KNOWLEDGE GOVERNMENT: ANALYSIS AND PROSPECT

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Abstract: In this paper, we defined the knowledge government as the government in which its knowledge activities are highly encouraged for its productivity. From the perspective of this concept, we attempted to examine the four processes of knowledge activities, that is, knowledge creation-proliferation-utilization-accumulation. Empirical analysis shows that all four independent variable, IT-Engine, Institutional System, Individual and Organization Factors affect government innovation. Since institution and IT-Engine variable work independently, these are required to perform at the same time. However, IT-Engine and institutional variables affect organizational innovation by influencing individual and organization. This implies that IT technology and institutional system should be a prior concern for the governmental innovation. Because organization and individual variable are affected by the IT-Engine and institutional foundation respectively, it could be inferred that innovating individual and organization factors should be performed by effectively implementing IT-Engine and the institutional foundation, including team system and the merit-based payment.

INTRODUCTION

Knowledge plays a major role in shaping economic, political, and cultural dimensions. Peter Drucker predicts that knowledge itself, not capital or labor, will be a key ingredient in a Post-capital society (Drucker, 1993: 29). No one would repute the importance of knowledge-based economy and knowledge-based society. To become a genuine sense of the knowledge-based society, three primary actors, including government, business, and workers, should be knowledge oriented (KIET, 1999: 30).

While the paradigm of knowledge government has been lively discussed in international areas such as OECD and World Bank, there has been little, if any, in Korea, academically as well as practically. Although Kim Dae Jung Government proclaimed the vision called, "Construction of a Creative Knowledge-based Nation" in August 15, 1998, the concept and paradigm of knowledge government has not been systematically set up yet. Indeed, they are still in a very beginning stage.

Against this backdrop, in this paper, I have two research purposes in mind. First, I will explore some theoretical concept and model of knowledge government. In doing so, I will pay special attention to the relationship between knowledge process and the government reform models that have been previously dealt with. Secondly, I will evaluate the progress and efforts of the Korean government reform in light of knowledge government. The evaluation will be performed based on the analytical framework which was built up by the criteria of knowledge and knowledge basis.

THEORETICAL REVIEW: KNOWLEDGE GOVERNMENT

Knowledge

Concept

Knowledge is an intellectual capital. The whole market value for a company is more than the asset

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value for the company. In the gap between the asset value and the market value places the knowledge or intellectual capital. In this sense, knowledge or intellectual capital refers to the facts, technology, and know-how embedded in an organization, which is useful for the decision-making and management of the organization. Most scholars define knowledge along the similar line (see Table 1). To take a few examples, Nonaka & Takewchi (1995) defines knowledge as a skill acquired by an actual experience or belief. Davenport, Long, and Beers (1998) defines it as an information associated with one's experience, context, judgement, or thoughts. Leonard & Sensiper (1998) refers to the information based on the reference of experience, therefore, it is readily applicable.

Table 1. Definition of Knowledge.

Scholars	Definition
Nonaka & Takeuchi (1995)	Information and skills acquired by an actual experience or belief
Wiig (1995)	Information constituted of truth, belief, prospect, concept, judgement, expectation, methods, know-how, that are formulated, integrated, and documented to be used for a context-specific problem solving
Leibeskind (1996)	Information confirmed its validity through a certified verification process
Heibeler (1996)	A meaningful information documented and retained by an organization; it is readily applicable and it is not affected by the position mobility of the members in the organization
Davenport, Long, Beers (1998)	Information associated with one's experience, context, judgement, or thoughts
Leonard & Sensiper (1998)	Information connected with the issues at hand and based on the reference of experience

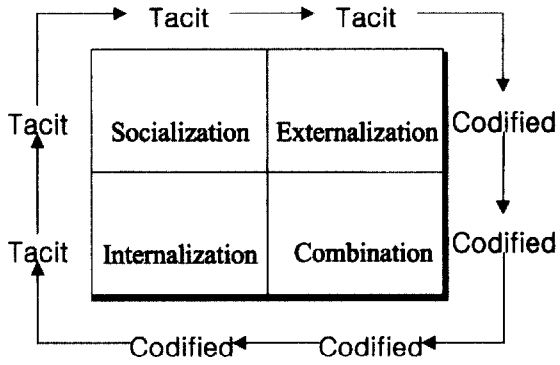
Typology

OECD classified knowledge as four categories. First, 'Know-what' is the fact that is typically called information. Second, 'Know-why' is the natural law or scientific knowledge that is produced by research organization. Third, 'Know-how' is the capacity to perform tasks. Finally, 'Know-who' is to know about who pertains the ability to do something (OECD, 1996: 12). While the first two types are called 'codified knowledge,' which could be obtained through books or data bases, the latter two are called 'tacit knowledge,' which should be acquired by one's practical experience.

Nonaka Ikujiro also categorized knowledge as explicit or tacit knowledge. He also suggested the four-stage cycle of knowledge transformation, namely, externalization-combination-internalization-socialization (Nonaka, 1995: 96~97) (see Figure 1). In a similar vein, Samsung Economic Research Institute (1999) summarized the processes of knowledge transformation as five steps, that is, creation-accumulation-sharing-utilization-learning (see Figure 2).

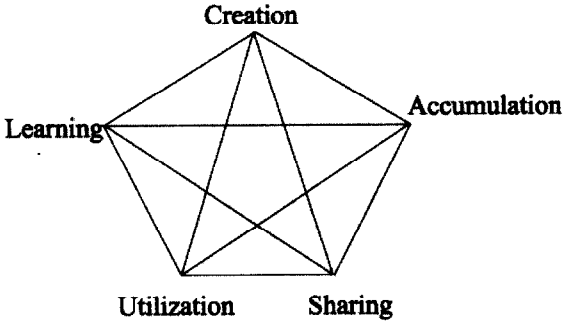
If we have such kind of 'stage perspective' on the knowledge process, knowledge activity inside the government could be summarized as four stages, as shown in Table 2. The knowledge process in the

Figure 1. The Four Stage Cycle of Knowledge Transformation.



* Source: Nonaka, 1995: 96~97.

Figure 2. The Five Stage Cycle of Knowledge Transformation.



* Source: Samsung Economic Research Institute (1999).

government could be categorized by personal-level and organizational-level knowledge activities. The organization-level activities focus on the goal attainment at an administrative level, while personal-level endeavors primarily focus on improving productivity at an individual stage.

Knowledge in the Government

Knowledge management in the government is about how to create, spread out, access and utilize information to enhance the capability of governmental problem-solving. Meta policy, originally proposed by Y. Dror is a good example. Meta policy activities, according to Dror, include surveying, processing values, and determining policy-making strategies. In these whole policy processes, knowledge plays the role of a key currency. In this sense, we can categorize the government knowledge as the following three dimensions: 1) problem defining & solving, 2) institution building & operating, 3) strategic positioning (Samsung Economic Research Institute, 1999). The knowledge for problem defining and solving is a type of analytical skill and is primarily required for the desk officer. The knowledge for institution building & operating is needed for the middle management. Lastly, the knowledge for strategic positioning is for the executive leaders (see Table 3).

Table 3. Dimension of Knowledge and Key Issues.

Dimension of Knowledge	Key Issues
Problem Defining & Solving	· Gathering facts and opinions · Defining the role and function of government · Analyzing and preparing alternatives (Analytical tools such as cost-benefit Analysis)
Institution Building & Operating	· Establishing incentive system for knowledge creation (e.g., guarantee for intellectual property right) · Institutionalizing the interactive process among the actors involved in the policy-making · Legal and regulatory framework
Strategic Positioning	· Leadership · Setting a shared vision · Sharing and spreading out the government knowledge · Identifying needs of the clientele · Performance-oriented management

Table 2. Governmental Activities for the Knowledge Management.

Knowledge Processes	Governmental Activities for the Knowledge Management	
	Organizational Level	Personal Level
Creation	R&D in the Governmental Process, Policy Evaluation, Audit and Inspection	Personal Know-how Improving Productivity
Proliferation	Information Sharing	Openning Personal Knowledge Storehouse
Utilization	Utilization in the Policy Making Process	Knowledge Utilization through Personal Ties
Accumulation	Classification and Maintenance of Government Document	Accumulating to the Personal Storehouse

Figure 3. The Critical Conditions for the Knowledge Government.

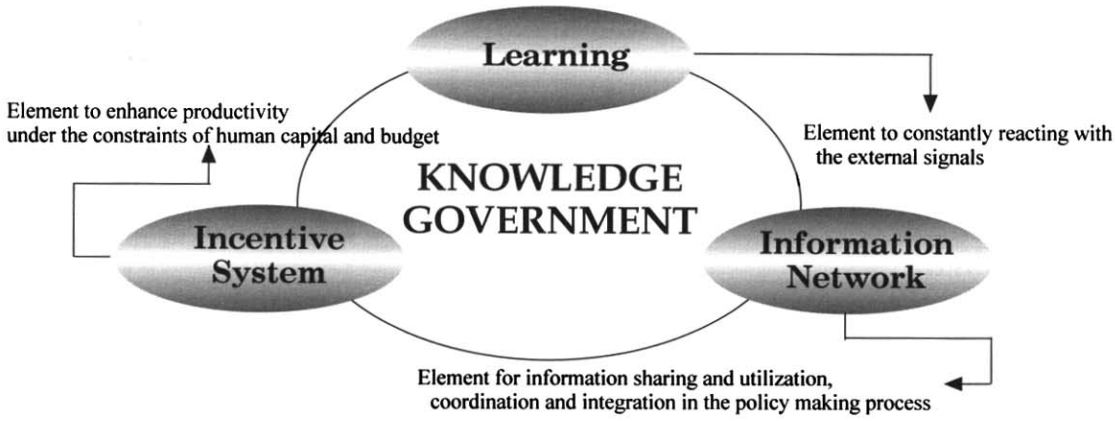
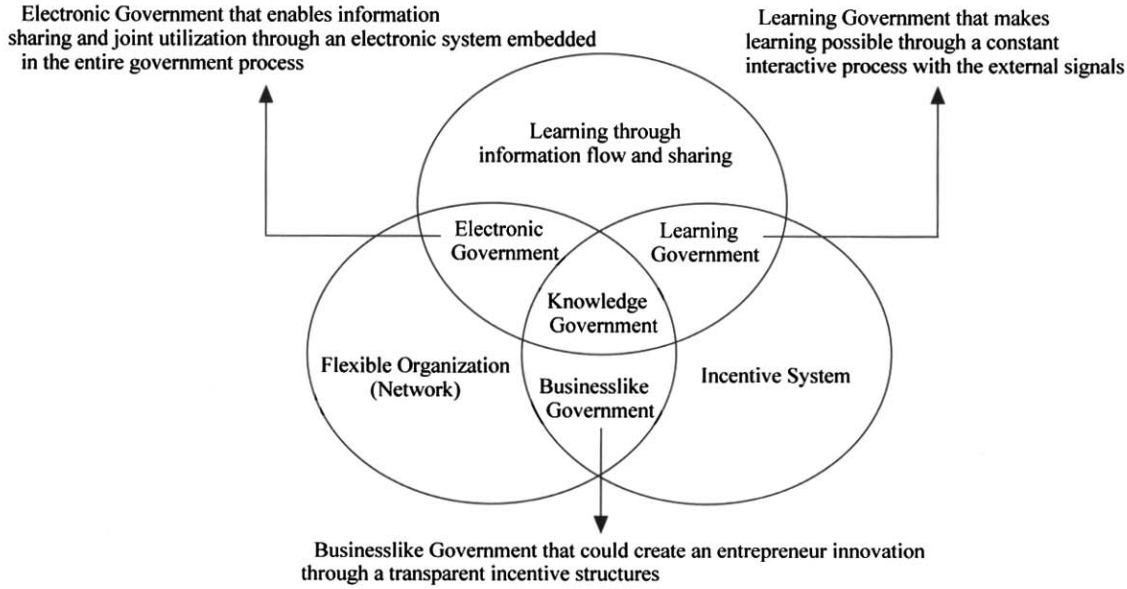


Figure 4. Knowledge Government as a Sharing Point of the Businesslike, Learning, and Electronic Government.



Knowledge Government

With these concept, typology of knowledge needed for government activity, we can explore the concept of knowledge government. Knowledge government is defined as "the government system in which knowledge can be spontaneously created, easily utilized, freely spread out, and well documented" and therefore it is not only a productive system internally but an effective system to deliver public service (KIET, 1999). For a knowledge government to be operated well, however, the following three conditions are prerequisite at minimum (See Figure 3).

First, for a useful knowledge to be created, an incentive system should be set up. Knowledge and information contain uncertainty. To utilize knowledge which includes uncertainty in essence, some kind of risk will be accompanied. Therefore, if a rewarding system was not appropriately provided, innovation could not spontaneously spring up. Secondly, for a knowledge to be utilized and

accumulated, learning is essential. Knowledge, above all, is meaningful when learning actually takes place. To do that, an organization structure needs to be flexible and flat. Finally, information network is important to support the previous two conditions. It serves as a physical conduit for the learning knowledge to be circulated.

If we take these three conditions seriously, we find that knowledge government is knitly associated with the government innovation models that have been previously dealt with. This is because internal incentive system, learning organization, and information network, the items just mentioned, are the key elements for the businesslike government, learning government, and electronic government respectively. In this respect, knowledge government might be understood as a shaping point of businesslike, learning, and electronic government. (see Figure 4).

Knowledge Process and the Previous Government Reform Models

Knowledge government is a new concept and therefore we cannot find the word in the previous discussions of government reform. Nevertheless, if we understand the concept as a process, we could recognize that knowledge government locates in a continuum of the previous government-reform efforts.

More specifically, first, the incentive element discussed in the businesslike government is more related with the dimension of knowledge creation because, to create knowledge, an incentive system is essential. Without any payoff system, it is hard to expect for someone to create knowledge (Son, 1998). Secondly, learning government is closely associated with the dimension of knowledge creation and utilization. Learning is a prerequisite source for knowledge creation. It is also crucial for knowledge to be efficiently utilized. As we will discuss later, the evaluation system and R & D efforts for the learning government served as a feedback for a knowledge creation and utilization.

Finally, information network and database discussed in the electronic government are primarily connected with knowledge proliferation and accumulation. Database and network are two key instruments for knowledge proliferation and stockpiling (see Table 4).

Table 4.

Knowledge Process	The Previous Reform Models
Creation	Learning Government · Businesslike Government
Proliferation	Electronic Government
Utilization	Learning Government
Accumulation	Electronic Government

EMPIRICAL AN ALYSIS FOR KNOWLEDGE GOVERNMENT

Based on conceptual framework for knowledge government reviewed above, I will further employ empirical analysis. The main research themes of this study are as follows: 1) What is knowledge government itself ? 2) Is knowledge government really necessary? 3) If knowledge government has the substantial entity and its rationale is recognized, how could we create the foundation necessary for knowledge government? Finally 4) What are the ultimate necessities to create knowledge government? For this analysis to be addressed, we will analyze the survey data gathered from the twelve governmental departments. The survey was conducted from Nov. 22 to Dec. 4, 1999. A total of 240 survey questionnaires were distributed to the randomly chosen twenty government officials in each department. A total of 198 survey questionnaires were returned, which accounted for 82.5% of the response rate. 197 questionnaires, excluding one irrelevant case, were used in the data analysis. I performed the data analysis by using SPSS 8.0 and

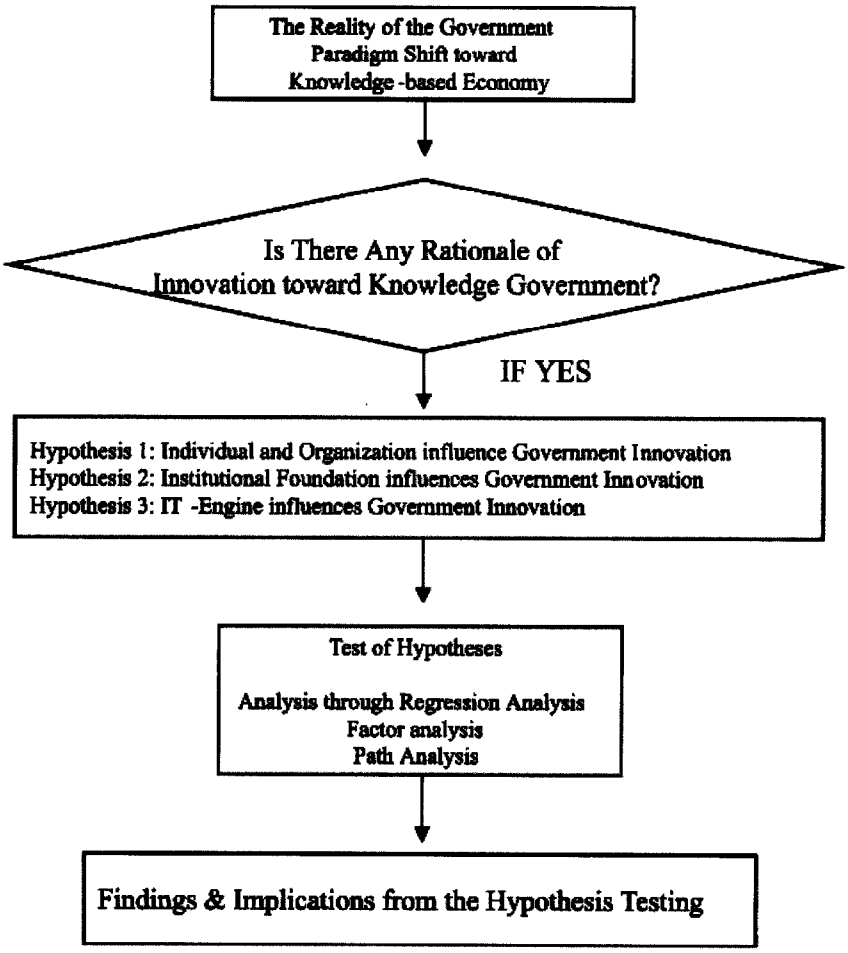
EXCEL 97. The statistical methods, performed here, include cross-analysis, correlation analysis, bivariate and multivariate regression analysis, and factor analysis.

The Logic of Analysis

Empirical analysis in this paper are divided into two main parts. First analysis is to review the rationale and strategies for knowledge government, starting by analyzing government officials' awareness of the concept of 'knowledge government.' This analysis uses the equal-interval measurement by observing correlation between the related variables. Second is to analyze nominal measure, which supplements the logic of knowledge government, asking, for example, what is the meaning of knowledge government, and what kind of information system is used.

After shedding light on the necessity of discussion of knowledge government, I will examine the foundation necessary to create knowledge government. Finkelstein (1996) identified the factors necessary for knowledge management as follows: 1) experts, 2) software designed for the certain objectives in experts group, and 3) a series of deliberately developed cultural norms supported by merit-based and incentive systems for experts. Samsung Economic Research Institute (1998) indicated the following four factors as bases for knowledge government: 1) organization culture, 2)

Figure 5. Analytical Framework.



leadership, 3) organization members as the subject of knowledge government, and 4) IT-Engine.

In this research, based on these literature review of knowledge government and knowledge management, I explore three factors influencing knowledge government. First variable is the individual attitude and organization culture. For the new paradigm of knowledge government to be set up successfully, the government is required to create new culture in advance to accept this new paradigm. Organizational culture to set up knowledge government should be open and based on open communication, including the exchange of information and knowledge, the cooperation, and trust and value sharing. For this to be realized, trust culture should be precedent in organization, and organization needs to guarantee transparency and accessibility to measure the trust (Han, 1999).

The second variable is the institutional foundation such as open personnel management system, team system, and incentive system. This institutional foundation is expected to affect first variable. We can infer that these institutional foundations determine organization performance by influencing each individual and organization. The flexible organizations introducing open personnel system, team and incentive system have become the prime concern in the field of knowledge management.

Finally, the third variable is the IT-Engine. In the contemporary management literature, numerous successful performances of organization innovation are attributed to this variable. IT-Engine can determine the performance of innovation by influencing each individual and organization.

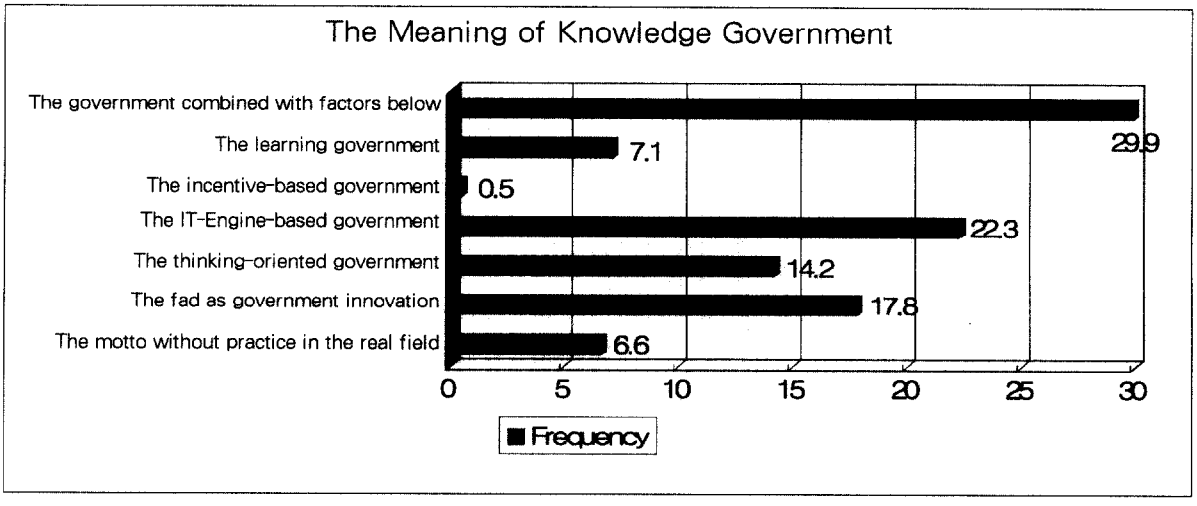
Empirical Analysis

Concept of Knowledge Government

Perception of Knowledge Government

First of all, I examined how the government officials perceive the concept of knowledge government. According to my empirical results, the majority recognized that knowledge government has several meanings. This is similar to the study of KIET (1999) in the context that knowledge government shares some commonality of entrepreneurship and electronic government that emphasize learning process and incentive system. Among the 'combining components of government', the survey shows that knowledge government is more directly related to the electronic government in the sense that it broadly introduces IT-Engine more than incentive system and organizational factors (22.3%) (see Figure 6). This point warns that such

Figure 6. The Meaning of Knowledge Government.



essential parts as learning and merit management can become pointless due to the current tendency that sorely emphasizes the IT-Engine.

Another focal point is that government officials regard knowledge government as a fad, which accounts for 24.4%. This also strongly indicates that the discussion of knowledge government could end up with failure if some strong strategy to perform the knowledge government are not prepared and follow up.

The government officials consider the reasons why the government reform does not have successful achievements as follows: 1) only government officials are only considered as the object of innovation (25.4%), 2) the intention of government reform is political (40.1%) (see Figure 8). In other words, government officials recognize that innovation mechanism has not been properly embedded, and they are regarded as the mere object of government reform. Therefore there is a possibility that a vicious circle would be repeated unless there negative perceptions are overcome (Samsung Economic Research Institute, 1999). The reason why innovation mechanism has not been properly institutionalized within government officials can be attributed to the lack of organizational and institutional foundation like incentive and team system. This point is related to the following analysis.

Figure 7. The Performance of Government Innovation.

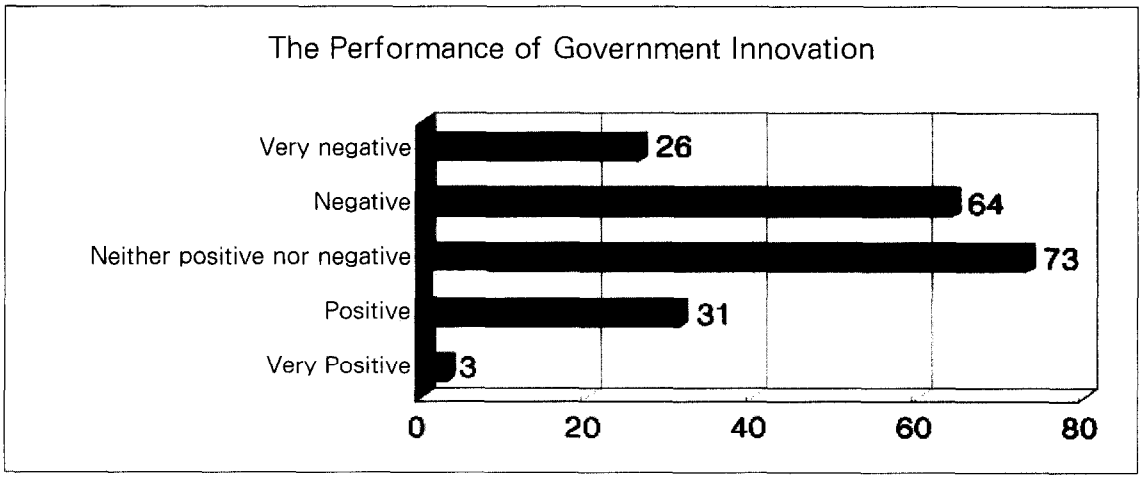
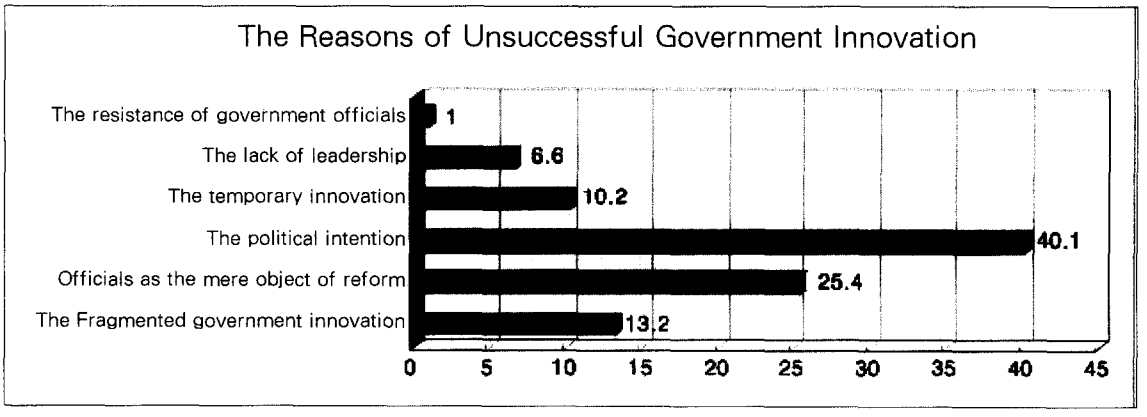


Figure 8. The Reasons of Unsuccessful Government Innovation.



The Necessity of the Discussion of Knowledge Government

Despite the fact that government officials feel confused about the concept of knowledge government, they recognize the importance of discussion of knowledge government. That is, the officials resist the excessive innovation, but more than 53.0% of respondents have consensus that the discussion of knowledge government is necessary. The urgent fields for reform are personnel management (29.9%), organization factor (24.4%), information system(12.2%), and finance(7.6%).

Analyzing Factors for Knowledge Government

In this paper, among the variables of equal-interval scale, factor analysis is adopted to find meaningful variables. Since factor analysis can bind variables into those which have similar data characteristics, it is expected to find out significant variables to perform correlation and regression analysis. Five factors loaded with more than 0.4 resulted from the Varimax rotation method can be explained as follows.

① F1: The organization variable
② F2: The performance of government innovation (dependent variable)
③ F3: The individual variable
④ F4: The institutional foundation of knowledge government
⑤ F5: IT-Engine

According to the factor analysis, the variables such as organization and individual, institutional foundation, and IT-Engine influence the performance of government reform. Hence, organization and individual attitude, institutional foundation, and IT-Engine variables are deduced as factors affecting government innovation.

Table 5. The Result of Factor Analysis Using Varimax Method.

	F1	F2	F3	F4	F5
Organization Effectiveness with Knowledge Sharing	**.894**	-.031	.217	.023	.053
Organizational Effectiveness with Learning Process	**.890**	.074	.217	.026	.112
Job Performance	.198	**.712**	.010	.016	-.052
Effective Sharing Knowledge and Information	-.103	**.709**	.165	.158	-.098
Performance of Government Innovation	-.209	**.616**	.294	-.042	.188
Active Attitude of Government Officials for Innovation	.391	**.568**	-.236	.042	.307
Individual Attitudes related with Learning Process	.195	.107	**.876**	.047	.035
Effectiveness of Open Personnel System	-.112	.108	-.0004	**.743**	-.033
Effectiveness of Incentive-based Payment	.073	.325	.095	**.730**	.099
Effectiveness of Team System	.124	-.215	.081	**.697**	.015
Effectiveness of Electronic Government	.062	-.063	.069	.016	**.853**
Increase of Work Productivity From the IT Technology	.085	.101	-.013	.005	**.845**

Test of the Strategies for the Effective Establishment of Knowledge Government

To operate the cluster of variables deduced by factor analysis into one variable, this study has attempted to categorize the variables forming each factor structure into the five variables. This transformation was performed using the arithmetic mean of those factors. The five categorized variables are as follows.

I performed the correlation analysis to identify whether regression among each variable would be relevant or not. According to the results of correlation analysis, the independent variables such as individual, organization, institutional foundation, and IT-Engine are significantly correlated with the dependent variable with a 5% significance level (see Table 7).

A path model is set up to deduce the policy

Table 6. Operationalization of the Variables.

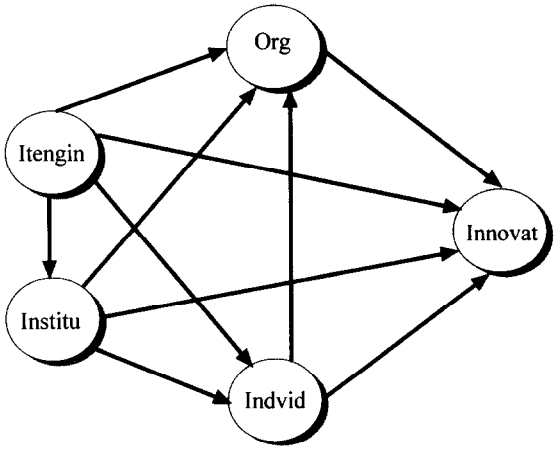
Factor	Original Definition	Operationalized Variables	
F1	· Organization effectiveness with knowledge sharing · Organizational effectiveness with learning process	Name	Definition
		Org	Organization Variable
F2	· Job performance · Effective sharing knowledge and information · Performance of government innovation · Active attitude of government officials for innovation	Innovat	Performance of Government Innovation (Dependent Variable)
F3	· Individual Attitudes related with learning process · Individual Attitudes related with knowledge sharing	Indvid	Individual Variable
F4	· Effectiveness of open personnel system · Effectiveness of incentive-based payment · Effectiveness of team system	Institu	Institution Variable
F5	· Effectiveness of electronic government · Increase of work productivity from the IT technology	Itengine	IT-Engine Variable

Table 7. The Result of the Correlation Analysis

Correlation Variable		Correlation Coefficient
The Result of Government Innovation (Innovat)	Organization Variable	.145*
	Individual Variable	.251**
	Institution Variable	.184*
	IT-Engine Variable	.173*

* $p < 0.05$, ** $p < 0.01$

Figure 9. Hypothesis of Path Model.



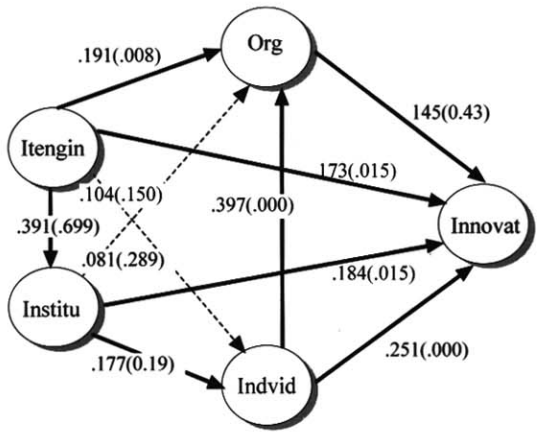
implications based on the empirical results. The path model helps to identify the spillover effect of one policy to another by clarifying the policy structures.

Figure 9 hypothesizes that all variables can basically affect one another. The path analysis supported by the result of regression analysis is as follows (Figure 10). The correlation of path from IT Engine → Indvid, IT Engine → Instutitu, and Institu → Org turns out to be insignificant with a 5% α-level. The other paths are all significant with the same significance level.

Test of Hypothesis and Policy Implications

According to the result of aforementioned path analysis, all four independent variables, including individual, organization, institutional foundation, and IT-Engine are found to be statistically significant for government innovation. It is also found that institution variable affects individual attitude variable, and individual attitude variable does affect organization variable. In addition, it turns out that information technology affects government innovation through directly and indirectly, the one through organization variable. Based on this analysis, policy implications could be inferred as

Figure 10. The Path Model Supported by the Regression Analysis.



※ ( ) = sig

follows.

Achievement of Effective Information Technology

It is verified that we need institutional foundation increasing effective information technology and individual efficiency to establish knowledge government. IT-Engine properly designed for organization provides flexibility which could not be imaginable in the document-based, Analogue-style organization. Since the fact that information technology increases the effectiveness of organization beyond time and space is well understood.

More than 92% of respondents are positive about the fact information system can increase productivity, and particularly more positive when internet network is successfully built in (see Figure 12).

Figure 11. Situation of Information System Usage in the Government.

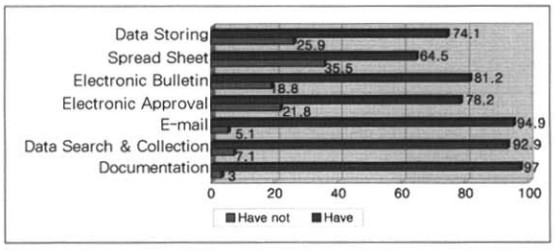
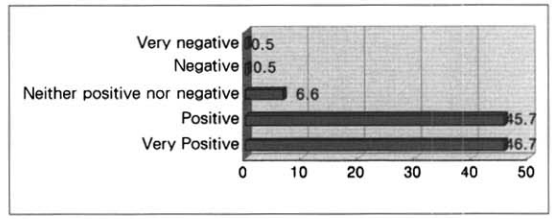


Figure 12. The Influences of Information System on Work Productivity.



Institutional Foundation to Increase the Effectiveness of Organization

It is found that organizational and institutional innovation factors, including team system and merit-based payment, and open personnel management affect organizational innovation. The direct influence of this institutional factor (0.184) is somewhat higher than that of IT-Engine (0.173).

Nevertheless, despite of the significance of merit-based system and open personnel management, these have not been well set up yet. Only 21.8% of organizations have merit-based system. Moreover negative opinion (39.6%) dominated the positive perception (21.4%) about this system. Ha (1996) indicated that government officials are more likely to prefer promotion than the business-like merit-based payment system. Basically government officials do not want to be evaluated, and do not like the 'popping up' in organization. This study also confirms that government officials prefer promotion (26%) and merit-based system throughout the whole department (35.5%), not one by one individually (see Figure 13-4). As the cases of the merit-based payment system for the whole team perform well in the private companies, the government may need to benchmark the mechanism.

The fact that government officials prefer promotion more than individual merit-based payment system would answer the question of why they are negative about open personnel management. Introducing open personnel management to accumulate knowledge and enhance the flexibility of organization is desirable for whole organization, but not for

Figure 13. Perception about the Team and Merit-based System.

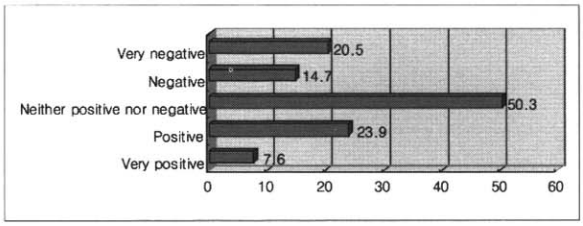


Figure 13-1. The Influence of Team System

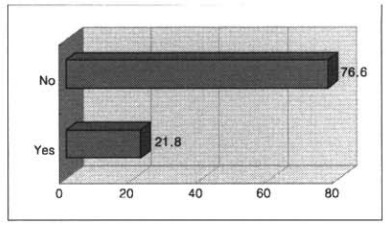


Figure 13-2. The Existence of Merit-based Incentive System

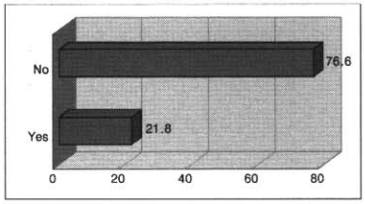


Figure 13-3. Is Influence of Merit-based Incentive System Positive?

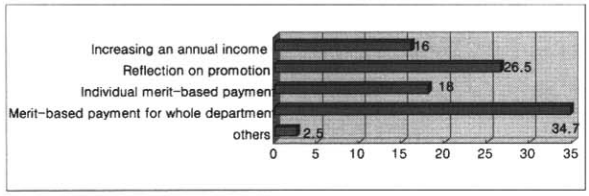


Figure 13-4. Which Factor is the most desirable Incentive System?

individual official (see Figure 13-4). Therefore, to introduce open personnel management, there fac tors should be seriously considered in advance.

Individual Attitude toward Innovation and Organizational Culture

According to the result of the factor analysis, it is found that learning and proliferating knowledge — both by individual and organization — influence organizational innovation (see Figure 14). However, the influence of learning and proliferating knowledge on individual is found more negative than that on organization. This result implies that the incentive system rewarding individual for the knowledge proliferation is not currently sufficient or dose not work well.

Figure 14. Survey on the Individual and Organization- related Variables.

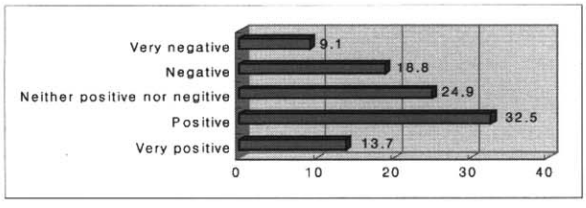


Figure 14-1. Learing Process Influences Individual?

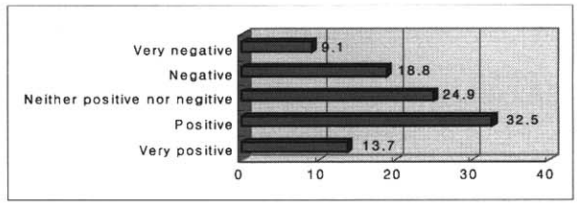


Figure 14-2. Learing Process Influences Individual?

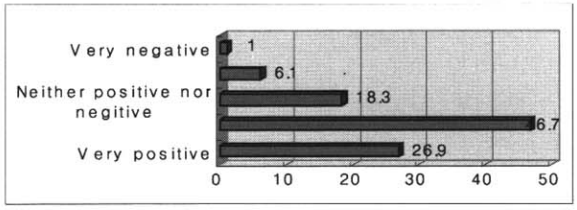


Figure 14-3. Proliferating Knowledge Influences Individual?

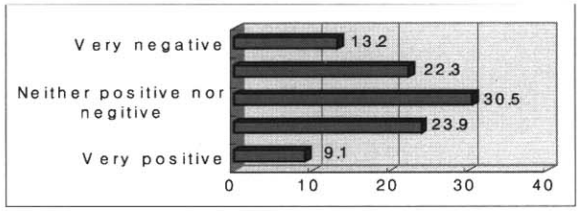
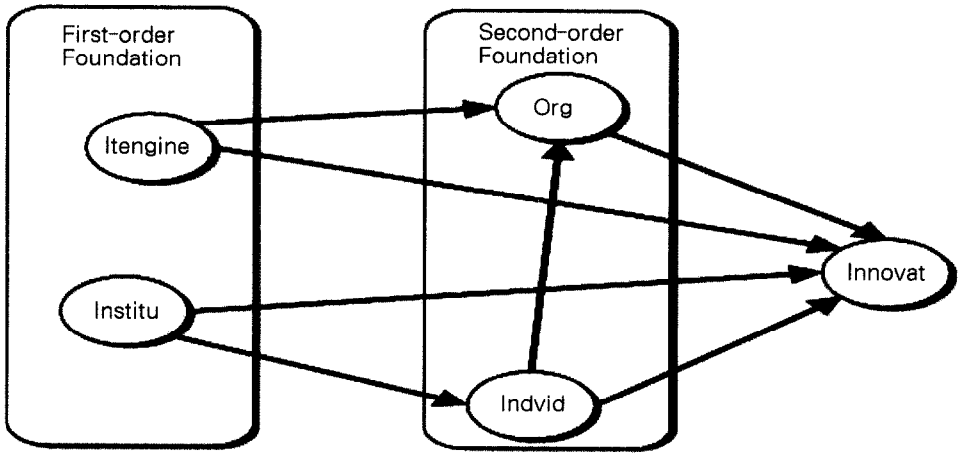


Figure 14-4. Proliferating Knowledge Influences Organization?

Figure 15. The Causal Relationship of Variables: The First and Second-order Foundation for the Government Innovation.



Policy Priority

The above mentioned path analysis shows that all four independent variable affect organization innovation. Since institution and IT-Engine variable work independently, these are required to perform at the same time. Along with this, because organization and individual variable are affected by the IT-Engine and institutional foundation respectively, IT-Engine and institutional foundation can be regarded as the 'first foundation' for organization innovation (see Figure 15). Finally, although the result of organization innovation is affected by all the first and second foundations, but from the strategic viewpoint it could be inferred that innovating individual and organization factors by effectively introducing IT-Engine and the institutional foundation, including the merit-based payment, should be the prior concern.) This result needs to be more cautiously scrutinized with the follow-up study. That is, should we introduce technology and institution first, or should we introduce those when we are ready?

CONCLUSION AND IMPLICATIONS

More than one and half years have passed since President Kim Dae-Jung proclaimed the vision of "Construction of a Creative Knowledge-based Government" in Aug. 15, 1998. This paper has tried to evaluate the progress of the knowledge government with linkage to government innovation. At a time that the knowledge government is a new paradigm, I explore the theoretical framework for the knowledge government and try to analyze empirically the result and efforts in the government to create knowledge government.

According to my empirical analysis, IT-Engine and institutional variables affect organizational innovation by influencing individual and organization. This implies that IT technology and institutional system should be a prior concern for the governmental innovation. In reality, however, the fact that those factors have not been properly built in becomes a serious barrier for the effective knowledge government. Information and knowledge management system, for example, have not sufficiently embedded in our government.

The diverse discussions of model for government innovation have been discontinuous and fragmented. In fact, without sufficient discussion of learning, entrepreneurship, and electronic govern-

ment, we cannot identify the concept of and model for knowledge government. The important thing is that the theories of government innovation should be closely integrated, but should not be dealt with separately. This study could have some significance in the sense that it provides the government with an integral model for knowledge government. It also framed the analytical framework which includes learning, electronic, and the entrepreneurship government.

However, this research has its own limitations and constraints. The first conceivable constraint is a conceptual one. This paper derived the paradigm of the knowledge government from some dimensions of the previous models and defined it as the sharing point of the learning, entrepreneurship and electronic government. Admittedly, some of these concepts are overlapping and thus interchangeable. In fact, the electronic and knowledge government have many comparable aspects, just like information and knowledge do. Nevertheless, this study tries to show that knowledge government is closely related concept with the previous models of government reform, and evaluate some critical factors of the knowledge government.

Also, this paper excludes the basic philosophical discourse of interface with citizens, which includes freedom, democracy, and equity. After the mid-18th century, numerous Enlightenment philosophers dreamed of realization of "vision and social idea" with the "freedom, equality, and philanthropy." Habermas emphasized the continuity of imperfect project through the discourse theory. This philosophical discussion should be related to the realization of electronic democracy driven by information technology. But I, in this research, exclude this basic discourse because of the lack of space and the need to concentrate on the topic pertain to this study.

This paper focuses on government management system in terms of 'knowledge and productivity,' and performed empirical research accordingly.

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