

COST OF POLLUTION AND ITS CONTROL IN PULP AND PAPER INDUSTRY

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Abstract

Pulp and paper making process requires large amount of water, energy, chemicals and wood resources, and produces various wastes and emissions that must be controlled or treated. The aim of the study is to determine the economic impacts of pollution in pulp and paper industry and to investigate the root causes of pollution and develop a model that can bring down pollution in pulp and paper industry. A detailed review related with Pollution in chemical Industries especially in Pulp and Paper Industry was conducted. After Identifying major pollutants in paper industry and impacts in human health as well as plant machineries from literature review, the next step was to prove the existence of pollution scientifically using statistical tools and techniques. It was identified that pollution not only has a direct impact on employee health but also has an effect on the management of the company economically. Also pollutant atmosphere in highly chemical exposed areas may lead to inefficient utilization of working hours. At the heart of this approach is to calculate the cost of pollution as there were no studies conducted in India related to cost of pollution in Chemical industries. The research also suggests certain alternative solutions to bring down the pollution in pulp and paper Industry

Keywords: Pollution in chemical industries, Cost of pollution, Economic model for pollution control

1.INTRODUCTION.

Chemical industries have come under increasing criticism over the last two decades for increasing air pollution and soil/groundwater contamination. Pulp and papermaking requires large inputs of water, energy, chemicals, and wood resources, and produces various wastes and emissions that must be controlled or treated. Impacts on the environment can potentially come from toxic and hazardous chemicals in air and water emissions, thermal loading to natural waterways, odor-causing chemicals, air pollutants from combustion, and solid wastes. The industry is taking steps to minimize environmental impacts by increasing the use of recycled paper, improving energy efficiency, and making capital investments for effective compliance with regulations. Pulp and papermaking processes have traditionally consumed large amounts of water, generating wastewater that can contain chlorinated compounds,

volatile organics, sulfur compounds, and other chemicals. The pulp and paper industry also generates more than 12 million tons per year of solid waste, consisting primarily of de-watered sludge. The standard treatment for these wastes in the past was to deposit them in landfills. Today they are more often being handled by incineration, conversion to useful products, and land application. Most solid waste from mills, such as sludge from deinking plants, is non-hazardous and requires no special handling.

2.LITERATURE REVIEW

This section discusses the information from literatures published by researchers so far in the area of Pollution and its control in Chemical industries especially in Pulp and paper industries. Many potential sources of air pollutants exist in the pulp and paper production process. From [1], compounds considered as air pollutants can form inadvertently during pulping, bleaching, chemical recovery and fuel combustion.

Combustion of materials containing inorganic substance will also result in formation of ashes. Some ash may escape the combustion chamber as fly ash. Direct emissions of purchased materials are rare at pulp and paper industries [1].The best example is chlorine purchased for pulp bleaching.

Identified the effect of pollution control on corporate financial performance in a transition economy. In particular, it assesses whether better pollution control, as measured by lower air pollutant emissions, improves or undermines financial success, as captured by accounting-based measures of financial performance, e.g.profitability [4].New evidence on whether or not firms that perform well on environmental criteria also perform well financially [5].

[3] Analyzed CEP's reputation indices of environmental performance, which classified 49 companies as high, medium or low environmental performers based on anecdotal information about regulatory compliance and the existence or lack of proactive environmental programs such as recycling or waste reduction programs.

Research on the effects on firm performance of “best practices” of environmental management, which are supposed to enable firms to simultaneously protect the environment and reduce costs, has so far ignored the roles of existing firm resources and capabilities[3].

Some authors assume that environmental protection mainly causes costs to a company whereas others believe that environmental protection generally pays off and thus improves the bottom line[5].

[6] Focuses on a crucial element in understanding the link between corporate environmental performance and economic performance and sheds some light to the conflicting empirical results in this field of research.

Role of Industrial Engineers in Pollution Prevention

This section reviews the potential role of industrial Engineers in preventing pollution caused by manufacturing processes. . It outlines what is currently being done in order to control pollution within systems and how there needs to be a focus on how to prevent it at the source. The paper ends with proposed solutions in applying industrial engineering concepts to minimize waste by-products and leaves the door open to the creation of standardized programs that would benefit many businesses worldwide. A new concept has emerged that shifts a portion of this responsibility to industrial engineers, who are known to deal with removing wastes in processes to make systems more efficient. What kinds of wastes are industrial engineers currently dealing with? They work to remove extra motion, process steps, waiting times, idle times, and wastes from a current system. Waste can generally be categorized in two separate categories: excess resource use and output waste. The latter is the most important waste to control because of its high negative effects on the environment. Excess resource use just deals with the internal process steps, not necessarily producing tangible wastes. Industrial engineers are not usually concerned with the external waste that a process creates; they are focused on the internal wastes that prevent certain systems from operating at their full potential.

Need and Significance of the Study

The topic is significant in this era of green sustainability. The topic looks in to the economic effects of pollution considering the huge expenses for employee health care, plant maintenance and for the welfare of surrounding villages. There are only a very few studies showing the impact of air pollution on the entrepreneur of the industry. The Literature review did not show any similar studies done in India. The studies showing all the probable bad effects of pollution have not been carefully evaluated.

3.RESEARCH METHODOLOGY

Research designs are plans and the procedures for a research. This plan involves several decisions that should be used to study a topic. There are three types of research designs mainly: qualitative, quantitative and mixed methods. Qualitative research explores the relationships of individuals or groups towards a social or human problem while quantitative methods are means for testing objective theories by examining the relationship among variables. A population can be defined as including all people or items with the characteristic one wish to understand. The population for the present study consisted of employees in HNL, Kottayam.

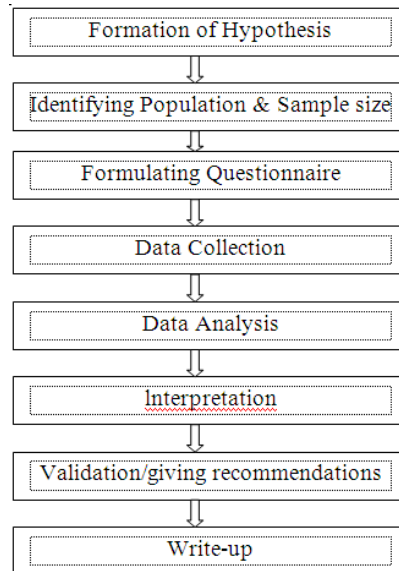


FIGURE1.RESEARCH METHODOLOGY FLOW DIAGRAM

The overall goal of the project proposed herein is to identify the various air and water pollutants affecting the health of employees in Pulp and Paper industry. The purpose, objectives, scope and methodology of the study was identified clearly. There has been no research in literature specifically looking for the economic impacts of pollution in Pulp and Paper Industry. This is the first study in India that investigates the cost of pollution and develops a model which could bring down pollution in Paper Industry. This project therefore promises to make significant results into Pulp and Paper industries and hope that the results of the study will definitely paves a way to formulate new strategies.

The research design for this study involved a questionnaire survey administered to a sample of employees, and the responses to pollution in the industry and its impacts on their health, working hours etc. The research population comprised of all working employees of the organization from which a sample 160 people was then selected.175 questionnaires were provided to employees holding different positions and 124 responses were collected. Further, a statistical analysis was conducted using the software SPSS so as to investigate the attitude of employees.

3.1 Hypothesis testing

Hypotheses are formulated to verify the effect of pollution of Employees health employee absenteeism and inefficient utilization of working hours. The Hypotheses formulated in this research are

- H1: There is no significant Relation between Pollution and Employee Absenteeism
Ha: There is significant Relation between Pollution and Employee Absenteeism.
- H2: There is no significant Relation between Pollution and Utilization of Working Hrs
Ha: There is significant Relation between Pollution and Utilization of Working Hrs
- H3: There is no significant Relation between Pollution and Physical Fatigue
Ha: There is significant Relation between Pollution and Physical Fatigue

3.2 Cost of pollution

This section discusses the economic impact of pollution on the management of Pulp and Paper Industry. The first phase of the research proves the existence of pollution in the industry with its impacts on employee health, employee absenteeism and its impacts on the utilization of working hours. For each of the above proved results, the company has to pay economically. This says the ultimate impact of pollution affects the management economically.

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Cost of Pollution is mainly calculated in this paper from

- Maintenance Cost
- Cost of Pollution due to Inefficient Utilization of working Hours
- Cost of Pollution due to Employee Absenteeism

4. RESULTS AND DISCUSSIONS

The results of the empirical analysis are being discussed in this section. By using the software package SPSS, the statistical part of this research was carried out.

The phase comprises of the frequency analysis of the variables to chi-square test. The descriptive statistics computed for the study are first presented in an outline of the characteristics of the sample with regards to the variables included in the study. Thereafter the analysis of the constructs relevant to the study, which is the effect of pollution on employee health, employee absenteeism and inefficient utilization of working hours are presented with the aid of inferential statistical procedures. The study was concluded on the basis of the obtained results. The particulars provided and discussed in the previous chapters will serve as a background for the current section of the research.

The results of the Hypothesis tests are

TABLE I: RESULTS FOR HYPOTHESIS 1

Scale	Observed N	Expected N	Residual
1.00	4	23.2	-19.2
2.00	19	23.2	-4.2
3.00	49	23.2	25.8
4.00	26	23.2	2.8
5.00	18	23.2	-5.2
Total	116		

TABLE II: TEST STATISTICS

Chi-Square	46.845 ^a
Degrees of freedom	4
Asymp. Sig.	.000

Table I gives Probability Value (P) obtained is less than 0.5. Hence the null hypothesis is rejected and alternative hypothesis accepted. The result indicates a significant Relation between Pollution and Employee Absenteeism.

TABLE III: RESULTS FOR HYPOTHESIS 2

Scale	Observed N	Expected N	Residual
1.00	12	23.0	-11.0
2.00	71	23.0	48.0
3.00	26	23.0	3.0
4.00	5	23.0	-18.0
5.00	1	23.0	-22.0
Total	115		

TABLE IV: TEST STATISTICS

Chi-Square	140.957 ^a
Degrees of freedom	4
Asymp. Sig.	.000

Table II gives Probability Value (P) obtained is less than 0.5. Hence the null hypothesis is rejected and alternative hypothesis accepted. The result indicates a significant Relation between Pollution and Inefficient Utilization of Working Hrs. Chi-square test is conducted using SPSS to find the association between Pollution and Physical Fatigue of Employees and following results were obtained.

TABLE V: RESULTS FOR HYPOTHESIS 3

Scale	Observed N	Expected N	Residual
1.00	12	23.2	-11.2
2.00	62	23.2	38.8
3.00	34	23.2	10.8
4.00	7	23.2	-16.2
5.00	1	23.2	-22.2
Total	116		

TABLE VI: TEST STATISTICS

Chi-Square	107.879 ^a
Degrees of freedom	4
Asymp. Sig.	.000

Table III gives Probability Value (P) obtained is less than 0.5. Hence the null hypothesis is rejected and alternative hypothesis accepted. The result indicates a significant Relation between Pollution and Physical Fatigue of Employee.

Calculation of Cost due to Pollution

TABLE VII: NUMBER ABSENTEES DUE TO POLLUTION RELATED DISEASES

Month	Absentees	
	<i>Digester Section</i>	<i>Bleaching Section</i>
April	6	13
May	10	11
June	8	9
July	6	11
Aug	10	10
Sept	11	9
Oct	9	8
Nov	8	7
Dec	10	12
Jan	10	9
Feb	9	11
March	7	8
Total	104	118

The average salary per employee is Rs.28000 per month.

So for a total of 222 employees with 8 hr duty time, the calculations is as follows

Average salary per hour for an employee = Rs.120

Total expense for overtime to meet 222 employees = Rs.426240

The time study reports show an employee can work only an average of seven hrs per shift due to pollution problems. The remaining hrs lost can only be maintained after arranging extra work time. This would also calculate in overtime accounts.

Average Salary per month = Rs.28000

Average salary per hour = Rs.120

Total employees in digester and bleaching section = 138

Overtime per hour = Rs.240

Total Expense = Rs.777600

TABLE VIII: TOTAL COST OF POLLUTION RELATED TO OVERTIME

Total Absent	222
Over Time Hrs due to Absenteeism	1776
Overtime Expense due to Absenteeism	Rs.426240
Overtime Expense due to inefficient utilization of Working Hrs	Rs.777600
Total	Rs.12,03,840

Maintenance cost due to pollution can be calculated from extra expenses from the management to meet pollution related losses, quick maintenance of metallic parts, painting, change of roofs etc due to corrosion. From the maintenance cost of last four years it has been understood that a considerable amount lost due to pollution related corrosion.

The following table gives Total Maintenance cost and maintenance cost due to pollution.

TABLE IX: MAINTENANCE COST DUE TO POLLUTION

year	Total Maintenance Cost(Cr)	Maintenance cost due to pollution(Cr)
2008-09	9.8	1.56
2009-10	9.2	1.38
2010-11	14	2.8
2011-12	14.2	2.84

This increasing trend in maintenance cost and huge expenses to meet overtime points the seriousness of pollution and gives economic impacts of pollution on management of the industry. The cost was calculated from extra expenses from the management to meet pollution related losses, employee health issues, inefficient working hours and corrosion related accidents.

5.CONCLUSION

The Pollution in Chemical industries especially Pulp and Paper Industry was studied in detail. Various diseases associated with chemical pollutions have been studied during the research work. The impact of

pollution on the employees for the company was studied in detail. The pollution has a major role in employee absenteeism, and inefficient utilization of working hours etc. From the company records it was found that a considerable amount is spending to meet the health requirements of the employees. The cost of pollution which is calculated during the research points the need of serious thinking to formulate pollution control strategies from the managerial level itself.

Major Findings includes

- Major pollution outcome areas were identified in Pulp and Paper Industry.
- The Economic impacts of pollution were identified and calculated the cost of pollution for last year.
- Pollution was found to be a major reason for quick maintenance of metallic parts.

The study concludes the importance of formulating pollution control strategies in Chemical industries especially in pulp and paper industry

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