Full Length Research Paper

The impact of industrial knowledge management and environmental strategy on corporate performance of iso-14000 companies in Taiwan: The application of structural equation modeling

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The aim of this study is to investigate the relationships between environmental strategy, the environmental knowledge circulation process, and corporate performance by the investigation and data sampling of companies approved for International Organization for Standardization 14000 certification in Taiwan prior to December 2007. Data were collected via questionnaires and structural equation modeling was employed to verify the hypothetical construction of the study. The results indicated that (1) environmental strategy is positively associated with the environmental knowledge circulation process and corporate performance; (2) the environmental knowledge circulation process is positively associated with corporate performance. Companies adopt positively proactive strategy which could improve the Environmental Knowledge Circulation Process (EKCP) and corporate performance, including environmental performance and financial performance. EKCP can also help corporation manage tacit and explicit environmental knowledge more effectively through environmental knowledge management. Hence, company with efficient EKCP not only can consistently enhance green knowledge assets and its international competitiveness, but also can create green business opportunity for corporate and environmental sustainable development.

Key words: Environmental strategy, environmental knowledge circulation process, corporate performance, Taiwan.

INTRODUCTION

The rapid industrialization has been accompanied by environmental pollution and greenhouse gas emissions in Taiwan.

In the latter half of the 1980s, resident's awareness raised toward environmental protection that caused serious and frequent environmental disputes in Taiwan. Government and corporations start to consider the important of environmental management and begin to invest money, equipment, and technology in pollution prevention. Taiwan's environmental problems that require urgent solutions, such as the water pollution and heavy metal pollution, have increased social awareness of environmental issues in general and many corporations are now attempting to demonstrate that they are taking their responsibility to reduce the impact of business operations on the natural environment very seriously. On the other hand, without proper environment policy in the developing countries, rapid economic growth has brought more serious pollution and health problems to those countries (Lüdeke, Petschel-Held and Schellnhuber, 2004). In order to solve these various environmental problems, a number of environmental strategies and environmental protection theories have been developed and studied in Taiwan, such as green supply chain management, environmental knowledge management (EKM), and green innovation (GI). Scientific studies have

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been conducted with the aim of investigating how environmental management systems that afford significant environmental improvement affect corporate performance (CP).

Many studies have focused on only one or two environmental protection theories and do not specify clearly how well the companies perform in terms of reducing pollution and how they can profit from the implementation of these theories. Therefore, a serious question arises: "Could industries benefit from the use of environmental protection theories?" This paper begins by discussing theories and the literature regarding ES, EKM and CP, then systemically investigates the relationships between them by analyzing the results of questionnaires using structural equation modeling.

The aim of this study is to understand whether or not the implementation of an ES and an environmental knowledge circulation process (EKCP) can improve CP and provide an example of a way in which the government could draw up regulatory laws pertaining to environmental protection and at the same time boost corporate performance.

ENVIRONMENTAL KNOWLEDGE CIRCULATION PROCESS

Environmental management

Petak (1980) defined EM (Environment Management) as "managing human affairs so as to achieve an acceptable balance between the quality of the human environment and the quality of the natural environment," suggesting that EM could be used to find a balance between economics, ecological protection, and the environment. Environmental management is also indispensable in the process of achieving sustainable development.

When a company performs systematic environmental management, improvements in corporate sustainability are more likely. According to Wagner (2005), the longer-term relationship between environmental performance and economic performance has been studied for over a decade; more detailed reviews of this body of literature are provided by Günther et al. (2004) and Wagner (2001). Based on this research, Wagner (2005) revealed that in firms with pollution prevention-oriented corporate environmental strategies, the relationship between environmental and economic performance is more positive, thus rendering improvement in corporate sustainability more likely.

As indicated above, environmental management has been discussed for many years, and many researchers have proved that environmental management is very effective for environmental protection.

Knowledge management

Knowledge management (KM) is a very important factor

in determining whether a business will succeed or not. For example, the supply chain depends on knowledge of diverse areas including raw materials, planning, manufacturing, and distribution. Similarly, product development requires knowledge of consumer requirements, new science, new production techniques, marketing, etc.

Moreover, Lin (1999a) suggests that establishing a knowledge management database could lead to benefits in terms of data sharing and knowledge creation, which could also increase competitiveness. Liu et al. (2001) suggest that proper use of knowledge management could increase employee potential and accelerate the integration of employee knowledge and Sarvary (1999) states that "with a good KM system, the job is much more challenging and people can concentrate on problem-solving rather than on number-crunching and data collection."

Therefore, if an efficient knowledge management system is established, companies can create the new technology and devise the new strategies required in order to compete with other corporations and improve their corporate performance.

Environmental knowledge management

Increased use of knowledge management (KM) and environmental management (EM) is a global trend and industries have gradually begun to focus more and more on these concepts; however, a new issue is the question of how to combine KM with EM and apply them in real situations.

Nonaka and Takeuchi (1995) define tacit knowledge as a kind of personal characteristic that is too abstract to be able to transfer to another person or even express using words and Howells (1996) states that tacit knowledge is a kind of expertise that is not editable. Tacit knowledge is obtained through informal learning and as a sequential process, environmental knowledge management (EKM) must therefore combine the management of both explicit knowledge and tacit knowledge, through which organizations can control their environmental impact via the creation, accumulation, sharing, utilization and internalization of environmental knowledge. Finster et al. (2001) define an environmental knowledge management (EKM) system as "consistency in the tools, mechanisms, processes, structures, people, policies, strategies, data, and information that enables the creation, capture, accumulation, storage, retrieval, use, and transfer of knowledge that improves an organization's overall impact on the environment." EKM is also defined as a "system to connect data, analysis and people, presenting an opportunity to formalize industrial ecology in a business setting" (Wernick, 2003). Wernick uses enterprises in North America as examples and reports that EKM improves corporate performance via knowledge management and can not only improve industrial ecological innovation but also greatly reduces the cost of informa-

tion searches, for example, for environmental regulatory and market information (Wernick, 2003). In addition, according to Wernick (2003) and Finster et al. (2001), EKM can be considered as a powerful knowledge management system in the area of environmental knowledge learning that enables organizations to move towards business and environmental sustainability.

Environmental knowledge circulation process (EKCP)

According to Lee and Kang (2005), the knowledge circulation process (KCP) has five components: know-ledge creation, knowledge accumulation, knowledge sharing, knowledge utilization and knowledge internali-zation. When KCP efficiency increases, the knowledge manage-ment performance index (KMPI) will also increase, enabling firms to become knowledge-intensive. This study is based on this argument, combining the concept of environmental management to devise an EKCP that can be used to assess the environmental knowledge management performance of companies. There are five components of the EKCP: environmental knowledge creation (EKC), environmental knowledge accumulation (EKA), environmental knowledge sharing (EKS), environ-mental knowledge utilization (EKU) and environmental knowledge internalization (EKI).

In order to ensure international competitiveness in the field of sustainable development, corporations must include consideration of environmental issues in their corporate values and culture.

Environmental strategy

Knowledge management and environmental strategy

With the advent of the 21st century, competition among corporations as to who can make the most profit is intense and the question of how to survive in today's fast-changing environment is a crucial one. Therefore, mana-gers and supervisors must devise and implement systematic strategies, for example, expanding the busi-ness rather than allowing deficit spending. Moreover, in the current knowledge-based economy, knowledge is regarded as a key factor in the success of a business, and the way in which a company creates and shares its knowledge dictates to a large extent its sustainable competitive advantage and profitability (Desouza and Evaristo, 2003; Hansen et al., 1999; Nonaka, 1991; Prahalad and Hamel, 1990).

Conclusively, in today's fast-changing economic society, there are all kinds of development backgrounds and goals among the various corporations in existence and managers must therefore use knowledge manage-ment to devise strategies with built-in flexibility in order to

be able to respond to changes in economic and environ-mental conditions.

Environmental management and environmental strategy

When corporations face environmental management challenges, one important question must be answered: "What is the most suitable environmental management approach to use?" Brockhoff et al. (1999) argue that the environmental reaction of corporations can be divided into four categories based on the attitudes of companies to governmental regulations: (a) Defenders, (b) Escapists, (c) Dormant and (d) Activists. Slater and Angel (2000) used the degree to which corporations react to environmental stress and their strategic behavior to divide organizations' environmental strategies into four categories: (a) Inactive strategy, (b) Reactive strategy and (c) Proactive strategy. Therefore, the process of businesses becoming environmentally responsible must be a gradual one and corporations must internalize this concept into the application of their strategy and regard it as an important goal of the corporation. Only by doing this can environmental protection have a significant impact on companies in the future.

In this study, we integrate all of the above-described research and divide environmental management strate-gies into four categories: (a) Positively proactive, (b) Positively responsive, (c) Negatively reactive and (d) Negatively receptive. Data are also analyzed and the results discussed.

CORPORATE PERFORMANCE

Knowledge management and corporate performance

Corporate performance can be assessed in terms of two domains: financial performance and environmental performance (Olson and Slater, 2002; Frigo, 2002). Knowledge management could be described as purposeful activity designed to decide upon a strategy and implement organizational activities, with the ultimate aim of improving both financial and environmental perfor-mance. Hult (2003) stated that many corporations perform knowledge management in order to improve corporate performance. Therefore, major considerations of companies are how to obtain, refine, store and share knowledge and how to balance financial and environ-mental performance.

Over the past 20 years, technology, trade and industry management have produced a tremendous amount of knowledge and wealth with land and natural resources becoming less important during this period. Hence, if a country and its enterprises want to survive and succeed in the midst of these dramatic and accelerating changes,

they must rely on knowledge. Drucker (2000) stated that" for every type of organization, transformation into an information-oriented organization is best." Choi and Lee (2002) explore how knowledge management strategies improve corporate performance and report that a personnel strategy is more likely to be effective in terms of socialization.

According to Lin and Tseng (2005), there are five facets of KM that influence corporate performance, as follows: (a) the knowledge required to enhance an enterprise's competitiveness, (b) the implementation of knowledge management, (c) a knowledge management plan, (d) the knowledge required to enhance an enterprise's competitiveness as perceived by top managers and (e) the knowledge required to enhance an enterprise's competitiveness as perceived by employees.

In conclusion, there is an intensive correlation between performance and knowledge management and corporations must therefore establish an efficient knowledge management process in order to promote both financial and environmental performance.

Environmental management and corporate performance

The impact of environmental management activities on competitiveness and corporate economic success has been debated strongly for many years (Bragdon and Merlin, 1972; Porter and van der Linde, 1995; Palmer et al., 1995; Lankoski, 2000).

Nowadays, more than 35,000 companies are using standardized environmental management systems and this number seems to be increasing rapidly. Hence, companies are gradually starting to focus on environmental management because it could assist in balancing their environmental and financial performance. In addition, a company's adoption of techniques that emphasize reduction of waste and green product improvement in the quest to reduce their environmental impact can be associated with improvement in their environmental performance. Russo and Fouts (1997) state that environmental activity is positively related to corporate performance; for example, it helps companies to lower manufacturing costs, reduce consumption of resources, improve their market share and better their image. Effective EM leads to improved financial performance through market gains and cost savings. The use of a strong environmental management system along with the implementation of a carefully-planned company strategy can not only minimize a company's environmental impact and enhance its environmental performance, but can also improve its financial performance (Klassen and McLaughlin, 1996).

Environmental strategy and corporate performance

Companies must devise and implement their environ-

mental strategy carefully because it will influence their financial performance (FP) and environmental performance (EP). For example, a remarkable worldwide sales figure of over 50,000 was achieved for the Toyota Prius hybrid car by the end of the year 2000. It should be noted that the success of this hybrid system was possible because the management of Toyota clearly set the two design goals of double the fuel efficiency and extra low emissions right at the start (Lee et al., 2004). A positive environmental strategy could therefore be positively correlated with corporate performance.

According the research discussed above, we present the following hypotheses:

H1: Environmental strategy is positively associated with the environmental knowledge circulation process.
H2: The environmental knowledge circulation process is positively associated with corporate performance.
H3: Environmental strategy is positively associated with corporate performance.

METHODOLOGY

This study investigates the relationships between ES, EKCP and CP by analyzing a large amount of data pertaining to real-world application of ES and EKCPs in various types of companies; the authors therefore adopt a quantitative research method rather than a qualitative one. Figure 1 shows the research framework of this study, in which the relationships between environmental strategy, the environmental knowledge circulation process and corporate performance are discussed through a survey of the literature and hypotheses are developed regarding these variables.

Samples and analytical methods

A questionnaire was sent out to companies belonging to the four major manufacturing industries in Taiwan, the machinery-metal industry, the computer science and electronic engineering industry, the petroleum and chemical industry and the commodity industry, all of which were ISO 1400-certified before the end of December, 2007.The research questionnaires were sent by mail in July, 2008 to companies located in Hsinchu Science Park, Central Science Park, Southern Taiwan Science Park, the Export Processing Zone and so on, which include samples of companies based in the north, central and southern areas of Taiwan. Completed questionnaires received by the end of October 2008 were included for analysis: 1200 copies were sent out with 332 valid and 7 invalid completed surveys were received back; hence, the valid response rate was over 28%. SPSS and AMOS software were used to analyze the data and test the hypotheses proposed above.

Construct definitions and measurement development

All constructs and measures were based on items from existing instruments, related literature, such as the theories of Lee et al. (2005) and the views of experts in the field of environmental protection. The questionnaire was split into two major parts: the first recorded the subject's demographic information and the second recorded the subject's perception of each variable in the model. The demographic variables assessed were the company category , number of workers, capital assets and whether or not environ-
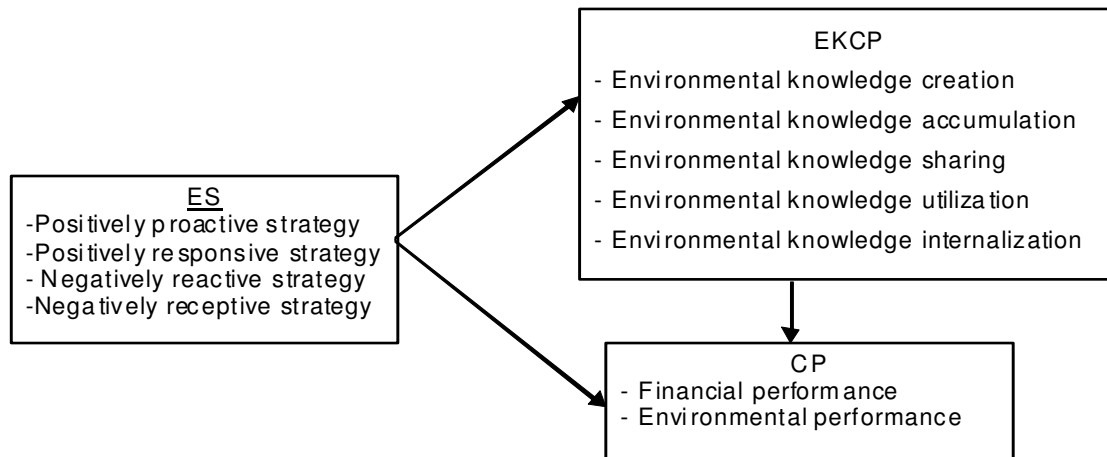
Figure 1. The research framework of this study. Ps. ES = Environmental strategy, EKCP = Environmental Knowledge Circulation Process, EP = Environmental Performance.

environmental accounting is performed. Data were measured using a seven-point Likert scale, ranging from strongly disagree (1) to strongly agree (7). The desired balance and randomness of the questionnaire was ensured as the items were randomly sequenced in order to reduce the potential ceiling effect that can induce bias in the responses. The items in the questionnaire were then taken as research variables according to the conceptual model of the study. According to the methodology of structural equation modeling, the variables of the present research are as follows:

Exogenous variables

There is one exogenous latent variable in the present study: environmental strategy. The exogenous latent variables of environmental strategy are reflected in the categories of positively proactive strategy, positively responsive strategy, negatively reactive strategy and negatively receptive strategy.

Endogenous variables

The endogenous latent variable in the present study is corporate performance. Corporate performance is reflected in two observable variables, financial performance and environmental performance.

As mentioned above, a seven-point scale was used for all questions: 7, strongly agree; 6, agree; 5, partially agree; 4, not applicable; 3, partially disagree; 2, disagree; 1, strongly disagree. The point score for every joint variable was obtained by dividing the total number of points by the number of questions.

RESULTS AND DISCUSSION

Descriptive statistics

In total, 1200 questionnaires were sent out to companies who met the study criteria, as described above, 352 of which were returned. Twenty of the 352 respondents failed to complete the questionnaire, citing reasons such as contravening company policy, staffing constraints and irrelevancy; consequently, a total of 332 completed

questionnaires, which represents a response rate of 28%, were included for analysis, the results of which are shown in Table 1.

All variables were measured using a seven-point Likert scale ranging from 1 (strongly disagree) to 7 (strongly agree) to indicate respondents' perceptions of the relative predictability of each variable.

According to the quartile of averages, environmental strategy was divided into four categories of strategy in this study: positively proactive strategy, positively responsive strategy, negatively reactive strategy, negatively receptive strategy (Table 2); 120, 111, 71 and 30 companies were identified as belonging to these respective categories. On the scales of environmental knowledge creation, environmental knowledge accumulation, environmental knowledge sharing, environmental knowledge utilization and environmental knowledge internalization, the averages are over 5.0, which mean that all responders agreed that EKCP is important in their company. In addition, the standard deviation of each variable ranges from 0.96 to 1.03, showing a slight variation in the range of answers given (Table 3). The averages of the financial performance and environmental scales are over 5.0; therefore, every enterprise recognizes that if they focus on environmental protection, they can increase their financial and environmental performance (Table 3).

Measurement model

Structural equation modeling (SEM) is used as the research model in this study and the measurement model was evaluated using confirmatory factor analysis (CFA) to test the overall fit of the model. The model included 71 items describing ten latent constructs: environmental strategy, the environmental knowledge circulation process, environmental knowledge creation, environmental

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Table 1. Analysis of basic sample data.

Basic information	Item	Returned samples	Percentage	Cumulative percentage
The four major manufacturer categories	Machinery-metal industry	69	20.0	20.0
	Computer science and electronic engineering industry	98	30.0	50.0
	Petroleum and chemical industry	89	27.0	77.0
	Commodity industry	76	23.0	100
	Fewer than 99	54	16.0	16.0
Number of workers	100 - 999	77	23.0	39.0
	1000 - 2000	96	29.0	68.0
	More than 2000	105	32.0	100
Capital assets	Less than 80 million NT dollars	39	12.0	12.0
	80 - 200 million NT dollars	51	15.0	27.0
	200 - 500 million dollars	67	20.0	47.0
	More than 500 million NT dollars	175	53.0	100

Table 2. The four categories of environmental strategy.

Category	Method of classifications	Number of companies
Positively proactive	Average > Q3	71
Positively responsive	Q2 < Average ≤ Q3	120
Negatively reactive	Q1 < Average ≤ Q2	111
Negatively receptive	Average ≤ Q1	30

(Q1 = 4, Q2 = 5, Q3 = 6).

Table 3. Averages and standard deviations of observed variables of EKCP and corporate performance.

Observable variable and item	Average	SD
Environmental knowledge creation	5.21	1.03
Environmental knowledge accumulation	5.24	0.96
Environmental knowledge sharing	5.07	1.02
Environmental knowledge utilization	5.10	.99
Environmental knowledge internalization	5.21	1.02
Financial performance	5.28	1.08
Environmental performance	5.46	1.10

Table 4. Model evaluation and overall fit measurement.

Measure	Criteria (Bagozzi and Yi, 1988)	Value
P of Chi square χ^2	< 0.05	0.00
RMSEA	< 0.08	0.07
NFI	> 0.9	0.73
CFI	> 0.9	0.78
PNFI	> 0.05	0.67
PGFI	> 0.05	0.72

Table 5. Standardized factor loadings.

Item	Factor loading
ES→EKCP	0.818
ES→EP	0.538
EKCP→EP	0.333
ES→EI	0.608
EKCP→EI	0.279
EP→EPF	0.968
EP→EPN	0.958
EKCP→EKA	0.908
EKCP→EKS	0.933
EKCP→EKI	0.885
EKCP→EKU	0.918
EKCP→EKC	0.941

knowledge accumulation, environmental knowledge sharing, environmental knowledge utilization, environmental knowledge internalization, corporate performance, financial performance and environmental performance. CFA was performed using AMOS software; the goodness-of-fit indices of the hypothesized measurement model are summarized in Table 4. The P of Chi square χ^2, Root mean square error of approximation (RMSEA), Normal fit index (NFI), Comparative fit index (CFI), Parsimony Normed Fit Index (PNFI) and Parsimony Goodness of Fit Index (PGFI) were used to judge the overall fit of the model; most model fit indices exceeded their respective common acceptance levels, with the exception of NFI and CFI, demonstrating that the measurement model exhibited a good fit with the data.

The completely standardized factor loadings for the observed variables are presented in Table 5: most factor loadings are over 0.50, demonstrating the good fit of the measurement model with the data.

Reliability test

The measurement model used must be of high validity and reliability so as to reflect reality and to ensure that the statistical analysis results are meaningful. A positive test result for reliability is obtained when the method reflects similar results when tested again under the same conditions (Moser and Kalton, 1989). Cronbach (1951) proposed the α-reliability parameter, which is the most commonly used criterion to measure reliability; this measure is used in this study. If α is lower than 0.35, the reliability is low; if α is between 0.35 and 0.7, the reliability is intermediate; and if α is higher than 0.7, the reliability is high. Cronbach's α for all variables in this study is over 0.75 and this method is therefore of high reliability (Table 6).

Validity test

The validity of the questionnaire refers to its correctness and effectiveness, meaning what level it really can test to. Few tests offer quantification of validity, so it is difficult to

ascertain whether the validity is high or low. Therefore, the test of validity is more subjective than that of reliability.

The questionnaire is based on the theories of Lee et al. (2005), designed to amplify construct validity and integrate many specialists' and scholars' opinions and has been revised enough times to have sufficient content and face validity.

Structural model

Given an adequate measurement model, the hypotheses can be tested by examining the structural model. Figure 2 shows the standardized path coefficients and their significance in the structural model.

Hypothesis 1

The environmental knowledge management factors consist of five observed variables: environmental knowledge creation, environmental knowledge accumulation, environmental knowledge sharing, environmental knowledge utilization and environmental knowledge internalization (Figure 2). The factor loadings, λ1 (environmental knowledge creation), λ2 (environmental knowledge accumulation), λ3 (environmental knowledge sharing), λ4 (environmental knowledge utilization) and λ5 (environmental knowledge internalization) of the environmental knowledge management factors of the latent variables are 0.94, 0.92, 0.93, 0.92 and 0.89, respectively, indicating that the preliminary fit index is favorable. On the other hand, the path coefficient, λ6 (ES→EKCP), of ES to the latent variables of EKCP practice is 0.54, suggesting that ES has a positive relationship with the implementation of an EKCP. Therefore, if a company wishes to manage environmental knowledge more effecttively, they should first improve their environmental strategy.

Table 6. Cronbach's α for the EKCP, environmental strategy, corporate performance.

Observable variable	Item	Cronbach's α	Cronbach's α
EKC	5	0.89	
EKA	8	0.93	
EKS	7	0.93	Cronbach's α for the EKCP = 0.97
EKU	4	0.89	
EKI	8	0.91	
Environmental strategy	14	0.97	
Positively proactive strategy	14	0.91	
Positively responsive strategy	14	0.84	
Negatively reactive strategy	14	0.93	
Negatively receptive strategy	14	0.97	
Financial performance	8	0.94	Cronbach's α for EP = 0.97
Environmental performance	6	0.94	
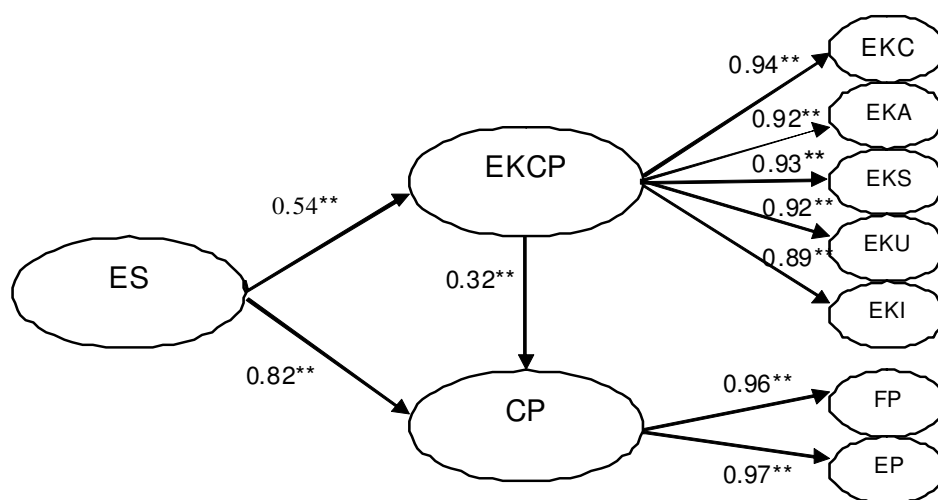
Figure 2. Hypothesis testing results. Note: Path significance: **: $p < 0.01$.

Also, $\lambda1$ is higher than $\lambda2$, $\lambda3$, $\lambda4$ and $\lambda5$, indicating that the motive of enterprises behind the adoption of EKCP is environmental knowledge creation, because all hope to find new and competitive environmental knowledge management methods.

Hypotheses 2 and 3

The factor loadings, $\lambda7$ (Financial performance) and $\lambda8$ (Environmental performance), of the corporate performance latent variables are 0.96 and 0.97, respectively. On the other hand, the path coefficient, $\lambda9$ (EKCP→CP), of EKCP to the latent variables of EP practice is 0.32, suggesting that EKCP factors have a positive relationship with the implementation of CP practices. This can be interpreted as follows: companies want to improve their corporate performance and agree that EKCP is an effective means by which to achieve that goal. The

values of $\lambda7$ and $\lambda8$ are almost equal to 0.97, indicating that financial performance and environmental performance are both important factors for companies in deciding whether or not to adopt EKCP. Moreover, the path coefficient, $\lambda10$ (ES→CP), of ES to the latent variables of CP practices is 0.82, suggesting that ES factors are strongly positively correlated with the implementation of CP practices. Compared with EKCP, ES has a greater influence on CP and companies agree that ES will contribute to CP.

Moreover, according to the quartile of averages of the items assessed, environmental strategy was divided into four categories of strategy in this study, positively proactive strategy, positively responsive strategy, negatively reactive strategy and negatively receptive strategy and AMOS5 was used to analyze the data (Table 7). The results showed that companies belonging to the positively proactive strategy category are most suited to the application of this model and those belong-

Table 7. Test of overall model fit for the four environmental strategy categories.

Fit test	Suggestion	Positively proactive strategy	Positively Responsive strategy	Negatively reactive strategy	Negatively receptive strategy
Absolute fit test				Not suitable	Not suitable
P of Chi squareχ^2	P < 0.05	0.00	0.00	for this model	for this model
RMSEA	<0.08	0.082	0.080	EKCP→EP	ES→EP
Relative fit test				P = 0.586	P = 0.844
NFI	>0.90	0.393	0.313	EKCP→EKI	EKCP→EP
CFI	>0.90	0.462	0.373	P = 0.002	P =.005
Parsimonious fit test					EKCP→EKI
PNFI	>0.50	0.691	0.665		P = 0.373
PGFI	>0.50	0.749	0.730		

ing to the negatively receptive strategy category are the most unsuitable. Companies with a positively proactive strategy routinely take environmental protection into consideration and make improvements in their corporate performance year after year; however, those with a negatively receptive strategy will not consider environmental protection to be an important factor in the management of their business and are therefore unsuitable for this model. In addition, a company cannot improve their corporate performance if they adopt a negative strategy in the face of the environmental regulations of governments around the globe.

Conclusion

In the study, environmental strategy is classified into four categories: positively proactive strategy, positively responsive strategy, negatively reactive strategy and negatively receptive strategy.

The results show that a positive environmental strategy can lead to an efficient EKCP and it was also found that an ES and EKCP are necessary elements for companies because they can improve both environmental and financial performance (Huang and Shih, 2008). Besides, companies that adopt positive environmental strategy not only can prevent environmental pollution efficiently but also can improve the corporate image and company performance (Claver et al., 2007). Moreover, the implementation of a positive environmental strategy could consistently enhance the international competitiveness of a company and protect the quality of the environment, a win-win situation in terms of corporate success and environmental sustainable development. Hence, this research provides an obvious illustration that may convince companies to adopt a positively proactive environmental strategy. Besides, when environmental protection is emphasized, pollution may also be reduced, the elimination of air emissions, water pollution and waste enabling conservation of a better environment for future generations.

The results also indicate that EKCP can effectively improve environmental performance and financial performance via environmental knowledge creation, environmental knowledge accumulation, environmental knowledge sharing, environmental knowledge utilization and environmental knowledge internalization (Huang and Shih, 2008).

In green business, environmental knowledge is a valuable intangible asset for creating and sustaining competitive advantage. Corporate that with systematic management of environmental knowledge and environmental database can improve the innovation culture in organization and help employees accumulate individual skills. The environmental knowledge sharing makes the organization's core value more active and EKCP more effective through continuous learning and training. The environmental knowledge internalization, converting explicit knowledge into tacit knowledge, can improve employees' environmental awareness that will benefit the enterprise's core environmental values.

Therefore, EKCP, a never-ending process of environmental knowledge creating, accumulation, sharing, utilization and internalization, can help companies continuously improve environmental protection, enhance green competitive advantage and maximize corporate profit.

The research also indicates a direction that the Taiwan government could take in terms of implementing regulations and laws to restrict the environmental impact of firms and encourage them to adopt a positive environmental strategy and an efficient EKCP. Moreover, company can raise financial performance and improve environmental pollution problem when they focus on the issue regarding Environmental Knowledge Circulation Process. Hence, when implementing the KM system the firm must develop a framework and process for identifying, capturing and diffusing important knowledge in a structured way within an adaptable organization culture (Huseby and Chou, 2003).

Furthermore, the implementation of EKM could be good criteria for selecting the appropriate information technology tools to facilitate industrial green competition. Environmentally friendly products would constitute a considerable market, so companies moving forward with a green differentiation strategy to prevent the risk of imitation from competitors, this measure will enable companies acquire competitive advantage.

In summary, Environmental Knowledge Circulation Process and positive environmental strategy could make an important contribution to corporate performance where environmental knowledge management is abundantly utilized. Therefore, the investments in environmental knowledge management should be, for the future of Industries, encouraged by governments and other authoritative bodies. In addition, most studies in this area only investigate the relationship between EKCP and ES, ES and CP, or EKCP and CP, but this study provides a concrete and complete model of the relationships between ES, EKCP and CP that other scholars are able to review and a base for further research in this and related areas. This successful and useful research could also provide a demonstrated example to other developing countries toward corporate and global sustainable development.

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