



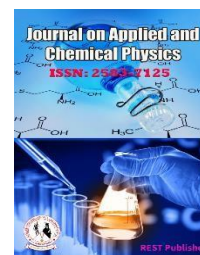
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Environmental Science and Pollution Using DEMATEL Method

Aqeela A. Sattar Qureshi

Royal College, Maharashtra, India.

Corresponding Author Email: aqsattar@gmail.com

Abstract: Effective decision-making procedures are required for sustainable development as environmental science and pollution have elevated to the status of major global concerns. The Decision-Making Trial and Evaluation Laboratory (DEMATEL) technique is what we suggest using in this study to examine the intricate interrelationships between environmental science parameters and pollution. The DEMATEL technique makes it possible to identify and rank important aspects, supporting thorough environmental management decision-making. Global issues like pollution and environmental science present serious dangers to the world and its population. As opposed to pollution, which is the introduction of dangerous compounds or contaminants into the environment that have a negative impact on ecosystems and human health, environmental science concentrates on comprehending the natural systems, processes, and interactions within the Earth's environment. For detecting and resolving the causes and effects of environmental deterioration, as well as for creating environmentally friendly options for a happier and more resilient planet, an understanding of environmental science and pollution is essential. As it supports environmental preservation, health security, equitable growth, policymaking, and international cooperation, environmental science and pollution research is of utmost importance. Research equips society to address environmental issues and move towards a healthier and more resilient future through expanding scientific knowledge and understanding. Using a quantitative approach, this method analyses complex systems and the interactions between variables. It is a structured method that aids in identifying interdependencies and levels of influence among diverse components. Non-metal mineral product industry, General equipment manufacturing, Mining and washing of coal, Textile industry and Food manufacturing industry. Non-metal mineral product industry got 1st rank, Mining and washing of coal got 2nd rank, Textile industry got 3rd rank, Food manufacturing industry got 4th rank, and General equipment manufacturing got 5th rank. Non-metal mineral product industry got 1st rank with less compensation.

Keywords: Environment Science, MCDM, DEMATEL, Air Pollution, Industries.

1. INTRODUCTION

The first and second issues of Environmental Science and Pollution Research and Journal of Cleaner Manufacturing are included in the majority of these publications, but not all of them. Since 2014, environmental reforms have received support under local state legislation everywhere. Environmental economics and energy policy also rank third and fourth, despite their controversies. Over time, the output rate has remained constant. The majority of renewable energy's total contribution from 2013 to 2018 is reviewed in fifth place, following sustainable energy [1]. Environmental issues, particularly air pollution, are worsening. India's situation is even worse due to population density, population increase, and industrialization. The health of the people is seriously threatened by the scenario of rising air pollution. The health needs theory suggests that people's income, age, and environment can all impact their health capital, including factors such as pollution, lifestyle choices (such as smoking or exercise), education, and more. It is possible to reduce a factor that affects the condition of human capital by addressing the environmental impact of air pollution. The importance of health capital and how it affects health by raising attrition rates due to personal health issues is also emphasized [2]. The main goal of every state is to have a healthy economy. Economic development and growth principles are pursued to advance social well-being, achieve sustainability, and optimize the use of available resources. However, environmental contamination, including smog and thick fog, is a challenge that is changing the landscape [3]. By utilizing information from specific molecular tests, we can characterize secondary products of organic matter and learn more about their environmental history. Assessments of production fluxes and cross-correlation can be used to achieve this. The application of Methods for Single Source Releases and Sampling from Surrounding

Atmosphere allows for separation and analysis. Popular examples from the natural environment (aerosol particles) and emissions from burning biomass (smoke) will be used to illustrate this [4]. The issue has various opposing viewpoints. Some wealthy nations want to outsource a portion of their production to developing nations for reasons such as cost savings and less stringent environmental regulations. However, there are also environmental regulations in place. Outsourcing production to developing nations with lax environmental rules is driven by the desire to avoid the additional costs associated with compliance in industrialized nations [5]. In India; cities are where most people reside. Extensive research on the ingestion of pollutants through soil-crop systems in agriculture indicates that oral intake is believed to be the primary method of exposure to heavy metal contaminants in humans. Pollutants in urban areas can easily reach people through non-dietary consumption, inhalation, or skin contact, even if they are not used for agriculture. Heavy metal contamination in cities has increased over the past 20 years, and rapid urbanization and industrialization have made these areas a severe concern. The observed issues are all consequences of rapid economic expansion [6]. These studies are tremendously helpful for policymakers. The goal of urban planners is to reduce noise and pollution in residential neighbourhoods. Waste management, recreation, risk assessment, and transportation-related studies are often components of sustainable urban development. Prioritization approaches that allow researchers to assess the relative importance of characteristics valued collectively by respondents in everyday test scenarios are particularly valuable. Evaluating each aspect separately in multifactorial selection circumstances leads to poor measurement [7]. The direct effect of aerosols on the Earth's radiation equilibrium involves the absorption and scattering of ultraviolet rays back into space. The indirect effect is the increase in solar energy reflected by clouds. The particle size and chemical composition of aerosols significantly influence their direct radiative effect. Anthropogenic aerosols have relatively significant radiative impacts compared to their mass contribution due to their radioactivity [8]. According to the notion of endogenous growth; technological advancement is the primary driver of economic expansion. Extensive research indicates that technological development has greatly aided in promoting economic growth and environmental stewardship worldwide [9]. Microplastic contamination is a growing environmental concern. Microplastics in the oceans have received a large portion of current research attention. However, there is limited data on the presence of microplastics in fresh water, particularly in Asia. The purpose of the current study was to investigate the amount and level of microplastics in the sediments and surface water of Rawal Lake, the capital of Pakistan [10]. Education alone can address this dangerous environmental issue by combating social ignorance at this critical moment. Students, as future educated workers, entrepreneurs, and policy leaders in the fight against plastic pollution, constitute the most important group in terms of raising awareness. As the nation's future foundation, they can influence more people to become aware of the issue. However, this issue is worsening [11]. Integrative analysis and associated selection-modelling techniques have been employed in marketing research for many years to evaluate consumer behaviour and preferences for various product attributes. The application of integrative analysis in environmental science and management has recently been increasing. Ecological research has also been assessed in this review, and other domains exhibit similar trends. These strategies share the common feature of evaluating trade-offs while considering multiple significant factors simultaneously [12]. Traditional monitoring, modeling, and emerging contaminants play a crucial role in understanding the health effects on individuals exposed to them and our ability to anticipate them. Accurate description of the atmosphere's chemical state is necessary for accurate analysis of air pollution. Effective integration is facilitated by efficient computing tools and observational data samples. Many developed air quality models are crucial for managing air quality. However, selecting one model over others can be challenging due to their differences [13]. Climate change and air pollution have negative effects on tourism indicators, leading to deforestation and a reduction in natural resources. The tourism sector has experienced a systematic decline due to significant climatic changes and rising air pollution. There are various ways to explore the cause-and-effect relationships. Climate, air pollution, and tourist indicators are all global issues. A unidirectional, bilateral, and non-causal examination of the global relationships between climate parameters, air pollution, and tourist indicators is needed. The tourism sector constantly faces formidable obstacles due to reduced commitment, limited resources, and decreased relevance from government organizations, primarily due to problems like air pollution and climate change [14]. Several empirical studies have examined the interactions and long-term equilibrium linkages between macroeconomic variables, pollution, and ecosystems. However, low-development and emerging nations seem to lag behind in terms of readiness and adaptation to climate change and its effects, mainly due to the lack of progressive research relevant to the study [15].

2. METHODOLOGY

DEMATEL Method: Identification is frequently conducted using the Decision-Making Test and Evaluation Laboratory (DEMATEL) approach, which is an important aspect of straightforward systems in several domains. However, despite the significant efforts put into developing DEMATEL, it is still best suited for simple systems and unable to address decision-making issues in complex systems. In this paper, we propose a hierarchical DEMATEL technique for multisystem complex systems, considering various factors, influences, and the existence of a hierarchy. The first step is to decompose the complex systems into a hierarchical structure, providing a theoretical basis for simplification. Vertical deformation expands, while horizontal deformation has a variety of impacts, establishing a hierarchy and incorporating numerous system elements [16]. We suggest using a fresh approach based on DEMATEL that takes into account the weight of each source. The initial step is determining the total-correlation matrix by assessing the resemblance between sources. Next, the calculation of importance and significance is performed. Finally, employing Dempster's method, a weighted average admission outcome can be derived. The suggested model is demonstrated to be effective for both competing contracts using numerical examples, reducing the complexity of computation and proof [17]. To determine critical factors and criteria, the DEMATEL technique evaluates supplier performance and provides a novel method of gathering data for selecting a Supply Chain Management (SCM) provider. In our study, seventeen professional purchasing employees in the electronics industry received a fuzzy DEMATEL questionnaire specifically designed for this purpose. According to the findings, consistent product delivery is of utmost importance and exhibits a significant relationship with influence and other factors [18]. In various aspects of life, such as social, professional, and personal realms, people frequently face decision-making situations where they need to consider multiple options. Decision-making techniques have been widely discussed in scholarly literature. However, most of these techniques are based on idealistic assumptions, such as the independence of each aspect in a complex framework and its impact on risk. In reality, there is a significant relationship between risk variables and the information sources used in decision-making. Therefore, it is necessary to develop a decision-making framework that considers risk factors and information sources. Integrating the DEMATEL technique allows for this [19]. Setting a threshold value is crucial for decision-makers, as it provides a cut-off value to exclude unlikely results in the T-matrix and offers insights into how one element influences another. Consequently, the effects are appropriately evaluated, and an acceptable value is selected and displayed on each graph [20].

$$a_{ij} = \frac{1}{N} \sum_{k=1}^N x_{ij}^k$$

The DEMATEL technique has been modified to construct a network of interconnected elements, enabling the collection of collective knowledge to build a structural model. By employing this approach, we can visually observe the causal relationships between factors using a cause-and-effect diagram. The findings obtained through DEMATEL provide information about the effects each factor has on the entire emergency system. Through careful examination and discourse, we can identify which elements are fundamentally important to the system and which are not; thereby determining the crucial success factors for the system [21]. This study outlines the evaluation criteria for outreach workers' performance, followed by the application of the Decision Making Testing and Evaluation Laboratory (DEMATEL) method. This method not only determines the importance of the criteria but also reveals the connections between those requirements. The essay is structured as follows: a brief discussion on the DEMATEL technique in various case studies related to Environmental Science and Pollution [22]. Additional studies have also confirmed the advantages of the DEMATEL approach. Lin and Wu (2008) found that DEMATEL is an effective method for causal analysis, allowing researchers to separate important systemic criteria into cause and effect groups. This method enables producers to agree on highly influential criteria. Cheng (2009) used DEMATEL to handle uncertainty in ranking real estate agent service quality expectations. DEMATEL, combined with other criterion decision-making (MCDM) methodologies, has been successfully employed in various study domains to assess the development of sustainable management systems in small and medium-sized businesses. It is a versatile approach that can address complex causality problems and provide development options based on an industry or organization's core competencies [23]. Graph theory provides a valuable tool for visualizing and finding solutions to complex problems. Maps generated through graph theory present mathematical outcomes in a clear and unambiguous manner. In DEMATEL, digraphs serve as the foundation, as they can demonstrate directed relationships between factor groups and effect groups. Directed maps, or digraphs, are more helpful than undirected graphs in illustrating these relationships and subsystems [24]. The DEMATEL method is also utilized in the Laboratory for Testing and Evaluation to calculate the risk of failure [25].

Evaluation Parameters:

- 1) An essential industry that supports manufacturing, agriculture, and infrastructure growth is the non-metal mineral products sector. It offers the materials required for uses in manufacturing, agriculture, and building. This industry can continue to meet the rising demand for non-metal mineral products while reducing its environmental impact by using proper environmental management practises.
- 2) Manufacturing as well as assemblage of a broad range of tools and machinery used in numerous industries is included in general equipment manufacturing. To manufacture reliable and usable equipment, design, fabrication, and assembly procedures are used. The industry makes a substantial contribution to raising production and efficiency in several industries, satisfying consumer demand, and upholding safety and regulatory standards.
- 3) Coal extraction from mines and subsequent purification steps are included in the mining and washing of coal process. The availability of coal as an energy source depends on these activities. Depending on the features of the coal seam, different mining techniques are used, while washing improves coal quality and lessens environmental effects. Coal mining operations must have efficient environmental oversight and safety procedures.
- 4) The manufacture, processing, and sale of textiles and textile-based goods are all included in the textile business. There are several processes involved, from locating raw materials to making fabrics and completed things. The sector contributes significantly to the creation of jobs, international trade, and the global economy. To secure a sustainable and creative vision for the textile sector, efforts are being undertaken to address social and environmental issues and embrace technology breakthroughs.
- 5) The processing, packaging, and distribution of a broad range of food products are all included in the food manufacturing business. It involves several steps, from gathering raw materials to processing them into consumable finished commodities. While guaranteeing quality, safety, and compliance with legal requirements, the industry is essential in fulfilling the demand for processed food items.

3. RESULT & DISCUSSION**TABLE 1.**Environmental Sciences and Pollution

	Non-metal mineral product industry	General equipment manufacturing	Mining and washing of coal	Textile industry	Food manufacturing industry	Sum
Non-metal mineral product industry	0	1	4	2	2	9
General equipment manufacturing	3	0	2	1	1	7
Mining and washing of coal	2	1	0	3	2	8
Textile industry	2	3	2	0	2	9
Food manufacturing industry	2	1	1	2	0	6

Table 1 shows the Environment Sciences and Pollution Dataset. The Evaluation Parameters are Non-metal mineral product industry, General equipment manufacturing, Mining and washing of coal, Textile industry and Food manufacturing industry.

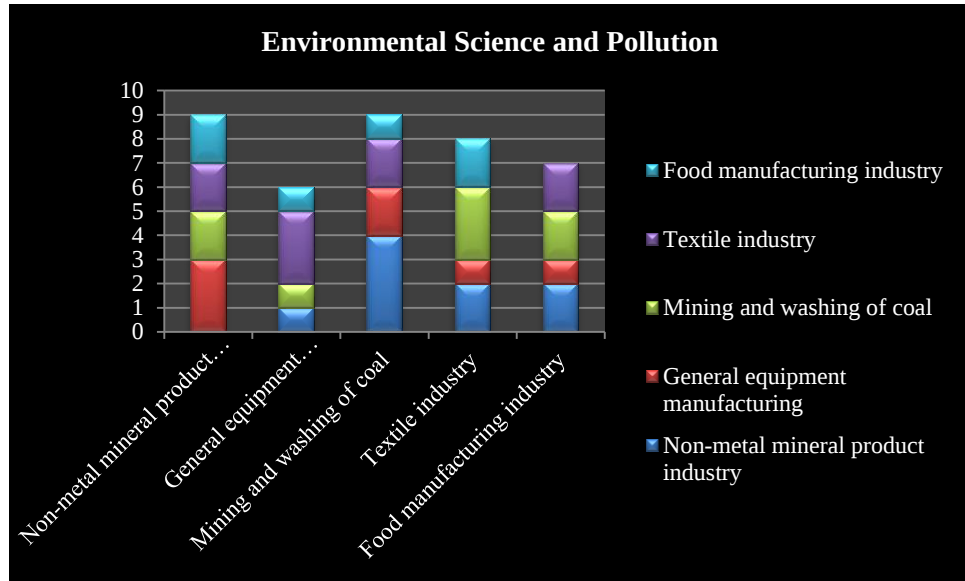


FIGURE 1. Environmental Sciences and Pollution

TABLE 2. Normalized direct Relation matrix (Y)

	Normalized direct Relation matrix (Y)				
Non-metal mineral product industry	0	0.111111	0.444444	0.222222	0.222222
General equipment manufacturing	0.333333	0	0.222222	0.111111	0.111111
Mining and washing of coal	0.222222	0.111111	0	0.333333	0.222222
Textile industry	0.222222	0.333333	0.222222	0	0.222222
Food manufacturing industry	0.222222	0.111111	0.111111	0.222222	0

Table 2 shows the Normalized direct Relation matrix (Y) for all the Evaluation parameters.

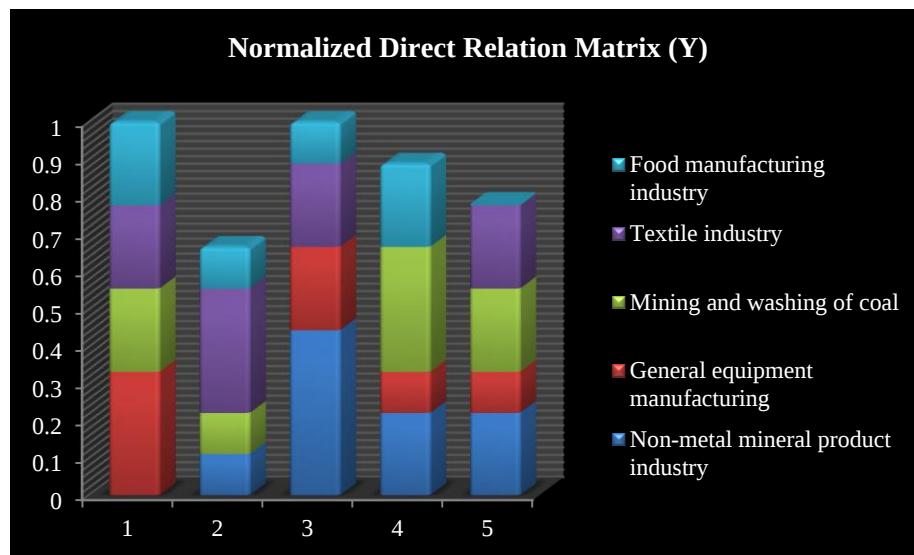


FIGURE 2. Normalized direct Relation matrix (Y)

TABLE 3. Identity Matrix (I)

Identity (I)				
1	0	0	0	0
0	1	0	0	0
0	0	1	0	0
0	0	0	1	0
0	0	0	0	1

TABLE 4. I -Y

I -Y				
1.0000	-0.1111	-0.4444	-0.2222	-0.2222
-0.3333	1.0000	-0.2222	-0.1111	-0.1111
-0.2222	-0.1111	1.0000	-0.3333	-0.2222
-0.2222	-0.3333	-0.2222	1.0000	-0.2222
-0.2222	-0.1111	-0.1111	-0.2222	1.0000

TABLE 5. (I -Y)⁻¹

(I-Y) ⁻¹				
2.564094701	1.238162	1.961298	1.699092	1.520792
1.550601079	1.924865	1.548393	1.341389	1.200626
1.610770363	1.153705	2.489573	1.627331	1.401006
1.734973013	1.378373	1.790174	2.465285	1.48436
1.306611874	0.923516	1.282323	1.255275	1.956882

Table 5 shows the Inverse matrix of (I-Y)

TABLE 6. Total Relation Matrix (T)

Total Relation Matrix (T)				
1.564095	1.238162	1.961298	1.699092	1.520792
1.550601	0.924865	1.548393	1.341389	1.200626
1.61077	1.153705	1.489573	1.627331	1.401006
1.734973	1.378373	1.790174	1.465285	1.48436
1.306612	0.923516	1.282323	1.255275	0.956882

Table 6 shows the Total Relation matrix (T) for all the Evaluation parameters. Where threshold Value (alpha) is 1.416 and all the bold data in T matrix are above the Threshold value.

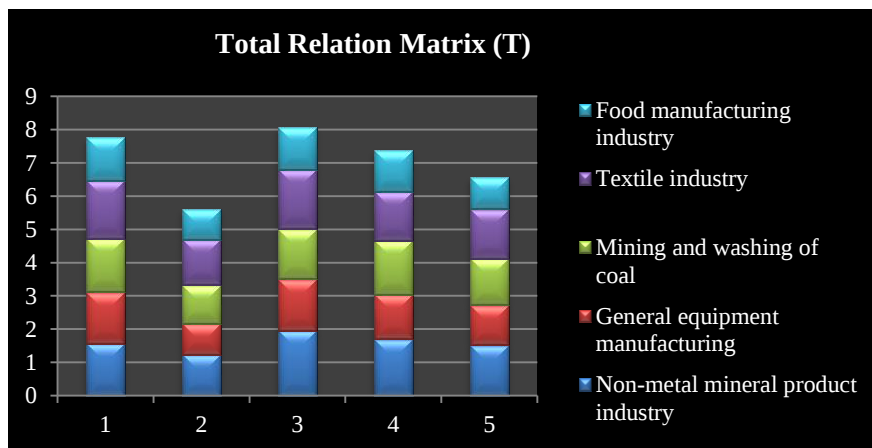
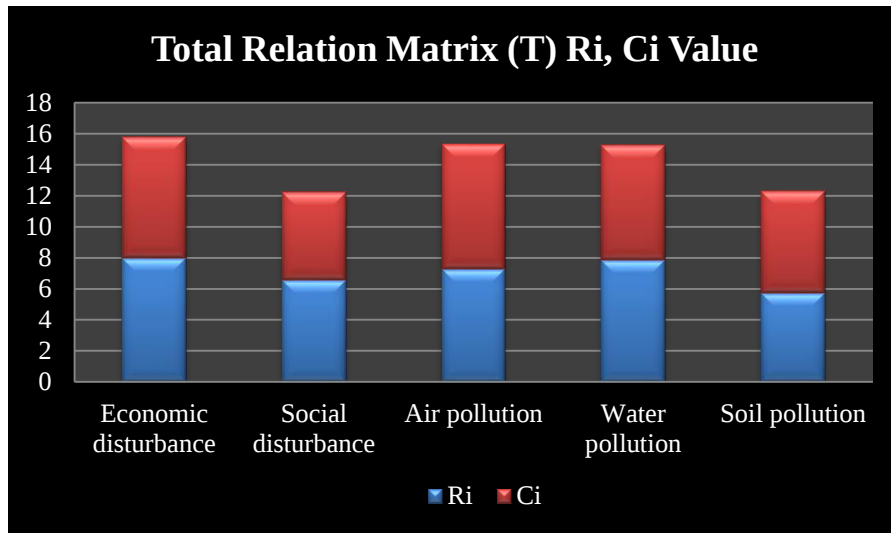
**FIGURE 3. Total Relation Matrix (T)**

TABLE 7. Total Relation Matrix (T) Ri, Ci

	Ri	Ci
Non-metal mineral product industry	7.98344	7.767051
General equipment manufacturing	6.565873	5.618621
Mining and washing of coal	7.282385	8.071762
Textile industry	7.853165	7.388371
Food manufacturing industry	5.724607	6.563665

Table 7 shows that the Ri & Ci values.

**FIGURE 4.** Total Relation Matrix (T) Ri, Ci**TABLE 8.** Total Relation Matrix (T) Ri+Ci, Rank, Ri-Ci and Identify

	Ri + Ci	Ri - Ci	Rank	identity
Non-metal mineral product industry	15.75049	0.216389	1	cause
General equipment manufacturing	12.18449	0.947252	5	cause
Mining and washing of coal	15.35415	-0.78938	2	effect
Textile industry	15.24154	0.464794	3	cause
Food manufacturing industry	12.28827	-0.83906	4	effect

Table 8 shows that Non-metal mineral product industry got 1st rank, Mining and washing of coal got 2nd rank, Textile industry got 3rd rank, Food manufacturing industry got 4th rank, and General equipment manufacturing got 5th rank.

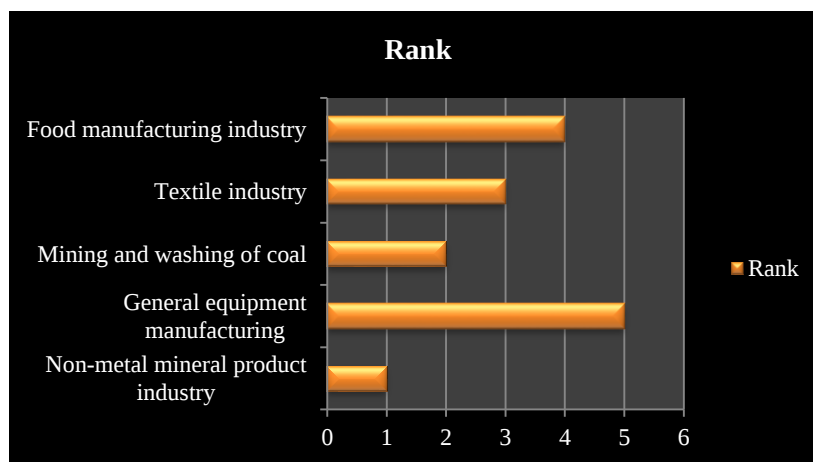
**FIGURE 5.** Rank

Figure 5 Concludes that Non-metal mineral product industry got 1st rank

4. CONCLUSION

Environmental issues, particularly air pollution, are worsening. India's situation is even worse due to its high population density, increasing population, and rapid industrialization. The health of its people is seriously threatened by the scenario of rising air pollution. The health needs theory holds that people's income, age, and environment can all have an impact on their health capital, including factors such as pollution, lifestyle choices (such as smoking or exercise), education, and more. Addressing the environmental impact of air pollution can help mitigate a significant factor that affects the condition of human capital. Understanding the importance of health capital and how it influences health can help reduce attrition rates caused by personal health issues. The primary goal of every state is to have a healthy economy, which requires economic development and growth principles that promote social well-being, sustainability, and efficient utilization of available resources. However, environmental contamination, including excessive smog and dense fog, is changing the landscape. To address this issue, it is suggested to use a fresh approach based on DEMATEL, which takes into account the weight of each pollution source. The initial determination of the total-correlation matrix relies on the resemblance between sources. The calculation of importance and significance follows thereafter. Finally, using Dempster's method, a weighted average admission outcome can be derived. The suggested model has been proven effective for competing contracts, as demonstrated by numerical examples, reducing the complexity of computation and proof [17]. To determine critical factor criteria, the DEMATEL technique evaluates supplier performance, enhancing and offering a novel method of gathering data for selecting an SCM provider. For this study, seventeen professional purchasing employees in the electronics business received a fuzzy DEMATEL questionnaire created specifically for this purpose. The findings highlight the crucial importance of consistent product delivery and its significant relationship with other influencing factors. Based on the discussion, the Non-metal mineral product industry ranked first, followed by Mining and washing of coal in second place, Textile industry in third place, Food manufacturing industry in fourth place, and General equipment manufacturing in fifth place.

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