Environmental Management in Thermal Power Plants - A Path Analytic Model Study in Indian Context

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Abstract
This paper presents a path analytic model showing the influential relationship among various environmental management (EM) variables for thermal power plants in India. In recent years, the need and importance of environmental management has been recognized by researchers and practioners as well. Thermal power plants are pollution prone industries and hence the importance of environmental management gains precedence over other aspects.for this sector. Therefore, thermal power plants operating in India are selected for this study. Seven EM variables for thermal power plants are examined and the influence of one over the other is investigated using path analysis. Data were collected on EM variables from 152 thermal power plants operating in India and having capacity of more than 100 MW each. The results indicate that top management involvement and serious environmental impact assessment (EIA) exercise would help to achieve environmental management goals. The findings of the study will be useful for EM executives of power plants to formulate suitable strategies for effective environmental management.

Keywords: Environmental Management, Thermal Power Plants, Path analysis.

1. INTRODUCTION

Environmental pollution stands as one of the most pressing global challenges today. It poses significant economic, physical, and day-to-day impacts on human lives. Moreover, the contamination of the environment is increasingly linked to the prevalence of various diseases. Over time, environmental pollution has escalated due to a myriad of factors, including rapid industrialization, population growth, wasteful resource utilization, urban expansion, adoption of less environmentally friendly technologies, and poverty.

India, in particular, grapples with escalating environmental problems. The country's remarkable economic development and the exponential population growth, soaring from 300 million in 1947 to over one billion today, are exerting immense pressure on the environment, infrastructure, and natural resources. B. Bowonde (1986) conducted a comprehensive study on environmental management issues specific to the Indian context. His findings underscored the complexity of India's environmental challenges, stemming from the intricate interplay of surging population density, industrialization, urbanization, and inadequate environmental management practices.

In 2010, the Central Pollution Control Board (CPCB), in collaboration with IIT-Delhi, conducted a survey spanning 88 industrial clusters across the nation. This survey unveiled a disturbing reality, with 44 industries registering pollution levels exceeding 70 points on a 100-point scale, while the remainder fell within the 60-70 point range. The emissions stemming from Thermal Power Plants are a significant contributor to this pollution, encompassing carbon dioxide (CO2), nitrogen oxides (NO), sulfur oxides (SO), chlorofluorocarbons (CFCs), and various airborne inorganic particles like fly ash and soot. Notably, carbon dioxide, methane, and chlorofluorocarbons are recognized as greenhouse gases.

India's energy requirements have been surging in tandem with the establishment of critical industries essential for sustainable economic growth. Thermal Power Plants have emerged as a cornerstone in meeting India's energy demands, contributing to 80% of the country's energy production. However, the emissions of carbon dioxide from these power plants, which accumulate in the upper atmosphere, exacerbate temperature rises each year. This phenomenon contributes to climate change and global warming, with profound implications for the environment. Consequently, the focus of this study is directed towards Thermal Power Plants.

An Environmental Management System (EMS) encompasses internal policies, assessments, plans, and implementation measures relating to an entire organizational unit and its interactions with the natural environment (Coglianese and Nash, 2001). EMS represents a structured and well-documented approach to address environmental challenges, with a keen emphasis on environmental regulations, standards, and customer requirements.

In recent years, mounting concerns regarding the greenhouse effect and global warming have fostered heightened awareness of environmental issues. These environmental concerns extend beyond the realm of pure science and delve predominantly into the sphere of effective management. Hence, environmental management should be an integral component of corporate vision, mission, and strategy. Prudent planning in this regard can lead to the realization of coveted objectives centered around conserving the natural environment and its resources.

The current study delves into the various variables constituting environmental management in Indian thermal power plants. It endeavors to identify these environmental management variables and uncover the intricate interplay among them.

KEY ISSUES IN ENVIRONMENTAL MANAGEMENT

Numerous pivotal concerns are intertwined with Environmental Management (EM). A review of existing literature reveals that researchers have predominantly addressed issues encompassing stakeholder pressure, the facilitative mechanisms driving EM implementation, the spectrum of EM activities, the execution of Environmental Impact Assessments (EIA), the level of engagement of top management, the efficacy of attaining environmental objectives, and the EMS's role in enhancing organizational performance. These encompassing issues can be outlined as follows:

2.1 Stakeholder Pressure

Stakeholders encompass any group or individual capable of impacting or being impacted by an organization's objectives, as articulated by Freeman (1984). Expanding on this, Savage, Nix, Whitehead, and Blair (1991) define stakeholders as groups or individuals with interests and the potential to influence an organization's activities. Henriques and Sadorsky (1999) further categorize stakeholders into four distinct groups, namely Regulatory Stakeholders, Organizational Stakeholders, Community Stakeholders, and the Media.

Regulatory stakeholders comprise governmental bodies, legislators, and competitors. Organizational stakeholders encompass consumers, suppliers, managers, employees, and shareholders. Community stakeholders involve nearby residents and environmental groups, while the media encompasses print, electronic, broadcasting, and internet-based outlets.

Numerous prior studies have emphasized the substantial impact of stakeholder pressure on environmental management practices. For instance, Yi-Chun Huang (2005) conducted a study in Taiwan that delved into the facets of environmental management and the influence exerted by stakeholders on enterprises in Taiwan. The study scrutinized the intricate relationship between environmental management and the sway of various stakeholders. Huang's findings notably revealed a positive correlation between environmental management and regulatory stakeholders, organizational stakeholders, community stakeholders, and the media.

Du (1995) also highlighted the escalating pressure on enterprises, prompting potential actions that may encompass employee training and the implementation of environmental management practices.

2.2 Supporting Mechanisms for Environmental Management Implementation:

Training and raising awareness among internal personnel, suppliers, and customers about environmental concerns play a pivotal role in aligning environmental objectives with business goals. The availability of resources and the commitment of senior management to develop and implement an Environmental Management System (EMS) are crucial factors contributing to the successful execution of environmental management practices. These combined elements are commonly referred to as "supporting mechanisms" essential for effective environmental management.

Past research has consistently underscored the significance of these factors in the implementation of Environmental Management (EM). For instance, Goh Yen Nee (2011) conducted an empirical study revealing that the availability of organizational capital resources poses a significant challenge in the context of ISO 14001 EMS implementation. Cook and Seith (1992) discovered that environmental training serves as a motivating factor for employees to actively engage in environmental initiatives. To this end, organizations are advised to institute environmental awareness training programs that impart lasting knowledge to employees, encompassing not only the organization's environmental management framework and policies but also its environmental footprint (Hale M, 1995, Cohen-Rosenthal E, 2000; Miller 1996; Burleigh, 1997).

2.3 Environmental Management Activities:

The significance of environmental activities has increased both in research and practice. Environmental management activities are regarded as one of the way to integrate the natural environment into corporate decision making. This implies a requirement to perform financially as well ecologically. One specific environmental management activity that is stressed as an enabler in both, firm-level incentive considerations and individual-level employee behavior is the provision of environmental training programs by the firm for its employees. Here it has been stressed, that training can raise environmental concerns and hence support pro-environmental behavior of individual employees (Fernandez et al., 2003), potentially resulting in economic benefits (Brio et. al., 2007). Environmental activities for thermal power plants may include development of environmental policy and programs, methods of fly ash disposal, measures of stake emission and recycling of solid waste and rubbish etc.

2.4 Environmental Impact Assessment Exercise:

Environmental Impact Assessment (EIA) has received various definitions since its inception (Yanhua et al., 2011; Samarakoon and Rowan, 2008; Snell and Cowell, 2006; Bruhn-Tysk and Eklund, 2002; Perez-Maqueo, 2001; Duinker and Greig, 2007; Lee and George, 2000). Consequently, offering a comprehensive definition of EIA can be challenging. Nevertheless, it can be characterized as a systematic process aimed at identifying, examining, analyzing, evaluating, and predicting the consequences of planned activities or policies. This process involves consultations with affected stakeholders and employs the results of the analysis and consultations in the planning, authorization, and implementation of the activity (Toro et al., 2012; Kwiatkowski and Ooi, 2003; Yanhua et al., 2011; Cashmore, 2004). EIA, therefore, serves as an anticipatory and participatory environmental management tool, grounded in principles like transparency, public involvement, and accountability (CENN, 2004; RTPI, 2001).

It's important to note that EIA practices can vary from one country to another. Numerous studies, such as Wood (2003a) and Okello et al. (2008), underscore the importance of legislation in ensuring the effectiveness of EIA. While some countries have EIA legislations that mandate project approval before commencement, others rely on regulations, guidance, or ad-hoc procedures (Glasson et al., 2000).

2.5 Top Management Involvement

Top management wields considerable power and authority within an organization. They are responsible for establishing the organization's mission and vision. When top management is fully committed to a cause, they provide the necessary resources to support it. Without such commitment, the successful implementation of any new initiative becomes challenging. The degree to which top management actively engages in Environmental Management System (EMS) activities serves as a measure of their strong commitment and support. It is crucial for top management to allocate sufficient resources for the continuous improvement of environmental management, ultimately leading to pollution prevention.

The support of top management can significantly influence the success of an EMS by empowering employees to drive changes, shaping the organizational culture to align with these changes, implementing systems to encourage desired behaviors (such as rewards or incentive programs), providing training, and enhancing communication across the organization (Gupta and Sharma, 1996; Leitch et al., 1995). In a case study-based research focused on the Printed Circuit Board (PCB) industry in Hong Kong, conducted by Chin and Pun (2001), it was revealed that top management commitment is a critical factor in the successful implementation of EMS ISO 14001.

To implement the EMS effectively, top management must also grasp the existing organizational culture. Once this culture is understood, top management can take steps to modify it, making the organization more adaptable and responsive to changes. Cultural shifts do not happen overnight and often require an extended period to take root. However, as Wilms et al. (1994) concluded, the direction set by management is followed by the organization. Whatever course of action management takes and the intensity of their commitment directly influence the organization's trajectory. Top management can also act as change champions to facilitate a smoother and more comprehensive organizational transition.

2.6 Effectiveness of Achieving Environmental Goals

Environmental goals are typically established to provide a framework for promoting ecological sustainability. Effectiveness in achieving these goals is attributed to individuals, groups, or organizations. The degree of success in attaining environmental goals hinges significantly on the effectiveness of measuring environmental performance. The process of evaluating performance and selecting suitable environmental performance indicators is continuous. Environmental performance assessment serves as a management tool, supplying organizations with consistent, objective, and substantiated data over time. This information aids in assessing whether the organization is aligning with the environmental standards and criteria set by its management.

2.7 Contribution of EMS to Organization's Performance

The management of environmental performance is increasingly recognized as a strategic concern for organizations (Henri and Journeault, 2008). Previous research has suggested that environmental management can enhance the competitiveness of firms (Porter and Van der Linde, 1995; Trung and Kumar, 2005). The relationship between proactive engagement in environmental issues and financial performance has posed a puzzling question in the literature. This puzzle arises because, while some studies have reported a positive relationship (e.g., Aragon-Correa and Rubio-Lopez, 2007; Galdeano-Gomez et al., 2008; Nakao et al., 2007; Wahba, 2008), others have not found a clear positive impact of environmental proactivity on financial performance (Link and Naveh, 2006; Watson et al., 2004). Empirical research conducted by Petra Christmann (1999) focused on the effects of best environmental management practices on financial performance. The study encompassed 88 chemical companies and revealed a moderate relationship between best practices and cost advantages, which are significant factors influencing firm performance.

1. RELATIONSHIPS AMONG VARIABLES – HYPOTHETICAL MODEL

The positive influence of stakeholder pressure and managerial environmental awareness on the implementation of environmental practices is notable. Organizations recognize two primary sources of environmental pressure: governmental and non-governmental. Both sources significantly explain the adoption of environmental practices. Environmental management demonstrates a positive correlation with various stakeholder groups, including regulatory stakeholders, organizational stakeholders, community stakeholders, and the media. Emphasizing stakeholder involvement in the Environmental Impact Assessment (EIA) process enhances environmental assessment, resulting in projects that yield greater social benefits, fewer environmental costs, and increased economic and financial advantages.

The commitment of senior managers to develop and implement an Environmental Management System (EMS) stands out as the most crucial factor in determining the overall success of the EMS. Without strong commitment at the highest levels, the EMS team's efforts may face the risk of failure.

Environmental management activities serve as vital means to incorporate the natural environment into corporate decision-making, emphasizing the need for financial and ecological performance. The connections between economic and environmental planning should be institutionalized through an EIA process to enhance firm performance.

The achievement of environmental goals depends significantly on the effectiveness of measuring environmental performance. Environmental performance evaluation serves as a management tool, providing organizations with reliable, objective, and verifiable information to assess whether they are meeting the environmental criteria set by management. Thus, the extent to which environmental goals are met reflects the success of EMS implementation and, ultimately, organizational performance. Therefore, the expected relationships between various variables can be expressed in the following functions:

Function 1: Supporting mechanisms for EMS implementation = f (Stakeholder pressure)
Function 2: Environmental management activities = f (Stakeholder pressure and supporting mechanisms for EMS implementation)
Function 3: Environmental Impact Assessment (EIA) exercise = f (Stakeholder pressure and supporting mechanisms for EMS implementation)
Function 4: Top Management Involvement = f (Stakeholder pressure and supporting mechanisms for EMS implementation)
Function 5: Effectiveness of achieving environmental goals = f (Environmental management activities, EIA exercise, and top management involvement)
Function 6: Contribution of EMS to organization's performance = f (Environmental management activities, EIA exercise, top management involvement, and effectiveness of achieving environmental goals)

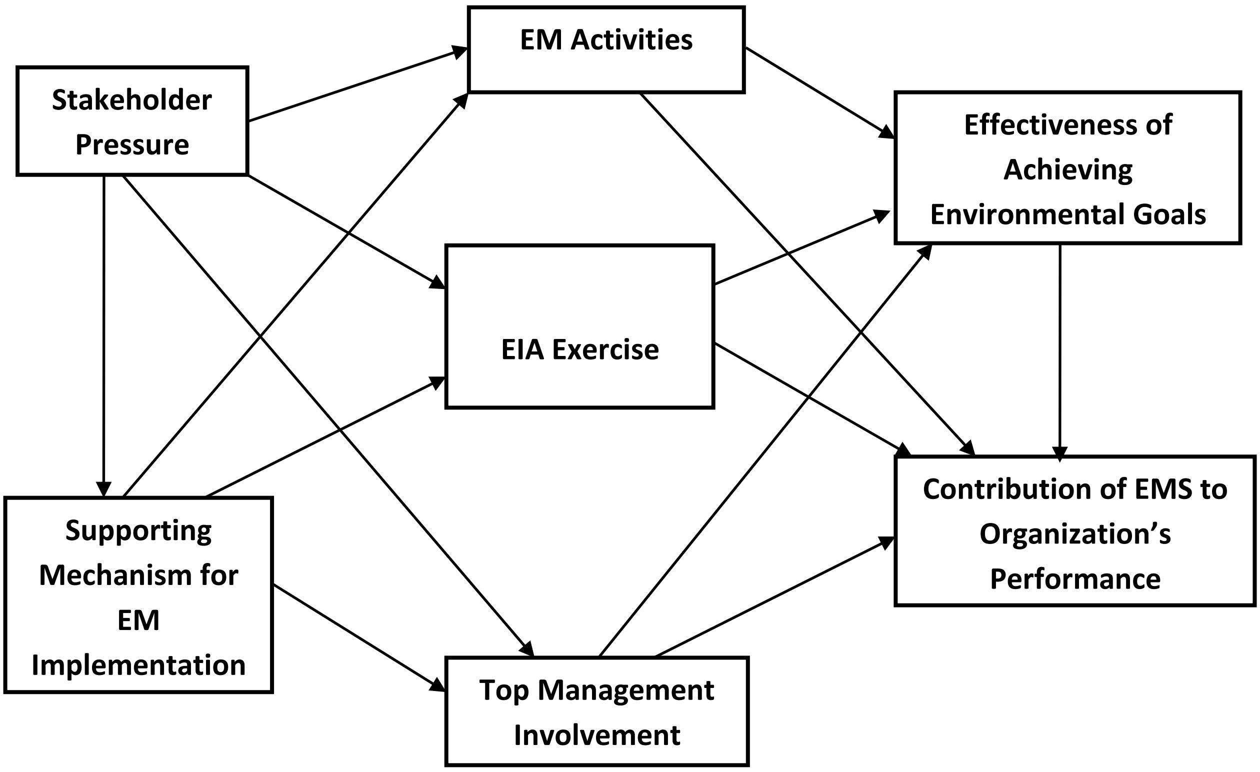

Fig. 1: Hypothetical Model showing Relationships between EM Variables

These relationships are visually represented in Figure 1 and can also be formulated as the following hypotheses:

Hypothesis I: The presence of supporting mechanisms for Environmental Management (EM) implementation is influenced by stakeholder pressure.

Hypothesis II: Environmental Management (EM) activities are influenced by stakeholder pressure and the availability of supporting mechanisms for EM implementation.

Hypothesis III: The engagement in Environmental Impact Assessment (EIA) exercises is influenced by stakeholder pressure and the existence of supporting mechanisms for EM implementation.

Hypothesis IV: The degree of top management involvement is influenced by stakeholder pressure and the presence of supporting mechanisms for EM implementation.
Hypothesis V: The effectiveness of achieving environmental goals is influenced by EM activities, participation in EIA exercises, and top management involvement.
Hypothesis VI: The contribution of the Environmental Management System (EMS) to organizational performance is influenced by EM activities, involvement in EIA exercises, top management participation, and the effectiveness of achieving environmental goals.
Regenerate

4. RESEARCH METHODOLOGY

4.1 Measurement

The research variables were assessed using multi-item indicators, employing a five-point Likert-type scale for all measurements.

1. **Stakeholder Pressure:** This construct was evaluated using thirteen items, encompassing factors such as the influence of regulatory authorities, community pressures on the organization's environmental actions, market pressures, and internal organizational pressures.
2. **Supporting Mechanisms for EM Implementation:** To assess the mechanisms supporting the implementation of Environmental Management (EM), twelve items were considered. These items included senior management commitment, regular meetings, training and awareness programs for internal personnel, suppliers, and customers, as well as the availability of necessary resources.
3. **EM Activities:** Environmental Management (EM) activities, aimed at preventing negative environmental impacts, were evaluated. These activities included measures related to fly-ash disposal, water discharge/pollution control activities, and solid waste recycling, among others.
4. **EIA Exercise:** The significance of Environmental Impact Assessment (EIA) exercises and the extent of analysis conducted by power plants were assessed using ten items. These items covered various aspects of EIA, such as air emissions, water discharge, soil contamination, waste generation, stack emissions, and waste recycling.
5. **Top Management Involvement:** The involvement of top management in environmental matters was measured using three items: their perception, vision, and views regarding Environmental Management (EM).
6. **Effectiveness of Achieving Environmental Goals:** The effectiveness of achieving environmental goals was assessed by measuring the importance and extent of accomplishment of eight environmental goals. These goals encompassed activities such as emissions control and monitoring, improved waste disposal, and environmental education initiatives.
7. **Contribution of EMS to Organization's Performance:** To gauge the contribution of the Environmental Management System (EMS) to plant performance, various performance measures were considered. These measures included enhancements in operational efficiency, customer satisfaction, the identification of new market opportunities, and return on investment (ROI).

In all cases, multi-item indicators and a five-point Likert-type scale were used for data collection and assessment of the research variables.

4.2 Data Collection

A comprehensive questionnaire was meticulously developed to assess the various research variables. The content of the questionnaire was derived from an extensive review of the existing literature. To ensure the content validity of the instrument, it was initially shared with two senior faculty members from a technical educational institute and five managers from thermal power plants. Their valuable input led to refinements in the language and sequencing of the questionnaire. After incorporating all the suggestions and improvements, the revised questionnaire was administered.

Accompanied by a cover letter highlighting the objectives of the study, ten sets of questionnaires were dispatched to the Environmental Management (EM) heads of various plants. They were kindly requested to collect responses from senior executives in both the EM and operations departments of their respective plants and return the completed questionnaires to us. Approximately 2-3 weeks following the initial distribution, follow-up calls were made to those who had not yet responded, aimed at encouraging their participation. A follow-up mailing was also dispatched approximately one month after the initial mailing. Additionally, personal visits were arranged wherever feasible to ensure the collection of responses. In total, 112 plants actively participated in the study. The number of responses received and the count of participating plants from each sector are summarized in Table 1.

Table 1 Statistics of Obtained Responses

Category	Responses Obtained	No. of Plants Participated	Percentage of Total Plants Participated
Public Plants	259	67	59.82%
Private Plants	192	45	40.18 %
Total	**451**	**112**	**100 %**

4.3. Validity and Reliability of the research construct

The various research variables were assessed for construct validity and reliability using multi-item indicators. Construct validity evaluates the extent to which these indicators measure the underlying construct, while reliability assesses the consistency of the instrument.

To ascertain construct validity, factor analysis was employed to confirm whether the items measuring each construct grouped together and effectively measured a single underlying construct. The Method of Principal Component with Varimax rotation was utilized for the factor analysis. The results of the validity testing are presented in Table 2. It is noteworthy that the minimum factor loading for all constructs exceeded 0.5. As per the recommendation of Hair et al. (1998), items with loadings less than 0.5 on any factor or with loadings greater than 0.5 on more than one factor were excluded from further analysis.

Reliability, which gauges the internal consistency of the instrument, was assessed using Cronbach's alpha. Table 3 provides the alpha values along with descriptive statistics for each construct. Notably, all alpha values surpassed 0.6, which is considered an acceptable threshold for research of a similar nature (Nunnally, 1978). The results of both validity and reliability tests affirm that the instrument employed in this study is both valid and reliable.

Table 2 Validity of the Construct

Construct	Number of Items	Eigen Value	Variance Explained	Minimum Factor Loading

Stakeholder pressure	13	8.464	26.449	0.500
Supporting mechanisms for EM implementation	11	1.840	5.751	0.504
EM activities	9	6.139	15.741	0.560
EIA exercise	10	5.393	13.829	0.504
Top management involvement	3	2.356	6.042	0.584
Effectiveness of achieving environmental goals	8	4.497	34.589	0.607
Contribution of EMS to plant's performance	5	2.698	20.754	0.535

Table 3 Reliability Test

Construct	**Number of Items**	**Mean**	**Alpha**
Stakeholder pressure	13	2.81	0.924
Supporting mechanisms for EM implementation	11	3.23	0.853
EM activities	9	2.67	0.798
EIA exercise	10	3.52	0.707
Top management involvement	3	4.06	0.675
Effectiveness of achieving environmental goals	8	3.63	0.808
Contribution of EMS to plant's performance	5	3.85	0.924

4.4 Data Analysis and Discussion

The data were subjected to path analysis, which is a multivariate analytical approach used to empirically investigate sets of relationships in the form of linear causal models (Duncan, 1986; Hsi-Peng Lu and Da-Chin Yeh, 1998). While regression analysis primarily examines correlations, path analysis explicitly considers causation. Path analysis expands upon conventional regression analysis by allowing for the analysis of networks of equations involving multiple variables (Li, 1975; Hsi-Peng Lu and Da-Chin Yeh, 1998). The initial step in path analysis involves specifying a path diagram, which is a visual representation of the cause-and-effect hypotheses to be tested. The proposed model or path diagram for this study is illustrated in Figure 1. The evaluation of the hypothesized model was conducted using SPSS Amos software, version 20. The variance inflation factor (VIF) was computed to detect potential issues of multicollinearity, if present. Multicollinearity refers to strong correlations among independent variables. VIF values below two suggest the absence of multicollinearity.

Regarding goodness-of-fit indicators, the chi-square value was 96.71 (with 69 degrees of freedom) at a probability level of 0.102. This implies that the probability of obtaining a chi-square value as large as 96.71 by random chance is 0.1. In other words, there is a significant departure of data from the model at the 0.1 level.

The ratio of minimum discrepancy to degrees of freedom (CMIN/DF) serves as a measure of fit. A ratio close to one is considered appropriate for a correct model (James Arbuckle, 1997). In our model, a ratio of 1.40 indicates a good fit. A ratio of chi-square to degrees of freedom exceeding two suggests an inadequate fit (Byrne, 1989), while a ratio less than one indicates model overfitting.

Other fit indices, including Boolen's Relative Fit index (RFI), Boolen's Incremental Fit index (IFI), Tucker-Lewis index (TLI), and Comparative Fit index (CFI), should also approximate one for a good fit (James Arbuckle, 1997). Additionally, the Goodness of Fit index (GFI) and Adjusted Goodness of Fit index (AGFI) are used to assess model fit, with values close to one indicating better fit.

The root mean square residual (RMR) represents the square root of the average squared discrepancy between observed and estimated variances and covariances under the assumption that the model is correct. A smaller RMR indicates a better fit, with values around 0.05 or less indicating a close fit, while an RMR of zero signifies an exact fit. An RMR of approximately 0.08 or less suggests a reasonable error of approximation. Table 4 provides values for various goodness-of-fit indices.

Table 4 Evaluation of Fitness of Hypothesized Model

Measures of Fitness of Model	**Value**
Chi Square/Degree of Freedom	1.40
Boolen's Relative Fit Index (RFI)	0.81
Boolen's Incremental Fit Index (IFI)	0.87
Tucker-Lewis Index (TLI)	0.92
Comparative Fit Index (CFI)	0.87
Goodness of Fit Index (GFI)	0.94
Adjusted Goodness of Fit Index (AGFI)	0.77
Root Mean square Residual (RMR)	0.01

To ensure comparability of the absolute scores of composite indicator variables, a standardization or normalization scoring technique was applied. The critical ratios for all paths exceed 1.96, except for a single path, indicating that path coefficients are significantly different from zero at the 0.05 level. However, the critical ratio for the path from supporting mechanisms for EM implementation to EIA exercise is measured at 0.904. This value suggests that the path coefficient for this particular path is not statistically significant. Notably, EIA exercise plays a crucial role in promoting sustainable development and protecting ecosystems by facilitating intra-generational and intergenerational equity (Yanhua et al., 2011). Therefore, the influence of supporting mechanisms for EM implementation on EIA exercise should not be underestimated. Figure 2 provides the path coefficients for all paths within the hypothetical model.

Squared multiple correlations for each endogenous variable were calculated and are presented in Table 5. These squared multiple correlations represent the proportion of variance in each variable that can be explained by its predictor variables. The values of squared multiple correlations indicate that environmental impact analysis exercise, environmental activity, effectiveness in achieving environmental goals, contribution of EMS to organization's performance, and top management involvement are highly accounted for by their respective predictor variables.

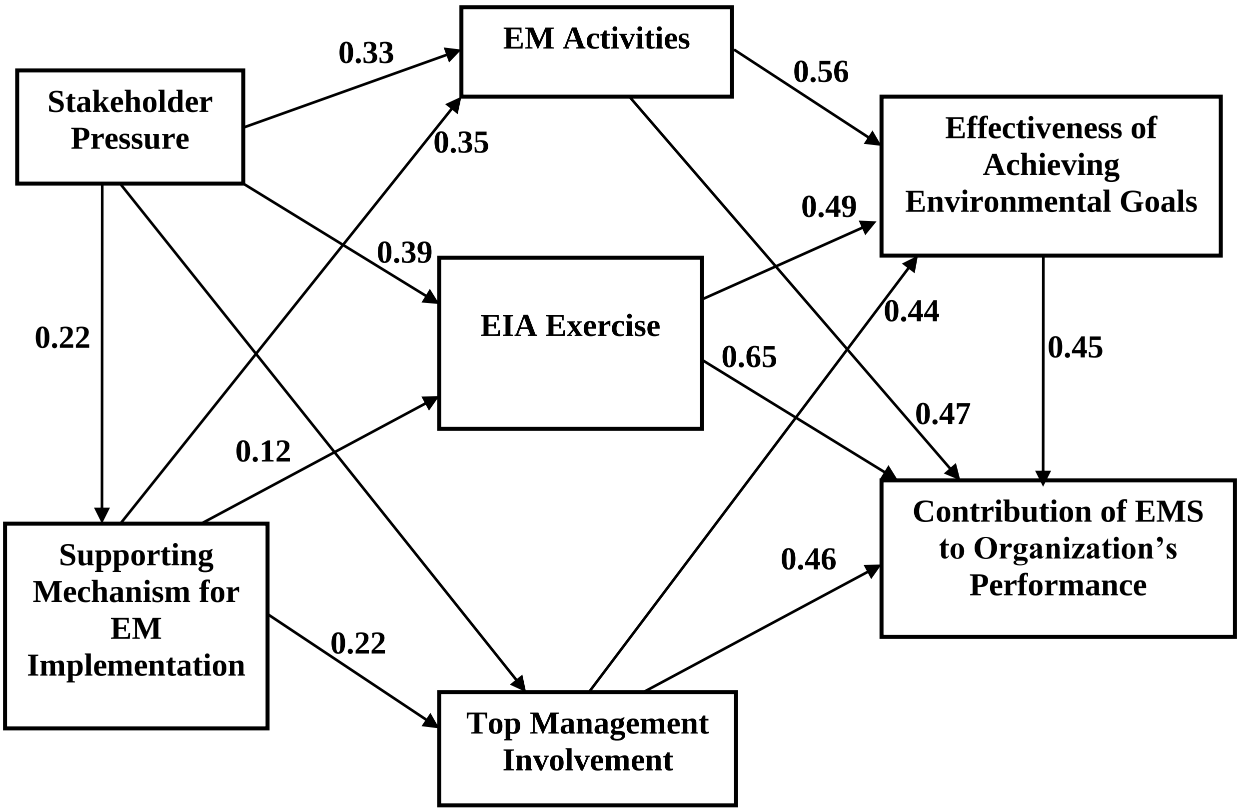

Fig. 2: Model with Path Coefficients between Environmental Management Variables

Table 5 Squared Multiple Correlation of Endogenous Variables	
Endogenous Variables	**Squared Multiple Correlation**
Top management involvement	0.71
Environmental impact analysis exercise	0.59
EM activity	0.54
Effectiveness of achieving environmental goals	0.65
Contribution of EMS to organization's performance	0.77
Supporting mechanisms for EM implementation	0.39

The data analysis strongly supports all hypotheses except for Hypothesis III, which receives partial support. Interestingly, the influence of supporting mechanisms for EM implementation on EIA exercise was found to be insignificant. This could be due to a lack of awareness or insufficient emphasis on improving the level of implementation by the managements of thermal power plants. Existing literature suggests that the development and implementation of an EMS are crucial factors in determining the overall success of an EMS. Therefore, the importance of supporting mechanisms for EM implementation in relation to EIA exercise should not be underestimated.

As depicted in Fig. 2, the path coefficients between the effectiveness of achieving environmental goals and environmental impact analysis exercise, effectiveness of achieving goals and top management involvement, and EM activities indicate that the effectiveness of achieving environmental goals is significantly influenced by these three factors. This confirms our findings that the effectiveness of achieving environmental goals is primarily dependent on these three variables. The contribution of EMS to organizational performance is found to be influenced by EM activity, environmental impact analysis exercise, and top management involvement. Our results support the prevailing notion that these three variables play a significant role in influencing the contribution of an environmental management system to organizational performance. Additionally, the path coefficient from the effectiveness of achieving environmental goals to the contribution of EMS to organizational performance indicates that the contribution of EMS to organizational performance is greatly affected by the effectiveness of achieving environmental goals.

CONCLUDING REMARKS

This study represents the pioneering effort to examine the influential relationships among various EM variables. It is evident that the effectiveness of achieving environmental goals is significantly influenced by EM activities, EIA exercise, and top management involvement. Top management should recognize environmental management as a vital undertaking and view it as a strategic investment. Environmental concerns should be integral to the vision of top management. Embracing these principles will undoubtedly contribute to the realization of environmental goals. Similarly, power plants should acknowledge the impact of relevant aspects and conduct thorough analyses to facilitate the achievement of environmental goals.

However, it's worth noting that this study has certain limitations. Data were exclusively collected from EM executives, excluding other key stakeholders within the plants, such as operations managers and customers.

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