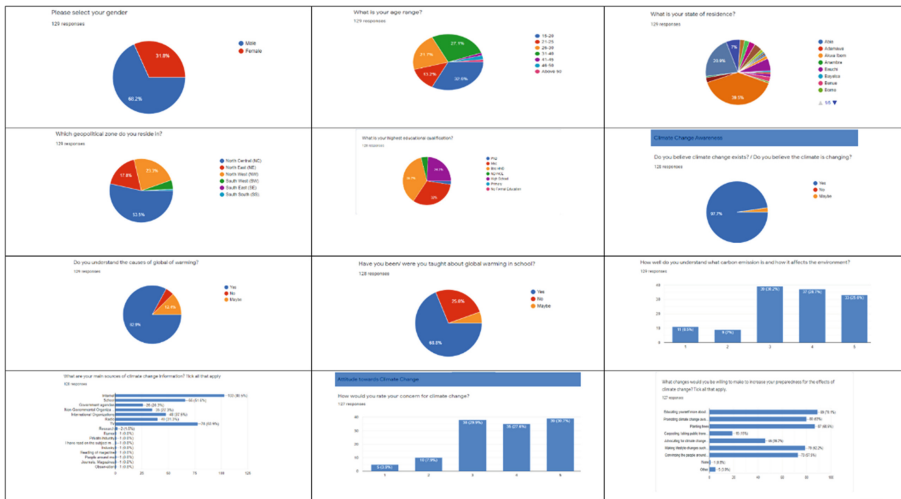


Fig. 1. Survey result

## 5 Calculator

Knowing the amount of carbon we emit based on our daily activities is called “carbon footprint” [14]. Knowing our carbon footprint would also help also in reducing the amount of carbon we emit and this is the current trend used for mitigating carbon emission. Scientists believe individuals are also a major contributor of emission based on their activities and fuel/power consumption and usage. According to [14] the bigger our carbon footprint the larger our carbon emission to the society. Family can also help by reducing their carbon footprint. However, we can only reduce our carbon footprint when we have knowledge of the amount of carbon we emit daily according to our activities.

There are many carbon footprint calculators, which are designed and developed, based on the situation in Europe and US. Meaning currently there is no official carbon emission calculator made for Nigeria. Based on our knowledge the closest work on carbon footprint was the research done in Lagos state [15]. However, they did their calculator manually, which is a tedious process and time-consuming method.

The calculator was integrated with a recommender system. The essence is for the recommender algorithm to suggest ways and processes that individuals and industries can use in reducing their carbon footprint.

## 6 Recommender System

According to [13] recommender system are intelligent computer that helps users in making a decision. The goal of our recommender system is to help in reducing carbon emissions. This system will calculate users’/industries carbon footprint. Then suggest another alternative for reducing and mitigating carbon emissions. The below image depict how the system would function.

## 7 Recommendation

Our survey shows that majority of the responders have little knowledge about carbon emission, its cause and impact. However, the level of education influenced this output. This generated a new question that is what about people that have less educational qualification and worst-case serious non-educated people. This led to the following recommendation

- There is a need to run a pen and pencil survey.
- There is a need to organize seminars, training and workshop in remote and rural areas
- There is a need for the government to engage individuals, NGOs and industries.
- There is a need to incorporate climate change education in all curricular rights from primary to tertiary institution.

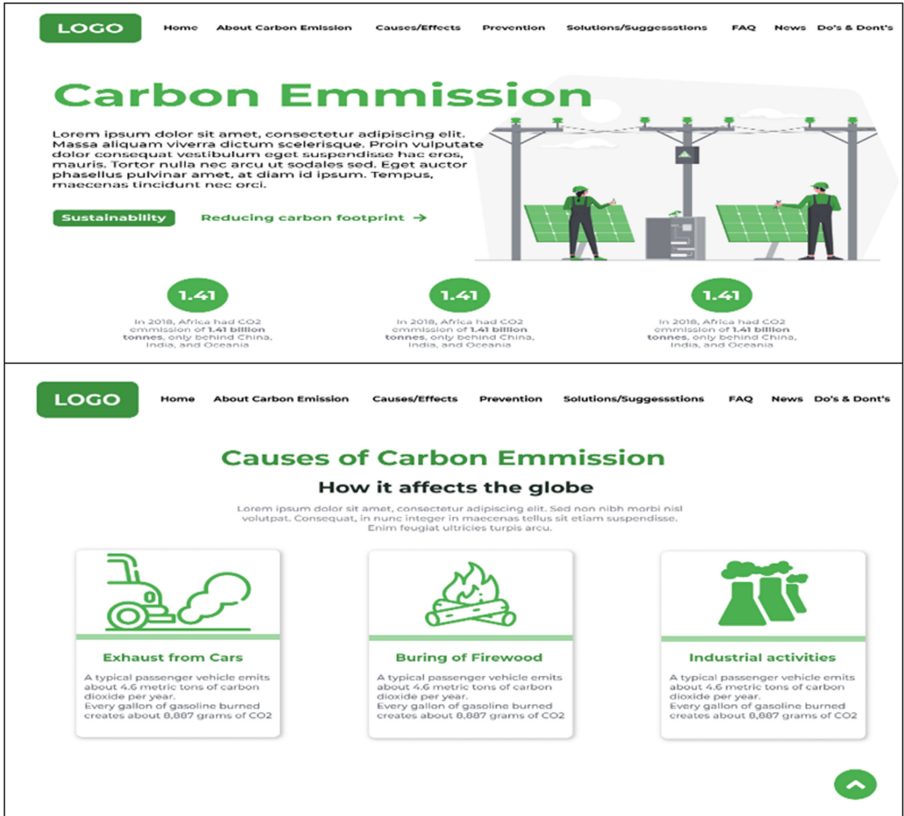


Fig. 2. Recommendation system

## 8 Conclusion

The awareness level of the survey responders on carbon emission was more than our assumption and perception of people on changing climatic factors and their impacts on health is higher. There is a need to run a physical survey for people in remote and rural areas. This is to ascertain the carbon emission knowledge level in these vulnerable areas. Further to protect our next generations a carbon emission education needs to include in our educational curriculum at all levels.

For future work to get an effective working recommender system there is a need to build a calculator based on Nigeria’s reality and factors. This calculator can accurately monitor carbon emissions from individuals and industries. These would help the system in suggesting other alternatives to reduce carbon emission and ways to mitigate it.

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