

**STUDY OF DETERMINANTS OF PROACTIVE
ENVIRONMENTAL STRATEGIES
IN
POWER AND CEMENT SECTORS**

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IN
POWER AND CEMENT SECTORS**

by

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Department of Civil Engineering

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to the



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Certificate

This is to certify that the thesis titled “**Study of Determinants of Proactive Environmental Strategies in Power and Cement Sectors**” being submitted by Arun Kumar Vishwakarma in the Department of Civil Engineering, Indian Institute of Technology Delhi, for the award of the degree of “Doctor of Philosophy” is a record of bonafide research work carried out by him under our guidance and supervision. He has fulfilled the requirements for the submission of this thesis, which to the best of my knowledge has reached the requisite standard.

The material contained in this thesis has not been submitted in part or full to any other university or institute for the award of any degree or diploma.

April 2018

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ABSTRACT

Why do some firms go beyond minimum environmental compliance by adopting specific proactive environmental strategies (PES)? What motivates the firms to adopt PES voluntarily? Are these factors similar for the same type of firms in a sector or different industrial sectors have different reasons for the adoption of PES? Any emerging economy like India depends on the growth of the infrastructure for its economic development. Power sector and cement sector are two critical sectors which are essential for the development of infrastructure of a country. Not only these two sectors are the leaders in contribution to infrastructural growth, but they are also responsible for damage caused to the environment due to their emissions. The damage caused to the environment from these two sectors has compelled the environmentalists to raise their voice against them. Such opposition has forced the government to formulate laws for the environmental protection. The environmental regulatory bodies enforce these laws. Stringent environmental protection laws and protest from the stakeholders has forced the companies to adopt cleaner technologies for protecting the environment. The Indian power and cement sectors have witnessed a quantum jump from the old conventional techniques to technologies which are at par with global standards. The waste from one industrial process has become the raw material for the other thus reducing the environmental damage. The blending of cement with fly ash by the cement sector has restricted the environmental hazard caused by this highly toxic waste from the power sector. Several studies have been carried out to identify the determinants of PES in different sectors. However, no such research has been carried out specifically for the power and cement sectors. PES are considered to be more stringent than required by extant laws, Companies adopting PES ensure transparent environmental reporting and fore sighting of any prospective change in environmental legislation which has the potential to harm the financial interest of the companies. Pressure from the stakeholders, local communities, judiciary, market, and media may decide the environmental behaviour of the

polluting companies. Companies may develop specific capabilities to gain a competitive advantage. An extensive literature review was carried out for developing a scale for the survey. The primary objective of the survey was to collect information regarding constructs like environmental vanguard, industry dynamics, business profitability, natural resource conservation and emission reduction, cleaner technology, and sustainable vision. The questionnaire method was preferred as it allows collecting a relatively large sample in a short period. The questionnaire was pretested and validated through a pilot study. Following the pilot study, a survey questionnaire was finalised, including a covering letter, which described the purpose of the research and assurance of anonymity to the respondents. A seven-point Likert scale is used for the study for its accuracy and ease of use, and for capturing respondent's exact point of view. The final questionnaire used for the study consisted of 49 items. The first part of the questionnaire covered the necessary information of the respondents like name, department, designation, and sector, along with brief introduction about the research. The second part of the questionnaire consisted of various items capturing the essence of different constructs.

Statistical tools SPSS and AMOS were used for the statistical analysis. Exploratory factorial analysis (EFA) was carried out for the validity and reliability of the constructs. The research was implemented using a combination of confirmatory factor analysis (CFA) and structural equation modelling (SEM). The empirical analysis uses a two-stage process in which the measurement models are first developed and confirmed using CFA to obtain latent constructs of PES. In the second stage, the measurement model and the SEM are estimated jointly to examine the determinants of PES using path analysis. Business practices, performance improvement, market pressure and benefits, and institutional pressure were observed as determinants of adoption of PES in the power sector. On the other hand, organisational capability, market benefits, environmental risk management, and stakeholder pressure were

found to be determinants in the cement sector. Observed determinants were ranked using path analysis. Performance improvement and institutional pressure were observed to be key determinants of adoption of PES in power sector. Organizational capability and market benefits emerged as key determinants of PES in the cement sector.

The objective of the research is to provide an understanding of the causes of PES adoption so that business leaders, policymakers, and the environmentalists can adopt evidence-based practices for the effective implementation of PES.

सार

क्यों कुछ कंपनियां विशिष्ट सक्रिय पर्यावरण रणनीतियों (PES) को अपनाने से न्यूनतम पर्यावरण अनुपालन से आगे बढ़ती हैं? क्या कंपनियां को स्वेच्छा से पीईएस को अपनाने के लिए प्रेरित करता है? क्या ये कारक एक क्षेत्र या विभिन्न औद्योगिक क्षेत्रों में समान प्रकार की कंपनियों के समान हैं या PES को अपनाने के लिए अलग-अलग कारण हैं? भारत जैसे किसी भी उभरती हुई अर्थव्यवस्था अपने आर्थिक विकास के लिए बुनियादी ढांचे के विकास पर निर्भर करती है। ऊर्जा क्षेत्र और सीमेंट क्षेत्र दो महत्वपूर्ण क्षेत्र हैं जो किसी देश के बुनियादी ढांचे के विकास के लिए आवश्यक हैं। न सिर्फ़ ये दोनों क्षेत्र बुनियादी ढांचे के विकास में योगदान करने वालों में अग्रणी हैं बल्कि वे उत्सर्जन के कारण पर्यावरण को हुए नुकसान के लिए भी जिम्मेदार हैं। इन दोनों क्षेत्रों से पर्यावरण को हुई क्षति ने पर्यावरणविदों को उनके खिलाफ आवाज उठाने के लिए मजबूर किया है। इस तरह के विरोध ने सरकार को पर्यावरण संरक्षण के लिए कानून तैयार बनाने के लिए मजबूर किया है। पर्यावरण नियामक निकाय इन कानूनों को लागू करते हैं। कड़े पर्यावरणीय संरक्षण कानून और हितधारकों के विरोध ने कंपनियों को पर्यावरण को बचाने के लिए स्वच्छ प्रौद्योगिकियों को अपनाने के लिए मजबूर किया है। भारतीय पावर और सीमेंट क्षेत्रों में पुरानी परंपरागत तकनीकों की जगह वैश्विक मानकों के बराबर प्रौद्योगिकियों के लिए एक लम्बी छलांग देखी गई है। एक औद्योगिक प्रक्रिया से उत्पन्न कचरे दूसरे के लिए कच्चे माल बन गए हैं जिससे पर्यावरणीय क्षति कम हो गई है। सीमेंट क्षेत्र द्वारा फ्लाई ऐश के साथ सीमेंट के मिश्रण से ऊर्जा क्षेत्र से उत्पन्न इस अत्यधिक विषैले अपशिष्ट की वजह से पर्यावरणीय खतरे को कम किया गया है। विभिन्न क्षेत्रों में PES के निर्धारकों की पहचान करने के लिए कई अध्ययन किए गए हैं। हालांकि, बिजली और सीमेंट क्षेत्रों के लिए विशेष रूप से ऐसा कोई शोध नहीं किया गया है। वर्तमान कानूनों के लिए आवश्यक PES को और अधिक कठोर माना जाता है, PES को अपनाने वाली कंपनियां पारदर्शी पर्यावरण रिपोर्टिंग सुनिश्चित करती हैं और पर्यावरणीय कानूनों में किसी भी संभावित बदलाव को देख रही हैं जिसमें कंपनियों के वित्तीय हित को नुकसान पहुंचाने की क्षमता है। हितधारकों, स्थानीय समुदायों, न्यायपालिका, बाजार और मीडिया का दबाव प्रदूषणकारी कंपनियों के पर्यावरण व्यवहार का कारण हो सकता है। प्रतियोगी लाभ हासिल करने के लिए कंपनियां विशिष्ट क्षमताओं का विकास कर सकती हैं। सर्वेक्षण के लिए एक पैमाने को विकसित करने के लिए एक व्यापक साहित्य समीक्षा की गई। सर्वेक्षण का प्राथमिक उद्देश्य पर्यावरणीय अग्र-दल, उद्योग गतिशीलता,

व्यवसाय लाभप्रदता, प्राकृतिक संसाधन संरक्षण और उत्सर्जन में कमी, स्वच्छ प्रौद्योगिकी और सतत विकास दृष्टि जैसे कारकों के बारे में जानकारी एकत्र करना था। प्रश्नावली विधि को पसंद किया गया था क्योंकि यह एक छोटी अवधि में एक अपेक्षाकृत बड़े नमूना इकट्ठा करने की अनुमति देता है। प्रश्नावली को एक प्रायोगिक अध्ययन के माध्यम से पूर्व परीक्षण किया और मान्य किया गया था। पायलट अध्ययन के बाद, एक सर्वेक्षण प्रश्नावली को अंतिम रूप दिया गया, जिसमें एक आवरण पत्र भी शामिल था, जिसमें उत्तरदाताओं का नाम न छापने के आश्वासन और शोध के उद्देश्य का वर्णन किया गया था। एक सात सूत्री Likert पैमाने इसकी सटीकता और उपयोग में आसानी के लिए अध्ययन के लिए प्रयोग किया जाता है, और प्रतिवादी के सटीक दृष्टिकोण पर कब्जा करने के लिए। अध्ययन के लिए प्रयुक्त अंतिम प्रश्नावली में 49 आइटम शामिल थे। प्रश्नावली के पहले भाग में नाम, उत्तरदायित्व, पदनाम और क्षेत्र जैसे उत्तरदाताओं की जरूरी जानकारी शामिल है, साथ ही अनुसंधान के बारे में संक्षिप्त परिचय के साथ। प्रश्नावली के दूसरे हिस्से में विभिन्न कारकों के सार को पकड़ने वाले विभिन्न वस्तुओं के शामिल थे। सांख्यिकीय साधन SPSS और AMOS सांख्यिकीय विश्लेषण के लिए इस्तेमाल किया गया। संरचनाओं की वैधता और विश्वसनीयता के लिए अन्वेषण संबंधी तथ्यात्मक विश्लेषण (EFA) किया गया था। अनुसंधान को पुष्टित्मक कारक विश्लेषण (CFA) और संरचनात्मक समीकरण मॉडलिंग (SEM) के संयोजन का उपयोग करके कार्यान्वित किया गया था। अनुभवजन्य विश्लेषण एक दो चरण की प्रक्रिया का उपयोग करता है जिसमें माप मॉडल पहले विकसित किए गए हैं और PES के अव्यक्त निर्माण के लिए CFA का उपयोग करके पुष्टि की है। दूसरे चरण में, माप मॉडल और एसईएम का विश्लेषण संयुक्त रूप से PES के निर्धारकों को पथ विश्लेषण के आधार पर किया जाता है। बिजली के क्षेत्र में PES को अपनाने के निर्धारकों के रूप में व्यापारिक प्रथाओं, प्रदर्शन सुधार, बाजार दबाव और लाभ, और संस्थागत दबाव देखा गया। दूसरी तरफ, सीमेंट क्षेत्र में निर्धारिती होने के लिए संगठनात्मक क्षमता, बाजार लाभ, पर्यावरण जोखिम प्रबंधन, और हितधारक दबाव पाया गया। निरीक्षण किए गए निर्धारकों को पथ विश्लेषण का उपयोग करके रैंक किया गया था। पावर सेक्टर में PES को अपनाने के प्रमुख निर्धारकों के रूप में प्रदर्शन सुधार और संस्थागत दबाव देखा गया। सीमेंट क्षेत्र में PES के प्रमुख निर्धारक के रूप में संगठनात्मक क्षमता और बाजार लाभ उभरकर सामने आए।

अनुसंधान का उद्देश्य PES अपनाने के कारणों को समझना है ताकि व्यापारिक नेताओं, नीति निर्माताओं और पर्यावरणविद
PES के प्रभावी कार्यान्वयन के लिए साक्ष्य आधारित प्रथाओं को अपना सकें।

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ABBREVIATIONS

AMOS	Analysis of a Moment Structures
BPO	Business and Profitability Oriented
CCS	Carbon Capture and Storage
CFA	Confirmatory Factor Analysis
CMV	Common Method Variance
COP	Conference of Parties
CPCB	Central Pollution Control Board
CSI	Cement Sustainability Initiative
CSR	Corporate Social Responsibility
CT	Cleaner Technology
EFA	Exploratory Factor Analysis
EU	European Union
EMS	Environmental Management System
EVO	Environment Vanguard Oriented
GCV	Gross Calorific Value
GW	Giga Watt
ID	Industry Dynamics
IEA	International Energy Agency
IPCC	Intergovernmental Panel on Climate Change
ISO	International Organization for Standardization
kCal	Kilo Calorie
Kg	Kilogram
KMO	Kaiser Meyer Olkin
kWh	Kilo Watt Hour
LEED	Leadership in Energy and Environmental Design

MTPA	Million Tonnes per Annum
NGO	Non-Governmental Organization
NRCER	Natural Resource Conservation and Emission Reduction
PCA	Principal Component Analysis
PES	Proactive Environmental Strategies
PPM	Parts Per Million
PV	Photo Voltaic
SEM	Structural Equation Modelling
SPSS	Statistical Package for Social Sciences
SPM	Suspended Particulate Matter
Sq. M.	Square Metre
Sq. Km.	Square Kilometre
SV	Sustainable Vision
ROR	Run Of River
R&D	Research and Development
T&D	Transmission and Distribution
Chemicals	
Al_2O_3	Aluminium Oxide
CaO	Calcium Oxide
CO_2	Carbon Dioxide
CaCO_3	Calcium Carbonate
Fe_2O_3	Iron Oxide
NO_x	Nitrogen Oxide
SiO_2	Silicon Dioxide
SO_x	Sulphur Oxide