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Measuring challenges in adoption of sustainable environmental technologies in Indian cement industry

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A B S T R A C T

The Indian cement industry has adopted various environmental protection technologies, but adoption of these new environmental technologies and development of working model could not resolve many issues related to environmental concern among Stakeholders. This paper examined the current technologies used by the cement companies and the challenges they are facing in adoption of these technologies. This research describes the effects of cement manufacturing on global warming, water, coal and other pollution emissions during cement production process and involves environmental manufacturing technologies. The study measures the challenges of introducing environmental technologies by creating a model of challenges. including challenges in perceived usability of technology, challenges in perceived utility, challenges in user engagement, and challenges in intent to use behaviour. The study examines the challenges of introducing environmental technologies into the Indian cement industry to mitigate air, water, and energy pollution and to highlight the new environmental technologies and development of the model. The data from 1540 professionals responsible for using the environmental technology were gathered and analysed with t test and regression analysis. The final outcome of the research is the model expressing the challenges in adoption of environmental technologies in India.

1. Introduction

Indian Cement industry is an important part of its economy with employment of over one million people. The Indian cement industry has drawn numerous investments since its legalisation in 1982, rendering it the second most significant in the country. In India, the cement industry is forecasted to rise by 8.96% in 2014-2014 at an annual compound pace. India is the world's second largest cement maker and in 2019 accounted for more than 8 % of global installed power. Actual Cement production reached 334.48 million tons (MT) in fiscal year 2020 while the capacity of cement production (Fig. 1) reaches 550 tons by 2020. About 98 percent of total capacity is in the private sector and the rest is related to the public sector. The top 20 firms make up approximately 70% of India's overall cement output (Chouhan et al., 2020). Demand from the cement industry is expected to reach a constant level of 550 to 600 tons per year (MTPA) by 2025, depending on the needs of different industries, namely residential construction, commercial or factory or house construction. A total of 210 large cement factories make it one. The total installed capacity in the country is 410 tons (Fig. 1), while the remaining is made of 350 mini cement plants. 77 are in the

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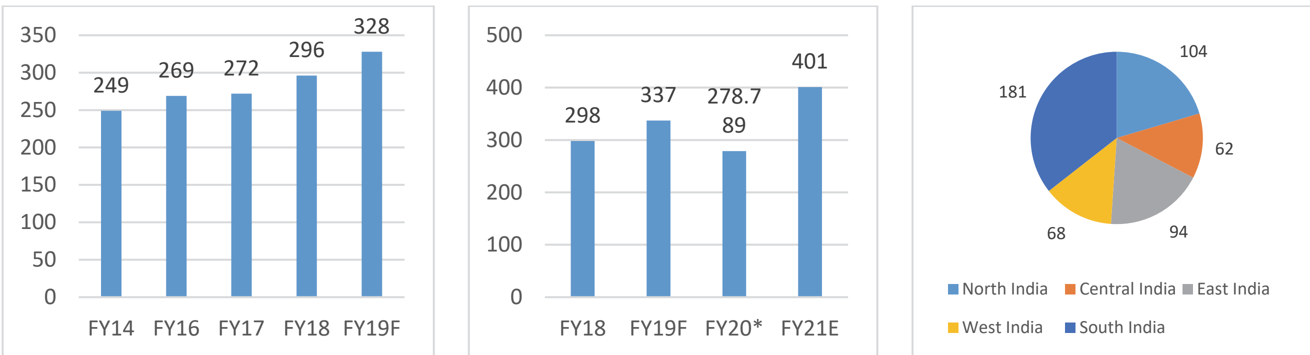
States of Andhra Pradesh, Rajasthan, and Tamil Nadu, of the 210 major cement factories of India. Cement revenues were amounted to 58,407 billion RS ($8,29 billion) in India during the ninth Fiscal Year of 2020. India's exports of cement, clinker and asbestos increased by 13% in fiscal year 2016 - fiscal year 2019 - in 2020 (until September 2019), reaching $ 177.93 million. At the same time, importations of cement, clinker, and fibre cement has grown at an annual growth rate of 15.01% to reach $ 57.61 million in fiscal year 2019. To improve the capital sources for financing public services, the Corporation of Credit Guarantee Improvement applies to current regulations that have been reported by the RBI and will be implemented during fiscal year 2020 (Ojha et al.,2020).



Cement Consumption (mn tonnes) Cement Production (mn tones) Region wise cement capacity 2019

*January 2020 E-Estimated

Fig. 1. Cement consumption/ production and region wise cement capacity
Source: IBEF.org (Indian brand equity foundation)

Operating expenditures in the last decade have been inflationary. Production costs: gas, power and freight account for approximately 55% to 60% of industrial cost of service (Khan et al., 2014; Nagabhushana & Sharada Bai, 2011). In this scenario, a relatively new initiative in Indian cement industry is expected to see broader usage in future co-generation (the generation of electricity and useful heat together, particularly the use of the steam left over from power generation to heating). It was effectively adopted by 15 cement plants and a 200 MW cogeneration power was installed. Cogeneration is projected to have more than 600 MW of industrial capacity. The cement industry in India is also building plants utilising green energy sources, including solar and wind energy. The cement industry in India were terrifically successful in relation to protecting the environment. Factories have taken several steps to reduce emissions from smokestacks and volatile particles. India's plants are also very environmentally friendly. In the last decade over 17 million trees were planted to act as carbon sinks. The abandoned mines were turned into water tanks with rainwater harvesting and recreational areas (Chouhan et al., 2020). The National Cement and Building Materials Council (NCB) under the Indian Ministry of Commerce and Industry, dedicated to research, development, technology, absorption and transfer, training and industrial services for the cement industry. Till 2020, the Council has completed 4,189 projects, of which 3,319 are industry-funded projects and 870 are R&D projects. To meet the government's expected demand of 415 million tons, for the 2019-2020 periods, with corresponding an installed capacity of at least 460 million tons with an occupancy rate of 90%, is required. They are expected to show rapid expansion and reach 850 million tons / year capacity till 2030 and an installed capacity of 1.35 billion tons / year by 2050. The industry aims at continuous modernization and technological modernization with the latest technologies to improve energy, environment and quality standards.

1.1 Technology used by cement companies

Inputs are converted in an enterprise utilising the technologies used in cement facilities for knowledge, machinery, techniques and processes. In the last three decades, the Indian cement industry has also suffered many technical changes and helps to raise cement in India. Today, it's a strange combination of old and tiny wet treatment facilities and big pre-calcining facilities with the current technical advancement. At present they are constructing high-technology cement plants that complement plates installed in other areas of the world. The main purpose of this paper is to examine all the challenges in the adoption of sustainable technology in the cement industry in India. First, we have presented the environmental impact of production of one ton of cement in Table 1 as under:

Table 1
Environmental impacts for 1 ton of concrete (Source: Higgins, 2006)

Impact	100% PC	50% GGBS	30% Fly Ash
Greenhouse gas (CO_2)	142 kg (100%)	85.4 kg (60%)	118 kg (83%)
Primary energy use	1,070 MJ (100%)	760 MJ (71%)	925 MJ (86%)
Mineral extraction	1,048 kg (100%)	965 kg (92%)	1007 kg (96%)

A proud flag holder of global energy efficiency improvements, the Industry is a major supplier to the country's globular economy.

Table 2 reveals the technology used by the Indian cement companies.

Table 2
Snapshot of technology use by cement

Area of working	Work / control element	Technology
Climate Change	Publishing our emission data.	Installing Waste Heat Recovery Systems (WHRS).
	Set environmental performance targets.	Tree plantation.
Use of waste as Energy Resource	Innovative usage of waste.	Municipal Solid Waste (MSW) processing plant, MSW to Refuse Derived Fuel (RDF).
	Rice husk, rubber tyre chips, mustard waste. Saw dust.	
	Using spent fuel, organic contaminants, residual of distillation, cotton and bottom sludge pollution.	
	Conservation of natural resources and productive use of waste.	
Energy Management	Usage of renewable energy through wind power and solar energy.	Installing solar panels on major building roofs (Solar capacity of 400KW Ultratech).
	Raise the use of biomass energy.	Alternate fuel firing and producing blended cement.
Water Management	Sustain reduction in our water footprint.	Recycling of water.
	Integrated plants have zero water discharge.	Rainwater-harvesting, recharging of ground water by building check dams.
		Desalination plant from sea water.
		Wet scrubber system.
Biodiversity Management	Use of rice husk, rubber tyre chips, mustard waste and saw dust in its cement plants as sources of fuel.	Extracting 150 tonnes of RDF from 500 tonnes of MSW per day.
	Use of automobiles, refinery, and pharmaceutical industry as fuel.	Set the clinker to replace products such as fly ash and slag of thermal and steel power stations (62% of our cement produced).
Material management	Use of slag and Fly Ash in grey cement.	Surface miners and over land belt conveyor to arrest these ill effects of mining.
Process optimisation	Slurries as substitute for raw material to reduce its carbon footprints.	Sequential Blasting Machine.
	Emissions of SPM.	Air pollution control equipment like ESP
	Wastage of cement.	Pulse jet type of bag filter or a hybrid of ESP and bag filter combination.

Source: Author's Own Compilation

2. Sustainability through technology by cement companies: New wave

The 20th century was marked by the exploitation of natural resources by companies around the world, which led to consequences such as global warming, which today constitutes an urgent challenge for all humanity. The depletion of non-renewable natural resources such as fossil fuels and the emission of greenhouse gases such as CO2, SO2 and NOx are causing climate change. This raises serious questions about the sustainability of companies' current business models that focus only on economic gains. India has experienced a disturbed monsoon program that has caused drought or early rainfall in most countries. The time has come when stakeholders began to question the sustainability of companies after Mother Earth was mercilessly mined. The best companies in the world have started working on a sustainable development strategy based on the triple bottom line (Chouhan et al., 2020). However, the Indian cement industry has an incredible commitment to achieving sustainable environmental goals, as confirmed by a report by the cement industry published in April 2018 (Carbon Disclosure Project, UK). Five of the world's top ten cement companies in the report's low-carbon transition league are from India (Chouhan et al., 2020).

Table 3
Low carbon transition league is from India.

Particulars	UOM	Global Avg	India Best	India Avg
Electrical Energy Consumption	kWh/tonne of cement	91	64	80
Thermal Energy Consumption	GJ/tonne of clinker	3.5	2.83	3.1

Source: cement manufacturing association https://www.cmaindia.org/key-areas/environment/

The spectacular performance of energy consumption is the result of continuous work to optimize operating costs. Since electricity and fuel account for around 50% of the industry's manufacturing costs, targeted efforts to reduce energy consumption have been key to seizing opportunities. In order to provide future stakeholders with a better universe, the industry is committed to minimizing the use of single-use plastics and ensuring the effective disposal of plastics used to conserve natural resources and promote environmental sustainability (Maina et al., 2020).

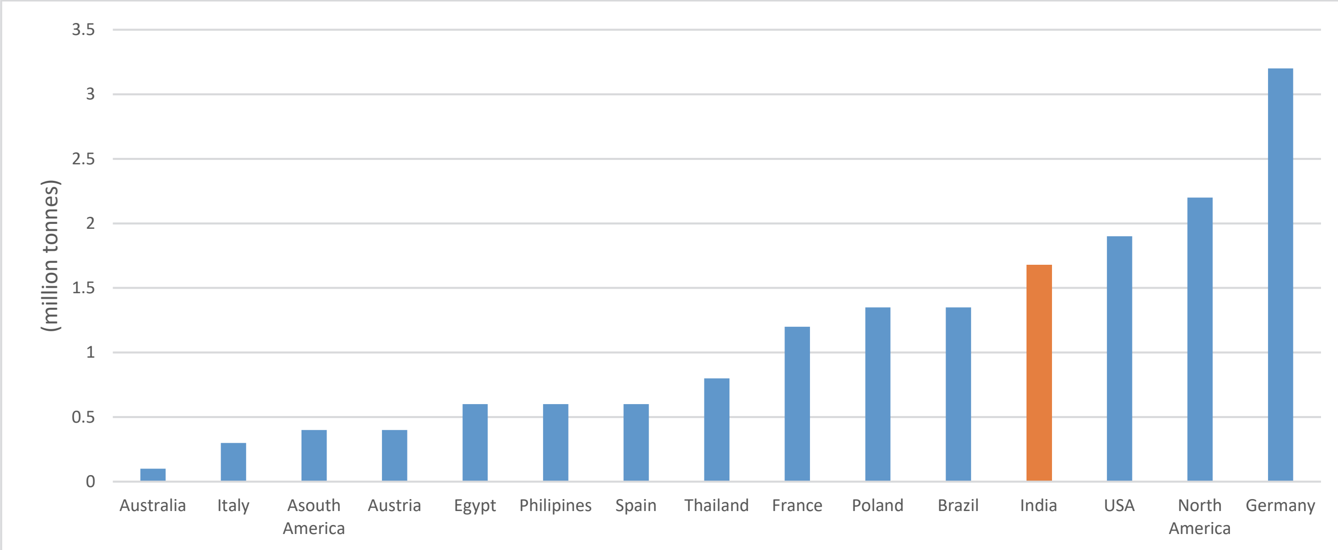


Fig. 2. Alternative Fuel Utilisation(Country wise)
Source: Cement Sustainability Initiative(https://www.cmaindia.org/key-areas/environment/)

The implementation of green energy and substituting clinker with fly ash and human waste is more relevant in India, as a major participant in the waste heating recovery of combined energy and heat. In 1996, the driver of sustainability in the sector decreased the CO2 emissions by 1.12 per tonne, from nearly 36 per cent in 2017 to 0.719 per tonne. The sector is aiming at investments ranging between $29 billion and $50 billion to meet its target of reducing CO2 pollution to 2050 in order to achieve these friendly outcomes (Khan et al., 2014). Indian cement facilities work in a sustainable commercial, social and environmental manner. CSRs pursue activities in health and family services , local infrastructure construction initiatives, contribution to social services, preservation of cultural heritage, conservation of natural capital, policy to improve the position of women, schooling, welfare society, etc. (ojha et al., 2020). Sustainable development in the construction sector requires less consumption of concrete in the construction sector thanks to innovative architecture and smart construction designs, less consumption of cement in concrete due to the efficient use of chemical and mineral additives, as well as an optimal size and classification of aggregates. Increasing emphasis is placed on the use of environmentally friendly building designs that use environmentally friendly (Khan et al., 2014), resource-saving processes and materials throughout the life cycle of the structure. At the same time, research and development efforts aim to develop and apply planning methods for concrete buildings and structures over a given lifetime, the use of C&D waste in construction, and the replacement of sand, natural by bottom ash (Chouhan et al., 2020).Indian cement industry is firmly committed to sustainable development through the tripartite "Conservation, Recycling and Renovation" strategy. Make unremitting efforts to integrate sustainability issues, mainly in energy saving, value for money and environmental planning. The Indian cement industry's perseverance culminated in effective co-processing experiments of toxic fuel waste in cement ovens, including refineries, waste oil, paint loam, ETP rings, spent washing and more. It operates against foreign best practises for the usage of AFR, and co-processing is projected to quickly become standard practise in the Indian cement industry.

3. Methodology and data analysis

The objective of this research is to evaluate the Indian cement industry in terms of adoption of sustainable technologies and challenges in adoption for delivering an adoption model for environmental technology. The process followed for the current study includes Sampling including the cement plants are established across the country and Data was taken from the whole universe for current analysis and we have attempted to cover all cement business units. Universe comprises Cement Industry in India and its major players: Associated Cement corporations, Cement corporations of India, Ambuja Cement, Aditya Birla group, JK Cement, L&T Cement. Ultratech cement, Grasim Industries, and Jaypee Cements. Cement and other companies are included in the universe. Cements for the public, the private and mini-field industry and for Ultratech cement industries, and Jaypee Cements. Second, 183 big cement and 350 Mini Cement Plants were clarified in the sample size having capacity of 70% of the total production capacities were selected for gathering data from of Indian cement industry. A structured questionnaire is prepared and shared by using the google docs format and the data was gathered from 1540respondents of various cement companies. For sampling Convenience sampling is considered for this research.

The data regarding the various aspects of the challenges in adoption of the environmental technologies in Indian cement industry gathered is analysed in this section.

3.1 Demographical profile

Demographical profiles of respondents are presented as under:

Table 4
Distribution of the respondents

Age in years	Frequency	Percent	Gender	Frequency	Percent
20-30	990	64.3	Male	1200	89.55
30-40	350	22.7	Female	340	10.45
40-50	140	9.1	Total	1540	100.0
Above 50	60	3.9			
Total	1540	100.0			
Occupation	**Frequency**	**Percent**			
Sustainability reporting personnel	380	24.7	**Experience in Years**	**Frequency**	**Percent**
Head accounts/ Accountant	500	32.5	0-2	700	45.5
General manager	510	33.1	2-5	430	27.9
Top management /CEO/CFO/COO/CPO	150	9.7	5-10	250	16.2
Total	1540	100.0	Above 10 years	160	10.4

Table 4 shows the Age wise distribution of respondents, which showed that the highest respondents were between the ages of 20-30 years (64.3%) accompanied by the respondents of 30-40 years (22.7%). The interviewees are gender wise and indicate that the highest number of interviewees are male (89.55%), then female (10.45%). The competent and logical distribution of interviewees showed that the highest responders were general management officers (33.1 percent) and head accounts (22.7 percent). Experience reveals that the respondents were usually handled (33,1%) led with heads/accountants' interviewees (22,7%) with the most interviewees.

3.2 Use of Technology

As per the objectives the study first the use of environmental technology in cement companies are measured and the technologies that are used significantly by the companies as per the respondents are identified. For this purpose, following hypothesis is developed: H_1= Environmental technology is used significantly by the cement companies in India.

To analyse the above hypothesis the data gathered is analysed by using one sample t test and the results are presented in Table 5 as follows,

Table 5
One-Sample Statistics

Environmental Technology	SPSS code	Mean	Std. Deviation	Std. Error Mean
Installing Waste Heat Recovery Systems (WHRS)	E_Tec_1	3.1883	1.21413	.09784
Tree plantation	E_Tec_2	3.4870	1.15604	.09316
Municipal Waste Recycling Facility, MSW to Refuse Derived Fuel (RDF)	E_Tec_3	3.4156	1.26130	.10164
Installing solar panels on major building roofs	E_Tec_4	3.5195	1.22725	.09889
Alternate fuel firing, and producing blended cement	E_Tec_5	3.2338	1.07127	.08633
Recycling of water	E_Tec_6	3.2597	1.16487	.09387
Rainwater-harvesting, recharging of ground water by building check dams	E_Tec_7	3.5909	1.16940	.09423
Desalination plant from sea water	E_Tec_8	3.3766	1.10895	.08936
Wet scrubber system	E_Tec_9	3.4481	1.34331	.10825
Extracting RDF from MSW per day	E_Tec_10	3.4675	1.27914	.10308
Replace clinker with fly ash and slag from thermal power plants and steel plants	E_Tec_11	3.6234	1.15514	.09308
Surface miners and over land belt conveyor to arrest these ill effects of mining	E_Tec_12	3.7208	1.16875	.09418
Sequential Blasting Machine	E_Tec_13	3.8442	1.25313	.10098
Air pollution control equipment like ESP	E_Tec_14	3.9156	1.22048	.09835
Pulse jet philtre form or hybrid ESP philtre combination	E_Tec_15	3.6234	1.10304	.08889
Designed key performance indicators	E_Tec_16	2.8571	1.05675	.08516
R&D efforts extended from Resource protection, electricity and environmental sustainability, pollution, etc.	E_Tec_17	3.3701	1.14875	.09257
Reduced Water demand and improved Workability	E_Tec_18	2.7792	1.09811	.08849
Higher long-term Strength gain	E_Tec_19	3.2403	1.21028	.09753
Reduced Heat of Hydration	E_Tec_20	3.5325	1.07963	.08700
Decreased Permeability and Increased Durability	E_Tec_21	3.4675	1.27402	.10266
Reduced Efflorescence and Shrinkage	E_Tec_22	2.6299	1.21511	.09792
Ground granulated blast furnace slag (GGBFS)	E_Tec_23	3.7013	1.05490	.08501
Ground granulated blast furnace slag (GGBFS)	E_Tec_24	3.7273	1.04333	.08407
Indicative 1-ton Portland cement CO2 emissions	E_Tec_25	2.1753	1.06110	.08551

Table 5
One-Sample Statistics

One-Sample Test results						
	Test Value = 3.5					
	t	df	P value	Mean Diff.	95% Conf. Interval of the Diff.	
					Low	Up
E_Tec_1	-3.186	1539	.002	-.31169	-.5050	-.1184
E_Tec_2	-.139	1539	.889	-.01299	-.1970	.1711
E_Tec_3	-.831	1539	.408	-.08442	-.2852	.1164
E_Tec_4	.197	1539	.844	.01948	-.1759	.2149
E_Tec_5	-3.084	1539	.002	-.26623	-.4368	-.0957
E_Tec_6	-2.560	1539	.011	-.24026	-.4257	-.0548
E_Tec_7	.965	1539	.336	.09091	-.0953	.2771
E_Tec_8	-1.381	1539	.169	-.12338	-.2999	.0532
E_Tec_9	-.480	1539	.632	-.05195	-.2658	.1619
E_Tec_10	-.315	1539	.753	-.03247	-.2361	.1712
E_Tec_11	1.325	1539	.187	.12338	-.0605	.3073
E_Tec_12	2.344	1539	.020	.22078	.0347	.4068
E_Tec_13	3.408	1539	.001	.34416	.1447	.5437
E_Tec_14	4.226	1539	.000	.41558	.2213	.6099
E_Tec_15	1.388	1539	.167	.12338	-.0522	.2990
E_Tec_16	-7.549	1539	.000	-.64286	-.8111	-.4746
E_Tec_17	-1.403	1539	.163	-.12987	-.3127	.0530
E_Tec_18	-8.146	1539	.000	-.72078	-.8956	-.5460
E_Tec_19	-2.663	1539	.009	-.25974	-.4524	-.0671
E_Tec_20	.373	1539	.710	.03247	-.1394	.2043
E_Tec_21	-.316	1539	.752	-.03247	-.2353	.1704
E_Tec_22	-8.886	1539	.000	-.87013	-1.0636	-.6767
E_Tec_23	2.368	1539	.019	.20130	.0334	.3692
E_Tec_24	2.703	1539	.008	.22727	.0612	.3934
E_Tec_25	-15.492	1539	.000	-1.32468	-1.4936	-1.1558

The results of one sample *t* test revealed that for variables at 5% level of significant the *t* values are significant ($p<0.05$) thus the above hypothesis is accepted for the variables Installing Waste Heat Recovery Systems (WHRS) (E_Tec_1), Alternate fuel firing, and producing blended cement (E_Tec_5), Recycling of water (E_Tec_6), Surface miners and over land belt conveyor to arrest these ill effects of mining (E_Tec_12), Sequential Blasting Machine (E_Tec_13), Air pollution control equipment like ESP (E_Tec_14), Designed key performance indicators (E_Tec_16), Reduced Water demand and improved Workability (E_Tec_18), Higher long-term Strength gain(E_Tec_19), Reduced Efflorescence and Shrinkage (E_Tec_22), Ground granulated blast furnace slag (GGBFS) (E_Tec_23), Ground granulated blast furnace slag (GGBFS) (E_Tec_24) and Indicative CO2 emission from production of 1 ton Portland cement (E_Tec_25) and we can say that these technologies are used significantly by the cement companies in India.

3.3 Measuring challenges in adoption of environmental Technology

As per the objectives of the research the challenges in adoption of the environmental technology is measured in this section. For this purpose, the section analyses the challenges in 5 different categories with measuring the dependence of categories on each other. The first part is the Challenges in Perceived ease of use of technology, perceived usefulness, Attitude towards using technology and behavioural intention is measured and for which the following hypotheses are being made:

H1= Attributes challenge in perceived ease of use significantly influence the challenges in adoption of environmental technology.

H1= Attributes challenges in perceived usefulness significantly influence the challenges in adoption of environmental technology

H1= Attributes Attitude towards using technology significantly influence the challenges in adoption of environmental technology.

H1= Attributes of behavioural intention of use of technology significantly influence the challenges in adoption of environmental technology.

To measure the above hypotheses and identifying the variables, the multiple regression analysis is used with SPSS software and the results are shown in table 6 as under:

Table 6
Regression analysis of the Challenges in Perceived ease of use of technology

A- **Descriptive Statistics** **(N=1540)**

Variables	**SPSS Code**	**Mean**	**Std. Deviation**
Challenges in Perceived ease of use of technology	Ease_Use	3.5000	.99836
Avoiding Technology for Technology's Sake	Ease_1	2.6494	1.09385
Using technology is easy	Ease_2	2.9156	1.18239
Increase the work of the manager or subordinate	Ease_3	2.5714	1.14251
Difficulty in integrating it with their regular activity	Ease_4	2.8312	1.23566
Proper implementation and incorporation of new technology	Ease_5	2.4805	1.15028
Anticipating the needs of the users	Ease_6	3.5065	1.20590
Challenges in Perceived usefulness of the technology	Per_usefulln	3.0455	1.17902
Creating a Vision	Usef_1	2.9870	1.26794
Adequate staff training for the new technology	Usef_2	2.9545	1.22789
Professional Development	Usef_3	2.9156	1.36698
Funding and return on investment	Usef_4	2.9935	1.26541
Existing procedures and systems need to be adjusted	Usef_5	2.9870	1.09058
Challenges in Attitude towards using technology	Attit_tech	3.7468	1.00692
Scheduling for Success	AT_1	2.3961	1.10506
Systems and Procedures	AT_2	3.0649	1.31694
Managers and workers are adaptive	AT_3	3.0000	1.25766
Monitoring data and progress is easy after adoption	AT_4	3.2922	1.24683
Challenges in Behavioural intention of use of technology	Beh_int	2.9221	1.31125
Unlocking Motivation	BI_1	3.1883	1.20332
Data and Progress Monitoring	BI_2	3.0714	1.25301
Discomfort in daily use	BI_3	2.8766	1.23843
Insecurity thinking	BI_4	3.0000	1.17712
Maintaining the Enthusiasm	BI_5	3.6039	1.16831

B-Regression coefficients

Variables	Variable name	Adj. R2	ANOVA	Sig.
Perceived ease of use of technology	Ease_2 Ease_6 Ease_3	.285	21.315	.000d
Perceived usefulness of technology	Usef_5 Usef_4	.687	168.898	.000c
Attitude towards using technology	AT_4 AT_3 AT_1	.253	18.238	.000d
Behavioural intention of use of technology	BI_2 BI_1	.643	138.667	.000c

C- Coefficients

Model		Unsta.Coefficients		Stand.Coefficients	t	P	r			Collinearity Statistics	
		B	Std. Error	Beta			Zero-order	Partial	Part	Tolerance	VIF
3	(Constant)	2.182	.241		9.071	.000					
	Ease_2	.361	.074	.427	4.892	.000	.473	.371	.334	.613	1.63
	Ease_6	.202	.067	.244	3.015	.003	.429	.239	.206	.714	1.40
	Ease_3	-.172	.066	-.196	-2.595	.010	.040	-.207	-.177	.817	1.22
2	(Constant)	.216	.163		1.321	.188					
	Usef_5	.702	.060	.649	11.61	.000	.804	.687	.52	.655	1.52
	Usef_4	.245	.052	.263	4.706	.000	.644	.358	.21	.655	1.52
3	(Constant)	2.720	.245		11.115	.000					
	AT_4	.209	.088	.259	2.392	.018	.471	.192	.167	.415	2.407
	AT_3	.234	.089	.292	2.622	.010	.449	.209	.183	.394	2.535
	AT_1	-.152	.067	-.166	-2.276	.024	-.085	-.183	-.159	.913	1.095
2	(Constant)	.074	.185		.399	.690					
	BI_2	.535	.076	.511	7.000	.000	.771	.495	.338	.438	2.28
	BI_1	.378	.080	.347	4.754	.000	.730	.361	.230	.438	2.28

The result of the analysis revealed that for variables Ease_2, Ease_6, Ease_3 with r=.547, Adjusted R Square=28.5 Percent with Std. Error of the Estimate is .84427 and the model fit ANOVA, f value is 21.315 which is significant. This means that the above hypothesis is accepted and 3 variables of perceived ease of use Ease_2, Ease_6, Ease_3 significantly influence the challenges in adoption of environmental technology. The result of the analysis revealed that for variables Usef_5, Usef_4 with r= 0.831, Adjusted R Square=68.7 Percent with Std. Error of the Estimate is 0.65963 and the model fit ANOVA, F value is 168.898 which is significant. This means that the above hypothesis is accepted and 2 variables of perceived usefulness Usef_5, Usef_4 significantly influence the challenges in adoption of environmental technology. The result of the analysis revealed that for variables AT_4, AT_3, AT_1with r= 0.517, Adjusted R Square=25.3 Percent with Std. Error of the Estimate is 0. .87049 And the model fit ANOVA, F value is 18.238 which is significant. This means that the above hypothesis is accepted and 3 variables of attitudeAT_4, AT_3, AT_1 significantly influence the challenges in adoption of environmental technology. The result of the analysis revealed that for variables BI_2, BI_1 with r = 0.805, Adjusted R Square=64.3 Percent with Std. Error of the Estimate is 0.78368 And the model fit ANOVA, F value is 138.667 which is significant. This means that the above hypothesis is accepted and 2 variables of Behavioural intention BI_2, BI_1 significantly influence the challenges in adoption of environmental technology. The next part is to measure that whether the Perceived ease of use and perceived usefulness is creating attitude towards use of environmental technology or not and for which the following hypothesis is being made:

H1= Perceived ease of use and perceived usefulness are behind the challenges against the in adoption of environmental technology.

To measure the above hypothesis and identify the variables, the multiple regression analysis is used with and results are shown in Table 7 as under:

Table 7
Results

A. Descriptive

	Mean	Std. Deviation	N
Attit_tech	3.7468	1.00692	1540
Per_usefulln	3.0455	1.17902	1540
Ease_Use	3.5000	.99836	1540

B-Regression coefficients

Variables	**Variable name**	**Adj. R2**	**ANOVA**	**Sig.**
Attit_tech	Per_usefulln Ease_Use	.346	41.403	.000[c]

C- Coefficients[a]

Model		Unst.Coefficients		Stand.Coefficients	t	*p*	r			Collinearity Statistics	
		B	SE	Beta			Zero-order	Partial	Part	Tolerance	VIF
2	(Con.)	1.830	.249		7.359	.000					
	Per_usefulln	.408	.064	.477	6.356	.000	.571	.459	.416	.759	1.318
	Ease_Use	.193	.076	.191	2.548	.012	.426	.203	.167	.759	1.318

a. Dependent Variable: Attit_tech

The result of the analysis revealed that for variables Per_usefulln, Ease_Use with r = 0.595, Adjusted R Square=34.6 Percent with Std. Error of the Estimate is 0.81454 and the model fit ANOVA, F value is 41.403 which is significant. This means that the above hypothesis is accepted and 2 variables of attitude making i.e., Per_usefulln, Ease_Use significantly influence the attitude towards challenges in adoption of environmental technology. The final part is to measure that whether the attitude is shown in the behaviour as challenges for adopting environmental technology or not and for which the following hypothesis is being made:

H1= attitude is behind the behaviour for challenges against the in adoption of environmental technology.

To measure the above hypothesis and identifying the variables, the multiple regression analysis is used with SPSS software and the results are shown in Table 8 as follows,

Table 8
Results

Descriptive Statistics

	Mean	Std. Deviation	N
Beh_int	2.9221	1.31125	1540
Attit_tech	3.7468	1.00692	1540

B-Regression coefficients

Variables	**Variable name**	**Adj. R2**	**ANOVA**	**Sig.**
Beh_int	Attit_tech	.528	29.952	.000[b]

Coefficients[a]

Model		Unst.Coefficients		Stand.Coefficients	t	Sig.	r			Collinearity Statistics	
		B	Std. Error	Beta			Zero-order	Partial	Part	Tolerance	VIF
1	(Con.)	.942	.374		2.517	.013					
	Attit_tech	.528	.097	.406	5.473	.000	.406	.406	.406	1.00	1.00

a. Dependent Variable: Beh_int

The result of the analysis revealed that for variables Beh_int with r = 0.406, Adjusted R Square=52.8 Percent with Std. Error of the Estimate is 1.20241 and the model fit ANOVA, F value is 29.952 which is significant. This means that the above hypothesis is accepted and 1 variables attitude of making i.e., Beh_int significantly influence the attitude towards challenges in adoption of environmental technology.

4. Challenges in adoption of environmental technology model

On the basis of the above analysis the regression method used the model is developed and called as Challenges in Adoption of Environment Technology in Cement Industry Model, the model is shown as under:

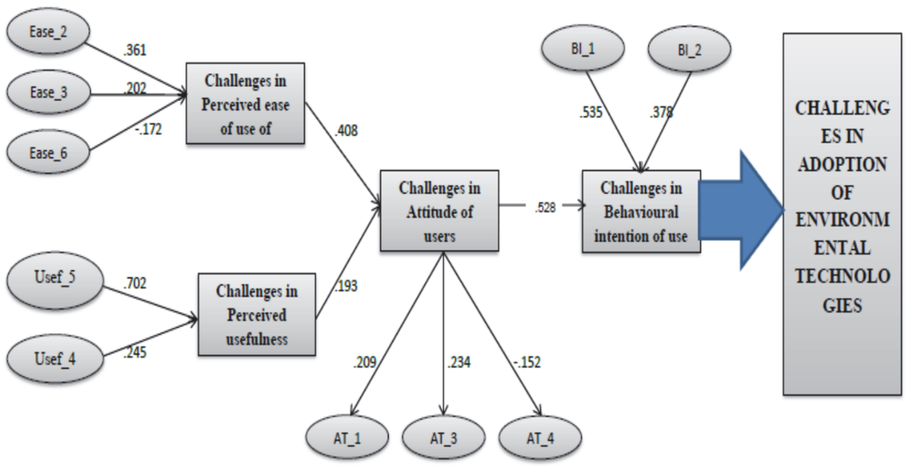


Fig. 3. Challenges in Adoption of Environment Technology in Cement Industry Model

The current model of the challenges in the adoption of the environment technology presented here revealed that the perceived ease of use of technology is possible when the use of technology becomes easy (Ease_2, 0.361) with the Increase the work of the manager or subordinate (Ease_3, 0.202) when it also Anticipate the needs of the users (ease_6, -0.172), as shown in the first part of the model. Further the Perceived usefulness is measured by 2 variables Existing procedures and systems need to be adjusted (Usef_5, 0.702), Funding and return on investment (Usef_4, 0.245). Further the attitude challenges are there as monitoring data and progress is easy after adoption (AT_4, 0.209), Managers and workers are adaptive (AT_3, 0.234) Scheduling for Success (AT_1; -0.152) and the behaviour is created with the 2 variables as Data and Progress Monitoring (BI_2) and Unlocking Motivation (BI_1). With these variables the 4 components of the model is developed and further the interrelationship of the variables as per the adoption of environmental technologies acceptance model shows that the challenges in the adoption is created with the challenges in the perceived ease of use of technology (0.408) and challenges in perceived usefulness(0.193) and further the challenges in the behaviour intention of use is based on the challenges in the attitude of users (0.528).

5. Future prospects

The future prospect of the challenges for adoption of environmental technology model is based upon its variable that challenges against adoption of the technology. The companies need to improve these points included in the model to successfully implement the environmental technology. Thus, in case of the cement company before adoption of the environmental technology must check the points including that the use of technology is become easy, should not increase the work of the manager or subordinate with anticipation of the needs of the users. Further Existing procedures and systems need to be adjusted, Funding and return on investment should be looked into, attitude should be developed for monitoring data and progress is easy after adoption, Managers and workers should be of adaptive nature, Scheduling for Success and Data and Progress Monitoring and Motivation should be improved before it should be implemented.

6. Conclusions

The total 8 to 10 percent of the world's CO2 emissions is contributed by manufacturing cement. By analysing and discussing the current technologies regarding environmental protection the companies may prepare for the adoption of the environmental technologies, yet there are some other challenges that are identified with the help of this research and further it can be concluded that cement companies are well aware of impact of their operations on environment and society at large. Cement companies are addressing this issue seriously in their core as well as competitive strategies. The paper has presented challenges in adoption of environmental technologies and further the model on the basis of the technology acceptance model is developed so as to make the process of adoption of Environmental technologies makes easier. Hopefully, this paper would be helpful to all of us to unite all actors to effectively engage in maintaining and protecting the world's global ecosystem by leveraging environmental technology.

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