CHAPTER 5

DATA ANALYSIS AND RESEARCH RESULTS

This chapter begins with the survey sample which comprises of the response rate and descriptive statistics of the sample. Then the data analysis and research results are presented. Finally, all hypotheses stated in Chapter Three are tested.

5.1 SURVEY SAMPLE

This section presents the response rate and descriptive statistics as follows:

5.1.1 Response Rate

Table 5.1 shows sample size and response rate of mail survey. After 1,555 questionnaires were mailed (756 questionnaires to companies in food industry and 799 questionnaires to companies in electrical / electronics industry), 98 questionnaires were returned as undeliverable, which comprise of 56 questionnaires mailed to companies in food industry and 42 questionnaires to companies in electrical / electronics industry. The reasons caused questionnaires return are business closed and address changed as the majority. Hence, the effective sample size reduced to 1,457. Thereafter, the 215 responses were received, leading to a response rate of 14.7%. Of this number, 25 questionnaires were disqualified due to respondents not from two specific industries, too many missing values, or denial to answer. Thus, the effective response rate was reduced to 13.0%.

Table 5.1 Sample Size and Response Rate

Topic	Food Processing	Electrical & Electronics	Total
Companies shown in DIW's list	5,566	2,048	7,614
Mail sent	756	799	1,555
Deduct mail returned*	56	42	98
Mail reached respondents	700	757	1,457
Mailed replied	122	93	215
Deduct unusable questionnaires**	18	7	25
Usable questionnaires	104	86	190
Response rate	17.4%	12.3%	14.7%
Effective response rate	14.9%	11.4%	13.0%

* Mail returned due to business liquidation, change of address, or unclear address.

** Unusable questionnaires due to respondents not from two industries, too many missing values, or denial to answer.

Table 5.2 shows the response rates categorized by firm size (measured in terms of total assets) and by industry.

Table 5.2 Response Rate Categorized by Firm Size and Industry

Firm Size	Food Processing		Electrical & Electronics		Total	
	Q'ty	% Response	Q'ty	% Response	Q'ty	% Response
Small Firms (Total assets < 50 million ฿)	21	11.0	18	9.5	39	20.5
Medium Firms (Total assets = 51 - 200 million ฿)	39	20.5	33	17.4	72	37.9
Large Firms (Total assets > 200 million ฿)	44	23.2	35	18.4	79	41.6
Total	104	54.7	86	45.3	190	100

5.1.2 Descriptive Statistics

Descriptive statistics of some interesting variables were computed including means, standard errors of mean, standard deviations, minimums, and maximums. Next, frequency tables of those variables were computed to check errors in keying data and reporting some variables descriptively. These frequency tables are shown in the result section of this chapter. Lastly, Pearson bivariate correlations for all variables were run and checked whether there was any pair of independent variables that had high correlations or multicollinearity. This principle is important because multicollinearity can distort the standard error of estimate and may lead to incorrect conclusions as to which independent variables are statistically significant. A common rule of thumb is that correlations among the independent variables between –.70 and .70 do not cause difficulties (Mason et al., 1999). The usual remedy for multicollinearity is to drop one of the independent variables that are strongly correlated. It was found that the following variables (in question number 21 of questionnaire) were highly correlated ($r \geq .7$) with each others, i.e., *energy conservation fund*, *environmental preservation fund*, *industrial loan*, *exemption of income tax*, *exemption of import duty on clean technology equipment*, *free consulting services from foreign organizations*. Hence, only *energy conservation fund* (labeled as FUND.EC), *waving of operation permit fees* (FREEDUTY), and *awareness of CT incentives* (HELP.KNO) as the representatives of this group were kept for further analysis. Furthermore, high correlation also existed between two variables in question number 23, i.e., INFO.FOE (*awareness of the CT widespread among the competitors*) and INFO.IND (*awareness of the CT widespread in the industries*) with the value of $r = .856$. Hence, INFO.FOE was dropped while INFO.IND and INFO.NEI (*awareness of the CT widespread among the neighboring firms*) were kept for further analysis. Finally, it was found that the following variables (in question number 31 of questionnaire) were

highly correlated ($r \geq .7$) with each others, i.e., CT.ADV1 (*healthy market share by CT*) and CT.ADV2 (*customer satisfaction by CT*), CT.ADV3 (*profitability by CT*) and CT.ADV4 (*cost reduction by CT*) and CT.ADV5 (*energy savings by CT*), CT.ADV9 (*better surrounding environment by CT*) and CT.ADV10 (*social recognition by CT*), and INTENT1 (*willingness to adopt CT*) and INTENT2 (*willingness to develop CT*). Therefore, only CT.ADV1, CT.ADV4, CT.ADV6, CT.ADV7, CT.ADV8, CT.ADV10, and INTENT1 were kept for further analysis.

5.1.3 Data Examination

Data examination comprises of outlier checking and normality testing. All variables are checked for outliers by a box plot. It was found that there were no significant outliers in this examination. The effect of outliers was not strong because after trying to delete outliers, the mean of each variable changed less than one standard error of mean.

Normality testing is considered as an important early step in almost every multivariate analysis (Tabachnick & Fidell, 1996). Thus, all variables were assessed by statistical and graphical methods. For statistical approach, the z value ($z = \frac{\text{skewness}}{\text{SQR}(6/N)}$, where N = sample size) of all variables were computed.

The normality of these variables is acceptable when z value is not more than $\pm$ 1.96, which corresponds to a .05 error level (Hair et al, 1995). For graphical methods, the visual check of the histogram with normal curve was done. It was found that the normality of these variables was acceptable.

5.1.4 Validity and Reliability Test

Multiple items were used to construct eleven independent variables in this study. Selection of items was based on the literature review, comments from professors, plant managers of leading manufacturing companies in food industry and electrical / electronic industry, and pilot study. This showed face validity of the research.

The reliability of the multi-item scales was assessed based on coefficient *alpha* and item-to-total correlations. The items with low item-total correlations were dropped. Following the recommendations of Gerbing and Anderson (1988), purified scales were then subjected to a factor analysis to assess the unidimensionality and construct validity. After eliminating the items with loading factor lesser than 0.5, the remaining items were averagely combined procedure to form the summated scales.

The unidimensionality and construct validity of multi-item scales used to measure the independent variables were assessed by subjecting all the purified scale items to a principal component factor analysis. The scale items and their factor loadings are provided in Table 5.3 – 5.5. After eliminating the items with loading factor lesser than 0.5, the remaining items were combined via the averaging procedure to form the summated scales. The reliability of the multi-item scales was assessed based on Cronbach's coefficient alpha. It was found that all of the coefficient alphas were higher than the minimum acceptable level of 0.7 as recommended by Nunnally (1978).

Table 5.3 Factor Analysis of Institutional Factors

ITEMS	REG.PRESS	STAK.DEM	INCENTIV	CT.WIDE
GOV.FR	.710			
LAWINTER	.653			
NGO	.617			
WEEHACP	.545			
G0V.THAI	.526			
LAWTHAI	.524			
SUPPLIER		.774		
EMPLOYEE		.765		
CUSTOMER		.677		
RIVAL		.657		
ASSOCIA		.617		
COMMUNI		.521		
SHAREHOL		.509		
FUND.EC			.876	
FREEDUTY			.850	
HELP.KNO			.839	
INFO.IND				.682
INFO.NEI				.590
EIGEN VALUE	4.669	2.803	1.674	1.471
% OF VARIANCE	22.234	13.348	7.970	7.005
CUM. % OF VARIANCE	22.234	35.582	43.552	50.558
CRONBACH'S ALPHA	.7083	.8153	.8779	.7145

Table 5.4 Factor Analysis of Organizational Factors

ITEMS	CT.INPUT	CO.CAPA	CO.SIZE
CT.INP8	.694		
CT.INP5	.660		
CT.INP7	.650		
CT.INP3	.650		
CT.INP6	.648		
CT.INP4	.638		
CT.INP10	.588		
CT.INP9	.530		
CO.CAPA2		.886	
CO.CAPA3		.865	
CO.CAPA1		.745	
CO.SIZE1			.877
CO.SIZE2			.830
EIGEN VALUE	3.948	2.233	1.582
% OF VARIANCE	26.323	14.884	10.547
CUM. % OF VARIANCE	26.323	41.207	51.754
CRONBACH'S ALPHA	.7995	.8080	.7728

Table 5.5 Factor Analysis of Management's Factors

ITEMS	ADV.COM	ADV.SOC	ADV.ECO	WILLING
CT.ADV1	.884			
CT.ADV6	.734			
CT.ADV7	.678			
CT.ADV8		.849		
CT.ADV10		.843		
CT.ADV4			.929	
INTENT2				.911
EIGEN VALUE	2.045	1.777	1.155	1.014
% OF VARIANCE	29.219	25.393	16.50	14.482
CUM. % OF VARIANCE	29.219	54.612	71.112	85.594
CRONBACH'S ALPHA	.7447	.7920	-	-

5.1.5 Bivariate Correlations

Bivariate correlation was done for the second time to test whether there were some pairs of independent variables with high correlation. All new eleven independent variables from factor analysis were put into this test. The printout report revealed that there was no pair of variables with high correlation as shown in Table 5.6. Most of the correlation values are not high than 0.50. A few pairs of independent variables, i.e., ADV.COM and ADV.ECO, ADV.COM and ADV.SOC, and ADV.COM and WILLING, that have the correlation of 0.506, 0.641, and 0.507 respectively. However, these high correlation values are still within the range of -.70 and .70 as recommended by Mason et al (1999). All findings from bivariate correlations would be used for testing hypotheses, which were proposed in Chapter 3.

5.1.6 Analysis of Variance (ANOVA)

Analysis of variance is used to compare the means of the groups to see if there are any reliable differences among them (Tabachnick and Fidell, 1996). Through an analysis of the variation in the data, both among and within the groups, conclusion can be made about possible differences in group means.

Table 5.6 Pearson Correlation Matrix

Variables	REG.PRES	STAK.DEM	INCENTIV	CT.WIDE	CO.SIZE	CO.CAPA	CT.INPUT	ADV.COM	ADV.ECO	ADV.SOC	WILLING	CT.INVES
REG.PRES	1.000											
STAK.DEM	.208**	1.000										
INCENTIV	.176*	.089	1.000									
CT.WIDE	.175*	.107	.298***	1.000								
CO.SIZE	-.028	.083	.148*	.148*	1.000							
CO.CAPA	.208**	.033	.134	.034	.179*	1.000						
CT.INPUT	.219**	.109	.318***	.252***	.092	.189**	1.000					
ADV.COM	.270***	.194**	.180*	.154*	.100	.416***	.355***	1.000				
ADV.ECO	.197**	.277***	.298***	.212**	.192**	.183*	.264***	.556***	1.000			
ADV.SOC	.157*	.258***	.083	.222**	.066	.227**	.264***	.641***	.360***	1.000		
WILLING	.242***	.170*	.162*	.077	.085	.293***	.185*	.507***	.391***	.380***	1.000	
CT.INVES	.372***	.391***	.362***	.146*	.307***	.357***	.168*	.270***	.348***	.231***	.364***	1.000

*** Correlation is significant at the 0.001 level (2-tailed)

** Correlation is significant at the 0.01 level (2-tailed)

* Correlation is significant at the 0.05 level (2-tailed)

The ANOVA was run to find the differences in group means of eleven factors which were used as dependent list while industry type, company type, education level of the majority of employees, export level, and main export markets were used as factors. Post hoc multiple comparisons were conducted by using the least significant difference (LSD) approach to identify which comparisons among groups have significant differences. The summary of ANOVA results is shown in the result section of this chapter.

5.1.7 Multiple Regression Analysis

In order to look into the findings regarding the predictability on the dependent variable (i.e., CT.INVES) of the eleven independent variables (i.e., REG.PRES, STAK.DEM, INCENTIV, CT.WIDE, CO.SIZE, CO.CAPA, CT.INPUT, ADV.COM, ADV.ECO, ADV.SOC, and WILLING), stepwise multiple regression analysis was conducted in this study for this purpose. This method will select variables for inclusion in the regression model. It starts with selecting a best predictor of the dependent variable. Additional independent variables are selected in terms of the incremental explanatory power they can add to the regression model. Independent variables are added as long as their partial correlation coefficients are statistically significant. Independent variables may be dropped if their predictive power drops to a non-significant level (Hair et al, 1995).

In addition, it is necessary to control some variables that are likely to affect the investment in clean technology (McGrath et al., 1995). These variables include IND.TYPE (industry type) and EXPO.TO (main export markets). Although not testing theory, the significant results implied that any test that did not control such inputs was likely to show spurious results.

5.2 RESULTS

The results of this study are divided into three parts: descriptive statistics, analysis of variance, and stepwise multiple regression analysis

5.2.1 Descriptive Statistics

Result in this part are arranged in accordance with the research model proposed in chapter 3. The data are presented in terms of frequency and percentage as shown in the following tables.

i) Company Profile

Table 5.7 shows several company profile statistics of the respondents. From the analysis, over half of respondents (54.7%) are firms in the electrical / electronics industry. The majority (54.7%) of them are Thai-owned firms.

With regard to firm size in terms of total assets, nearly half of respondents (41.6%) are large firms (firms with total assets greater than 200 million bath). With regard to firm size in terms of employee number, over half of respondents (51.6%) are large firms (i.e., firms with employees greater than 200 people).

With regard to marketing activities in the year 2000, the majority (51.6%) of respondents have sales volume lesser than 400 million baht. About one fifth of respondents (20.5%) have no export while about one quarter (27.4%) have Japan as their major export market. It should be noted that while 41.6 and 51.6% of the respondents are large companies in terms of total assets and employees number respectively, but the majority of them (51.6%) have sales volume lesser than 400 million baht.

With regard to the ratio of employees with clean technology training to total employees, the majority of respondents (60.0%) are firms with no clean technology training for their employees.

Table 5.7 Company Profile of the Sample

Characteristics	Frequency	Percent
Industry		
Electrical / Electronic	86	45.3
Food Processing	104	54.7
Total	190	100
Company Type		
Thai Owner	104	54.7
Foreign Owner	38	20
Joint Venture	48	25.3
Total	190	100
Total Assets		
≤ 50 million bath	39	20.5
51–200 million bath	72	37.9
> 200 million bath	79	41.6
Total	190	100
Number of Employees		
≤ 50 persons	20	10.5
51–200 persons	72	37.9
> 200 persons	98	51.6
Total	190	100
Sales Volume		
<400 million bath	98	51.6
401-1200 million bath	52	27.4
>1200 million bath	35	18.4
Missing	5	2.6
Total	190	100
Export to Sales Volume Ratio		
0%	39	20.5
1% - 25%	31	16.3
26% - 50%	22	11.6
51% - 75%	20	10.5
> 75%	68	35.8
Missing	10	5.3
Total	190	100
Main Export Market		
No Export	39	20.5
Countries in Asia Region	44	23.2
Japan	52	27.4
Western Countries	39	20.5
Missing	16	8.4
Total	190	100
Employee Number with CT Training		
No CT Training	114	60.0
1% - 25% of total employees	34	17.9
26% - 50% of total employees	15	7.9
51% - 75% of total employees	13	6.8
> 75% of total employees	14	7.4
Total	190	100

ii) Institutional Factors

Table 5.8 shows the frequency distribution of the perceived effects of regulatory pressures on firms to adopt clean technology. The majority of respondents have the different views of the effects of these variable. WEEE / HACCP regulations and ISO 14000 standard series were rated as variables with high effect; Thai environmental laws, international environmental laws, and Thai government agencies as variables with moderate effect; and foreign government agencies and NGOs as variables with low effect.

Table 5.8 Frequency Distribution of Perceived Effects of Regulatory Pressures on Firms to Adopt Clean Technology

Variable	Frequency	Percent
Perceived Effect of Thai Laws		
Little / No Effect	42	22.1
Moderate Effect	93	48.9
High Effect	55	28.9
Total	190	100
Perceived Effect of International Laws		
Little / No Effect	71	37.4
Moderate Effect	82	43.2
High Effect	37	19.5
Total	190	100
Perceived Effect of WEEE / HACCP Regulations		
Little / No Effect	46	24.2
Moderate Effect	71	37.4
High Effect	73	38.4
Total	190	100
Perceived Effect of ISO 14000 Standard Series		
Little / No Effect	40	21.1
Moderate Effect	70	36.8
High Effect	80	42.1
Total	190	100

Table 5.8 (Continued)

Variable	Frequency	Percent
Perceived Effect of Thai Government		
Little / No Effect	50	26.3
Moderate Effect	76	40.0
High Effect	64	33.7
Total	190	100
Perceived Effect of Foreign Governments		
Little / No Effect	92	48.4
Moderate Effect	65	34.2
High Effect	33	17.4
Total	190	100
Perceived Effect of NGOs		
Little / No Effect	96	50.5
Moderate Effect	74	38.9
High Effect	20	10.5
Total	190	100

Table 5.9 shows the frequency distribution of the perceived effects of stakeholder demands on firms to adopt clean technology. The greater part of respondents have the dissimilar views for the effects of these variable. Customers was perceived as a variable with high effect; employees, shareholders, and community as variables with moderate effect; and suppliers, competitors, and Federation of Thai industries as variables with low effect.

Table 5.9 Frequency Distribution of Perceived Effects of Stakeholder Demands on Firms to Adopt Clean Technology

Variable	Frequency	Percent
Perceived Effect of Employees		
Little / No Effect	66	34.7
Moderate Effect	72	37.9
High Effect	52	27.4
Total	190	100
Perceived Effect of Customers		
Little / No Effect	45	23.7
Moderate Effect	62	32.6
High Effect	83	43.7
Total	190	100

Table 5.9 (Continued)

Variable	Frequency	Percent
Perceived Effect of Shareholders		
Little / No Effect	56	29.5
Moderate Effect	85	44.7
High Effect	49	25.8
Total	190	100
Perceived Effect of Suppliers		
Little / No Effect	102	53.6
Moderate Effect	67	35.3
High Effect	21	11.1
Total	190	100
Perceived Effect of Competitors		
Little / No Effect	74	39.0
Moderate Effect	70	36.8
High Effect	46	24.2
Total	190	100
Perceived Effect of Federation of Thai Industries		
Little / No Effect	93	49.0
Moderate Effect	79	41.6
High Effect	18	9.5
Total	190	100
Perceived Effect of Community		
Little / No Effect	46	24.2
Moderate Effect	80	42.1
High Effect	64	33.7
Total	190	100

Table 5.10 shows the frequency distribution of the awareness of incentives available for clean technology adopters, and the level of respondents' need for each type of incentives. Nearly half (44.7%) of the respondents were not aware the availability of incentive for the clean technology adopters. The majority of them did not require incentives in terms of waiving plant operation permit fees and energy conservation funds.

Table 5.10 Frequency Distribution of the Awareness of Incentives Available and the Level of Need for Each Type of Incentives

Variable	Frequency	Percent
Awareness of Incentives Available		
Not Aware	85	44.7
Little Aware	63	33.2
Moderately Aware	33	17.4
Highly Aware	9	4.7
Total	190	100
Need for Waiving of Plant Operation Permit Fees		
No Need	94	49.5
Little	5	2.6
Moderate	45	23.7
High	46	24.2
Total	190	100
Need for Energy Conservation Funds		
No Need	90	47.4
Little	13	6.8
Moderate	30	15.8
High	57	30.0
Total	190	100

Table 5.11 shows the frequency distribution of the number of environmental audits by the government agencies. The majority of respondents (65.3%) were audited averagely just 1 time per year. Some of them (17.9%) have never been audited by the government agencies in the past 5 years.

Table 5.11 Frequency Distribution of the Number of Environmental Audits

Variable	Frequency	Percent
Number of Environmental Audits		
Never	34	17.9
1 Time / Year	124	65.3
2 Times / Year	20	10.5
> 2 Times / Year	12	6.3
Total	190	100

iii) Organizational Factors

Table 5.12 shows the frequency distribution of the level of CT input from the organizations that promote clean technology adoption. The majority of respondents never received or received little CT inputs from all kinds of organizations. It should be noticed that among the CT promoter, NGOs were ranked by the respondents as the most inactive organizations while the print media are the best channel for acquiring CT knowledge.

Table 5.12 Frequency Distribution of the Organizational Factors

Variable	Frequency	Percent
Technology Intensive Capability		
No / Low	29	15.3
Medium	98	51.6
High	63	33.1
Total	190	100
Technology Development Capability		
No / Low	41	21.6
Medium	99	52.1
High	50	26.3
Total	190	100
Newer Machines & Equipment Capability		
No / Low	43	22.6
Medium	95	50
High	52	27.4
Total	190	100
CT Input from Head Quarter / Joint Co.		
Never / Little	137	72.1
Moderate	38	20.0
High	15	7.9
Total	190	100
CT Input from Government Agencies		
Never / Little	126	66.3
Moderate	55	29.0
High	9	4.7
Total	190	100
CT Input from Consultants		
Never / Little	140	73.7
Moderate	41	21.6
High	9	4.7
Total	190	100

Table 5.12 (Continued)

Variable	Frequency	Percent
CT Input from NGOs		
Never / Little	172	90.5
Moderate	16	8.4
High	2	1.1
Total	190	100
CT Input from Academic Institutions		
Never / Little	149	78.4
Moderate	37	19.5
High	4	2.1
Total	190	100
CT Input from Customers		
Never / Little	146	76.9
Moderate	31	16.3
High	13	6.8
Total	190	100
CT Input from Federation of Thai Industries		
Never / Little	138	72.6
Moderate	45	23.7
High	7	3.7
Total	190	100
CT Input from Suppliers		
Never / Little	158	83.2
Moderate	28	14.7
High	4	2.1
Total	190	100
CT Input from Print Media		
Never / Little	103	54.2
Moderate	77	40.5
High	10	5.3
Total	190	100
CT Input from Internet		
Never / Little	138	72.6
Moderate	45	23.7
High	7	3.7
Total	190	100

iv) Management Factors

Table 5.13 shows the frequency distribution of the perceived competitive advantage caused by CT. The majority of respondents have the different views of the CT effect on the competitive advantage. In particular, they perceived that CT has no or little effect, moderate effect, and high effect on healthy market share, continuous technology improvement, and customer satisfaction and superior product quality, respectively.

Table 5.13 Frequency Distribution of the Perceived Competitive Advantages Caused by CT

Variable	Frequency	Percent
Perceived Healthy Market Share by CT		
No / Little Effect	78	41.1
Moderate Effect	69	36.3
High Effect	43	22.6
Total	190	100
Perceived Customer Satisfaction by CT		
No / Little Effect	41	21.6
Moderate Effect	69	36.3
High Effect	80	42.1
Total	190	100
Perceived Superior Product Quality by CT		
No / Little Effect	42	22.1
Moderate Effect	69	36.3
High Effect	79	41.6
Total	190	100
Perceived Continuous Technology Development by CT		
No / Little Effect	53	27.9
Moderate Effect	90	47.4
High Effect	47	24.7
Total	190	100

Table 5.14 shows the frequency distribution of the perceived economic advantage caused by CT. The majority of respondents have the same views of the CT effect on the economic advantage. In particular, they perceived that CT has moderate effect on profitability, cost reduction, and energy savings.

Table 5.14 Frequency Distribution of the Perceived Economic Advantages Caused by CT

Variable	Frequency	Percent
Perceived Profitability by CT		
No / Little Effect	50	26.3
Moderate Effect	78	41.1
High Effect	62	32.6
Total	190	100
Perceived Cost Reduction by CT		
No / Little Effect	46	24.2
Moderate Effect	76	40.0
High Effect	68	35.8
Total	190	100
Perceived Energy Savings by CT		
No / Little Effect	39	20.5
Moderate Effect	76	40.0
High Effect	75	39.5
Total	190	100

Table 5.15 shows the frequency distribution of the perceived social advantage caused by CT. The majority of respondents have the same views of the CT effect on the social advantage. In particular, they perceived that CT has high effect on company image, surrounding environment, and social recognition.

Table 5.15 Frequency Distribution of the Perceived Social Advantages Caused by CT

Variable	Frequency	Percent
Perceived Better Company Image by CT		
No / Little Effect	20	10.5
Moderate Effect	55	28.9
High Effect	115	60.5
Total	190	100
Perceived Better Surrounding Environment by CT		
No / Little Effect	15	7.9
Moderate Effect	46	24.2
High Effect	129	67.9
Total	190	100
Perceived Social Recognition by CT		
No / Little Effect	34	17.9
Moderate Effect	64	33.7
High Effect	92	48.4
Total	190	100

Table 5.16 shows the frequency distribution of the management's willingness to adopt and develop CT. The majority of respondents have the high level of willingness to adopt and develop CT.

Table 5.16 Frequency Distribution of the Management's Willingness to Adopt and Develop CT

Variable	Frequency	Percent
Willingness to Adopt CT		
No / Little	28	14.7
Moderate	67	35.3
High	95	50.0
Total	190	100
Willingness to Develop CT		
No / Little	34	17.9
Moderate	75	39.5
High	81	42.6
Total	190	100

v) Clean Technology Adoption

Table 5.17 shows the frequency distribution relating to the statistics of CT adoption. First, it reports that over half of respondents (55.8%) are companies with CT adoption. Second, it reveals that the majority of CT adopters (67%) began CT adoption within the past 3 years. Finally, it shows that the greater part of CT adopters (39.6%) have the amount of CT investment in the range of 100,000 to lesser than 1,000,000 baht.

Table 5.17 Frequency Distribution Relating to the Statistics of CT Adoption

Variable	Frequency	Percent
Number of CT Adopters		
Not Adopt	84	44.2
Adopt	106	55.8
Total	190	100
Duration of CT Adoption		
1 – 3 Years	71	67.0
4 – 6 Years	23	21.7
> 6 Years	12	11.3
Total	106	100
Amount of CT Investment		
< 100,000 baht	17	16.0
100,000 – 999,999 baht	42	39.6
1 – 5 million bath	25	23.6
> 5 million baht	22	11.6
Total	106	100

Table 5.18 shows the cross-tabulation between the amount of clean technology investment and some variables (i.e., industry type, company type, main export market, sales volume, firm size, and firm capabilities). The following observations are made.

Percentage of respondents with no CT investment in electrical / electronics industry (44.2 %) is equal to the one in food processing industry.

Percentage of the respondents with no CT investment in Thai company group is the highest (48.1 %) while the one in foreign company group is the lowest (36.8 %).

Percentage of the respondents with no CT investment in no-export group is the highest (59.0 %) while the one in Japan group and the one in Western countries group are the lowest (38.5 %).

Percentage of the respondents with no CT investment in low sales volume group (< 400 million-baht) is the highest (51.0 %) while the one in high sales volume group (> 1,200 million bath) is the lowest (25.7 %).

In terms of firm size by total assets, the majority of small firms (48.7%), medium firms (55.6%), and large firms (31.6%) are found that they have no CT investment.

Percentage of the respondents with no CT investment in no / low technology intensive capability group is the highest (79.3%) while the one in high technology intensive capability group is the lowest (19.1%).

Percentage of the respondents with no CT investment in no / low technology development capability group is the highest (63.4%) while the one in high technology development capability group is the lowest (32.0%).

Percentage of the respondents with no CT investment in no / low newer machines and equipment capability group is the highest (58.1%) while the one in high newer machines and equipment capability group is the lowest (30.8%).

Table 5.18 Cross - tabulation between CT Investment and Some Variables

Variable	Clean Technology Investment (million baht)								Total	
	0		< 1		1 – 5		> 5			
	Q'ty	%	Q'ty	%	Q'ty	%	Q'ty	%	Q'ty	%
Industry Type										
Electrical / Electronics	38	44.2	27	31.4	6	7.0	15	17.4	86	100
Food Processing	46	44.2	36	34.6	15	14.4	7	6.8	104	100
Total	84		63		21		22		190	
Company Type										
Thai Company	50	48.1	34	32.7	14	13.4	6	5.8	104	100
Foreign Company	14	36.8	12	31.6	4	10.5	8	21.1	38	100
Joint Venture Company	20	41.7	17	35.4	3	6.2	8	16.7	48	100
Total	84		63		21		22		190	
Main Export Market										
No Export	23	59.0	12	30.8	2	1.1	2	1.1	39	100
Countries in Asia	20	45.5	20	45.5	3	1.7	1	0.6	44	100
Japan	20	38.5	16	30.7	7	4.0	9	5.2	52	100
Western Countries	15	38.5	8	20.5	7	4.0	9	5.1	39	100
Total	78		56		19		21		174	
Sales Volume										
< 400 million baht	50	51.0	39	39.8	8	8.2	1	1.0	98	100
400 – 1,200 million baht	22	42.3	16	30.8	6	11.5	8	15.4	52	100
> 1,200 million baht	9	25.7	6	17.1	7	20.0	13	37.2	35	100
Total	81		61		21		22		185	
Firm Size by Total Assets										
Small	19	48.7	18	46.2	2	5.1	0	0.0	39	100
Medium	40	55.6	23	31.9	6	8.3	3	4.2	72	100
Large	25	31.6	18	22.8	17	21.5	19	24.1	79	100
Total	84		59		25		22		190	
Firm Capabilities										
- Technology Intensive										
No / Low	23	79.3	5	17.2	1	3.5	0	0.0	29	100
Medium	49	50.0	34	34.7	8	8.2	7	7.1	98	100
High	12	19.1	20	31.7	16	25.4	15	23.8	63	100
Total	84		59		25		22		190	
- Technology Development										
No / Low	26	63.4	12	29.3	1	2.4	2	4.9	41	100
Medium	42	42.4	28	28.3	18	18.2	11	11.1	99	100
High	16	32.0	19	38.0	6	12.0	9	18.0	50	100
Total	84		59		25		22		190	
- Newer machines & equipment										
No / Low	25	58.1	12	27.9	3	7.0	3	10.0	7	100
Medium	43	45.2	28	29.5	17	17.9	7	7.4	95	100
High	16	30.8	19	36.5	5	9.6	12	23.1	52	100
Total	84		59		25		22		190	

Note: Percentages shown are the proportions within each range of CT investment.

Table 5.19 shows the cross-tabulation between the amount of clean technology investment in each industry and main export markets. In food industry, the cross-tabulation shows that the majority of respondents with no CT investment (31.7%), with CT investment between 1 – 5 million baht (42.9%), and with CT investment higher than 5 million baht (57.1%) are the respondents with Japan as the main export market. In electrical and electronics industry, the cross-tabulation discloses that the majority of respondents with no CT investment (32.4%) are respondents with no export and the one with countries in Asia as the main export markets. It also reveals that the greater part of respondents with the highest CT investment (i.e., greater than 5 million bath) are the respondent with EU / US as the main export markets.

Table 5.19 Cross - tabulation between CT Investment in Each Industry and Main Export Markets

Variable	Main Export Markets								Total	
	No Export		Countries in Asia		Japan		EU / US			
	Q'ty	%	Q'ty	%	Q'ty	%	Q'ty	%	Q'ty	%
Food Processing Industry										
No CT Investment	11	26.8	8	19.5	13	31.7	9	22.0	41	100
< 100,000 baht	2	22.2	1	11.1	3	33.3	3	33.3	9	100
100,000 – 999,999 baht	6	25.0	11	45.8	4	16.7	3	12.5	24	100
1 – 5 million baht	1	7.1	3	21.4	6	42.9	4	28.6	14	100
> 5 million baht	1	14.3	1	14.3	4	57.1	1	14.3	7	100
Total	21	22.1	24	25.3	30	31.6	20	21.0	95	100
Electrical & Electronics Industry										
No CT Investment	12	32.4	12	32.4	7	18.9	6	16.2	37	100
< 100,000 baht	2	25.0	3	37.5	3	37.5	0	0	8	100
100,000 – 999,999 baht	2	15.4	5	38.5	4	30.8	2	15.4	13	100
1 – 5 million baht	1	14.3	0	0	3	42.9	3	42.9	7	100
> 5 million baht	1	7.1	0	0	5	35.7	8	57.1	14	100
Total	18	22.8	20	25.3	22	27.8	19	24.1	86	100

Note: Percentages shown are the proportions within each range of CT investment.

5.2.2 Analysis of Variance (ANOVA)

Table 5.20 to Table 5.23 show the results from ANOVA runs which compare means of CT.INVES among company type, educational level of the majority of employees, major export markets, and sales volume. Table 5.24 shows the results from ANOVA run which compares means of the management factors among the amount of CT investment.

Table 5.20 Differences of Means of CT Investment among Company Type

Variable	Company Type			Significant Differences (LSD)
	1 Thai Company	2 Foreign Company	3 JV Company	
CT.INVES	1.23	1.95	1.63	2 > 1 *

* Significant differences by LSD test at 0.05 level

Table 5.20 reveals that clean technology investment of foreign firms is significantly higher than that of Thai firms.

Table 5.21 Differences of Means of CT Investment among Employees' Education Level

Variable	Employees' Educational Level		Significant Differences (LSD)
	1 Primary School	2 Secondary School or Higher	
CT.INVES	1.15	1.77	2 > 1 *

* Significant differences by LSD test at 0.05 level

Table 5.21 shows that clean technology investment of firms with secondary school employees (or higher) as the majority is significantly higher than that of firms with primary school employees as the majority.

Table 5.22 Differences of Means of CT Investment among Major Export Markets

Variable	Main Export Markets				Significant Differences (LSD)
	1 No Export	2 To Countries In Asia	3 To Japan	4 To EU / US	
CT.INVES	0.92	1.14	1.73	1.97	4 > 1**; 4 > 2*, 3 > 1*

* Significant differences by LSD test at 0.05 level

** Significant differences by LSD test at 0.01 level

Table 5.22 illustrates that clean technology investments of firms with US/EU as main export markets are significantly higher than that of firms with no export and firms with countries in Asia as main export market. It also shows that clean technology investments of firms with Japan as main export market are significantly higher than that of firms with no export.

Table 5.23 Differences of Means of CT Investment among Sales Volume

Variable	Sales Volume			Significant Differences (LSD)
	1 < 400 mB	2 400–1200 mB	3 > 1200 mB	
CT.INVES	1.01	1.60	2.69	3 > 2, 1** ; 2 > 1*

* Significant differences by LSD test at 0.05 level
** Significant differences by LSD test at 0.01 level

Table 5.23 discloses that firms with sale volume greater than 1,200 million baht have clean technology investment significantly higher than firms with sale volume lesser than 1,200 million baht. It also shows that firms with sale volume equal to or greater than 400 million baht have clean technology investment significantly higher than firms with sale volume lesser than 400 million baht.

Table 5.24 Differences of Means of Management Factors among CT Investment

Variable	Clean Technology Investment				Significant Differences (LSD)
	1 No Investment	2 < 1 million bath	3 1 – 5 million baht	4 > 5 million baht	
ADV.COM	1.69	2.05	2.11	2.21	4, 2 > 1**; 3 > 1*
ADV.ECO	1.65	2.36	2.36	2.36	4, 3, 2 > 1**
ADV.SOC	2.21	2.40	2.58	2.70	4 > 1** ; 3 > 1*

* Significant differences by LSD test at 0.05 level
** Significant differences by LSD test at 0.01 level

Table 5.24 reveals that the management's perception of the competitive advantage and economic advantage enhanced by clean technology in firms with CT investment is higher than that of firms without CT investment. It also shows that that the management's perception of the social advantage enhanced by clean technology in firms with CT investment greater than 1 million bath is higher than that of firms without CT investment.

5.2.3 Multiple Regression Analysis

Table 5.25 shows the result from stepwise multiple regression analysis. Lists of dependent variables and independent variables used in the stepwise multiple regression analysis are shown below.

List of Dependent Variables

CT.INVES (amount of investment in clean technology)

List of Independent Variables

1) REG.PRESS (effect of perceived regulatory pressures)
2) STAK.DEM (effect of perceived stakeholder demands)
3) INCENTIV (effect of the awareness of and need for incentives available for clean technology adopters)
4) CT.WIDE (effect of the awareness of clean technology widespread)
5) CO.SIZE (effect of company size)
6) CO.CAPA (effect of company capabilities)
7) CT.INPUT (effect of clean technology input from other organizations)
8) ADV.COM (effect of the management's perceived competitive advantage enhanced by clean technology)
9) ADV.ECO (effect of the management's perceived economic advantage enhanced by clean technology)
10) ADV.SOC (effect of the management's perceived social advantage enhanced by clean technology)
11) WILLING (effect of the management's willingness to adopt and develop clean technology).

In according to the potential confounds, this study sought to control for a variety of factors which might influence the amount of investment in clean technology by manufacturing firms in Thailand. Consequently, this study controlled specifically for industry type and major export markets.

Table 5.25 Stepwise Multiple Regression Results

Independent Variables	Dependent Variable (CT Investment)	
	Unstandardized Beta	Standardized Beta
CONSTANT	0.671***	0.000***
REG.PRESS	0.247***	0.204***
STAK.DEM	0.336***	0.279***
INCENTIV	0.077***	0.218***
CO.SIZE	0.126***	0.210***
CO.CAPA	0.134***	0.192***
WILLING	0.114**	0.157**
R	.674	
R^2	.454	
Adjusted R^2	.436	
Standard Error	1.09	
F – statistic	25.382***	

*** P-value is significant at the 0.001 level, 2-tailed t-test.

** P-value is significant at the 0.01 level, 2-tailed t-test.

Table 5.25 exhibits that only REG.PRESS, STAK.DEM, INCENTIV, CO.SIZE, CO.CAPA, and WILLING were added to the model because their partial correlation coefficients were statistically significant, while CT.WILD, CT.INPUT, ADV.COM, ADV.ECO, ADV.SOC, IND.TYPE (control variable), and EXPO.TO (control variable) were dropped because their predictive power decrease to a non-significant level. The overall model was statistically significant and explain 45% of the variance in the dependent variable (R2 = 0.454, F = 25.382, $P < 0.001$). The standardized beta values will be used in Chapter 6 for the discussion of identifying the extent to which the attribute of each factor contributes to the adoption of clean technology.

When performing the multiple regression analysis, multicollinearity problems should be addressed. Two of the general tools for assessing multicollinearity are (1) the tolerance value and (2) its inverse – the Variance Inflation Factor (VIF). These tools indicate the degree to which each independent variable is explained by the other independent variables. In other words, VIF is the value of an independent variable being regressed against the remaining independent variables while tolerance is the amount of variability of the selected independent variable not explained by the other independent variables. Thus very small tolerance values (and large VIF values) denote high collinerity. Hair et al. (1995) recommend that a common cutoff threshold is a tolerance value of 0.10, which corresponds to VIF values above 10. Fortunately, such problems turn out to be minor in this study. Table 5.26 exhibits that VIF values of all eleven variables are far below the common cutoff threshold of 10, i.e., they lie generally above 1.0 with the highest being at 1.563.

Table 5.26 VIF and Tolerance Values of 11 Independent Variables

Independent Variable	VIF	Tolerance
REG.PRESS	1.152	0.868
STAK.DEM	1.074	0.931
INCENTIV	1.075	0.930
CO.SIZE	1.067	0.937
CO.CAPA	1.159	0.863
WILLING	1.169	0.856
CT.WIDE	1.138	0.879
CT.INPUT	1.177	0.849
ADV.COM	1.563	0.640
ADV.ECO	1.362	0.734
ADV.SOC	1.248	0.801

5.2.4 Hypothesis Testing

In this section, the hypotheses set forth in Chapter 3 will be proven with the use of empirical data. Correlation approach is selected to assess strength and direction of relationship between a dependent variable and independent variables. Table 5.27 presents the bivariate correlation results arranged by hypothesis.

In addition to the correlation, the hypotheses are tested by the use of stepwise multiple regression analysis. Suggested by McGrath et al. (1995), the use of regression allows a researcher to control for all the potential confounds which might influence the dependent variable.

Hypothesis Testing 1:

The greater the perceived regulatory pressures, the higher the likelihood of clean technology adoption by manufacturing firms.

Reported in Table 5.27, this study's results supported the hypothesis. There is a significant and positive but rather low level of correlation (r = .372***) between the respondents' perceived regulatory pressures and clean technology investment.

Besides, more insight about the effect of the perceived regulatory pressure on clean technology adoption is attainable via the regression results analysis. The regression results displayed in Table 5.25 disclose the evidence that the regulatory pressures as perceived by the respondents is statistically significant (standardized beta = .204***) to explain the variation of clean technology investment.

Hence, both results significantly supported hypothesis 1.

Table 5.27 Testing the Hypothesis - Correlation Between Clean Technology Investment and the Independent Variables

Hypothesis	Independent Variable	Hypothesized Correlation with Clean Technology Investment	Actual Correlation with Clean Technology Investment	Results of Hypothesis Test
H1	Perceived regulatory pressures	+	0.372***	Supported
H2	Perceived stakeholder demands	+	0.391***	Supported
H3	Awarness and need for CT incentives	+	0.362***	Supported
H4	Awarness of clean technology widespread	+	0.146*	Supported
H5	Firm size	+	0.307***	Supported
H6	Firm capabilities	+	0.357***	Supported
H7	Clean technology input	+	0.168*	Supported
H8	Willingness to adopt and develop CT	+	0.364***	Supported
H9	Perceived competitive advantage	+	0.270***	Supported
H10	Perceived economic advantage	+	0.293***	Supported
H11	Perceived social advantage	+	0.231***	Supported

*** Correlation is significant at the 0.001 level (2-tailed)
* Correlation is significant at the 0.05 level (2-tailed)

Hypothesis Testing 2:

The greater the perceived stakeholder demands, the higher the likelihood of clean technology adoption by manufacturing firms.

The finding of this study as shown in Table 5.27 supported the hypothesis. There is a significant and positive but rather low level of correlation (r = .391**) between the respondents' perceived stakeholder demands and clean technology investment.

In addition, the regression results shown in Table 5.25 reveal the finding that the stakeholder demands perceived by the respondents are statistically significant (standardized beta = .279***) to explain the variation of clean technology investment.

Therefore, both results significantly supported hypothesis 2.

Hypothesis Testing 3:

The greater the awareness of and the need for clean technology incentives, the higher the likelihood of clean technology adoption by manufacturing firms.

Shown in Table 5.27, this study's results supported the hypothesis. There is a significant and positive but rather low level of correlation (r = .362***) between the respondents' awareness of and need for clean technology incentives and clean technology investment.

Moreover, the regression results illustrated in Table 5.25. disclose the evidence that the respondents' awareness of and need for clean technology incentives is statistically significant (standardized beta = .212**) to explain the variation of clean technology investment.

Accordingly, both results significantly supported hypothesis 3.

Hypothesis Testing 4:

The greater the awareness of the clean technology widespread, the higher the likelihood of clean technology adoption by manufacturing firms.

Exhibited in Table 5.27, this study's results supported the hypothesis. There is a significant and positive but very low level of correlation (r = .146*) between the awareness of the clean technology widespread and clean technology investment.

However, the regression analysis provided the result as shown in Table 5.25 that the respondents' awareness of clean technology widespread was dropped because its predictive power decreased to a non-significant level.

In summary, only correlation result significantly supported hypothesis 4.

Hypothesis Testing 5:

The greater the size of total assets and the number of employees of manufacturing firms, the higher the likelihood of clean technology adoption by manufacturing firms.

Conformed to the expectation, this study's results as shown in Table 5.27 supported the hypothesis. There is a significant and positive but rather low level of correlation (r = .307***) between the respondents' firm size and clean technology investment.

Furthermore, the regression results illustrated in Table 5.25 disclose the evidence that the respondents' firm size is statistically significant (standardized beta = .210***) to explain the variation of clean technology investment.

Hence, both results significantly supported hypothesis 5.

Hypothesis Testing 6:

The greater the intensity of manufacturing technologies and the new production machines and equipment, the higher the likelihood of clean technology adoption by manufacturing firms.

The finding of this study as shown in Table 5.27 supported the hypothesis. There is a significant and positive but rather low level of correlation (r = .357***) between the respondents' firm capabilities and clean technology investment.

In addition, the regression results shown in Table 5.25 reveal the finding that the respondents' firm capabilities is statistically significant (standardized beta = .192***) to explain the variation of clean technology investment.

Therefore, both results significantly supported hypothesis 6.

Hypothesis Testing 7:

The greater the clean technology input provided by organizations that promote the diffusion of clean technology, the higher the likelihood of clean technology adoption by manufacturing firms.

Shown in Table 5.27, this study's results supported the hypothesis. There is a significant and positive but very low level of correlation (r = .168*) between the clean technology input from organizations that promote the diffusion of clean technology and clean technology investment.

However, the regression analysis provided the result as shown in Table 5.25 that clean technology input was dropped because its predictive power decreased to a non-significant level.

In summary, only correlation result significantly supported hypothesis 7.

Hypothesis Testing 8:

The greater the management's willingness to adopt and develop clean technology, the higher the likelihood of clean technology adoption by manufacturing firms.

This hypothesis was supported by the finding of this study as shown in Table 5.27. There is a significant and positive but rather low level of correlation (r = .364***) between the management's willingness to adopt and develop clean technology and clean technology investment.

In addition, the regression results shown in Table 5.25 reveal the finding that the management's willingness to adopt and develop clean technology is statistically significant (standardized beta = .157**) to explain the variation of clean technology investment.

Therefore, both results significantly supported hypothesis 8.

Hypothesis Testing 9:

The greater the competitive advantage of clean technology perceived by the management, the higher the likelihood of clean technology adoption by manufacturing firms.

Reported in Table 5.27, this study's results supported the hypothesis. There is a significant and positive but low level of correlation (r = .270***) between the competitive advantage of clean technology perceived by the management and clean technology investment.

However, the regression analysis provided the result as shown in Table 5.25 that the competitive advantage of clean technology perceived by the management was dropped because its predictive power decreased to a non-significant level.

In summary, only correlation result significantly supported hypothesis 9.

Hypothesis Testing 10:

The greater the economic advantage of clean technology perceived by the management, the higher the likelihood of clean technology adoption by manufacturing firms.

The finding of this study as shown in Table 5.27 supported the hypothesis. There is a significant and positive but rather low level of correlation (r = .348***) between the economic advantage of clean technology perceived by the management and clean technology investment.

Nevertheless, the regression analysis provided the result as shown in Table 5.25 that the economic advantage of clean technology perceived by the management was dropped because its predictive power decreased to a non-significant level.

In summary, only correlation result significantly supported hypothesis 10.

Hypothesis Testing 11:

The greater the social advantage of clean technology perceived by the management, the higher the likelihood of clean technology adoption by manufacturing firms.

Shown in Table 5.27, this study's results supported the hypothesis. There is a significant and positive but low level of correlation (r = .231***) between the social advantage of clean technology perceived by the management and clean technology investment.

However, the regression analysis provided the result as shown in Table 5.25 that the social advantage of clean technology perceived by the management was dropped because its predictive power decreased to a non-significant level.

Hence, only correlation result significantly supported hypothesis 11.

5.3 SUMMARY

This chapter presents the characteristics of the survey sample together with the response rate. The results of descriptive statistics, correlation analysis, analysis of variance, and stepwise multiple regression analysis were also presented along with the results of hypothesis testing. Correlation analysis offered supported to all hypotheses while multiple regression analysis provided six supported hypotheses out of eleven proposed hypotheses. Discussion of these results is presented in the next chapter.