

**TEAM J AI FOR CO2 REDUCTION PROBLEM DOCUMENTATION**

1. **Problem Statement/Definition**

They say too much of a good thing is a bad thing, this applies to atmospheric CO2: In higher concentrations, it is a damaging pollutant. Hence

**Prevalence of the problem**

*[Provide figures and statistics of the number of people affected by the problem and current trend of development]*

The country’s annual greenhouse gas emissions were 506m tonnes of CO2 equivalent (MtCO2e) in 2015, according to [data](https://www.pik-potsdam.de/paris-reality-check/primap-hist/#id=jpn&entity=kyotoghgar4) compiled by the [Potsdam Institute for Climate Impact Research](https://www.pik-potsdam.de/pik-frontpage) (PIK).

* 1. **Cause of the problem**

*[Describe the situation that gave rise to the problem. The situation could be a lack of structure, resources, training etc.]*

* 1. **Who (whom) has identified the problem?**

*[What person or group of people identified the problem and documented it?]*

*[Are they the one(s) championing for a solution?]*

* 1. **Affected group/demography**

*[Describe the class/category/peculiarity of people mostly affected by the problem. This category can be based on one or mixture of any of the following: age, gender, geography, tribe, blood group, occupation, body type etc.]*

* 1. **Adverse effect of the problem**

*[What are the harmful undesired result of the continued existence of the problem]*

* 1. **Why should the problem be solved?**

*[What are the benefits of solving the problem? What will be the potential impact of eradicating the problem totally?]*

* 1. **List the major stakeholders leading advocacy or actively championing for this problem**

*[Provide names and contact details of associations, pressure groups, organizations, etc. leading advocacy for the problem, actively looking for ways to address the problem]*

* 1. **List the major stakeholders leading advocacy or actively building solutions for the problem**

*[Provide names and contact details of associations, pressure groups, organizations, etc. leading advocacy for the problem, actively developing or funding solutions]*

1. **Existing Solutions**

*[Describe current existing solutions (regardless of technology) as well as technical solutions or other alternative ways (advocacy, education, collaboration, etc.) currently used in managing the problem]*

* 1. **For each solution:**
     1. **What is origin and status of the solution?**

*[Describe the origin:*

* *Created during a hackathon*
* *Coming from academic research*
* *Startup incubator*
* *Work in the context of an NGO*
* *Others]*

*[Describe the status:*

* *Published article*
* *Published code/datasets*
* *Reference example for education*
* *Routinely used*
* *Sustainable and funded solution benefiting people today]*

*[Describe the sharing status:*

* *Available to all to use*
* *Published but has IP rights*
* *Available in Github/other places for public usage*
* *Only available commercially]*
  + 1. **Features of the Solutions**

*[Describe the unique functionalities and attributes of the solution]*

* + 1. **Shortcomings of the solutions**

*[Describe the failure or bad feature of the solution]*

1. **What needs to happen to address the problem?**
2. **AN INFERENCE ENGINE**

This is the brain of the prediction system. It provides reasoning about the information in the knowledge base. It helps in deducting the problem to find the solution. It also helps in formulating conclusions.

1. **A KNOWLEDGE BASE**

This is a repository of facts where all the knowledge about the problem domain is being stored. It’s like a large container of knowledge which is obtained from different experts of that specific field. The field we are concerned about here is material science. The success of this prediction system is largely dependent on how accurate and precise the knowledge is.

1. **USER INTERFACE**

This is the most crucial part of this intelligent prediction system. This component takes in the user’s query in a readable form and passes it to the inference engine. After which it displays the results to the user. The user in this case is the scientist/builder. In short, this interface helps the user communicate with the intelligent prediction system.

**3.1 Key physical infrastructures that must be in place**

1. SMART PLANT

The purpose of the smart plant is to operate to tighter specifications and involve a much greater understanding of the processes, greater automation and decision support. It would be a workforce that is trained and oriented toward a knowledge and information mindshare.

1. Data Center

This is a dedicated space within a building that houses critical applications and data. This is very critical in building a solution because our prediction system solely relies on data and it is very important to have a dedicated building where all these data are stored in which the prediction system could have access to.

**3.2 Stakeholders involved in solving the problem**

1. Material Scientist
2. The Builders
3. Knowledge Engineers
4. Decision Support System Engineers
5. Regulatory Agencies
6. The media

**3.3 Why is AI and Data is presumed to be helpful addressing this problem?**

The problem at hand is to provide an AI solution to CO2 emission. Carbon dioxide is an important component of the atmosphere because it plays multiple roles in keeping Earth’s climate stable. CO2 and other greenhouse gases are an essential part of the recipe because they trap heat in the atmosphere. With no CO2, Planet Earth would be in a perpetual ice age; However too much of it overheats the planet. Talking about the fertilization myth surrounding CO2, it’s only the right quantity of CO2 that can impact the fertilization of plants, an extra CO2 causes an imbalance within the crop’s chemical makeup causing a growth disruption in the plants.

The rate of CO2 emission keeps increasing and this is quite alarming. Through research, it was known that cement industry contributes eight percent of global anthropogenic CO2 emission.

*CO2 is a key greenhouse gas driving climate change, and it’s released by several aspects of cement production, (Professor Paul Fennell, Department of Chemical Engineering).*

For several years now, nouveau materials were discovered either through trial and error, intuition or through fortunate discovery that were actually not intended but as a result of the learning experience of the scientists, they were discovered. This was how cement was discovered. This has been going on from discovery to testing in the laboratory to passing clinical trials and so on. The whole process could take years. If we could speed up the process of discovery through artificial intelligence, why not? Obviously, since the goal is to discover more efficient, cost-effective and low carbon emission ways of making cement. The role of AI (Decision support system) here is to provide a friendly interface where the agents (in this case, the scientists and builders) can build scenarios, simulate and obtain reports and visualizations.

So what are the strengths of AI that could be used to make an impact?

1. **Prediction**: Cement was discovered by the scientists and builders when they mixed some materials together to see what would be formed. Through their trial and error, they discovered that if limestone was mixed with some other materials, cement would be produced, not minding the by product that could constitute as part of greenhouse gases. They never prompted further to check if any other combination of materials with similar structure could produce cement with less emission of carbon dioxide. Through the access of big data, algorithms can predict which ones combine to form interesting new materials, here in this case, cement. Also, through the predictive ability of AI, it could help predict the amount of CO2 that could be produced for each production and this would help the manufacturers in cutting down things they feel could help reduce the emission of CO2.
2. **Speed**: Smart systems powered by AI are known to be fast in processing. During the discovery stage, it could take years for scientists to be able to find a headway in discovering materials with similar structure in cement making. However, systems powered with AI could do that in split seconds. Going through the cloud and match several compounds in the knowledge base to the materials in question. The time between discovering a material and integrating it into a product could take several years. However, AI could lessen the time taken.
3. **Growth**: The fact that as more data is being fed back to the algorithm, the more it grows smarter and smarter each time. The use of deep neural networks as the framework of the decision support system makes it learn each time it makes a new discovery of materials. The more the data, the smarter the algorithms are.
4. **Visualizations**: The use of graphics and images improve the perception for the data analysis helping a faster recognition of trends, corrective actions can also be done.
5. **Process Control**: It could be used to control a physical process based on monitoring, in this case, the process of cement making.
   1. **List impact of data and available data /datasets surrounding the problem and the condition for their access**

The impact of data in Decision support systems can’t be overemphasized. It is a fact that the more data is being fed to the AI algorithm, the smarter the algorithm becomes. The AI solution we proposed has as its underlying framework, a decision support system. Decision support systems work for the processing, analyzing sharing visualization of important information data to aid in the process of knowledge aggregation and transformation. This implies that without data, our AI algorithm is just a stream of code with no impact. The availability of data helps the algorithm in making informed priority decisions.

To be able to create something new, the access and quality of data can’t be over emphasized because AI algorithms are just as good as the data they are trained on.

* 1. **Is such an approach feasible and sustainable?**

The significance of AI and big data can’t be over emphasized in making this solution a reality. This solution that has been proposed is quite feasible if a support system is put in place, availability of a data center and policy makers are in support. We have seen companies like IBM making use of a decision support system in aiding their business intelligence and decisions. We have seen the likes of MYCIN that is used in medicine for identifying various bacteria that could cause acute infections so why can’t AI be used in material science and manufacturing industry for predicting new materials that could be structured together to ad cement production in emitting low CO2.

1. **Possible Artificial Intelligence Solutions**

An intelligent prediction system of cement materials to facilitate CO2 emission reduction at the point of production.

**4.1 Technical features of the solutions**

**4.1.1 Must have**

* *A data dashboard that allows the data users and decision makers to visually synthesize data and easily navigate and quickly view data on different levels of the material engineering system.*
* *A beep alarm system that gets triggered once a new material has been found.*
* *An inbuilt voice control personal assistant, this is to offer a seamless way of interacting with the scientists and builders.*
* *A service delegation system that allows the system to have unbridled access to its knowledge base.*
  + 1. **Should have**
* *An explanation facility that explains how the prediction system arrived at the recommendation.*
* *A working memory that acts as a blackboard accumulating the knowledge about the case at hand, it will keep adding new information until a goal state is confirmed.*
* *A fuzzy logic system.*
  + 1. **Could have**
* *A pattern matcher and an efficient interpreter for matching rules against the available data.*
* *A knowledge base editor that monitors the changes made by the user.*
  + 1. **Would not have**
* *A consistency checking facility in which the system checks to see if the data being entered is conflicting with existing knowledge in the system.*
  1. **Documentation of the solution**

As regards to documentation of the solution, Data Science Nigeria has been doing the most by organizing hackathons and making it open source and introducing a template for documenting the solution and making it available to the solution builders and also available on the internet.

**5.0 Impact**

As discussed, the solution is an intelligent prediction system of cement materials to facilitate CO2 emission reduction at the point of production. Over the years, researchers have thought of several ways by which CO2 may be reduced, the idea of carbon capture and storage was brought up but we don’t have the existing technology to detect, capture and store carbon.

However, none has even thought about going down to the root of the problem, which is, what are the processes that lead to emission of CO2. Through research, we found out cement production constitutes to emission of CO2 even in large proportion. That is where our solution comes into play. What if the builders and scientists could see different models of cement making processes? What if there was a system that could search through different data and match compounds with similar structures with the materials used for making cement? After all, no one has gone on the quest to see if a new type of cement could be made with its processes not involving too much of CO2 emission. This solution if put in place, could help the builders expand their scope on different was by which cement can be made. Through the use of AI algorithm, the builders could visualize different models, see the end result without laying their hands on it.

* 1. **How is this solution different from already existing approaches?**

The most common existing approach is the use of Caron capture technologies. However, this isn’t safe either. Talk about the possibility of leakages on storing the CO2, which in turn leads to environmental contamination or the cost that would be incurred on burying tons of CO2. But if enough resources and manpower are directed towards looking for ways in which cement production can be made such that CO2 emission will be reduced, then why don’t we give it a go? The aspect of AI that would be employed is a decision support system otherwise known as Expert systems. This will help guide the decision making process of the builders and scientists on their quest in developing a new form of cement whose production process will emit small amount of CO2. If this can be successful, it’s application can be spread to oil and gas industries whose production processes emit huge amount of CO2.

* 1. **How will this solution empower problem owners and champions?**

If this solution could be brought into reality, it would serve as a way of telling individuals that there is nothing impossible with the use of AI technologies. If at the end of it all, cement production came to be with the use of new materials discovered through the help of the prediction system and the scientists, t could further gear them up to apply it in other aspects of manufacturing, oil and gas.

* 1. **How can this solution be sustainable?**

Sustainability can be ensured for this solution by making them fully open source and building communities that will help to foster the development of the solution. Calling for experienced knowledge engineers, material scientists, researchers with experience in this field will further increase the sustainability of the solution. Also, due to the fact that the solution is an open source project, it is not specifically being funded by a specific company hence there will be a need for a pool of funds to keep the solution functional and usable continually even by future generations to come.

* 1. **How this solution could help share more knowledge about problem solving**

As this solution I am proposing is quite new in the material science field, this would gear scientists up to open up to the power of AI and unlock things they ordinarily won’t have thought it could be possible. The success of this project would be a game changer in the industry and it would also awaken the intuitive abilities of some scientists. This isn’t just about building a workable solution, it is about developing a community of knowledge builders and innovation enthusiasts.