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PRIORITIZING BARRIERS IN THERMAL POWER PLANT USING FUZZY LOGIC :A SUSTAINABLE PERSPECTIVE

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ABSTRACT:
The main aim of the project is to identify the most critical barrier which comes under each sustainability goals with the help of (MCDM)-Multi Criteria Decision Making in which FUZZY DEMATEL tool suits the most in our case so we studied about that tool in order to implement that knowledge we gained about that tool to prioritize the major and crucial problem in each sustainable goal that we have taken.The purpose of this research is to identify list of barriers that affects sustainable goals in thermal power plant and find the most crucial problem with the help of MCDM method, to give optimal solution for that problem and to propose the solution which we have identified with the industrial experts.

INTRODUCTION:
The high rates of carbon, sulphur oxide, nitrogen, and particulate matter emissions, thermal power plants are generally water-intensive and polluting which can negatively affect respiratory reactions.
They severely deplete the available resources, exacerbating the contamination of the air and water. The good news is that if businesses start making real efforts to adhere to the Environmental Clearance regulations without breaking them, we can reduce the harm done to the environment and society. Even though they operate within a controlled environment, the effects are destroying people's minds, spaces, and means of subsistence. This introduction is to draw attention to the inconsistencies in the electricity sector, specifically with regard to thermal projects, as well as how the lives and rights of the populace are minimised during the decision-making process.Now-a-days it is becoming very difficult to fulfil sustainable goals which were proposed by World Health Organisation the major reason is because of power plants, industries, development of human wellbeing. It is our need to implement sustainable goals for better world(future), so in this case we took thermal power plant as reference and we took 3 major sustainable goal constrains and we listed out the barriers of sustainable goals in each category.
Identifying the crucial problem is not only our duty, we need to give the apt solution for the most crucial problem that we get from MCDM ((Multi Criteria Decision Making), method and the solution that we proposed need to be cross verified with the industrial experts in order to get implemented.

LITERATURE:
More than 210 GW of electricity in India are produced using 66% coal. Human health is significantly impacted by atmospheric emissions from coal-fired power m6bmb, plants. 111 plants

with a combined installed capacity of 121 GW used 503 million tonnes of coal in 2010–2011, producing an estimated 580 ktons of sulphur dioxide and nitrogen oxide particles which are harmful for human health[1] .The levels of metals like Pb, Cd, and Ni that are produced while burning coal in thermal power plants cause groundwater contamination that is higher than the limits accepted by WHO (World Health Organization)[2].It was discovered that the biochemical parameters of cattle raised within a radius of mercury-polluted water sources were negatively impacted by fly ash from thermal power plants. The effects of high mercury levels in the water the exposed cattle's liver and kidneys serve as bio accumulators of mercury. Estimating urinary alkaline phosphatases is a sensitive sign of nephrotoxic tubular damage that has already occurred[3].The reduction of nitrogen oxides, carbon monoxide, volatile organic compounds, and particulate matter emissions from vehicles has been a threat to living beings. Ozone and particle matter disrupt the radiative balance and hence contribute to global warming over a shorter period of time so this helped to enhance the air quality and lessen its negative health
effects on living things[4].Thermal power plants are the main source of heavy metal pollution in the environment. The effect of thermal power plants is seen most in the soil, as the soil is the final deposition area for the pollutants, heavy metal pollution in the soils surrounding the TTPP -As, Cd, Cr, Cu, Hg, Ni, Pb, and Zn contents of the soils in the area. These heavy metal contents are also very high in soils surrounding thermal power plants in India, China, Nigeria, and Serbia[5].Due to increase of the capacity of thermal power plants. In order to condense vapor cooled water is supplied to the condenser. The costs of technical or cooling circulating water are enormous, which make up 95 % of the total water consumption for the needs of thermal power plants. The vulnerability sources of coastal waters grow due to the harmful effects that excesses the concentration of natural substances with the increasing use of coastal waters forthe economic and social needs. Pollutions associated with the release of thermal power plant wastes products, requires special attention and the management of coastal waters.[6].Atmospheric SO2 emissions from thermal power plant which uses coal as the fuel
causes serious air pollution in urban areas and acid rain production in natural environment. The relevant SO2 emissions from thermal power plant contributes 60% of the national total pollution.[7].Energy and exergy-based techniques are used to analyse the Rankine cycle in thermodynamic analyses. Environmental impact assessments are also carried out for lignite, hard coal, biomass, fuel oil, and hydrogen. Sulphur oxides, nitrogen oxides, carbon dioxide, and carbon monoxide emission levels for various fuels are estimated for this purpose. The emission factor method is used to calculate the emission values. Utilizing hydrogen and biomass cuts emissions dramatically.[8].The Mississippi receives the most heat emissions overall (62% from coal-fired power stations and 28% from nuclear power plants, respectively), and it has the most instances where the standard 3 °C temperature increase limit is equalled or exceeded[9].Fly ash, a waste product of thermal power plants, as a potential major anthropogenic source of arsenic (As). Thermal power plants powered by coal are primarily used to generate electricity. Arsenic is one of the numerous hazardous elements found in coal and is extremely dangerous to both aquatic and terrestrial life, including humans. Waste materials from power plant dumped into an open ash pond in the form of a thin slurry, which causes ecological issues, dumping FA in an open ash pond has a major negative impact on the ecosystem[10].To better understand occupational diseases, dangers, and injuries among the workers of thermal power plants, this work has been undertaken while taking a few factors including age, skill, and experience into mind. The majority of injured employees are either highly talented or unskilled.Or skilled workers, overconfidence was shown to be the leading factor in accidents and near-accidents, while carelessness and a lack of awareness were prominent among unskilled workers.[11].Nitrogen oxide (NOx) emissions over the Chinese mainland are rising, and this has raised serious concerns due to its detrimental effects on local air quality and human

health. A unit-based approach is designed to investigate and get the temporal and spatial characteristics of NOx emissions from thermal power plants in China. Based on specific data on unitcapacity, boiler and burner patterns, feed fuel types, emission control methods, and geographic locations, the approach evaluates NOx emissions. The average NOx-intensity is predicted to be 2.28 g/kWh, significantly greater than that of industrialised nations, mostly because high-efficiency denitrification techniques like selective catalytic reduction are not used to their full potential (SCR)[12].

EXPERIMENTAL

Fuzzy Logic:

Traditional Traditional methods of quantification often struggle with addressing complex, people-centered problems due to the high uncertainty and complexity introduced by human factors. These methods are typically not effective in real-world scenarios where there is a high degree of uncertainty. This is where fuzzy logic, introduced by Zadeh, becomes valuable. Fuzzy logic is particularly useful in situations where the environment involves imprecise, uncertain, or fuzzy data. It helps in decision-making processes when the goals, constraints, and possible actions are not clear.The DEMATEL (Decision-Making Trial and Evaluation Laboratory) method is widely recognized as an effective approach for tackling such complex problems. Unlike traditional techniques, such as the Analytic Hierarchy Process (AHP), DEMATEL creates a structural model that illustrates the interrelationships between various factors in a complex system. One of the key strengths of DEMATEL is its ability to consider the interdependencies among factors using a causal diagram, something that many conventional problem-solving methods overlook. This makes DEMATEL a powerful tool for understanding and solving real-world decision-making problems under uncertainty.

FACTORS:

Environmental Barriers

1.Contamination of Air
2.Contamination of Water
3.Effects on flora and fauna
4.Transportation impact in Environment
5.Contamination of Land
6.Extinction of fresh water habitats
7.Causes Acid rain
8.Thermal pollution
9.Effect of fuel used in thermal power plant to Environment
10.Effect of radiotoxic element

Health and Safety Barriers

1.Hazardous condition
2.Unsafe ambience
3.Unsteady social and psychological stability of workers
4.Accidents in power plants
5.Spillage/Poisonous Emission
6.Injury to the workers
7.Fire accidents
8.Health impact on workers
9.Occupational diseases

10.Arsenic deposition in land

Consumption and Operational Barriers

1.Guzzling of water
2.Effect of water scarcity in thermal power plant
3.Usage of ABT(Availability Based Tariff)
4.Less efficiency and wastage of raw material
5.Drawback of Inductive loads
6.Effect of climate condition in production
7.Resource allocation Crisis
8.High failure rate
9.Sedimentation problem
10.Water wastage

RESULTS AND DISCUSSION

Fuzzy Dematal-Environmental barriers result

	Ri	Cj	Ri+CJ	Ri-Cj	Relation
E1	3.329413	2.806214	6.135627	0.523199	Cause
E2	2.870426	3.564366	6.434791	-0.69394	Effect
E3	3.084023	3.737418	6.821441	-0.65339	Effect
E4	2.006467	0.260277	2.266744	1.746189	Cause
E5	3.097706	2.691307	5.789013	0.406399	Cause
E6	2.539385	3.524383	6.063769	-0.985	Effect
E7	2.818772	2.698915	5.517687	0.119857	Cause
E8	2.639168	2.53624	5.175407	0.102928	Cause
E9	2.463564	3.1149	5.578464	-0.65134	Effect
E10	2.455968	2.370872	4.82684	0.085096	Cause

RANKING ORDER: (Largest to Smallest)
E3>E2>E1>E6>E5>E9>E7>E8>E10>E4

Fuzzy Dematel- Health and Safety Barriers result

	Ri	Cj	Ri+CJ	Ri-Cj	Relation
H1	1.903717	2.7442	4.647917	-0.84048	Cause
H2	2.680668	3.2412	5.921868	-0.56053	Effect
H3	2.518247	2.8187	5.336947	-0.30045	Effect
H4	2.93679	2.6294	5.56619	0.30739	Cause
H5	2.227459	1.7705	3.997959	0.456959	Cause
H6	2.461832	2.8457	5.307532	-0.38387	Effect
H7	2.945898	1.9629	4.908798	0.982998	Cause
H8	2.591891	3.4196	6.011491	-0.82771	Cause
H9	2.681406	2.572	5.253406	0.109406	Effect
H10	1.420984	0.3647	1.785684	1.056284	Cause

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RANKING ORDER: (Largest to Smallest)
H8>H2>H4>H3>H6>H9>H7>H1>H5>H10

Fuzzy Dematel-Consumption and Operational Barriers result

	Ri	Cj	Ri+CJ	Ri-Cj	Relation
C1	2.79488	2.659657	5.454537	0.135223	Cause
C2	3.379423	3.079514	6.458937	0.299909	Effect
C3	3.477084	2.302872	5.779956	1.174213	Effect
C4	2.408625	2.86567	5.274295	-0.45704	Cause
C5	0.776823	1.423754	2.200577	-0.64693	Cause
C6	2.657658	2.767629	5.425287	-0.10997	Effect
C7	3.634038	3.031582	6.66562	0.602456	Cause
C8	2.157427	2.36794	4.525366	-0.21051	Cause
C9	2.348995	2.317731	4.666727	0.031264	Effect
C10	2.574634	3.39324	5.967873	-0.81861	Cause

RANKING ORDER: (Largest to Smallest)
C7>C2>C10>C3>C1>C6>C4>C9>C8>C5

CONCLUSION :

The rapid pace of industrialization has led to the over-exploitation of natural resources, which, in turn, is contributing to the swift rise in global temperatures. This exploitation is causing significant biodiversity loss, environmental pollution, and global warming. Among the main contributors to these environmental issues are thermal power plants, which emit harmful gases that accelerate global warming. As sustainability becomes more critical, thermal power plants must incorporate sustainable practices into their operations. However, they face significant challenges when trying to achieve sustainability.A study was conducted to identify 30 barriers faced by thermal power plants in India across four categories: environmental, health and safety, consumption, and operation. These barriers were analyzed using the fuzzy logic DEMATEL technique. The study found that environmental pollution, lack of innovation, insufficient safety awareness, raw material shortages, worker safety concerns, and health issues are the primary challenges in these areas. To improve sustainability, the study suggests that thermal power plants should focus on adopting new technologies, shifting from fossil fuels to renewable energy sources, and reducing emissions and waste byproducts. These measures would help control emissions and promote more sustainable power production. Additionally, better use of raw materials can increase profitability, protect the environment, and enhance safety. Safety precautions for workers must be implemented based on their skill levels, as worker safety is a significant challenge that requires immediate attention.While this study focuses on thermal power plants in India, its methodology could be applied to similar contexts in other developing countries. Future studies could explore new insights by considering country-specific health, safety, and environmental challenges. One limitation of the study is that it does not address organizational risk factors, which could be an important area for future research. Additionally, other decision-making tools, such as fuzzy cognitive maps (FCM), Analytic Network Process (ANP), Analytic Hierarchy Process (AHP), and TOPSIS, could be used in future studies to further analyze and address the environmental challenges faced by thermal power plants.

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