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The Impact of Preventive Environmental Programs Implementatio on Sales growth, Manufacturing and Environmental Performanc the Chemical Industry of the USA

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Abstract

This study examined the impact of preventive environmental management practices on sales growth, manufacturing and environmental performance of the US chemical manufacturing companies. In order to investigate the impact, this study examined the relationship between the degree of preventive environmental programs and sales growth, manufacturing and environmental performances. Using a cross-sectional research design to test three hypotheses, a survey questionnaire was mailed to chemical companies in the USA. To investigate the relationship between the degree of preventive environmental programs and sales growth, manufacturing and environmental performances, t-tests were used. According to the results of t-tests the higher preventive implementation programs achieved better manufacturing and environmental performances than lower preventive or reactive strategies. But there was no difference in sales growth between tow groups.

Key words: Preventive Environmental Management, Company Social Responsibility, Sales Growth, Manufacturing Performance, Environmental Performance

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I. INTRODUCTION

Growing population, ozone depletion, greenhouse effect, acid rain, and hazardous and toxic wastes all fuel "green" challenges that threaten not only the health of the world but also the profitability and survival of many business. Despite the potential destruction of our natural environment, some firms selfishly blame environmental regulations for increased cost and decreased competitiveness. Investment in environmental technology for pollution control landfills and waste disposal cost, for example, have considerably increased over the past several decades, causing some firms to reduce and close down or at least significantly change their operations.

Increasingly stringent environmental legislation and enforcement, awareness of environmental performance, and commercial pressure from customers all stimulate the need for firms to design and implement environmentally sound practices. The growing influence of environmental awareness and green consumerism is being an increasing influence on business operation and profitability. But taking care of the environment is no longer a choice or nice-to-do, but rather a requirement of doing business. Both environmental innovation and regulation can help stimulate a competitive advantage through efficiency. Better technology and manufacturing systems enable reduction in the use of natural resources and materials. Environmental regulations also pressure firms to develop more efficient production systems. Improvement of existing operations or the introduction of new manufacturing process becomes new environmental standard within an industry.

Social responsibility can also offer advantage for those firms promoting the well being of the earth not only for today but also for the future. Socially responsible firms demonstrate a certain obligation for social well being Wood [19]. Socially responsible firms can gain a competitive advantage by providing new environmentally friendly products and services. For the sake of social responsibility, consumers and stakeholders scrutinize the corporate management of environmental issues. The success of Body Shop International, which sells only non-synthetic products, proves that environmentally conscious consumers present large market opportunities.

Is it possible to simultaneously achieve a competitive advantage and improve an environmental performance? In a manufacturing industry, what types of environmental strategy can provide a competitive advantage for an organization?

Historically, management viewed environmental issues with a reactive and minimal legal compliance approach, responding to an environmental crisis and the government regulations rather than taking a proactive or optimistic approach. Unfortunately, most firms still view environmental strategies and investment as narrowly defined legal functions, and not much beyond these.

Thus, studying the impact of proactive versus reactive environmental strategies on performance outputs offers an opportunity to cure management's doubt concerning the potential of environmental management achieving a competitive advantage. Until now, environmental studies have been primarily concerned with conceptual frameworks and anecdotal case studies of the impact of environmental management on firm's performance. This prior theoretical and exploratory approach stems from the difficulty of generalizing across industries and firms with respect to the environmental management issues and strategies Shrivastava [16]: Porter [13]. While case

studies provide specific instances for other situations, most prior empirical studies (Cochran and Wood [4]; Spencer and Taylor [17]; Chen and Metcalf [3]) focused only on the relationship between environmental results and financial performances neglecting the impact of environmental strategy on organizational performance.

However, preventive environmental management practice can lead to both process and product benefit that can result in a competitive advantage Porter & Linde [14]; Klassen [10]. In the context of resource conservation and social responsibility, the potential of reducing manufacturing cost and improving quality through implementation of preventive environmental practices should interest many chemical firms which release much more wastes than other manufacturing firms.

Thus, the main objective of this study is to investigate the relationship between preventive environmental management strategies and sales growth, manufacturing and environmental performances of the chemical manufacturing companies in the USA. More specifically, this empirical study examines whether the companies implementing high degree of preventive pollution programs achieve higher performances in sales growth, manufacturing and environmental activities than the companies implementing fewer or no preventive pollution programs do. The measurement of environmental and manufacturing performances are based on both perceptive (survey respondents) and objective (using third party resources) data: Objective environmental performance is captured using EPA's (Environmental Protection Agency) TRI (Toxics Release Inventory) data. Manufacturing performance includes manufacturing cost, quality, and product yields.

Ⅱ. REVIEW OF RELATED LITERATURE

2.1. Theoretical Foundations

A theoretical framework of environmental management and economic performance starts from the relationship between social performance and economic performance. McGuire et al. [12] suggests two theoretical arguments about social responsibility and financial performance. One argument is that socially responsible firms obtain competitive disadvantage because of the added costs, such as making extensive charitable contributions, promoting community development plans, maintaining plants in economically depressed locations, and establishing environmental protection and prevention. In contrast, the other argument is that there is a positive relationship between socially responsible firms and economic performances. In addition, socially responsible firms can place themselves in a better economic position compared to socially irresponsible firms.

Johnson [9] describes one philosophical foundation for a framework that posits the relationship between environmental performance and financial performance. He states that there is a major difference between environmental performance and CSR (Company Social Responsibility). He argues that the objective of environmental performances is consistent with economic objective, such as reducing cost. There is a synergistic effect between environmental performances and operating efficiency. The objective of environmental performances is to enhance economic performance. Social responsibility, on the other hand, ignores the objective of minimizing cost.

Klassen [10] also argues that environmental performance can lead to better financial performance, based on McGuire et al."s [12] argument that socially responsible firm can improve financial performance. Klassen & McLaughlin [11] proposed an elaborate conceptual model concerned with environmental management in manufacturing and financial performance. According to this model, firms that have improved environmental performance can have two benefits: (1) market gains: and (2) cost savings.

On the market side, customers prefer the products of environmentally responsible firms rather than irresponsible firms Klassen & McLaughlin [11]. Thus, manufacturers that make efforts to produce environmentally friendly products and minimize negative environmental impacts can expand their markets and develop a competitive advantage. With regard to cost, Klassen & McLaughlin [11] propose that firms, which can lower costs with the best available environmental liabilities, can avoid costs and penalties and in turn, result in improved financial performances. Moreover, reduced material and consumption can lead to improved productivity.

In support of Porter's theoretical framework [11], Porter & Linde [14] argue that conflict between environmental excellence and competitiveness is not necessarily true. Environmental excellence can be a competitive advantage not only for nations but also for firms. Porter and Linde [15] suggest that the mind-set of industry's private cost for prevention, remedy, and pollution control that lead to higher prices and reduced competitiveness, be based on a static view of environmental issues. In the real world, technology, products, processes, and customer needs, for example, are changing rapidly. Only a dynamic mind set can explain the win-win relationship between environmental protection and competitiveness.

Little evidence exists to support that adverse effects of stringent environmental policies of the US government have had on the competitiveness of US manufacturers Jaffe et al. [8]. Poter & Linde [15] contend that properly designed environmental regulations can trigger innovations that lower the cost of products, and, in turn, result in resource productivity making firms more competitive. According to the resource productivity model of Porter & Linde [15], pollution reflects inefficiency, ineffectiveness, and incompleteness of resources. Improving efficient processes and product could lead to the reduction of manufacturing cost and increase of the true economic value of products.

Product benefit can result from not only producing less pollution but also creating high-quality products, safer products, lower product costs, or lower costs of product disposal for the user. Process benefits result not only from the reduced pollution but also higher process yields, less downtime through more careful monitoring, more materials savings, better from safer workplace conditions, and improved disposal of the products as a by-product of process changes Porter & Linde [15]. Companies that improve environmental performance and introduce environmentally friendly products and processes in the market may be able to enjoy premium process for green product and define new markets.

Porter & Linde's theoretical framework [14][15] considers environmental regulation to be the most important motivational factor for innovating environmental technology and resource productivity. They also argue that the real world is dynamic and everything is changing, and the motives to improve environmental performance are not environmental regulations alone. Other factors such as firm's size and firm's goals and strategies also inspire

improvement in environmental performances.

Recently, environmental factors are playing an increasingly important and beneficial role in the strategic decision-making process. Hart [7] argues that pollution prevention, product stewardship, and sustainable development are three strategic capabilities for achieving a sustainable competitive advantage. Thus, consideration of environmental capability for strategic decision can be a competitive advantage for the firm. In turn, result in improved financial performance. Moreover, reduced material and consumption can lead to improved productivity Klassen & McLaughlin [11].

2.2. Review of Previous Social Performance and Economic Performance Studies

While there have been many studies on the relationship between CSR (Company Social Responsibility) and economic/financial performance, the literature survey of this study focuses on the relationship between corporate environmental performance and economic performance. One of the main research questions in this study is about how a proactive environmental strategy is related to economic performance. The study of Bragdon and Marlin [2] was based on the environmental ratings from CEP (Council on Environmental Performance) and economic/financial performance. While the sample size consists of only 24 firms from the pulp and paper industry. Only 17 out of 24 firms were utilized for the study based on the CEP rating data availability. The result suggested a positive relationship between the CEP evaluation and economic performance. The economic performance measures used were 1-year earnings per share (EPS) growth, 5-year ROE (Return on Equity), 1-year ROE, 5-year return on capital, and 5-year earnings growth.

Bowman and Haire [1] conducted a follow-up study to the one done by Bradon and Marlin [2], using the same 24 firm samples. They categorized the firms as "low," "medium" and "high" groups based on environmental performance (CEP ratings). The economic measure used was ROE. The findings of the study were interesting because ROE of high environmental performance group was lower than that of the medium and the low groups. Thus, Bowman and Haire [1] contended that there might be an inverted U-shaped relationship between environmental performance and ROE. The result of this study was limited by the small sample size, and no statistical basis for categorization of the groups Johnson [9].

Folger and Nutt [6] also used the same firm samples as Bradon and Marlin [2] used. They reduced the sample size to nine firms based on "significant merge activity," the record of "low earnings" and short history of the firms. The findings of their study suggested no relationship between economic performance and environmental performance. Small sample size may have influenced this result.

Spicer [18] used the same data set as Bradon and Marlin [2] and Folgers and Nutt's [6] used CEP environmental performance categorization of low, medium, high groups. However, he labeled groups as "best," "intermediate," and "worst" based on CEP rankings. He analyzed the data using different time period: 1969-1971; 1971-1973; and 1968-1973. While the sample size of the original CEP data set included 24 companies, he removed several firms from the sample due to financial data availability and the difficulty in defining the characteristics of companies in the pulp and paper industry. ROE, total assets, price-to-earnings ratio, and the measure of firm risk, that is "beta", were used for the measure of economical performance. The findings of the study showed a positive relationship, but only for the 1968-1973 time period.

Chen and Metcalf [3] replicated Spicer's study

with an improved methodology. While Spicer [18] considered firm size as a dependant variable, Chen and Metcalf [3] argued that firm size is not a dependant variable, but rather a control variable. After controlling the firm size, they found that there was no relationship between economic performance and environmental performance.

Spencer and Taylor [17] conducted a study based on the Fortune magazine's annual survey ratings on "community and environmental responsibility." The measures of environmental/financial performance were ROA (Return on Assets) and ROS (Return on Sales). The time period covered for these measures was a 5 year-span ending in 1982. The study found a positive relationship between community and environmental ratings and financial data. While this study used a larger sample (120 firms in 13 manufacturing industry) than the previous studies, this study was based on qualitative or perceptual environmental performance.

In 1988, using the same Fortune magazine's annual survey rating data of environmental performance for their study, McGuire et al. [12] extended their measure of economic performance. The measure of economic performance included ROA, total assets, asset growth, sales growth and other financial data including total return and sales risk-adjusted return. In addition, they divided their financial data into two periods, 1977-1981, and 1982-1984. They found a positive correlation between ROA and environmental performance for both period and a negative relationship between risk and environmental performance. There was no relationship between stock market measures and environmental performance. They observed slightly a stronger relationship between environmental performance and ROA of 1977-1981 than ROA of 1982-1984 and concluded that economic performance may lead to better environmental performance.

2.3. Recent Studies

Among recent studies, Johnson [9] extensively examined the relationship between several economical performance and objective environmental data of Fortune 500 companies. This study included a broad sample size, a rigorous methodology, and a quantitative economic and environmental performance data. The environmental measures of the study included both broad and objective measures such as TRI (Toxic Release Inventory) data from EPA (Environmental Protection Agency). Environmental fines and violations, super fund sites, RCRA (Resource Conservation and Recovery Act) corrective actions, oil and chemical spills obtained from IRRC (Investors Responsibility Research Center) as well as qualitative data such as environmental ratings of the CEP. The economic measures used were Total Return, Return on Investment (ROI), Return on Equity (ROE), ROA, Sales Growth, and Net Income Growth.

This study controlled firm size, industry type firm risk level. According to the result of the s some environmental performances, such as CEP r number of special spills, pounds of chemical number of spills, and number of super fund (1987-1989 period), affected financial performance environmental performance indicators affected onl among economic performances.

In Johnson's study, no strong relationship existed between toxic chemical emissions and federal regulatory violations. The relationship between poor environmental performance and better economic performance was found in several industry sectors. This finding implies that environmental policy or regulation shou adjusted to provide strong economic incentives corporations to improve environmental perfor

The causality of aggregate financial measures of firm level and environmental performance in Johnson's study was obscure due to the lack of

sound theoretical foundations. Thus, demanding more detailed measures of economic performance in future studies are required. Klassen [10] constructed an integrative conceptual model of environmental management and conducted the study of the relationship between manufacturing performance in terms of cost, quality, flexibility, delivery, and environmental performance measured by EPA's TRI data. He constructed an integrative conceptual model of environmental management. Klassen [10] conducted an environmental management strategy study based on the theoretical framework and manufacturing performance. Although his study focused only on furniture industry, methodology and the conceptual model of environmental management were much more improved from the previous studies.

According to the result of his study, a company that implemented a proactive environmental strategy was better than a company with reactive strategy in terms of manufacturing performance (cost and quality) and environmental performance (EPA's TRI data). Even though his study was based on the furniture industry, Klassen [10] synthesized the conceptual model from operations management strategy, environmental management, and corporate social performance literature. The important contribution of Klassen's work is that it represents the first attempt to examine the relationship between environmental management strategy and manufacturing performance and environmental performance based on an integrative conceptual model of environmental management approaches.

Improved theoretical development and research methodology in recent studies provide some solid evidence of the relationship between environmental management strategy and economic performance at the firm level, as well as the potential influence of environmental management strategy. Even though many researchers have conducted studies to analyze the relationships between social performance and economic/financial performance. findings have been consistent. However, Johnson [9] suggested that present environmental regulations of the US government do not provide economic motives for companies to improve negative environmental activities.

Ⅲ. RESEARCH METHODOLOGY

3.1. Hypotheses

Previous literature does not confirm that higher preventive environmental programs lead better organizational performance in terms of financial ratios and manufacturing and environmental activities. Specifically, according to Johnson"s study [9] environmental performances influenced only ROA among financial ratios. And the relationship between poor environmental performance and better economic performance was found in several industry sectors. Thus, it is important to investigate the relationship between preventive environmental programs and economical, manufacturing and environmental performances, in the chemical firms releasing much more toxic waste than other manufacturing firms. Among economical performances, sales growth per employee was chosen because the variable has been generally used to measure the growth of a firm and the measured objective data of the variable can be obtained.

The object of this study is to investigate the relationship between preventive environmental programs between sales growth, manufacturing and environmental performances in the US chemical industry. One comprehensive case study Dorfman et al. [5] identified 196 pollution reduction activities in the chemical industry. The

chemical plants studied varied in size (from a small plant which has only four employees to a large plant which has 3500 employees), age, type of products, and type of process. The 196 pollution reduction activities are categorized into 5 groups: (1) 78 process changes; (2) 60 operational changes; (3) 18 chemical substitutions; (4) 32 equipment changes; and (5) 8 product changes. It is clear that chemical companies use process changes most frequently, followed by operation changes, equipment changes, chemical substitution, product changes.

This study is based on these techniques be they are the most comprehensive in the che industry. Programs used to classify firms as reactive and proactive will include the following categories: (1) design of clean production process technology; (2) substitution of toxic materials with less toxic ones; (3) development of appropriate materials; (4) design of environmentally friendly products; (5) development of production and consumption systems with low material intensities; (6) equipment redesign for prevention; and (7) production of environmentally friendly products.

Based on the previous literature and the practices of preventive environment programs in the USA, we found that it is necessary to reexamine the effect of environmental preventive programs on sales growth, manufacturing and environmental performance. Thus, following hypotheses were developed.

Hypothesis 1: There is a positive relatio between the degree of pollution prevention pro and a firm's manufacturing performances in th chemical industry

Hypothesis 2: There is a positive relatio between the degree of pollution prevention pro and a firm's sales growth in the US chemical indu

Hypothesis 3: There is a positive relationship between the degree of pollution prevention programs and a firm's environmental performances in the US chemical industry

3.2. Description of Data Collection

3.2.1. Sample Selection

The Chemical industry has been subjected environmental regulation for many years. It is as that environmental regulation has already standardized. As the Dorfman et al.'s study Do [5] implies, the programs of preventive environ management strategy in the chemical industry is advanced level of implementation compared with industries. Thus, the population for this study US chemical manufacturing industry. The sample was chosen from the Standard Industry Code (SIC) between 2813 and 2869 classified as chemical industry based on the 1997 Millions Dollar Directory.

Structured questionnaires were sent to 1250 randomly selected chemical companies. The list of 1250 companies includes from small firms to very large firms. Because it is assumed that small firms do not have environmental managers, structured questionnaires were sent directly to the presidents of small firms with less than 100 employees, to the operation managers of medium size firms with employees of more than 100 but less than 150 and to the environmental managers of large firms with more than 150 employees. If the directory has a specific name of president, vice president, or operation manager, the questionnaire was sent to the specific person.

3.2.2 Development of Survey Responses

Of the 1250 questionnaires mailed, 102 responded (approximately 8.5 percent of response of which 16 were eliminated as unusable. The re rate of this study is relatively low. Environm

management and regulation issues are sensitive issues for the chemical companies and this may have caused the firms to be hesitant in responding to the survey. However, of 86 usable responses, approximately 72 percent (61 responses) of the total respondents were eager to know the results of this study.

Respondents were divided into two groups suc the firms implementing high degree of preve programs and the firms implementing low degr preventive programs.

3.3. Data Analysis Procedures and Statistical M

To analyze the data of all returned questionnaires, statistical analysis was conducted using the Statistical Package for the Social Science (SPSS). For statistical analysis of the data, t-test is a main statistical tool used for the study. T-tests were employed to identify the differences of manufacturing and environmental performance between the firms implementing high degree of preventive environmental programs and the firms implementing low degree of preventive environmental programs. The results of tests were utilized to analyze the relationship between implementation of preventive environmental programs and manufacturing and environmental performance.

Ⅳ. RESULTS

4.1. The impact of Preventive Environmental Programs on Manufacturing Performance

Manufacturing performance was measured by two sets of indicators. First, the respondent's perception of manufacturing performance was measured by questions focused on manufacturing performance such as manufacturing cost, quality, productivity, and other manufacturing performances. Secondly, objective data, specifically the change of sales amount, were obtained from the Million-Dollar Directory (1992-1997).

Table 1 summarizes the results of t-tests identifying the differences of manufacturing performance between the firms implementing high degree of preventive programs and the firms implementing low degree of preventive programs. According the results, there are statistically significant difference in terms of manufacturing performance between the firms implementing high degree of preventive programs. and the firms implementing low degree of preventive programs. The firms implementing higher degree preventive environment programs achieve better manufacturing performance than the firms implementing low degree preventive environment programs do.

Thus, based on the results of t-tests, the manufacturing variables such as manufacturing cost, plant efficiency, product yield, product quality, and process yield were significantly related to the degree of preventive implementation programs. According to the results mentioned above, hypothesis 1 is partly supported. Therefore, we can state that the degree of preventive environmental programs is positively related with manufacturing cost, plant efficiency, product yield, product quality, and process yield.

Table. 1 The Results of t-test between the High Degree and the Low Degree Firms

Manufacturing Performances	No. of Cases	Mean	S.D.	Prob.
Manufacturing Cost	81	5.605	.931	.017*
Competitive Position	81	5.296	1.259	.101
Plant Efficiency	82	5.488	1.091	.006*
Public Image	81	4.951	1.117	.296
Product Image	82	5.195	1.116	.114
Product Yield	82	5.256	1.052	.003*
Process Yield	82	5.207	1.119	.001*
Resale and Scrap Value	78	4.487	1.066	.572
Product Quality	80	5.425	1.203	.023*
Productivity	82	5.378	1.096	.119

* : P < 0.5

4.2. The Impact of Preventive Environmental Programs on Sales Growth

The firms that responded were classified as p and private firms. Only small portion of the firms participated in this study; thus, the use of data of organizational performances such as CompuStat was inappropriate. Participating private companies were called for publicly available financial data. All the private firms requested rejected the release of financial data due to security reason.

Therefore, sales for each company from the M Dollar Directory (1992-1996) were used as a fi performance indicator. Each participating organ was matched to the name listed in Directory. companies were eliminated due to the unavailab their names and 34 companies were eliminated f future analysis because data were not listed in th and 1996 Million Dollar Directory. As a resu companies were retained for this analysis. Each sales amount from 1992 to 1996 of 42 firms were divided by the number of employees to control firm size. Thus, Sales growth per employee was calculated by the difference between sales per employee in 1992 and 1996(see below):

1992 Sales per employee = (1992 Sales/employees)

1996 Sales per employee = (1996 Sales/employees)

Sales growth per employee = (1996 sales per employee - 1992 sales per employee)

Table 2 summarizes the results of t-test analyses on the difference in sales growth per employee between the degree of preventive implementation programs and the high degree of preventive implementation programs. Based on the results of t-test, the sales growth per employee was not significantly different by the degree of preventive program implementation programs.

Hypothesis 2 that higher preventive environmental programs lead higher sales growth per employee is not accepted. Thus, this implies that even if chemical firms implement high degree of preventive environmental programs, they may not achieve higher sales growth per employee.

Table. 2 The Results of the Degree of Implementation Programs and Sales Growth

Financial Performance	No. of Cases	Mean	S.D	Prob.
Sales Growth Per Employee	42	124,920	263,381	.688

4.3 The Impact of Preventive Environmental Programs on Environmental Performance

Like manufacturing performance, environmental performance was measured by perceptual data. The perceptual measures were

based on the survey responses, consisting of answers on wastes consumption, consumption of recycled materials, consumption of hazardous materials, the amount of chemical spills, total number of regulatory violations, and the amount of total emissions. To standardize the environmental performance data across companies, the items were asked on per unit basis. Table 3 summarizes the results of t-tests concerning environment performance between the high degree of preventive environment programs and the low degree of preventive environment programs. Four variables except environmental performance, excluding reduction in wastes consumption per unit produced and increase in consumption of recycled materials per unit produced, were found to be significantly different between the high degree of preventive environment programs and the low degree of preventive environmental programs. Thus, we can state that the variables of reduction in consumption of hazardous materials, reduction in the amount of chemical spills, total number of regulatory violations and reduction in the amount of total emissions are positively related with the degree of preventive environment programs. Thus, hypothesis 3 is partly accepted.

Table. 3 The Result of the t-test between the Degree and the Low Degree of Environm Implementation Programs

Environmental Performance	No. of Cases	Mean	S.D	Prob.
WS	82	5.305	1.062	.119
CR	80	4.750	.974	.295
CH	81	4.864	1.311	.002*
CS	83	5.289	1.375	.010*
TN	80	4.913	1.670	.037*
TE	83	5.470	1.347	.000*

*: P 〈. 05

The abbreviations used for t-tests are follows:

WS: Reduction in waste consumption per unit produced

CR: Increased in consumption of recycled materials per unit produced

CH: Reduction in consumption of hazardous ma per unit produced.

CS: Reduction in the amount of chemical spills per unit produced

TN: Total number of regulatory violations

TE: Reduction in the amount of total emissions per unit produced.

Hypothesis 3 suggested that there would be a significant relationship between the degree of preventive program implementation and environmental performance. According to table 3, there are significant differences in environmental performances of CH, CS, TN and TE between the firms implementing high degree of preventive programs and those implementing low degree of programs. The hypothesis dealing with reduction in the amount of total emissions per unit produced is supported. In addition, the hypotheses of reduction in the consumption of hazardous materials per unit produced, reduction in the amount of chemical spills per unit produced, and total of regulatory violations is supported. The result suggested that as firms implement more preventive environmental programs, environmental performance should be improved.

4.4. Preventive Environmental Programs and Toxic Release Inventory

The objective environmental performance data taken from the Toxic Release Inventory (TRI) 1987-1994 CD-ROM, provided by EPA Kansa City office. This data set was compared to total release. Each participating company was matched to the name listed on CD-ROM. 28

companies were retained for further analysis out of 86 companies in the sample. The remaining 58 companies were eliminated because of the unavailability of their names or no TRI data to 1989 or 1994. Each total release (toxic emissions) figure from 1989 to 1994 of 28 firms was divided by the number of employees to standardize the amount of total release. Each total release for calculation includes the quantity of the listed toxic chemicals that are released directly into air, water, and land. The number of employees in 1996 was used for standardization due to the concern about small sample size. Thus, total release was calculated by the difference between per employee total release in 1989 and 1994 (see below).

Total Release Improvement = (1989 Total Release - 1994 Total Lease)

Total Release Improvement Rate per Employee = (Total Release Improvement)/(Employees)

Table 4 summarizes the t-test analysis of the difference in total toxic release inventory between the low degree of preventive implementation programs and the high degree of preventive implementation programs. The result shows that there is statistical difference in total toxic release inventory between two groups. The result implies that the firms implementing high degree of preventive programs release less toxic inventory than the firms implementing low degree of preventive programs do. Based on the result, total amount of toxic release has a significantly positive relationship with the degree of preventive implementation programs. In other words, a greater degree of implementation programs would lead to a better performance of the environmental management dealing toxic release. This result of objective data is matched with the result of perceptual environmental data in the last section. The result of table 4 also supports hypothesis 3.

Table. 4 Analysis of the Degree of Preventive Implementation Programs and Toxic Release Inventory (TRI)

No. of Cases	Mean	S.D.	Prob.
28	929,912 (lbs)	3,614,932 (lbs)	.05*

*: $p < .05$

4.5. Results of Testing Hypotheses

Table 5 shows the summarizing results of testing hypotheses.

Table. 5 Results of Testing Hypotheses

	accept	reject
Hypothesis 1	O (partly)	
Hypothesis 2		O (fully)
Hypothesis 3	O (partly)	

V. FURTHER STUDY

This study examined the impact of preventive environmental management practices on manufacturing and environmental performance of the US chemical manufacturing companies. The impact of preventive environmental programs on manufacturing and environmental performance was identified. For further study, this environmental research should be conducted in Korea whose territory is small and has been contaminated since the beginning of economic development under the control of president Park. And no stem of this research has been conducted yet in Korea.

One of the research areas for future study is to investigate the preventive environmental management programs concentrating on different sectors of the chemical industry or other manufacturing industries. Preventive environmental programs may differ across industries in terms of seven categories.

The study on the impact of preventive environmental management in all industries will increase external validity and help identify the differences in the implementation of preventive environmental programs. The limited sample size due to the restricted availability of accounting and objective environmental data of public companies should be addressed in future studies. For example, in comparing accounting and environmental performance, more public companies or other performance measures should include in a study.

The philosophies of Total Quality Management (TQM) include continuous improvement of work process, customer satisfaction, and total commitment of employees on the quality improvement. The integration of TQM and pollution prevention approach of zero emission offers a way to go beyond the strict regulatory compliance of environmental management to complete quality environmental program responsibility. This integration will better enable firms to improve financial and environmental performance thanks to the proven holistic approach that TQM offers.

VI. CONCLUSIONS

In summary, environmental management continues to present a critical business challenge. No longer is the environmental management a choice of luxury. Regulations and consumer preference make it a business necessity. Even a small extra step toward prevention can provide with additional competitive advantage to the firm in an aggressive, fast-paced, and dynamic global world of the business. This study has examined the effect of preventive environmental programs on sales growth, environmental and manufacturing performance in the US chemical industry. This study examined the relationship between the degree of preventive programs and manufacturing performance and then the impact of the preventive programs on sales growth and environmental performance.

To examine the impact of preventive environmental programs on sales growth, environmental and manufacturing performance, t-test was utilized. The results of t-tests suggest that the higher preventive implementation programs lead to better improvement of environmental and manufacturing performance than lower preventive or reactive strategies do. No significant difference, however, was identified in sales growth (1991-1996) between firms with higher and lower preventive programs.

Significant differences existed between the higher preventive implementation firms and lower preventive implementation companies for self-reported environmental performance in terms of reduction in consumption of hazardous materials, reduction in the amount of chemical spills, total number of regulatory violations, and reduction in the amount of total emissions. These results imply that a higher implementation of preventive environmental strategies lead to better performance improvement than a lower implementation of preventive environmental strategies do in those areas.

REFERENCES

[1] Bowman, E. H. and Haire, M., A Strategic Posture Toward Corporate Social Responsibility, California Management Review, Vol. 18, No. 2, 1975, pp. 49-58.

[2] Bragdon, J. H. and Marlin, J. A. T., Is Pollution Profitable?, Risk Management, Vol. 19, No. 4, 1972, pp. 9-18

[3] Chen, K. H. and Metcalf, R. W., The Relationship Between Pollution Control Record and Financial Indicators Revisited, The Accounting Review, Vol. 55, No. 1, January 1980, pp. 168-177.

[4] Cochran, P. L. and Wood, R. A., Corporate Social Responsibility and Financial Perform Academy of Management Journal, Vol. 24, N 1984, pp. 42-56.

[5] Dorfman, M. H., Muir, W. R., and Miller, C. G., Environmental Dividends: Cutting More Chemical Wastes, INFORM, Inc.: New York, 1992.

[6] Folger, H. R and Nutt, F., A Note on Social Responsibility and Stock Valuation, Academy of Management Journal, Vol. 18, No. 1, 1975, pp. 155-160

[7] Hart, S., A Natural-Resource-Based View of The Firm, Academy of Management Review, Vol. 20, No. 4, 1995, pp. 986-1014.

[8] Jaffe, A. B., Peterson, S., and Portney, P. R., Environmental Regulation and the Competitiveness of U.S. Manufacturing: What Does the Evidence tell us? Journal of Economic Literature, Vol. 33, No. 2, March 1995, pp. 132-163.

[9] Johnson, S. D., "An Analysis of the Relationship Between Corporate Environmental and Economic Performance at the Level of the Firm", Doctoral Dissertation, University of Southern California, 1995.

[10] Klassen, R. D., "The Implications of Environmental Management Strategy for Manufacturing Performance", Doctoral Dissertation, University of North Carolina at Chapel Hill, 1995.

[11] Klassen, R. D. & McLaughlin, C. P., "The Impact of Environmental Management on Firm Performance", Unpublished Working Paper, University of North Carolina at Chapel Hill, 1994.

[12] McGuire, J., Sundgren, A., and Schneeweis, T., Corporate Social Responsibility and Firm Financial Performance, Academy of Management Journal, Vol. 31, No. 4, 1988, pp. 854-872.

[13] Porter, M. E., Essay: Americas Green Strategy, Scientific American, April 199 169.

[14] Porter, M. E. and Linde C. v. d., Green and Competitive: Ending the Stalemate, Harvard Business Review, Vol. 73, No. 3, September- October 1995a, pp.120-134.

[15] Porter, M. E. and Linde C. v. d., Toward a New Conception of the Environment-Competitiveness Relationship, Journal of Economics Perspectives, Vol. 9, No. 4, Fall, 1995b, pp. 97

[16] Shrivastava, P., "Greening Business: Profiting the Corporation and the Environment", Thomson Executive Press: Cincinnati, OH, 1996.

[17] Spencer, B. A. and Taylor, G. S., A Within and Between Analysis of the Relationship Between Corporate Social Responsibility and Financial Performance,

Akron Business Economic Review, Vol. 7, No. 18, 1987, pp. 7-18.

[18] Spicer, B. H., Investors, Corporate Social Performance and Information Disclosure: An Empirical Study, The Accounting Review, Vol. 53, No. 1, January 1978, pp. 94-111.

[19] Wood, D. J., "Corporate Social Performance Revisited," Academy of Management Review, Vol. 16, No. 4, 1984, pp. 691-718

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