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Assessing and Ranking Health, Safety and Environmental Risks through Analytical Network Process (ANP) Method in Cement Plant

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ABSTRACT: *In today's competitive world, decision-making and management are based on risk assessment. Accordingly, the present study deals with assessing and managing the risks of Health, Safety and Environment (HSE) aspects in cement factory through combining three widely used methods including failure mode and effect analysis (FMEA) to determine and estimate the level of risk, and to control and mitigate this risk using analytical network process (ANP) method. In this Project, three ANP models were used for risk assessment methods of FMEA. Then, paired comparisons of risks were performed through (ANP) in each set and provided to experts. In this study, overall for five general departments (materials milling, cement mill, stone crusher, baking, and loading house departments) all risks are identified. Regarding assessment of health risks, 52 risks were identified; the maximum level of risk was associated with Noise from the cement mill department. Considering assessment of safety risks, 29 risks were identified which the maximum risk was related to: falling from cement mill department (0.0601). Finally, with regards to the environmental risk assessment, 30 risks were detected, where the maximum risk was related to Reduction of resources and energy in the cement mill (0.064). The combination of the risk assessment methods including FMEA as well as simultaneous application of multi-criterion decision-making methods (MCDM) in particular ANP, is an efficient model in real assessment of levels of HSE risks ,So that they perfectly complement each other.*

Keywords: *FMEA, ANP, MCDM, HSE.*

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I. INTRODUCTION:

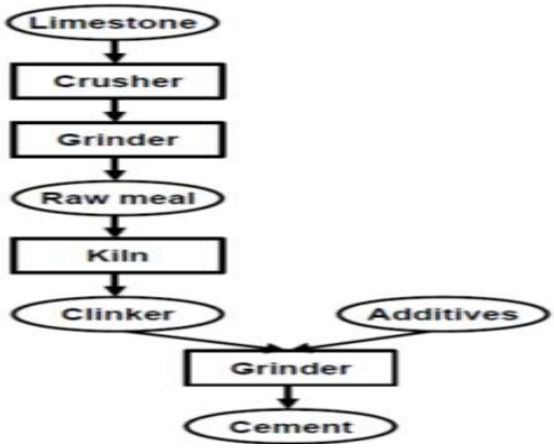
People's lives have been changed dramatically due to technological advancement in smart and diverse types of consumer electronics. These devices, known as the Internet of Things (IoT), are connected by advanced communication technologies to the Internet to exchange information People's lives have been changed dramatically due to technological advancement in smart and diverse types of consumer electronics. These devices, known as the Internet of Things (IoT), are connected by advanced communication technologies to the Internet to exchange information People's lives have been changed dramatically due to technological advancement in smart and diverse types of consumer electronics. These devices, known as the Internet of Things (IoT), are connected by advanced communication technologies to the Internet to exchange information

Environmental risk is the likelihood and impact of an unintentional mishap. Numerous contaminants are released into the environment as a result of shortcomings in waste management, trash transport, and waste treatment and disposal, posing substantial risks to human health along the way. The most frequently cited definition of risk in terms of occupational safety and health is "risk is the likelihood that a person may be harmed or suffer from adverse health effects if exposed to a hazard." Cement factories have a number of safety, health, and environmental hazards given their nature and type of activity. As a result, there is a chance that an accident will harm a worker, their tools, or the environment. Most cement production process mishaps involve explosions, fires, and equipment failure; employee injuries result from gliding, slipping, hitting things, falling objects, and lifting and carrying loads. Industrial workers in the cement industry are vulnerable to risks. Various stages of manufacturing process every stages hazards related personal protective equipments, unsafe condition for doing work. Workers' exposure to risks at work has an impact on their health[1]. Noise, dust, vibration, and emergency response are hazards in our working environment that highlight the impact of changing environmental patterns on the level and growth of productivity and efficiency in the industry[2]. In this paper states that continuous development day by day to boost efficiency, in cement manufacturing process to eliminate all wastages. Raising the quality of the product, lowering costs, enhancing product delivery, and decreasing waste are all important aspects of the cement manufacturing process. Implementation of cement industry day by

day to boost production helpful to our future. A new technique must be devised to properly control the cement producing process. To ensure that the manufacturing process is continuously improved [3]. In this paper researching about Safety is an essential component of the industrial management system. We can avoid any risk to human life, costly equipment damage, and unrest caused by low worker morale by implementing safe practices and procedures [4]. In this paper create a new model based on the original KMV model to assess the credit risk of the Chinese cement sector. By modifying certain factors in the basic model, we improve the accuracy of predictions and uncover that the revised version is more suitable to China's cement sector[5]. In this paper discussed condition-based maintenance (CBM) as a predictive strategy for spotting luggage cart breakdowns in airports. Maintenance strategy is represented by corrective, predictive, and preventive maintenance [6]. In this paper to pick an acid manufacturing company's maintenance strategy, a fuzzy ANP model taking risk, cost, and added value was presented [7].

II. ANALYSIS OF RISK IN CEMENT INDUSTRY

One of the most frequently used building materials worldwide is cement. Due to its widespread use, cement's health consequences have emerged as a significant concern for both the environment and workers. At various production processes like quarrying, crushing, raw material grinding, blending, kiln burning, cement grinding, and packaging in the cement industry, cement workers are particularly exposed to dust that causes lung function impairment, chronic obstructive pulmonary disease, restrictive lung disease, pneumoconiosis, and carcinoma of the lungs, stomach, and colon. One of the most significant concerns facing the cement business is ensuring that workers and contractors have safe and healthy working conditions, which is a basic component of corporate social responsibility.



- **Cement Manufacturing Process:**

A mixture of hydraulic cement components, chiefly calcium silicates, aluminates, and aluminum ferrites, are combined to form cement, which is a fine powder.

- **Failure Mode And Effect Analysis:**

Manufacturers can enhance the quality, dependability, and safety of their goods by using the comprehensive engineering technique known as failure mode and effects analysis (FMEA). Before products, programs, systems, and services are delivered to customers, the FMEA technique is used to identify, characterize, and remove known and possible failures, issues, and errors.

- **Materials and Methods**

Through the use of the FMEA method, we assessed the risks in various areas of the complex.we acquired failure modes along with its various components and failure impacts in amount using the risk priority number (RPN) equation and completed PFMEA worksheets utilizing FMEA Worksheets taken from the standard. The system's shortcomings were then reviewed.

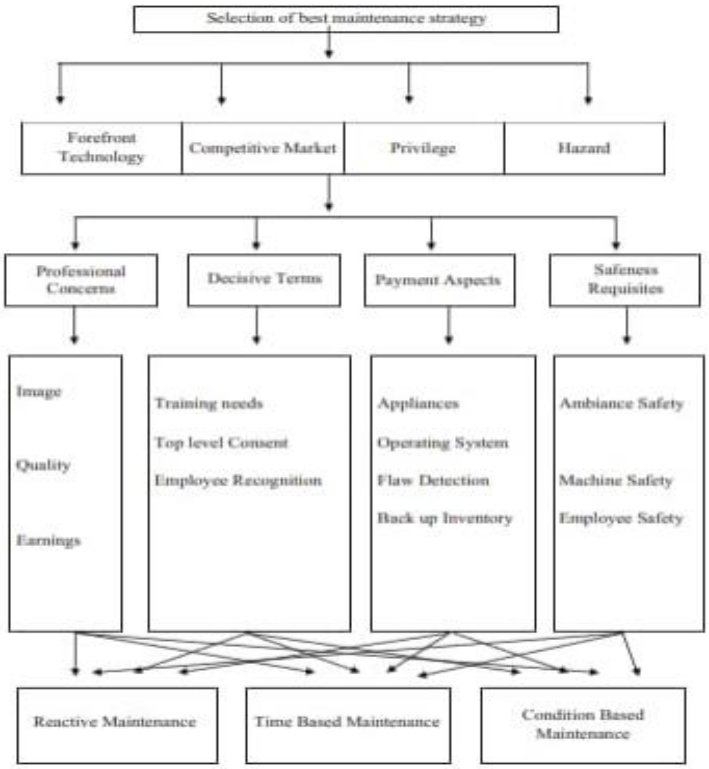
III. ANALYTIC NETWORK PROCESS (ANP) METHODOLOGY

Due to the consideration of intricate and interrelated relationships between decision elements and the capability to apply quantitative and qualitative attributes concurrently, the analytic network process is one of the multi-criteria decision-making methods that is frequently used to resolve various issues in the real world.

- **ANP model development:** The first step in an ANP study is to build the problem as a network structure. Generally, an ANP network structure has four parts: (1) the main model, (2) the benefits, opportunities, costs and risks (BOCR) model, (3) the ratings model and (4) the subnetworks. The goal of this illustrated ANP model is to select the optimum maintenance method in a cement industry where product quality and production loss are

the two main concerns. Choosing the best maintenance strategy is therefore crucial for this industry to achieve its manufacturing goals.

- **Data collection:** Questionnaires and expert interviews serve as the primary sources of data collecting to meet the goal. Four criteria and thirteen sub-criteria are determined based on the review of the literature and organizational study. A questionnaire addressing several elements related to the strategy selection is created in order to choose the desired maintenance planning of the industry.
- **Consistency:** Analysis of consistency is the conformance to facts, forms, or qualities that have already been articulated. It guarantees the accuracy of the comparing scale. By reducing response bias, this approach enhances the quality of decisions and establishes the validity of the study.
- **Calculating priorities:** Similar to how AHP is used, ANP uses pair-wise comparisons to determine priority vectors. The table of Saaty's fundamental scale describes the relative important levels.



- **Pair-wise comparison of dimensions:** A pair wise comparison matrix is generated to calculate the dimensions' relative influence from the standpoint of the maintenance policy.

The dimensions are sorted using the priority weights of the eigen vectors, which are computed.

- **Pairwise comparison matrices:** The model and research techniques discussed in this study measure a firm's performance in four areas: professional concerns, decisive requirements, payment issues, and safeness needs. This decision model takes into account and is dependent upon the many determinants, dimensions (criteria), sub-criteria, and enablers of the cement plant and their relationships.

IV. CONCLUSION

Systematic safety management is crucial in cement industry processes to prevent potential accidents and increase safety. It appears that implementing a documentation system for capturing equipment defects and occurrences can provide the basic information required to optimally assess subsequent safety. Furthermore, doing preventive maintenance can help to lessen the likelihood of equipment problems and their repercussions. Our findings indicated that, when compared to other risk assessment methods, FMEA can identify more hazards, and an important thing to note is that selecting a suitable method is critical in discovering more risks. To reduce risk, the Analytic Network Process (ANP) Methodology is applied. To that end, the company's health and safety policy should be integrated with its other policies.

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