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Development of an Electronic Greenhouse Gas Emission Management Platform: Managerial Implications*

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Abstract

Purpose: The Emission Trading Scheme (ETS), which enables structuring emission credits as a financial product, is taking a crucial position of global collaboration against climate change. Previous studies that have covered ETS subjects from the macro perspective contribute to facilitating legal enactment of this scheme. However, they have rarely addressed challenges aligned with issues arising from labor burdens for ETS works from the business perspective. **Research Design, data and methodology:** This study presents conceptual models that are expected to help design an electronic system. The study model contains four modules: emission allocation, data interface, reduction technology sharing, and emission trading. Two validation approaches, the Analytic Hierarchy Process (AHP) and regression analysis, are applied in confirming the feasibility of the proposed model. **Results:** This study suggests an IT system methodology to help improvement of the current K-ETS mechanism. In particular, this study addresses effectiveness for real businesses and the adaptability of this mechanism to other nations. **Conclusions:** The proposed IT platform diagram can contribute to successful operation of ETS by providing multiple benefits to participating companies through in-house allocation mechanisms, the soft-landing of ETS adoption to participating companies through reduction of technology-sharing, group purchases, and transaction costs through the trading system.

Keywords: Emission Trading Scheme, AHP, GHG

JEL Classification Code: E44, F31, F37, G15

1. Introduction

Emission trading mechanism (ETS), which is a private market framework that trades a financialized product originating from emission credit as an underlying asset, has highly contributed to acceleration of global collaboration to reduce greenhouse gas since the adoption of the Kyoto Protocol (Betz & Schmidt, 2015; Lee, Lin, & Lewis, 2008; Vespermann & Wittmer, 2011; Xu, Deng, & Thomas, 2016).

The Kyoto Protocol, enacted in 1997, innovated the previous one by both assigning emission quotas to each developed nation (Barrett, 1998; EdwinWoerdman, 2000; McKibbin, Ross, Shackleton, & Wilcoxen, 1999) and introducing flexible emission management mechanisms, such as Emissions Trading (ET), Clean Development Mechanism (CDM), and Joint Implementation (JI) (Klepper & Peterson, 2006; Woerdman, 2000). Many previous studies have focused on properties of the EU (European Union)-ETS, which is regarded as one of the successful frameworks in climate change, to derive policy implications in all social and economic dimensions. The expansion of climate change regulation coverage introduced by the Paris Agreement, which is the latest version after the Kyoto Protocol, catalyzed implementation of ETSs in multiple continents beyond EU (Almer & Winkler, 2017; Bodansky, 2016; Clémençon, 2016; Falkner, 2016; Rosen, 2015;

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Savaresi, 2016).

However, ETS work from the private sector seems challenging. A Korea Energy Economics Institute (KEEI) survey completed by environment managers who work at regulated bodies pointed out a policy of Monitoring, Reporting, and Verification (MRV) as the main obstacle, describing in survey responses that environmental managers of SMEs, who see constraints in time and workforce, responded that they can assign 10% of their total work hours to ETS work (Kim & Sim, 2017). The World Bank (WB) (2016) reported that ETS operational staff assigns 80% of their total work hours to system operation. Such a detrimental environment can cause passive behaviors against the emission trading but also can lead to no option without making a decision only at the terminal time.

In this regard, this paper proposes conceptual diagrams that help developing an automation system facilitating ETS tasks in favor of both the government and enterprises, and assesses its practicality by surveying industry experts on the validation format, applying both the Analytical Hierarchy Process (AHP) method and the regression tool. In detail, the proposed modules consist of allocation, data interface, knowledge-sharing, and trading. The fact that such creation solely covers conceptual modeling enables all nations to use this proposal for their systemic development. The purpose of this study uniquely contributes to society, differing from other studies in two ways. First, it challenges the new area. Researchers have not actively discussed the subject of system design but have tended to discuss either macro perspective subjects or individual business strategies (Borghesi & Montini, 2016; Borghesi, Montini, & Barreca, 2016; Olmstead & Stavins, 2011; Tuerk, Mehling, Flachsland, & Sterk, 2011). Second, the present study deepens the study level of this subject by including a chapter on a practicality test. The validity of a system design suggested by previous works cannot be confirmed because their purposes were limited to illustrate system functionalities without an applicability assessment (Asian Development Bank (ADB), 2016; Kachi, Unger, Böhm, Stelmakh, Haug, & Frerk, 2015; Sandor, Walsh, & Kanakasabai, 2008; The World Bank (WB), 2016). Compared to previous studies, this study focused on the assessment process.

The results of this study illustrate a fundamental issue that maximizes work efficiency by automatically supervising all work processes and ultimately accelerating the new paradigm of climate change. By considering the fact that each emission-related work is complicatedly networked by one another, the essentiality of central data management for communications between parties cannot be ignored (Bhatt, 2000; Bhatt & Troutt, 2005).

2. Variable Selection from Review of Previous Literature

This study captures key features of ETS as shown in Table 1. First, Kachi et al. (2015) study, which defines essential components such as scope and coverage, caps and targets, Allocation, Temporal Flexibility, Price Support and Containment Measures, MRV, Offsets, and Market Oversight, examined a background to forward designs of an ETS electronic system. However, such integration has been rarely observed weakens the practicality of the proposal (shown in Table 1).

Table 1: Comparison of Previous Studies

Contents	Kachi et al. (2015)	ADB (2016)	WB (2016)	Sandor et al. (2008)	EU (2015)
Allocation	V	V	V	V	V
MRV	V	V	V	V	V
Reduction ItemMana gement	-	-	-	V	-
Trading	V	V	V	V	V

The Asian Development Bank (ADB) (2016) guideline of linking ETSs illustrates a helicopter view of systemic integration by narrating key challenges in the perspective of politics and technology, by highlighting multilateral cooperation between sovereignties in the view of politics, and by containing Monitoring, Reporting, and Verification (MRV) and the allocation mechanism in terms of technology features. The World Bank (WB) (2016) guidebook that highlights ensuring integrity in emission accounting through implementation of online database clearly points out the necessity of designing a hub system for both data monitoring and knowledge sharing. The guidebook of WB (2016) also contains three chapters: terminology definition, policy framework, and technological framework. Among those three aspects, the last is fitted to this study's purpose. In that chapter, the WB (2016) underlines the necessity of developing a database hub for allocation, MRV, and trading.

A patent in the U.S. invented by Sandor et al. (2008), illustrates a full coverage of emission trading by stating that the inventors materialized the systemic approaches aligned with trading by inventing offset and exchange functions. Public guidebooks help system designing. The EU-ETS guidebook describes all ETS tasks between the public and private bodies from allocation to trading, and the guidebook illustrates trading mechanism in detail and more deeply than any other functions by enumerating applicable methods, such as banking that deposits current credits, borrowing that draws a portion of the future assignment, public trading where assigned credits are being publicly traded in real time, and over-the-counter trading where a buyer and seller privately conduct transactions (EU, 2015). A guidebook aligned with Korean ETS program presents all ETS works in a similar manner as that of EU-ETS (Korean Ministry of Environment, 2015).

Coverages of previous literature associated with ETS system development are distinct by source, while one of the main coverages can be derived in which an electronic system development is not impossible, and in many dimensions an integrated system is inevitable for maximizing resources. In this regard, this study pursues development of an ETS system by applying key variables such as allocation, MRV, reduction technology management, and trading, as identified in previous studies (Table 1). However, various previous works except a patent in the U.S. invented by Sandor et al. (2008) do not specifically translate qualitative rationales and proposals into practical products. In addition, the practicality of all works has not been proved. Based on that consideration, this study investigates the logic of each function by presenting diagrams and assesses their effectiveness by employing validation tools.

3. Modeling of the ETS architecture

3.1. Allocation Module

This study proposed an emissions allowance allocation framework with the goal of improving transparency in the allocation process and assuring consistency in that process, which are crucial to ETS operation (Kim & Sim, 2017) (As shown in Figure 1). In the first step, the government sets up both an annual national reduction scenario and benchmark coefficient on each facility type (Jeong, Hong, & Kim, 2018). Each nation has a specific limit to curb total emissions in order to achieve the goal of climate change that was required to be submitted under the Paris Agreement (United Nations Framework Convention on Climate Change (UNFCCC), 2015). Then, the government sets up a benchmark coefficient on each facility type in complying with the previously set reduction scenario. The system should allow flexibility in assigning a coefficient to each facility (Kim & Sim, 2017).

In the second step, private sectors upload the configuration of facilities and the emission trends for each facility to the system. This study proposes that these two data provided by the government and private sectors are linked to the government inputs, the reduction scenario, and the benchmark coefficient on each facility type, respectively. Following the regulations of EU-ETS and Korean-ETS, an emission quota for each facility type is assigned first because a reduction potential of a facility, which is the benchmark coefficient, heavily depends on the type rather than any other criteria, and then the total quota of an enterprise is determined (Ritchie, 2015). In this sense, the first link between the reduction scenario and the registered facilities determines a discrepancy between the government target and the enterprise request. The second link between the benchmark coefficient and the emission trend precisely resolves the observed gap.

The third step recalibrates the results from the previous stages by incorporating an economic outlook for the future. The business expansion ratio is a source for the adjustment. The previous outcomes, which are mostly derived by the past-looking process, can be unfit to the real practice. The ratio is essential if a business seeks to increase its facility's operating rate without modification of any configuration inside the site. Finally, the system informs the company of the next year's emission quota.

Those improvements will contribute to both the government and the business sides. The government can save workforce from the automation and gain the trust of businesses due to an improvement of transparency in the systemic allocation process. The business also can save workforce and have a better opportunity to resolve conflicts aligned with emission allocation than before.

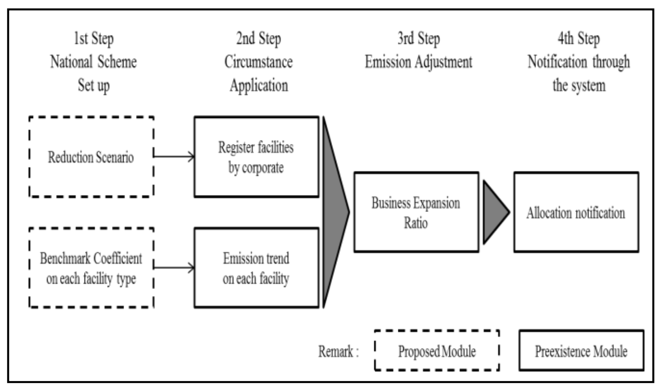

Figure 1: Proposed Allocation Process in the GHG System

3.2. MRV Improvement through Data Interface

Business needs to submit several relevant sources, such as company organization boundaries, procedures for data monitoring and quality assurance, emissions facilities categorized by governmental standards, and general business information (European Union (EU), 2015; Korean Ministry of Environment, 2015). The most challenging task is registering facilities and GHG data on those facilities, due to the excessive number of facilities and GHG data sources (The World Bank (WB), 2016).

The proposed module, which is technologically oriented through a data interface, aims to minimize preparation time by facilitating data transaction between systems, as shown in Figure 2. The module is supported by two data input sub-modules: company side and energy supplier. Connectivity and reliability critically impact the quality of the data interface from the perspective of the company. In terms of connectivity, it is necessary that enterprises should have a monitoring system that can be electronically linked to outside systems. Most of the extensive manufacturing sites operate a control center that monitors all critical tasks aligned with safety, production, utility, etc. As such, connectivity with the public system can be ensured.

The reliability of the uploaded data from external systems through a data interface should be secured. As such, a case study associated with a Korean governmental system for national waste management proves the reliability of the connection between public and private systems (Korean Ministry of Environment, 2012). Korean waste management law dictates that the company that disposes of industrial waste should report its waste type and amount to the system within 24 hours and the system allowed only handwritten documents and required extensive work from the business ((Korean Ministry of Environment, 2012). To resolve such inefficiency, a business association requested a data interface, and the government accepted the proposal and developed data interface functionality (Korean Ministry of Environment, 2012). Such innovation, which can transmit waste data to the governmental system on a daily basis, is regarded as a result of successful partnership (Korean Ministry of Environment, 2012).

In terms of energy suppliers, a data interface between the government system and billing systems of utility companies can contribute to shortened working time. The billing papers, which include energy cost and usage, are legal evidence for MRV. Currently, reporting employees gather all energy usage data from the energy monitoring systems, check and revise those data against the records of the bill, and register confirmed data to the governmental system. The implemented data interface function will simplify the verification process over emission registry, as handwritten data is replaced by automatic transmitted data in the GHG system. Verifiers should check numbers in all receipts of energy billing papers and data in the GHG system and examine whether data collection and reporting are executed by procedure according to corporate standards. After the improvement, verifiers can concentrate more on macro perspectives such as the corporate GHG system design and data flow and the technological structure of the GHG reduction scheme through spending saved time in data collection and reporting the check-in time limits of verification.

This innovation can catalyze emissions trading by monitoring emissions data in real time from the perspective of the emitter, can improve quality of verification process by focusing on more organizational and structural issues from the perspective of the verifier, and can help the government to practically design allocation methodology by reviewing the real data transmitted from the data interface and calibrate more sophisticated verification guidelines.

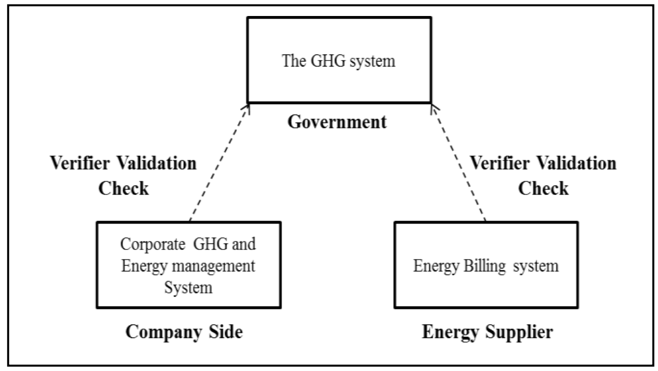

Figure 2: Proposed Data Interface Diagram

3.3. Reduction Item Management through Information Sharing

The module of information-sharing, which is aligned with reduction item management, is created from the perspective of the government that should support emission reduction efforts primarily managed by private bodies. It consists of two subparts: technology procurement and know-how sharing. Those two operate differently, but they are the same in terms of aiming to minimize emission reduction cost by applying information mechanism (Figure 3).

The technology procurement implies a reinforcing cycle between expansion of technology development and saving of procurement. It is arguable that mismatch between the emitter who actively seeks to procure reduction equipment and the developer who has invented high technologies but have not found clients, hinders maximizing efficiency. The module allows information sharing between buyer and seller and aims to build a community where a positive synergy circulates. The community benefits both technology developers and emitters. The developers can secure stable cash flows by easily finding clients and focusing on research and development in order to improve their economies. The GHG emitters can conveniently procure products and save costs in mass production.

The know-how sharing differs from technology procurement in that the sharing does not employ monetary compensation coming from buying and selling, but does use an indirect economic incentive mechanism. The module, which contains an electronic bulletin board as a channel of communication, can be simply built. The users are emitters and consultants who can share soft methods that help reduction. The government provides a benefit with a sharer, in regard to the frequency of case study sharing and the number of citation records. The benefit can be anything, including emission credit. Khanna and Rivkin (2000) argued that information sharing between affiliated firms contributes to implementation of a positive synergy in all relevant businesses.

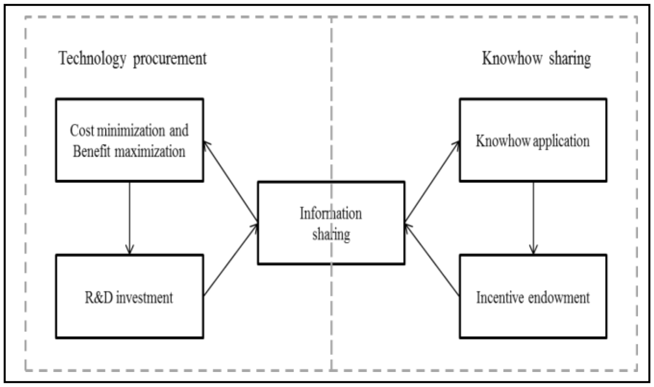

Figure 3: Proposed Information Sharing

3.4. Trading Module

The trading module is designed to support private bodies (shown in Figure 4). This study approaches this subject differently by solely designing a concept of systemic integration for trading. Previous studies have heavily focused on two subjects. One is the policy of trading transaction, and the other is the exploitation of current financial product architecture, such as derivatives and present goods, into defining an emission credit. The module is expected to contribute to companies by providing a dashboard that aggregates all sources into one system. Enterprises can have better opportunities not only to decide on either credit purchase or reduction technology procurement, but also to optimize their economic resources.

The dashboard is a visual screen that helps monitor current status of an enterprise. It contains information such as annually allowed emission quotas, emission account balances, reduction technology updates, monetary transaction records connected to the financial market, and price levels of emission derivatives and present products. A user also can access analysis packages that show two figures. One is the past time series trends and patterns around the variables belonging to the enterprise, and the other is to illustrate statistics around climate change ecology provided by the government database. Such a development contributes to shortening decision time in favor of the private participant.

For the success of this module, it is necessary to educate system users because the effective application of this tool requires background in the emission trading regulations to the financial market. In particular, SMEs can strive harder to apply the innovation due to the lack of labor than mega-enterprises.

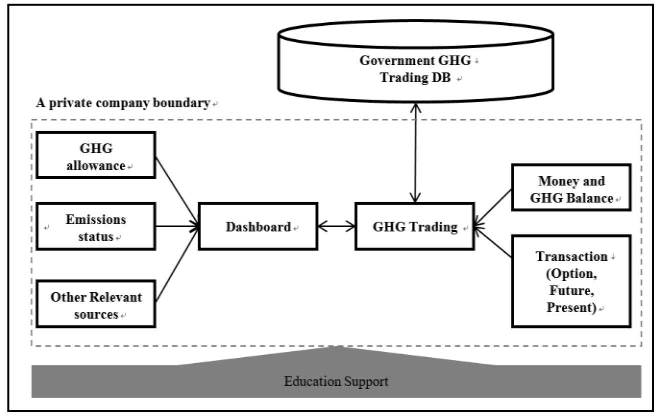

Figure 4: Trading Module Architecture

4. Modeling of the ETS architecture

The feasibility of the proposed system is assessed by applying the Analytic Hierarchy Process (AHP) for project feasibility and the regression analysis as a supportive mechanism for the results of AHP.

First, application of the AHP, which was developed by Wind and Saaty (1980) and intends to support qualitative and multi-standard decision-making as a survey tool, originates from the review of case studies. One of them is the Korean pre-feasibility test mechanism. The Korea Development Institute (KDI), which is a public body of public project feasibility assessors, uses this tool for decision-making on new public project proposals (KDI, 2008). Because the owner of this proposed ETS architecture is the government, using the AHP as a main evaluation standard seems adequate.

Second, the regression analysis, which is one of the most popular tools for validation, is used to validate the outcomes from the AHP above. Specifically, this tool shows a competency in analyzing causality between distinct variables. Here, this regression analyzes the proposed ETS model's effectiveness for governmental and business users in terms of micro perspectives. The regression outcomes are used to test the reliability of the AHP results.

4.1. Test 1: Analytic Hierarchy Process (AHP) Validation

4.1.1. Design of AHP Survey Body

This study executes the AHP study by complying with the guidelines of KDI (2008) that specifically illustrate methodologies of organizing surveying variables (as shown in Table 2). The KDI (2008) defines policy consistency, project risk, and contribution to society as key elements. This study creates an AHP survey framework by simulating the KDI's system and qualitatively justifies the relevancy of an individual survey question to this study's purpose.

Table 2: AHP Survey Question Structure

Subject	Criteria	Check Point
Policy Consistency	Consistency	− Consistency of the upper-level plan − Consistency of the line ministry'Plan
	Willingness	− Willingness of central or local government
Risk Management	Financing	− Financing possibility
	Project Risk	− Information Control, etc.
Contribution to Society	Allowance Allocation	− National Carbon Reduction management − Easy access to allocation information
	Data I/F	− Increase in efficiency in the work
	Reduction Item sharing	- Item sharing can contribute to minimize carbon reduction costs - Green market can be activated through collaborated market opening
	Trading	− Integrated information management for the exchange

4.1.2. Policy Consistency

Allison and Zelikow (1999) presented a case study in which a conflict between the US presidential office and the US navy caused a catastrophic consequence that some Soviet ships gained access to Havana, undermining US diplomatic strategies. Such an example clearly shows that a government project should be reviewed regarding its matching the guidance of the upper-level plan.

In this regard, a feasibility module presented by KDI includes a policy consistency test, which contains analyses of policy direction consistency and willingness of project execution (KDI, 2008). This study, which helps design public system development, applies the variables narrated by the KDI as the main variables in terms of policy consistency in the AHP survey questionnaire.

4.1.3. Project Risk

The project risk consists of two subparts: financing risk and management risk. The first one is included in the KDI AHP assessment, and a KDI feasibility test report with a subject of "Improvement project of IT system in National Tax Service (NTS)" evaluated an annual IT budget of the owner agency (Jeong, 2013). As such, the feature that the owner of the system presented by this study is a public agency remarks that financing risk governs the survivability of this project.

4.1.4. Contribution to Society

The purpose of the proposed system is to minimize social burdens for ETS operation by providing modules of allocation, data interface for MRV, reduction idea management activated by information sharing, and emissions trading supported by a dashboard function. As such, the feasibility of this proposed system should be tested regarding the degree of its contributions to society.

4.2. Test 2: Regression Analysis

The AHP model is designed to evaluate the feasibility of implementation on the government side in terms of macro perspectives. This regression model is intended to support the survey results of the AHP by assessing the proposed ETS model's effectiveness among governmental and business users in terms of micro perspectives. Because the system consists of four modules, system satisfactory levels for each module will be different, and user type of either governmental or business will influence the satisfaction level. The GHG emissions amount for each business should be checked because the emissions amount influences GHG counteraction working load to the business and GHG allocation complexity to the government. It is necessary to check governmental and business working satisfaction level change before and after the system implementation with respect to the GHG amount.

4.2.1. Business Effectiveness

One plausible outcome derived from the proposed system is a reduction of working hours. Kim (2009) suggested that two measurements such as reduction in working lead time and minimization of purchasing costs, effectively works in assessing the utility of an implemented system. Likewise, the quality of the proposed system, which aims to save working hours by replacing handwritten input through the data interface function, can be assessed. In addition, the feature of information-sharing, which expectedly creates synergistic effects around participants by expanding selection options and reducing marginal procurement costs due to mass production and purchase (Goold & Campbell, 1998), needs to be included in the assessment. The fact that the item sharing negatively affects the system if the sharing is operated in an unclear manner strengthens its essentialness in validation (Williamson, 1993).

4.2.2. Government Effectiveness

The effectiveness of the proposed system that targets achievement of the national emission target through transparent mechanisms in the process of allocation is necessarily included in the assessment.

5. AHP and Regression Survey Responder Sampling

AHP scores vary depending on responder's answer qualities. AHP responders to this study should have profound knowledge of GHG policies or business approaches to GHG counteraction. According to the demography of the sample, six men and four women participated in the AHP survey, and their average age was 35. Responder A is an environmental consultant and has participated in biomass energy development in China and a governmental GHG project of emissions allocation methodology research. B is an environmental manager who has over 5 years of experience in the GHG counteraction department in a big emissions-producing company, which emits more than 8 million CO_2 tons per year. C and E are public accountants and GHG verifiers and have participated in GHG verification for more than 10 companies. E is a PhD in environmental engineering and currently designs GHG counteraction policies for a big company. G is a governmental employee and supervises budgetary plans for national GHG counteraction. F, H, I, J are business consultants at a globally renowned consulting firm and participate in a governmental GHG project of emissions allocation methodology research. Therefore, it can be confirmed that the survey responders to the AHP are qualified, and that their answers will secure logical consistencies and authorities. Seven experts (A, B, C, D, E, F, and J) also participated in the regression survey since they observe working circumstances and situations through business consulting experiences or direct participation in GHG working processes.

6. Results and Discussion

6.1. Study 1: AHP

The average preference point, which is calculated with the exclusion of the lowest and the highest scores, is 0.82. Normally, if the point is over 0.5, the project is defined as feasible. So, the proposed project is regarded as feasible for pursuit. The consistency ratio value is less than 0.2, so we can assume that responders' answers are logically consistent.

Survey responders evaluate the weights of policy, risk, and project as 0.438, 0.214, and 0.348 (as shown in Table 3). The reason for the highest weight point in policy is that policy control and management are the basis of pursuing governmental projects. If the project is not consistent with national goals or a policy framework, the driving forces of the project will not be secured easily, and governmental budgetary department asks the project-pursuing department to severely cut or reduce the project budget. The project weight is scored as the second. The risk element is the lowest.

Although IT risks in terms of system security and project management in the implementation are crucial to pursuing projects, those risks are usually solved well with advanced firewalls and qualified management.

6.2. Study 2: Regression Analysis

Seven experts (A, B, C, D, E, F, J) responded from 19 businesses. Although some of those experts are not employees of their responding companies, they can give reliable answers because they have consulting or verification experience with the responding company. As GHG emissions amounts differ greatly across companies from 9 million CO_2 tons to 27 thousand CO_2 tons, all business amounts are standardized through z-value standardization methodology, and the amount range is adjusted to a 100-point scale from 0 to 100. In the survey, an increase in utility after the implementation is reported, when GHG emissions amounts, which are crucial to GHG counteraction to both business and government sides, are not considered. The most contributable category to the increase is trading. Businesses can potentially reap benefits from the minimization of unexpected risks from a standardized architecture proposed by this study. However, an increase in effectiveness on the governmental side was not as great as the increase on the business side (as shown in Table 4). The reason is that even though governmental user burdens decrease with the systemization that replaces handwritten working procedures, businesses will make greater requests of IT, such as resolution of system errors, than before. Generally, the systemization of the working process to the IT system contributes to an increase in working efficiency for users. The difference between before and after implementation is about 40 points, an almost 80% improvement from the current status on the business side (as shown in Table 4).

The survey results, including consideration for the GHG amount to each business on the business side, indicates that the emissions amount is directly correlated with the preparation level of GHG counteraction (as shown in Figure 5(a)) and is conversely correlated with a utility increase before and after implementation (as shown in Figure 5(b)). The regression line between emissions amount and utility level before implementation shows a strong positive relationship, and with an R^2 value of 0.7085, the line is acceptable.

An increase in utility level before and after implementation is not well detected in big emissions companies. One rationale is that support from this system in data collection for GHG registry does not minimize their current work because of embedded automation systems in big companies. However, small companies are not equipped with the big company system because system implementation is expensive. Thus, the level of convenience in the governmental system directly impacts utility change on small companies. The regression line is then negatively correlated, pointing out the R^2 value of 0.6999 to be acceptable. However, there are no relationships between emissions amount and utility level on the governmental side. R^2 values of regression lines are 0.0139 (as shown in Figure 5(c)) and 0.006 (as shown in Figure 5(d)). The reason for this is that governmental efficiency is hard to measure. Since there are hundreds of participants in ETS, it is unknown which problems and side effects will occur as a result of allocation to carbon credit trading. Also, even though labor utility increases with the total management of data through the system, other administrative demands such as IT requests will be generated and compensate for working convenience.

Table 3: AHP Weight Analysis

Category	A	B	C	D	E	F	G	H	I	J	Avg
Policy	**0.69**	**0.14**	**0.24**		**0.69**		**0.63**	**0.25**	**0.21**	**0.65**	**0.44**
Policy consistency	0.14	0.11	0.05		0.51		0.47	0.22	0.03	0.52	0.26
Willingness of project pursuing and preference	0.55	0.04	0.19		0.17		0.16	0.03	0.17	0.13	0.18
Risk	**0.08**	**0.14**	**0.09**		**0.21**		**0.11**	**0.09**	**0.72**	**0.27**	**0.21**
Financing	0.02	0.11	0.02		0.04		0.08	0.01	0.62	0.05	0.12
Project risk management	0.06	0.04	0.07	**Highest score**	0.18	**Lowest score**	0.03	0.08	0.10	0.21	0.10
Project specialties	**0.22**	**0.71**	**0.67**		**0.10**		**0.26**	**0.66**	**0.07**	**0.08**	**0.35**
Systemization of GHG allocation	0.06	0.22	0.03		0.03		0.05	0.23	0.04	0.05	0.09
Data I/F	0.02	0.03	0.37		0.06		0.14	0.21	0.02	0.02	0.11
Reduction item sharing	0.01	0.07	0.22		0.01		0.02	0.02	0.00	0.00	0.04
Carbon credit exchange	0.14	0.40	0.06		0.01		0.04	0.20	0.01	0.01	0.11

Table 4: Utility Change before and after Implementation

Category		Total (Max 100)	Allocation (Max 25)	Data I/F (Max 25)	Item sharing (Max 25)	Trading (Max 25)
Business	Before	52.11	11.32	14.74	16.58	9.21
	After	91.58	21.32	24.47	24.47	21.32
Gov	Before	45.26	11.32	12.63	10.53	10.79
	After	78.89	20.53	20.37	17.89	20.11

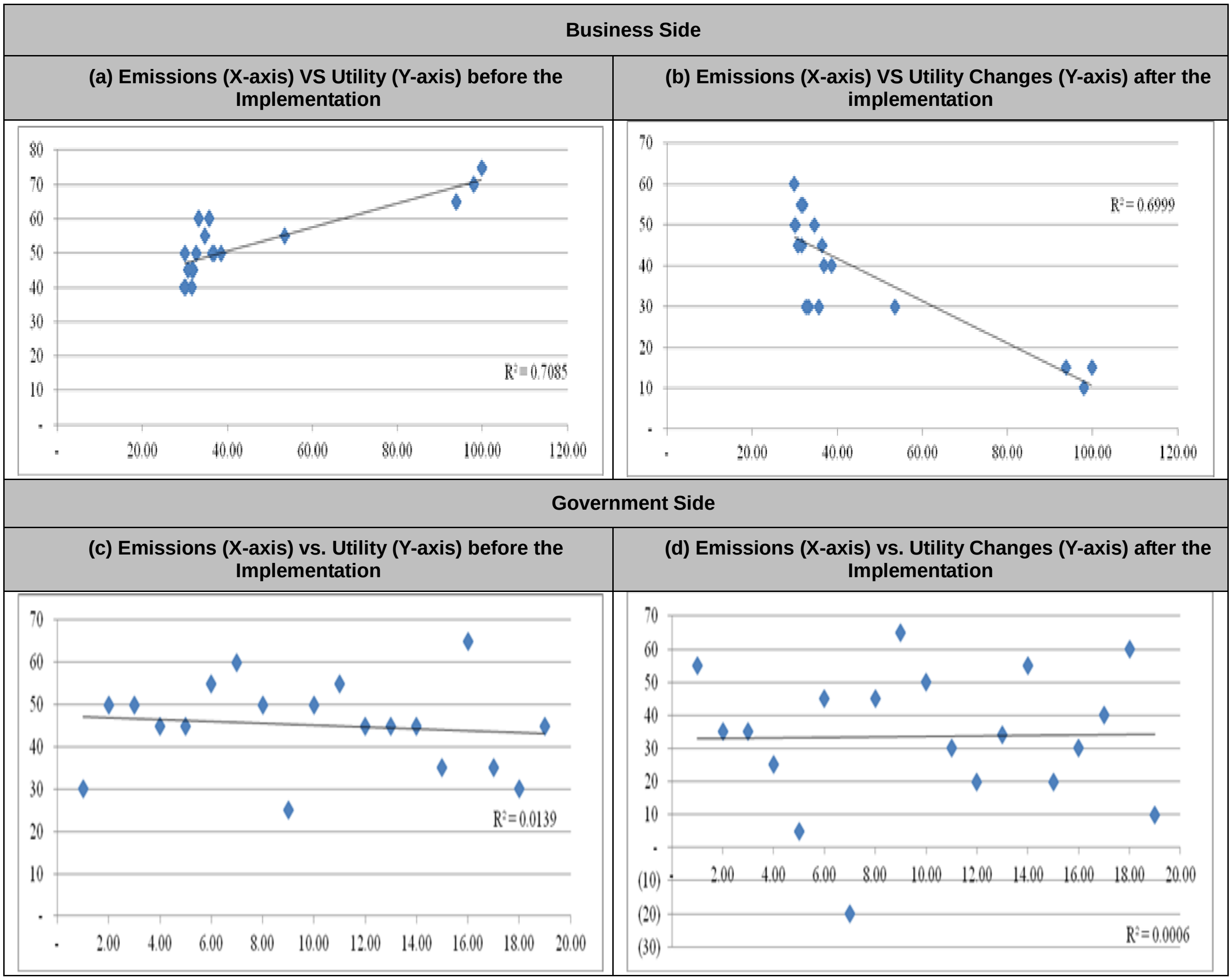

Figure 5: Emissions vs. Utility in the Business and the Government Sides

7. Discussion and Conclusions

This study suggests an IT system methodology to help improvement of the current K-ETS mechanism. In particular, this study addresses effectiveness for real businesses and the adaptability of this mechanism to other nations.

First, it is not difficult to observe failures of demand forecasting in many fields due to unpredicted events in the operation period. In this sense, the claim of verified practicality from the survey cannot guarantee the usefulness of the model in real practice. Specifically, the automation policy that this model pursues can adversely affect business by requiring more labor for system-setting. However, many alternatives can resolve such disadvantage. One plausible solution is to provide training from system-setting to operation with business users before the system shift from the old to the new. Meanwhile, opening a trial bed system can help the soft landing of the new system.

Second, the adaptability of this proposal to other nations can be an issue, considering that the new design is developed and tested only in the Korean environment. Each nation has its own environmental regulations associated with ETS, strengthening the above argument. However, similar core features across each nation's ETS reduce the burden of considering locality and allow the chance to apply a standardized model. The ADB (2016) seeks to link individual nations' ETS system, and The WB (2016) attempts to provide standardized guidelines for ETS system implementation. In this regard, it is expected that the proposed design of this study can be flexibly applicable to other countries.

In conclusion, this proposed IT platform diagram can contribute to successful operation of ETS by providing multiple benefits, such as data collection and verification through data interface, the support of systematic allowance allocation to participating companies through in-house allocation mechanisms, the soft-landing of ETS adoption to participating companies through reduction technology-sharing and group purchases, and the reduction of transaction costs through the trading system. The feasibility of this conceptual design is assessed by survey, but the uncertainty of materialization caused by unexpected events cannot be entirely avoided. The next study challenges this issue by defining problems and solutions during the implementation of a real system using the provided ideas. It is expected that this study will catalyze discussion of system design related to ETS, which is out beyond the scope of previous studies.

8. Policy Implications

Developing a system that integrates all relevant resources is essential to successfully facilitate an emission trading system in reducing administrative work in both government and private bodies. The success of this systemization depends on building an environment to adapt a new system to society. As such, three policy implications, which are suggestions for preparation for system development, can be derived.

First, frequent events that both advertise the new system and provide education about the emission trading regulation greatly shortens the adaptation time of a new system. The advantages derived from the system can be achieved by efforts of the users. At the inception of the new system, users are required to set all necessary components. Notifying improvement of work efficiency through a new system contributes to motivation using the system in-depth and materializing expected advantages to the fullest degree. Meanwhile, the government is required to continue its education program of ETS, which is strongly aligned with the origination of the new system. Specifically, the success of the module of reduction item management depends on the degree of understanding the full architecture of the ETS regulations. Understanding business opportunities can momentously drive the activation of item sharing that economically incentivizes business participants.

Second, elaborating incentive standards for sharing before the operation contributes to enhanced utilization of the system. The sharing, which ultimately cuts emission from a baseline at business-as-usual, is a key element of the proposed system. In many cases, emission reduction is achieved by shortened demand. That is not the aim that the nation pursues. Achieving a reduction without any adjustment in business operation is the key. Sometimes, GHG reduction is achieved by simply changing the manufacturing process innovation. Sharing such know-how can help other enterprises that are struggling to find alternatives. In order to facilitate such positivity, an incentive mechanism that provides economic benefits to sharers is essential.

Third, close communication between the system owner and the user contributes to active use of the developed system. First, in the designing stage, the government needs to gather input from the business field with the idea that the main user is the environmental manager of an enterprise. Reflecting overlapped ideas derived from claims and requests from a variety of entities can help to build the system more favorably for the users. In addition, strengthening technological support during the operation can increase accessibility to the system. Especially extensive claims, due to either malfunction of system or request of system operation aid, can occur shortly after its commissioning. Fast counteraction to issues assures the quality of maintenance and encourages users to access the system whenever they need to do so.

The suggestions offered above are not all of the factors that affect system success, but perfect preparation of them fundamentally assures that success. It is hoped that the next study challenges an issue associated with ETS system development and strengthens the validity of the policy implications

9. Advantages to Business

This development covers two areas: workload savings and open-access toward innovative ideas. First, the function of data interface architecture allows electronically exporting energy consumption records from power companies to energy consumers. This automatic process helps saving workloads as well as improving accuracy in data reporting. Second, the proposed IT reduction management module, which provides an environment where reduction item buyers and sellers can meet and transact the product of emission reduction technologies, greatly help the mechanism of ETS. Sharing ideas, which covers not only energy-saving or emission reduction hardware but also skills and experiences, optimize business resources and contribute to achieving a Pareto optimization curve, where all businesses fully maximize their potential in cutting emissions. In conclusion, this architecture, which designs modules of automatic data processing and knowledge sharing regarding emission abatement, contributes to alleviating environmental management costs, which unavoidably incur additional resource consumptions. It finally encourages enterprises more actively participating in the global movement of environmental management. Advanced distribution system (Sun & Lee, 2010) related to energy consumption (Islam, Ahmed, Saifullah, Huda, & Al-

Islam, 2017) and reduced carbon mission levels (Lee & Unger, 2012) should be more investigated in the future research. Further research might consider the effects on customer satisfaction (Cho, 2020; Kim & Cho, 2020), environment factor (Paik & Kang, 2018), economic factor (Wijaya, Ilmi, & Darma, 2020), consumer (Ryu, 2019), corporate social responsibility (Zahari, Esa, Rajadurai, Azizan, & Muhamad Tamyez, 2020) and sustainability (Mukherjee & Sen, 2019) in global context (Huo & Cho, 2020; Son & Cho, 2020)

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