

Urban E-Government Initiatives and Environmental Decision Performance in Korea

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ABSTRACT

Although e-government initiatives have been credited as engines of government reform, empirical evidence is insufficient to determine their effects on public sector performance. To explore the impact of e-government on local governance, this article examines how e-government initiatives influence the perceived performance of environmental decision making in an urban context and what organizational and contextual factors affect Web-aided decision performance. Data were collected from the content analysis of city government Web sites and a nationwide survey of city officials in Korea. Findings from path analysis show that (1) information technology leadership of senior management and Web site quality are key to decision intelligence, quality, and speed and (2) e-government Web divide, a gap in the capability of city Web sites to support public service delivery and democratic interaction, translates into disparities in environmental decision performance across cities. Additionally, environmental activism is a significant factor shaping the impact of e-government on environmental decision making. E-government initiatives contribute to local governance performance, but their impacts vary, depending on Web site quality and the entrepreneurial leadership of public managers.

INTRODUCTION

E-government initiatives embracing new Web technologies as tools for public service delivery and democratic participation have become a key component of public sector reform worldwide. The Bush Administration, for example, enacted the E-government Act in 2002 and announced E-government initiatives as a crucial part of the President's Management Agenda. Launched in 2003, the Office of E-Government has since orchestrated e-government efforts across agencies, emphasizing the Federal Enterprise Architecture and e-government performance management (Office of Management and Budget 2003). Considering information technology (IT) as a core element of the "Modernizing Government" initiative, the UK government also launched "Directgov" in 2005, a new

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government Web portal providing citizens with customized access to public information, and announced a “Transformational Government” strategy to facilitate more citizen-oriented, online public service delivery (Cabinet Office 2005). Newly democratized countries are engaged in such efforts as well. The Korean government launched the “G4C (Government for Citizens)” portal system for administrative service transactions in 2002 and, in 2006, a public participation portal that enables citizens to engage in policy discussion and to present their ideas to public policy makers online. Recently, the “U-Korea Master Plan” was developed, shifting a focus from wired e-government to wireless mobile government, seeking to provide public services seamlessly through the ubiquitous computing networks (Ministry of Information Communication 2006).

One important issue in e-government studies is whether government Web technologies impact public sector performance. Although e-government initiatives have been credited as engines of governmental reform, empirical evidence is insufficient to determine their effects on public agency performance.¹ Some researchers have recently assessed how agency Web sites may help improve public service delivery, citizen participation, and trust in government (La Porte, Demchak, and de Jong 2002; Scott 2006; Tolbert and Mossberger 2006; West 2005). Nevertheless, not only are studies on the impact of e-government Web sites very limited, but many of them are based mostly on speculative reasoning, rather than empirical analysis with rigorous methodologies (Musso, Weare, and Hale 2000; Norris and Moon 2005). Thus, it remains unclear as to whether e-government initiatives make a substantive contribution to public sector performance (Moon 2002).

To fill this gap, this article explores the effects of e-government initiatives on public sector performance, focusing on urban environmental decision making in Korea, which has recently emerged as one of the global leaders in e-government. According to the 2005 global e-government assessment by the United Nations, Korea was ranked number five among 191 countries in its Web features, information infrastructure, and IT human capital (United Nations 2005). At the municipal level, the capital city Seoul was cited as the best e-government in the world (Holzer and Kim 2005). As a leader in e-government, Korea provides a good setting for investigating the potential impact of new Web technologies on governance performance (Kim and Lee 2006).

In addition to e-government, urban environmental management has attracted wide attention from academics, practitioners, and citizens because pollution has often had a direct impact on the quality of life in urban settings. In particular, recent democratization in such countries as Korea and Taiwan brought institutional changes that have enabled citizens to participate in environmental decision processes and have motivated local elected officials to be more responsive to their constituencies’ environmental demands (Lim and Tang 2002; Tang and Tang 1997, 1999, 2006). E-government initiatives can potentially provide efficient channels for local stakeholders to participate in environmental decision making, leading to enhanced decision intelligence and quality.

1 In the MIS literature, many studies are available on the impact of conventional IT—such as DSS, group support systems, or database systems—on the performance of organizational decision making and knowledge management. But the literature is very scant on the impact of emerging Internet technologies on public sector decision making. Internet technologies are different from database or decision technologies in that they have tremendous interactive potential to support multiway communications with many stakeholders across times and places, whereas database or decision technologies can process data quickly but lack communicative potential. Thus, it is necessary to examine whether e-government initiatives employing interactive Web technologies impact the performance of public sector decision making.

E-government initiatives, however, may have divergent impacts on environmental decision making, depending on the technological, social, and political conditions of the local community. In Korea and many other countries, municipalities have in recent years been empowered to set their own policy priorities, creating variations in the utilization of information and communication technologies (ICTs). Municipal governments, for example, may differ in their technological capabilities to provide up-to-date environmental information to the public. Many social, political, and organizational factors may also cause a digital divide across communities, making performance gaps among them even wider. Additionally, despite the presence of multiple Web-based communication channels, the technology's potential may be dampened when a city government lacks entrepreneurial leadership that encourages its strategic use for democratic deliberation. The technology will also have a limited impact if no institutional incentives exist for online participation by citizens.

To illustrate the complex dynamics of e-government and urban environmental decision making, our research focuses on the following questions: (1) whether and how do e-government initiatives influence the perceived performance of environmental decision making in an urban context? and (2) what kinds of organizational, social, and political factors in a community affect the Web-aided decision performance?

To answer these questions, the next section introduces the debate on how Web technologies impact citizen participation and decision performance. This is followed by a discussion on how the management information system (MIS), organization theory, and environmental politics and behaviors literatures can help develop hypotheses connecting Web quality and other contextual factors to environmental decision performance. The fourth section describes a nationwide survey of city officials in Korea and the results of path analysis on the collected data. The final section discusses policy implications of the results.

WEB TECHNOLOGIES, CITIZEN PARTICIPATION, AND DECISION PERFORMANCE

E-government initiatives involve a paradigmatic shift from a Weberian form of bureaucracy to new forms of governing institutions based on an integrated information and communications infrastructure (Ho 2002). Despite a variety of perspectives and approaches, e-government initiatives emphasize the following common points: (1) managerial efficiency and (2) G2G (government to government interaction), G2C (government to citizens interaction), and G2B (government to business interaction) (Office of Management and Budget 2002). E-government also marks a turning point in public agencies' use of IT. E-government innovations go beyond internal managerial efficiency as underscored by the traditional MIS perspective, to focusing on interactive governance in which citizens are actively engaged in public decision-making processes (Bellamy and Taylor 1998; Frissen 1997; Ho 2002; Scavo and Shi 1999; Seneviratne 1999). Government Web sites and other Internet-based applications, for example, can provide the public with access to information on public policies and administrative services. They can also expedite responses to requests for specific services. Such Web-based channels as e-mail listserves, e-bulletin boards, video conferencing systems, and e-forums can help citizens access policy information, engage in policy deliberation, and contact key decision makers (Brewer, Neubauer, and Ceiselhart 2006; Musso, Weare, and Hale 2000; Thomas and Streib 2005).

The rise of e-government has triggered spirited debates on the impact of ICTs on public sector governance. A key issue in these debates concerns how ICTs may potentially shape public decision-making processes and thus decision performance. The e-government

literature suggests two competing views on the issue-reinforcement theory and mobilization theory.

Reinforcement theory argues that ICTs support prevailing interests in extant policy-making systems without changing their fundamental structures. ICTs provide elites and political activists with additional resources to further strengthen their influence in public decision-making processes (Norris 2001). Davis (1999) argues that the Internet provides an additional political platform to already active citizens or groups, rather than stimulate new kinds of political engagement by apathetic citizens. Weare, Musso, and Hale (1999) find evidence that Web site adoption by municipalities is conditioned by their existing social and demographic conditions such as socioeconomic status, social elite concentration, and information infrastructure in the local community. In these ways, ICTs may further empower the wealthy and the politically connected while further alienating the socially disadvantaged and indifferent citizens from policy-making processes (Norris 2001).

In contrast, mobilization theory suggests that the Internet helps create new opportunities for the politically marginalized to amplify their voices in policy processes (Norris 2001). According to Becker (2001), ICTs allow larger numbers of citizens across greater distances to rapidly access government information and communicate their opinions to political leaders. This capacity of ICTs helps expand plebiscitary opportunities such as citizens' initiatives or referenda, which empower citizens to be direct decision makers. Others emphasize the role of ICTs in fostering policy deliberations among the public. Online policy forums, for example, provide opportunities for citizens to ponder possible policy alternatives, exchange their opinions with others, and reach consensus through dialogue and persuasion before making final policy decisions (Grossman 1995; London 1995; Wilhelm 1999). Stanley and Weare (2004) find evidence that a decision-making forum on an agency Web site had some mobilizing effects that helped involve politically disengaged citizens in policy deliberation. Beierle and Cahill (2002) also reports that a Web-based forum on Public Involvement Policy, which had been initiated by the US Environmental Protection Agency in 2001, successfully solicited broad civic inputs from a variety of sources. Other theorists note ICTs' equalizing effects in promoting pluralist competition in public policy making. Internet-based communication, for example, can dramatically reduce the costs for organizing collective action, thus making it easier for citizens and grassroots groups that lack resources to get organized in affecting local decision-making processes (Bimber 2003; O'Lear 1999).

Overall, empirical studies are still too limited, and often inconsistent, to confirm either reinforcement or mobilization theory. Particularly, Weare (2002) criticizes the dichotomy as fruitless, emphasizing that the two contrasting effects are not mutually exclusive. Both reinforcing and mobilizing phenomena can simultaneously occur in different occasions because the Internet has "multidimensional" features that support different types of communication and participation activities. To examine empirically complicated causal links between ICTs and existing governance systems, the scholarly communities must pursue a variety of research programs with different foci, ranging from the design of Web technologies to the technologies' impact on individual political attitudes, decision-making processes, and outcomes (Weare 2002).

In an attempt to explicate such complicated mechanisms, this research focuses on e-government's impact on decision outcomes at the local level. Some e-government initiatives seek to realize democratic potentials of Web technologies as supported by mobilization theory. Many governments across the world has aggressively adopted

multiple e-democracy applications that support different types of civic engagement in decision making such as access to public information, public opinion polls, e-voting, deliberative forums, and direct channels to talk to city officials (Clift 2004; Organization for Economic Co-operation and Development 2003). An underlying assumption of e-government initiatives is that Internet-based civic engagement may help improve public decision making (Brewer, Neubauer, and Ceiselhart 2006). But it remains unclear whether such expanded opportunities for online participation lead to enhanced decision intelligence and quality.

Easy access to government online may help provide better civic inputs into decision making, enabling public officials to obtain better information on local situations and to identify citizens' demands. Citizens' local knowledge, preferences, and commitment to community objectives help design better alternatives for policy decisions (Kellogg and Mathur 2003; Scott 2006). For example, neighborhood pollution data provided online may help educate citizens on technical and scientific issues relevant to environmental policy making (Reeder 2001; Shulman et al. 2003). Decision quality can potentially be improved by incorporating scientifically grounded public values and judgment into environmental decision making (Shulman et al. 2003).

Yet, widened public access may generate information overload, overwhelm decision makers with useless information, and impede timely decisions. Additionally, citizens' voices amplified in local decision making through online channels may be just expressions of parochial self-interests lacking a balanced sense of the community interest. In this regard, online civic engagement may actually lead to inferior decisions.

Thus, it is important to examine whether public officials feel that interactions with citizens through e-government help improve decision-making performance, in terms of decision intelligence, quality of alternatives, and decision speed. It is also important to explicate how government Web quality and other contextual factors help shape e-government's impact on local decision-making performance. In the following section, we explain how insights from the MIS, organization theory, and environmental politics and behaviors literatures can help develop hypotheses relating various factors to environmental decision performance.

WEB QUALITY, CONTEXTUAL FACTORS, AND ENVIRONMENTAL DECISION PERFORMANCE

The MIS and organization theory literatures provide useful concepts for understanding the impact of ICTs on decision performance. Huber's (1990) work, for example, suggests that IT may have a positive impact on organizational intelligence, decision quality, and decision speed. Some scholars empirically examine influences of ICTs on the acquisition of decision information (Marshall, Prusak, and Shpilberg 1996), whereas others focus on their effects on decision quality (Chidambaram and Jones 1993; Gallupe, DeSanctis, and Dickson 1988) or decision speed (Gualtieri 1998; Judge and Miller 1991). Marshall, Prusak, and Shpilberg (1996), for instance, show that ICTs help store, transfer, and recreate organizational knowledge for decision making. Gallupe, DeSanctis, and Dickson (1988) find that group decision support systems (DSS) significantly enhance decision quality, especially when the group deals with highly difficult tasks. Chidambaram and Jones (1993) also provide evidence suggesting that electronic meeting systems improve the quality of decision processes and help generate solutions by facilitating communication among team members dispersed in different locations. Gualtieri (1998), however, warns

that new ICTs such as the Internet may reduce decision speed by causing information overload.

In contrast to the above studies focusing on only one dimension of decision making, Teng and Calhoun (1996) and Wood (2000) examine ICTs' impact on different facets of decision performance. Based on these previous studies, our research examines (1) the degree to which more useful information for decisions is collected (i.e., decision intelligence²), (2) the degree to which better alternatives are designed (i.e., decision quality), and (3) the speed in which the overall decision process proceeds (i.e., decision speed).

A local government's use of ITs is affected by characteristics of the local community (Dutton and Danziger 1982; Guthrie 1991). Sociopolitical contexts and institutional arrangements in which users are embedded influence the technology enactment process by which they perceive, adopt, design, and utilize the technology (Fountain 2001; Kim and Lee 2006). In our research, we focus on several factors that are commonly explored in the literature—IT leadership of senior management, e-government Web quality, seriousness of local environmental pollution, environmental activism, and salience of environmental issues in local elections.

IT Leadership

IT leadership refers to the support of senior management, including top managers and division heads, for the use of ICTs to improve on organizational processes and interactions with multiple stakeholders. When informed by an understanding of the advantages and challenges of ICTs, IT leadership can play an important role in developing more advanced Web sites. In addition, a key element of public leadership in the Information Age is a strategic vision to exploit ICTs for setting the direction for public sector reform, community development, and digital democracy (Harvard Policy Group 2000). Those leaders who understand the strategic value of Web-based communication with citizens will be more likely to support the development of advanced Web sites to facilitate online service delivery and citizen participation. Park and Baek (2001) find that IT leadership of top elected officials in a community helps improve the Web quality of municipal governments in civic service transactions. Leadership empowers IT departments by allocating more resources and encouraging IT personnel to design citizen-oriented Web applications with user-friendly interfaces (Park and Baek 2001). In their analysis of state government Web sites in the United States, Beierle and Cahill (2000) find that senior managers' support is key to the design of Web sites that provide the public with rich environmental information and create online opportunities for civic engagement in environmental policy making.

H₁ The stronger the IT leadership of a city's senior management, the more likely is the city to develop high-quality Web sites for environmental management.

As argued by Watts (2001), top management plays three critical roles in the success of IT-enabled innovations—as disseminators, disturbance handlers, and resource allocators. Top management leadership is key to communicating IT visions and values to an organization and its external environment, managing conflicts and unexpected problems caused by new

2 More specifically, decision intelligence refers to the degree to which an organization obtains and utilizes timely information and knowledge to design better alternatives, as well as to identify problems, opportunities, and challenges in making optimal decisions to address a given issue.

technologies, and allocating financial and human resources for maximizing IT effectiveness (Watts 2001). Bassellier, Benbasat, and Reich (2001) argue that public managers' IT knowledge and understanding of its values enable them to better align the technology with organizational goals, leading to improved outcomes. In addition, leadership helps diffuse new technologies among organizational members and incorporate them into core work activities (Chatterjee, Grewal, and Sambamurthy 2002; Cooper and Zmud 1990; Purvis, Sambamurthy, and Zmud 2001). Top management championship helps define rules, norms, and values about using Web technologies for organizational goals and work processes (Chatterjee, Grewal, and Sambamurthy 2002). It also makes cultural interventions to forge an organizational climate that supports ICT-enabled reforms, resulting in enhanced organizational performance in the public sector (Hennessey 1998). Brown, O'Toole, and Brudney (1998) find that in the public sector, leadership can help improve decision quality by stimulating organizational members' commitment to IT applications.

- H₂ The stronger the IT leadership of a city's senior management, the higher is the city's environmental decision quality.

Leadership activities, however, cannot be confined to an agency's internal management. They also need to seek ways to empower citizens to effectively use Web technologies in their interactions with officials. Leadership can help cultivate an information culture by promoting IT literacy among the public. For instance, government leaders can initiate educational programs to help the public understand the values of ICTs in their daily lives, businesses, and transactions with governments. Leadership also helps build information infrastructure in a community to offer citizens technical access to government information. Some local governments in Korea have taken initiatives to provide free PCs, high-speed Internet services, and home pages for some villages that did not have an IT infrastructure. They have also provided community information centers where citizens who cannot afford PCs can use public computers to access government Web sites (Ulsan Metropolitan Government 2002). In Santa Monica, CA, the city government adopted the famous Public Electronic Network. By providing public access to computers, the network enabled citizens to discuss the homeless issue online, leading to the adoption of an alternative policy (Docter and Dutton 1998).

Kouzmin and Korac-Kakadadse (2002) point out that interactive IT leadership in public agencies empowers a wide range of external stakeholders to access information on government operations, which in turn generates a need for them to share decision roles and responsibilities with officials. Park and Baek (2001) find that IT leadership of senior management in a municipal government leads to an increased use of its Web site by citizens for interacting with public officials. In communities with stronger IT leadership, citizens are more likely to use a government Web site to obtain environmental information, to suggest ideas for environmental decisions, and to report illegal polluters. These citizen inputs provide public managers with useful information for environmental decision making.

- H₃ The stronger the IT leadership of a city's senior management, the more likely is the city government to obtain useful online inputs for environmental decision making.

E-Government Web Quality

E-government Web quality refers to the degree to which the Web site provides (1) public access to government information, (2) smooth civic service transactions, and (3)

interactive channels such as cyber policy forums or e-bulletin boards for citizens to deliberate on policy issues or to make suggestions to public managers. E-government equipped with more diverse and advanced types of communication channels may facilitate citizen-government interactions, leading to enhanced decision intelligence, quality, and speed.

When multiple stakeholders are involved in an environmental problem, public managers need to understand their divergent interests and values in search for acceptable solutions (Mintzberg 1996). Direct communication through the Internet helps decision makers to hear a variety of voices from stakeholders (local citizens, civic groups, and experts), without the filtering by intermediate organizations (Coleman 1999; Richard 1999).

Decision-related information forms the basis on which public managers understand a policy problem, analyze its causes, identify risks, and construct alternatives (Bardach 1996; DeLone and McLean 1992; Huber 1990). With the aid of ICTs, decision makers can collect more timely, accurate, and comprehensive information for operational and managerial decision making (Huber 1990; Teng and Calhoun 1996; Wiig 2002). ITs may also improve forecast accuracy, speed up decisions, and facilitate stakeholder participation in decisions (Keller and Staelin 1987; Teng and Calhoun 1996). In turn, ICT-aided intelligence and analytical skills of decision makers help generate higher quality alternatives (Gallupe, DeSanctis, and Dickson 1988; Molloy and Schwenk 1995). Heintze and Bretschneider (2000) finds that IT adoption by public agencies significantly improves the quality of organizational decisions by engaging more people and as a result bringing more ideas into decision-making processes. Wood (2000) finds that public managers perceive the Internet as a kind of decision support technology and that their use of the Internet improves the quality of their decisions.

Different types of Web-based communication channels facilitate the utilization of different types and qualities of civic inputs in decision making. Communication channels such as letters, phones, e-mail, and video conferencing differ in their capabilities to communicate social cues and to overcome situational constraints such as time, location, and distance (Rice 1992). Certain channels can better communicate rich information clearly, whereas others transmit equivocal messages (Daft, Lengel, and Trevino 1987). In other words, the characteristics of a communication medium affect the contents and quality of information that it conveys. Thus, official Web sites incorporating more diverse types of communication channels enable public managers to gain richer information, which may lead them to design better alternatives to address policy problems.

- H₄ The higher the quality of its official Web site, the more likely is the city government to obtain useful online inputs for environmental decision making.
- H₅ The more useful online inputs for environmental decision making a city government obtains, the higher is its environmental decision quality.
- H₆ The higher the quality of its official Web site, the higher is the city's environmental decision quality.

The existing literature is not consistent on the effects of Web technologies on decision speed. Many studies (Huber 1990; Molloy and Schwenk 1995; Teng and Calhoun 1996) point out the positive impact of ICTs on speeding up decision processes by helping decision makers identify problems and grasp stakeholders' views quickly. Nevertheless, a Web-based system may also create information overload, resulting in public officials

taking more time to reach final decisions. Web-based communications often cause a deluge of information from the public, making the policy environment more complicated and in turn increasing the time and resources needed for decision making (Gualtieri 1998). From these debates, two competing hypotheses can be drawn as follows:

- H₇ The higher the quality of a city's official Web site, the higher is the city's speed in making environmental decisions.
- H₈ Alternatively, the higher the quality of a city's official Web site, the lower is the city's speed in making environmental decisions.

Seriousness of Environmental Pollution

Many studies on environmental behaviors (Dunlap and Scarce 1991; Inglehart 1995; Johnson and Scicchitano 2000; Lubell 2002; Pierce, Lovrich, and Matsuoka 1990) suggest that an individual's perception of pollution leads to "proenvironmental" behaviors. Pro-environmental activities include writing letters to public officials, making donations to environmental NGOs, attending public hearings on environmental issues, or voting for representatives who support stricter regulatory standards (Dunlap and Scarce 1991; Johnson and Scicchitano 2000). In a cross-society analysis on public support for environmental protection, Inglehart (1995) finds that the level of pollution in a society significantly affects proenvironmental behaviors in the population. Dunlap and Scarce (1991) report that the more citizens perceive pollution problems as serious and feel them as a dangerous threat to their lives, the more they support strong environmental regulation and commit to green consumerism (Dunlap and Scarce 1991; Lubell 2002). Johnson and Scicchitano (2000) also find that the public's perceptions of risks from environmental hazards or potential harms—for example, tap water contamination or nuclear power plants—lead to their willingness to take political actions.

When Web-based channels are available for citizens in these communities to convey their ideas to officials, proenvironmental activities will gain steam. Compared with offline channels, Internet-based communication helps reduce time and efforts the public take to express their environmental concerns in policy making (Bimber 1998, 2003; Davis 1999). Thus, citizens in a community suffering from serious pollution are more likely to suggest useful ideas and information for environmental protection and report illegal polluters via e-government Web sites. This contributes to information acquisition by public managers for decision making.

- H₉ The more serious a city's environmental pollution, the more likely is the city government to obtain useful online inputs for environmental decision making.

Local Environmental Activism

Environmental groups' activism empowers local communities to protest against developmental policies that have adverse environmental effects. Environmental groups may employ multiple strategies to influence public policy making (Dalton, Recchia, and Rohrschneider 2003)—legal challenges against enforcement slack, lobbying legislators (Tang and Tang 2000), drawing attention from the media (Tang and Tang 1999, 2004), and organizing street protests and demonstrations (Lim and Tang 2002). They may also engage in policy competition with government (Hong 2002) by developing alternative

proposals to existing policies and by developing campaigns and educational projects to help awaken the public's environmental concerns (Dunlap and Scarce 1991; Park 2002).

The rise of the Internet offers a valuable arena for environmental activists to exert their influence. Through the cyberspace, environmental activists can organize political dissent and civil disobedience against a public policy (Mancusi-Materi 1999). As in the case of the White House's home page crash in 1999, environmental groups organized cyber protests by disrupting government Web sites. Activists at different locations can connect to a targeted government Web site simultaneously to overload the server or utilize "e-mail bombing" to overwhelm the site (Brunsting and Postmes 2002; Mancusi-Materi 1999). Grassroots environmental groups isolated in a local community can also utilize e-mail communication and online forums to create cross-regional networks of political support for their local agenda, enhancing their influence on local decision making (O'Lear 1999). Thus, in regions where environmental activism is stronger, civic groups and citizens are more likely to go online and suggest useful online inputs for environmental decision making.

H₁₀ The stronger a city's environmental activism, the more likely is the city government to obtain useful online inputs for environmental decision making.

Salience of Environmental Issues in Local Politics

When an environmental issue becomes politicized as a major electoral issue in local politics, it helps awaken the environmental consciousness of the public or sharpen civic concerns for environmental problems. For example, the 1996 national election in Korea spotlighted an environmental conflict between two regional communities, Pusan and Taegu, over a plan to build a national industrial complex. The election hardened Pusan citizens' sentiment to oppose the plan that would have created serious water pollution in the community (Lim and Tang 2002). In another case, Lee Myong Baak, ex-candidate for Seoul city mayor in the 2002 local election, brought up the issue of restoring the Cheonggechon River, once a major waterway that cut through downtown but then in ruin. The issue of revitalizing the river contributed to awakening civic concerns about redesigning the city for sustainable development.

Likewise, the emergence of an environmental agenda in local politics triggers or reinforces the local public's environmental concerns (Tang and Tang 2004). As a result, citizens are more likely to take political action to pressure the local government to address environmental protection issues. Citizens are likely to support stronger pollution regulation, to make more environmental policy suggestions, and to give officials more useful information about illegal polluters or environmental conditions in their neighborhoods.

H₁₁ The more politically important environmental issues are in a city, the more likely the city government is to obtain useful online inputs for environmental decision making.

MEASUREMENT, DATA COLLECTION, AND ANALYSIS

To test the hypotheses, a path model is designed with four exogenous (independent) variables and three endogenous variables (two intervening variables and a dependent variable). The exogenous variables include the seriousness of environmental pollution in a city, political importance of environmental issues in local elections, local environmental

activism, and IT leadership. These variables are hypothesized to affect one intervening variable, Web-aided decision intelligence. In addition, IT leadership is hypothesized to affect e-government Web quality, another intervening variable. In turn, Web quality, decision intelligence, and IT leadership are hypothesized to affect environmental decision quality.

The hypotheses regarding decision speed are excluded from the path model and tested separately. Decision speed is not hypothesized to be causally related to other endogenous variables, so it is not included in the path model. Correlation analysis is attempted to test the hypotheses about the impact of Web quality on decision speed.

E-government Web quality was measured by content analysis using our Web evaluation system based on 86 criteria. From the period of April to September 2003, content analysis was conducted on the official Web sites of all 81 city governments in Korea, with a special focus on features related to environmental service delivery and participation. The Web sites of the other two municipal governments that were promoted to city status in October 2003 were not included in the analysis. The analysis was done twice on the same Web site to reflect any upgrades done during the period as well as to avoid measurement errors. Employing binary coding for most of the items, the analysis summed all the coded scores for a Web site with the same weight in order to generate a single value representing the Web site's overall quality. The coding resulted in a range of values—from the highest at 70 to the lowest at 22. To test the reliability of the Web quality measures, Cronbach's alpha analysis was conducted. The analysis shows that highest reliability was achieved when all indicators are combined into a single measure of overall Web quality. See Appendix 1 for a discussion of the conceptual and methodological issues related to our Web quality measures. See Appendix 2 for a detailed breakdown of the various dimensions of Web quality.

The other variables were measured by survey questions that employed a five-point Likert scale, ranging from strongly disagree to strongly agree (see Appendix 3). Some of the variables were measured by a single item, whereas others have multiple composite indices. Variables measured by multiple indices include environmental activism (three items), IT leadership (six items), decision intelligence (two items), and decision quality (two items). Our data collection was based on a nationwide survey of city officials in charge of environmental policy and management.³ From September to November in 2003, each set of survey questionnaires was mailed to five environmental officials per city randomly selected from all city governments around the country. Out of 395 questionnaires distributed to the officials in 79 cities, 315 valid instruments were completed and returned.⁴ The final return rate was about 80%. At least one instrument was obtained from each of the 74 cities. Officials in the remaining five cities did not return any questionnaires.

3 We directly mailed survey questionnaires to the environmental department in each city. On the cover of each survey questionnaire, it was indicated that the questionnaire should be distributed to officials in charge of environmental management and decision making. The survey implementation was helped by a nationwide network of high-level public officials, who we successfully contacted, who had passed the third local civil service exams. Members of the network in each city helped return the completed questionnaires that had been distributed to the environmental department.

4 The 315 sample size covers about 11% of the population, the total number of environmental officials in all cities around the country. We estimated the size of the population because we could not obtain direct information about it. From the Web-content analysis, we were able to obtain data on the number of city officials in environmental divisions in 45 randomly chosen cities out of 81. The total number of environmental officials in the 45 cities is 1,601 and the mean value is 35. By multiplying the mean value by the number of all cities, we estimated the population size, which is approximately 2,800. According to this estimation, the returned sample covers more than 10% of the entire population.

Test for Reliability and Validity of Survey Measures

To test the internal reliability and validity of the composite survey measures, Cronbach's alpha and factor analysis were employed, respectively. Alpha values of all the measures were over .6, the minimum level of acceptance (Garson 2004).⁵

In order to test construct validity and unidimensionality of multiple composite measures, the research undertook both confirmatory factor analysis (CFA) and exploratory factor analysis (EFA). All the composite items were checked to see if they would pass the rigorous test of CFA. For the items that failed to pass or could not be included in the test, EFA was conducted to check if they had construct validity. The results of factor analysis validated all the items as appropriate measures indicating each of the intended variables.⁶ At the end, the composite indices were averaged into a single score representing value of each of the variables and then entered into statistical analysis.

Statistical Analysis

Amos 5.0 was employed for statistical analysis. To test the hypotheses, path analysis was conducted with the maximum likelihood estimation (MLE) method, a standard method for testing a path or structural equation model.⁷ Test statistics for the goodness of fit of a proposed model, which shows whether a model as a whole is good enough to be acceptable, include many indices such as model chi-square, goodness-of-fit index (GFI), adjusted goodness-of-fit index (AGFI), root mean square residuals (RMR), root mean square error of approximation (RMESA), and so forth. The goodness of fit of a model is thus determined on the basis of not just one of them but a comprehensive consideration of the several fitness indices (Bohrnstedt and Knoke 1994; Garson 2004; Klein 1998).

While conducting the analysis, the multivariate normality assumption for path analysis appeared to have been violated. Mardia's coefficient that represents the multivariate kurtosis

5 Among them, those of composite items for two constructs were over .80—IT leadership ($\alpha = .86$) and decision quality ($\alpha = .81$). Those for the other two constructs—Web-based inputs for decisions ($\alpha = .679$) and environmental activism ($\alpha = .646$)—turned out to be slightly lower than .7, the popular cutoff level in the social sciences (Nunnally 1978). The two constructs, however, were retained because they are at least over the minimum acceptance level as described above.

6 To conduct CFA for the dependent variables, a two-factor model was designed and tested with the variables of decision intelligence and decision quality. The test result showed that the model was an extremely good fit, as evidenced by several indices for goodness of fit of the CFA model (model chi-square = 2.6, $df = 1$, $p = 1.06$, RMR = .006, GFI = .996, AGFI = .959). Another two-factor model was designed to conduct CFA for independent variables—environmental activism and IT leadership. The result showed that model chi-square was 148.28 ($df = 26$), which was significant at less than .00 level (p value = .0000), rejecting the model. Yet other fitness indices showed that the model is quite a good fit (RMR = .039, GFI = .901, AGFI = 829). Although the result showed that the model is within the acceptable range, EFA was tried to ensure that they have validity as composite indices. For EFA, principal component analysis was conducted to examine which items converged together on a factor by employing the Varimax rotation method. From the result of the analysis, two factors were drawn, all the eigenvalues of which were over 1. A factor loading of 0.5 was employed as a cutoff level to group the items. The items that were expected to be relevant with one another exactly converged on the same factor, proving that all the items are validated as appropriate measures indicating each of the intended variables.

7 In conducting path analysis, we have a choice either to use individual survey response as a unit of analysis or to create a single value representing the decision performance of a city government by averaging survey responses that were returned from the same city government. We did not choose to create the aggregate measures in order to avoid the potential bias stemming from small sample size. Path analysis using MLE is very sensitive to sample size, requiring 200 cases at the minimum in order to estimate without creating bias. If we used the averaged values, the sample size would be reduced to 74, the same number as that of cities that returned survey questionnaires. So the estimation could not be free from the potential bias caused by the small sample size. For a discussion on the bias created by small sample size in a path model using MLE, see Klein (1998).

value was 8.0, which means there was significant nonnormality. Nonnormality may bias the MLE estimates in two ways: on the one hand, it may mislead researchers to Type I error (rejecting a good model that should not be rejected) by inflating the model chi-square values, and on the other hand, it may underestimate standard errors, thus biasing the statistical significance of the regression coefficient for each variable (Garson 2004; Klein 1998; Smith, Heger, and Eakn 2001). Despite the possible bias introduced by nonnormality in testing the model, the model chi-square value appeared to be insignificant (chi-square = 8.74, degree of freedom [df] = 6, p value = 1.90) at the .05 level, showing that the model is still acceptable. Values of other fitness measures also supported this result. The GFI and AGFI values were .992 and .963, whereas the popular cutoff level in the social sciences is 0.9 (Bohrnstedt and Knoke 1994; Klein 1998), implying that the model was an extremely good fit.⁸

As a result of the analysis, seven regression coefficients out of nine in total appeared to be significant at the .05 level.⁹

Figure 1 marks significant relations with solid lines and insignificant ones with dotted lines. In addition, numerical scores on all the lines show standardized regression coefficients for each of the parameters. As an endogenous variable, decision intelligence is

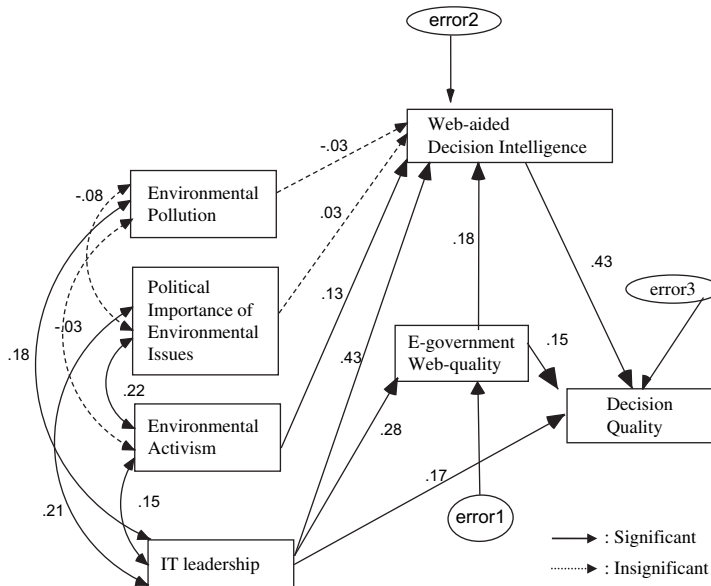
⁸ To detect and correct potential biases caused by nonnormality in the parameter estimation, however, bootstrapped estimation (Bollen and Stine 1993; Garson 2004; Smith, Heger, and Eakn 2001) was attempted with 200 randomly chosen samples from the original 308 samples that entered into the path analysis. The bias column in the Appendix 4 shows the values of biases caused by nonnormality in estimating standard errors for parameters. The SE-SE column shows standard errors of the bootstrapped standard error estimates, whereas the SE-Bias column presents the standard error of the bias estimate. Similar to T statistic in multiple regression, the CR refers to critical ratio that shows the statistical significance of each parameter estimate. A CR value of more than 1.96 means that the parameter estimate is significant at .05 level (Garson 2004). Overall, the biases seemed to be very slight, but the parameter for the causal relation of IT leadership and Web quality appeared to be more biased than any other ones. A comparison of the biased estimates under nonnormality with the bootstrap bias-corrected ones showed that the biases tended to deflate the p value of most of the estimates, while having not affected any regression coefficients as shown in both of the estimate columns. The bootstrap process corrected the problem, which resulted in appropriately raising p values of most estimates. Even considering the corrected p values, however, the estimates that appeared to be significant under nonnormality were still significant at the .05 level. This implies that the biases were not strong enough to mislead this research to accept the insignificant estimates as significant ones in the model (see Appendix 4).

⁹ Sensitivity tests were conducted to examine whether the different dimensions of Web quality create variations in their impacts on perceived decision outcomes. For the test, five additional sets of path analyses were conducted by replacing the overall Web quality variable with the dimensions that passed the reliability test—the two dimensions (administrative service delivery and democratic participation) and the subdimensions (vertical and horizontal interactivity).

The results were consistent across the different sets of analyses. Although slight differences were found in the path coefficients and p values of parameters, significant and insignificant relations were consistent across the analyses (see Appendices 5 and 6). For example, the impact of the democratic participation dimension on decision intelligence and quality are similar in strength to that of the administrative service dimension. This implies that different Web quality dimensions have similar impacts on perceived decision-making performance. The only exception, however, was found in the causality between Web quality and decision intelligence, when vertical interactivity was employed as the Web quality variable (see the bold-faced values in the Appendix 5). While confirmed significant in the other sets of analyses, the causality appeared to be insignificant (path coefficient = 0.93, p = .18) only in the case of vertical interactivity. This result may imply that vertical channels of e-government alone are not enough to affect decision intelligence. E-government may help improve decision intelligence, when providing rich policy information and horizontal channels, as well as vertical channels.

This article does not specifically analyze how each subdimension of Web quality impacts decision making, due to the lack of reliability of some of their indicators—administrative information provision, administrative interactivity, online transaction systems, and policy information provision. Future research needs to develop more robust indicators for these subdimensions and compare how information-oriented and interaction-oriented Web sites may differ in their impacts on decision-making performance.

Figure 1
Result of Path Analysis



directly and significantly associated with IT leadership, Web quality, and environmental activism in the order of strength. In particular, IT leadership is also indirectly associated with decision intelligence through the mediation of Web quality. In terms of total effects that combine the direct and indirect effects of the exogenous variables on the endogenous variable, IT leadership has the strongest effect, followed by Web quality and environmental activism (see table 1).

Decision quality appears to be associated with decision intelligence, IT leadership, and Web quality in the order of strength. Environmental activism is indirectly associated with it through the mediation by decision intelligence. Particularly, IT leadership is also indirectly associated with it in two paths through the mediation both by decision intelligence and by Web quality. In addition, decision intelligence has the strongest total effect, with IT leadership, Web quality, and environmental activism following it in the order of strength.

Finally, correlation analysis was conducted to test the hypotheses regarding the impact of Web quality on decision speed. According to the result, Web quality appeared to have a significant positive correlation with accelerating decision speed (Pearson's correlation coefficient = .257, $p < .0001$), whereas it was not significantly associated with slowing down the speed (Pearson's correlation coefficient = .070, $p < .270$).

KEY FINDINGS AND DISCUSSION

All our hypotheses are supported except the ones connecting environmental pollution and political importance to Web-aided decision intelligence (Hypotheses 9 and 11) and the one connecting Web quality to lowering decision speed (Hypothesis 8).

The results suggest that e-government does affect the perceived performance of urban environmental decision making. Web quality has a positive impact on improving both

Table 1
Standardized Total Effects for Decision Performance

	Environmental Pollution	IT Leadership	Environmental Activism	Political Importance	Web Quality	Decision Intelligence
Web quality	.000	*.280	.000	.000	.000	.000
Decision intelligence	-.030	*.484	*.129	.028	*.176	.000
Decision quality	-.013	*.425	*.056	.012	*.229	*.432

* $p < .05$.

decision intelligence and quality. The better the quality of its official Web site, the more the city government obtains useful information for decision making and enhances decision quality. A well-designed city Web site with multiple communication channels, as well as plenty of policy information, helps overcome information asymmetry between citizens and officials. It also helps citizens develop more mature ideas on policy issues and expedite the process for them to make suggestions to public officials. For example, such channels as online policy forums and Web-based communities offer citizens opportunities to engage in organized discussions and to exchange opinions with one another on various environmental issues (Wilhelm 1999). Increased chances for deliberation enable citizens to develop and provide more thoughtful inputs for public officials to better understand the decision context and diverse stakeholder views, leading them to come up with better policy choices.

In Korea, these Internet-based interactions between citizens and government have been bolstered by institutional and policy changes since the early 1990s. In particular, the revitalization of local electoral competition in 1992 created a political and administrative context that has motivated local elected officials to be more responsive to their constituencies. E-government has often been used as channels for local officials to identify local community needs. An increasing number of local governments have launched cyber policy forums for citizen consultation and Web-based channels for direct communication between citizens and the mayor. In some cities, the mayor's office has adopted standard operating procedures for monitoring online messages, arranging administrative responses to online complaints, and informing citizens about the results of administrative actions. Given Korea's mimetic culture, such practices have been rapidly diffusing all across the country. In addition, the Presidential decree on Public Information Disclosure as well as the E-government Act have encouraged both citizens and public officials to utilize Web-based channels for communication by mandating public officials' responses to online inputs for public service transactions and to civic requests for government information.

IT leadership has the strongest impact on Web-aided decision intelligence—the acquisition of useful decision information through online inputs—both directly and indirectly. The IT initiative of elected or high-level officials in a city forges an atmosphere in the community that encourages citizens to express their voices online. Leadership also helps create institutional arrangements and incentive mechanisms to support e-government systems, to initiate cultural programs to cultivate IT awareness among officials, and to allocate more budget and workforce to improve Web quality so that e-government can feature better channels to communicate with citizens. These lead them to gain more useful inputs for environmental decision making.

Additionally, environmental activism in an urban community facilitates decision intelligence with the aid of e-government. The more environmentally awakened and active the citizens and civic groups are, the more they provide valuable ideas for environmental

decisions through Web-based channels. Such active civic stakeholders tend to use official Web sites more intensely to amplify their voices in environmental decision making.

Significant factors directly influencing decision quality appear to be decision intelligence, IT leadership, and Web quality. The more useful the Web-based inputs for environmental decisions, the better the decisions tend to be. Better quality Web sites and stronger IT leadership also contribute to better decisions. Higher Web quality means that it has well-designed communication channels through which to provide citizens with better chances to comment on the city's environmental policy, which may lead to better decisions. Although not having a direct impact, environmental activism also indirectly contributes to improving decision quality by facilitating useful online inputs for decisions. It is noteworthy that in addition to its direct impact, IT leadership also has an indirect impact on improving decisions in several different ways, as shown in the figure 1. IT leadership indirectly contributes to environmental decisions by facilitating decision intelligence, as well as by helping to improve Web quality. It also influences decision quality through the other sequential path from IT leadership to Web quality, Web quality to decision intelligence, and in turn, decision intelligence to decision quality.

The positive impact of Web quality on the acceleration of decision speed reaffirms the theory that the Internet as a kind of decision technology contributes to speeding up decisions. Although more Web-based channels allow more voices from civic stakeholders in decision making, such advanced decision technologies as the DSS enhance the efficiency of processing immense amounts of information through Web sites. This may help reduce the information overload problem that is likely to be caused by tremendous Web-based inputs. Additionally, public officials can capitalize on Web-based communication channels to get a quick grasp of a variety of stakeholders' opinions on a certain issue, which may lead to speeding up decision processes.

Environmental pollution and salience of environmental issues in local politics appear not to have any significant impact on Web-aided decision intelligence. This implies that the factors encouraging proenvironmental behaviors offline are not necessarily leading to the same behaviors online. The conditions leading to the latter may be different from those to the former. Or, there might be some mediating factors that encourage offline behaviors to go online. This result raises important research questions that should be addressed in the future: (1) Are conditions fostering online proenvironmental behaviors different from those fostering offline behaviors? and (2) What are the mediating factors between offline and online proenvironmental behaviors?

IT leadership might be a key mediator between offline and online behaviors. IT leadership, for example, may help to forge a favorable climate for proenvironmental behaviors in cyberspace by cultivating computer literacy among citizens, providing public access to e-government, and offering them incentives to use Web-based channels to interact with public officials.

Our results also suggest that even in a community where environmental pollution is not serious or does not emerge as a key electoral issue, strong IT leadership and Web quality may facilitate citizen engagement via the Internet, leading to better environmental decision intelligence and quality. Conversely, without IT leadership and high-quality e-government, citizens may not be motivated to go online to express their environmental concerns in local decision making despite serious pollution and its political salience in the city.

Overall, IT leadership and Web quality seem to be the two most influential factors on perceived performance of environmental decision making. IT leadership affects all the

intervening and dependent variables including Web quality, decision intelligence, and decision quality through diverse paths. Web quality also influences decision intelligence, quality, and speed. This suggests that e-government initiatives positively affect the perceived decision performance when it offers multiple Web-based channels that enable citizens to access public information and articulate their ideas in decision-making processes. Additionally, the significant impact of environmental activism implies that political and social factors also affect Web-aided environmental decisions. The relationship between e-government initiatives and environmental decisions is shaped by the social context of a local community.

CONCLUSION

A key issue in e-government is to determine the effect of Web technologies on public sector performance. Although many studies are available about the impact of decision technologies—such as group support systems or DSS—on organizational decision making, the impact of Internet technologies on public sector decision making at the local level has rarely been explored with reliable empirical data.

This study has examined whether and how e-government initiatives and related variables affect the perceived performance of environmental decision making in an urban context. To explore the topic, the research created a conceptual framework, drawing on insights from the literature on MIS, organization theory, and environmental politics and behaviors. The research also collected empirical data through Web-content analysis and a nationwide survey of city officials in South Korea.

Our research provides survey-based evidence that e-government initiatives help improve the perceived performance of urban environmental decision making. Decision making in the public sector context often involves communication-intensive actions because public managers need to grasp, coordinate, and incorporate multiple stakeholder interests into decision processes (Mintzberg 1996). When providing well-designed interactive channels as well as access to rich policy information, e-government helps officials reduce the costs for communication with and coordination among stakeholders. Through a variety of online channels such as cyber forums, online opinion polls, and e-bulletin boards, public officials may efficiently hear different voices from citizens. The broad range of information officials received through these online channels helps officials scan the status of overall urban management. Considering a wide range of information, officials can get a better sense of whether current policy programs are on the right track, to what degree citizens are satisfied with them, and which policies and programs need special attention. In particular, such information is raw, directly provided by citizens, but not filtered, reinterpreted, or edited by the mass media or interest groups (Coleman 1999). Through Web-based channels, officials can gain a clearer sense of citizens' ideas, feelings, and discontents about their policies. In this sense, well-designed e-government helps identify emergent civic needs, design better alternatives, and decide policy priorities for the future.

The Internet has proven an effective tool in several occasions for ordinary citizens to pressure government to better address social issues. A famous example has been the Internet-based civic activities that led to the enactment of the Special Act to Prevent School Violence. In this case, a middle school student, who had been severely beaten by a group of senior students, posted a petition to eradicate school violence on the municipal Web site of Seoul in 2000. The information was rapidly disseminated through the Internet. After subsequent reporting by local newspapers, school violence emerged as a prominent public

policy issue. Many online communities and forums burgeoned on the issue and jointly initiated online signature collection campaigns against school violence. These online events also triggered an offline civic movement, involving a number of civic and grassroots groups. In response to the public outcry, the central government drafted the Act in the following year, which was passed in the National Congress (Cho and Song 2004). As shown in this case, the Internet has recently become a key medium through which ordinary citizens in Korea convey their discontents or suggestions to government bureaucracies. In several incidents, citizen messages swamped the Web site of the Blue House (President's office) or those of public agencies to urge them to properly address social issues, which often resulted in substantive changes to agency behaviors.¹⁰ Cyberspace in Korea has increasingly become a platform for ordinary citizens to influence the conduct of government.

The findings of this study have several policy implications. First, our analysis shows that the Web divide among city governments translates into disparities in their decision intelligence and quality. Local governments may improve their decision performance by embracing rapidly advancing Web technologies to enhance communication between officials and citizens. This will contribute not only to decision performance but also to building civic trust toward government (Tolbert and Mossberger 2006; Welch, Hinnant, and Moon 2005).

Second, IT leadership-training programs are needed to help public managers understand the strategic values of Web technologies. The results of our analysis underscore the critical role of IT leadership for the success of e-government. The way public managers perceive, design, and utilize Web technologies to interact with citizens greatly influences the effectiveness of e-government initiatives. Although adopted by a city government for innovations, Web technologies cannot realize their promised benefits without senior managers' support. To realize the potential of IT, leadership efforts should address potential organizational disruptions caused by new Web technologies and help align them with existing governance structures. Leadership-training programs should focus not only on cultivating IT literacy among public managers but also on their understanding of the advantages and challenges that Web technologies bring to urban management.

To conclude, the Korean experience highlights that e-government initiatives employing Internet technologies have a substantive impact on the perceived performance of local environmental decision making, but its impact varies, depending on the IT leadership of senior management as well as the quality of the municipal Web site. It is also supported by environmental activism—a key community context that encourages citizens to utilize Web-based channels to express their ideas in environmental decision making.

Several limitations of this study should be noted. First, this study did not collect direct data on Web utilization by citizens. Further research is needed to explore the actual extent to which citizens utilize E-government Web sites and what local conditions and demographic factors affect citizens' usage of government Web sites. Second, this study depends on the perception of public officials in measuring decision performance and other relevant independent variables. Although subjective measures by questionnaire surveys are commonly used in the MIS and organization theory literatures to measure decision intelligence, quality, speed, and other

10 Another example dramatizes Netizens' power to affect bureaucrats' behaviors. In 2004, an incident occurred that two middle school girls were regularly raped by a number of senior students for over a year in Milyang city. Upon finding that the local police office was mishandling the incident, many outraged citizens swamped the Web sites of both the President's office and local police with e-mail messages, which resulted in the police chief's official apology and an immediate change of the investigation team.

variables (Brown, O'Toole, and Brudney 1998; Chatterjee, Grewal, and Sambamurthy 2002; Chidambaram and Jones 1993; Cooper and Zmud 1990; Gallupe, DeSanctis, and Dickson 1988; Heintze and Bretschneider 2000; Judge and Miller 1991; Keller and Staelin 1987; Marshall, Prusak, and Shpilberg 1996; Molloy and Schwenk 1995; Norris and Moon 2005; Purvis, Sambamurthy, and Zmud 2001; Teng and Calhoun 1996; Wood 2000), perceived decision performance may be subject to survey respondents' potential bias. Thus, further research is needed to develop objective measures for decision performance and other relevant variables.

Another important agenda for future research is to examine e-government's impact on public decision making from the stakeholders' perspective. A gap may exist between public officials and stakeholders in the perception of e-government's impact on decision performance because of their divergent goals and interests. Empirical research employing a rigorous methodology thus is needed to explore: whether and how e-government initiatives create better opportunities for citizen participation in public decision making and whether and how e-government helps enhance stakeholders' perception on government's decision-making effectiveness.

APPENDIX 1

Conceptual and Methodological Issues on Web Quality Measurement

Several models for evaluating the Web quality of public agencies have been developed in the field of political science and public administration (Weare and Lin 2000). Adopting Wilson's (1989) concept of bureaucratic openness, the Cyberspace Policy Research Group has devised the "Website Attribute Evaluation Systems" (WAES) to gauge a government's responsiveness to citizen demands (Demchak, Frils, and La Porte 2000). The WAES consists of two dimensions: transparency and interactivity of an agency Web site. Transparency refers to the accessibility of government information, and interactivity refers to the degree to which a Web site offers channels for citizens to communicate with public officials (La Porte, Demchak, and de Jong 2002). To measure the two dimensions, the model includes indicators such as ownership, contact information, organizational and operational information, citizen consequences, freshness, reachability, and responses (La Porte, Demchak, and de Jong 2002).

West (2001) proposes another Web evaluation system, which employs 28 criteria for comprehensive evaluation, ranging from online databases and external links to nongovernmental sites, to government service portals, and personalization of Web sites. From an analysis of US city government Web sites based on these criteria, West identifies a big gap among them, with a few of them reaching the one-stop service portal standard and approximately two-thirds of them allowing for only one-way access to online publications. The findings imply that most city governments in the United States are still at initial stages in the evolutionary ladder of e-government.

Whereas the former models have been established to test general features of e-government, Beierle and Cahill (2000) propose a Web evaluation framework especially for environmental governance. The framework focuses on the extent to which a state government Web site provides environmental information and creates opportunities for civic engagement in environmental decision making. The model utilizes eight criteria, including opportunities for citizens to provide inputs into the agency, to make comments on regulations, and to interact with other citizens, as well as access to environmental laws, data on local environmental conditions, and polluter information.

Table 2
Alpha Values of Different Web Quality Dimensions

	Construct	Alpha Value	N of items
Web quality	Overall Web quality	.856	86
Dimensions	Administrative service delivery	.611	26
	Democratic participation	.837	60
Subdimensions	Administrative service information	.459	6
	Administrative interactivity	.558	12
	Online transaction systems	.460	8
	Policy information provision	.571	17
	Vertical interactivity	.744	27
	Horizontal interactivity	.722	16

Drawing on the insights from the models reviewed above, this article devises a Web evaluation system with 86 items measuring the capability of e-government to support environmental governance at the local level. The system is framed by two analytical dimensions—(1) public service delivery and (2) democratic participation in policy-making processes. Each dimension consists of several subdimensions, which in turn include detailed indicators to measure Web attributes. Public service delivery, for instance, includes three subdimensions—administrative service information, administrative interactivity, and online transaction systems. The participation dimension measures the degree to which Web-based channels are available for civic engagement in policy making. It consists of several subdimensions, including policy information provision, vertical interactivity (citizen to government), and horizontal interactivity (citizen to citizen). Detailed indicators for assessment, for example, include online forums, e-bulletin boards for posting suggestions, e-opinion polls, direct e-mail to decision makers, and video conferencing systems (see Appendix 2).

Cronbach's alpha was employed to test reliability of the Web quality indicators. For a more rigorous test, factor analysis should have been employed. One of the key assumptions of factor analysis is, however, that indicators have at least interval-level data (Kim and Mueller 1978). Yet, the Web quality indicators here are dichotomous measures, which are not amenable to factor analysis. A recent e-government study published in *Public Administration Review* (Scott 2006) also employed Cronbach alpha alone to test the reliability of Web evaluation indicators.

We took multiple sets of alpha tests on different dimensions of the Web quality measure. First, alpha test was conducted on the measures of each of the six subdimensions of Web quality—administrative service information, administrative interactivity, and online transaction systems, policy information provision, vertical interactivity, and horizontal interactivity. After that, we conducted other sets of alpha tests on the measures of the two main dimensions—administrative service delivery and democratic participation—combining the indicators of their related subdimensions, respectively. Then, we conducted another set of alpha tests on the overall Web quality measures including all the indicators together. The results show that although only vertical ($\alpha = .744$) and horizontal ($\alpha = .722$) interactivity out of the six subdimensions passed the test, both of the two main dimensions—administrative service delivery ($\alpha = .611$) and democratic participation ($\alpha = .837$)—passed the test. Alpha value was the highest ($\alpha = .856$) when all the measures are combined into a single construct of overall Web quality (see table 2).

APPENDIX 2**Table A2**
Web Evaluation System

Subdimension	Evaluation Index	Notes
Administrative service dimension		
Administrative information provision	Goals or mission statement of an environmental department in a city government Administrative service charter for city governance Administrative service charter for environmental administration Organization structure of a city government Hotlinks to its (sub) divisions in the organization structure Information on environmental service-related public notices, public events, and other news Independent home page of an environmental department	
Administrative interactivity	Position of each environmental official Name of each environmental official Job contents of each environmental official Phone number of each environmental official E-mail to each environmental official Division- or subdivision-level information on job contents Division- or subdivision-level information on phone number Division- or subdivision-level information on e-mail E-mail to general webmaster E-mail to environmental webmaster	
Online transaction	Online environmental transaction forms available Detailed guidelines on civic service affairs transactions Applying online Tracking the status of transactions Communicative access to officials in charge of each transaction Online polluter monitoring system (for reporting illegal polluters) Tracking the status of polluter reporting transactions Online disclosure of information on illegal polluters	
Democratic participation dimension		
Policy information provision	Detailed explanations on environmental policy-making process Current local environmental policy issues General description of policies to address environmental issues Detailed description of specific environmental policies, programs, or project plans Environmental laws and regulations Environmental policy-related research, reports, announcements, international treaties, or other data (Statistical) knowledge data on local environmental situations (e.g., pollution databases, geographic information system) Richness of pollution data posted on the Web site Hotlinks to environmental knowledge data on other regions Easiness of access to environmental knowledge data and other data	Downloadable/ posted Downloadable/ posted Downloadable/ posted Downloadable/ posted Downloadable/ posted Downloadable/ posted On environmental Web page or not

Continued

Table A2 (continued)
Web Evaluation System

Subdimension	Evaluation Index	Notes
Vertical communication: citizen to government interactivity	Listserve or e-mailing lists (online newsletter)	
	Budget information	
	Name of local governor (Mayor)	
	Phone number of local governor	
	E-mail to local governor	
	Bulletin board systems for citizens' suggestions to local governor	General/ environmental
	Online checking of the governor's feedback to civic suggestions	
	Names of key environmental decision makers	
	Positions of key environmental decision makers	
	Phone numbers of key environmental decision makers	
	E-mail to key environmental decision makers	
	Transaction system for citizen's policy proposals (Simin Chang-An Jedo)	
	Topic-free bulletin board system for citizens' suggestions to local decision makers	General/ environmental
	Cyber policy forums in the form of bulletin boards	General/ environmental
	Permission for a citizen to provide discussion topics for policy forums	
	Web-based real-time video conferencing system for policy forums	
Permission for a citizen to provide discussion topics for video conferencing		
Detailed guidelines on participation in video conferencing		
E-voting system for the agendas debated in the forums		
Online opinion polls on policy issues	General/ environmental	
Online openness of the results of the public opinion polls		
Online channels for suggestions for Web page improvement		
Hotlinks to city council		
Horizontal communication: citizen to citizen interactivity	Bulletin board system for free discussion on local issues	General/ environmental
	Topic-centered discussion forums on local issues	General/ environmental
	Chat rooms dedicated to free discussion on policy issues	General/ environmental
	Web-based video conferencing system for free discussion and meeting	
	Detailed guidelines on participation in video conferencing	
	Information on community-based environmental groups	
	Clickable hotlinks to local environmental groups	
	Information on national membership-based environmental groups	
	Clickable hotlinks to national membership-based environmental groups	
	Richness of Information on environmental groups	
	Clickable hotlinks to other civic groups	
	Web community	
	Clickable hotlinks to other environmental related sites (e.g., international environmental groups, research institute)	

APPENDIX 3**Table A3**
Survey Items that Measure Variables

Variables	Number of Items	Survey Questions
IT leadership	6	<ul style="list-style-type: none"> • City mayor has an active attitude toward developing institutions and procedures for IT-driven governmental innovations • City mayor is very interested in managing and improving the city government Web site • City mayor tends to emphasize Internet-based communication between officials and citizens • The head of the department to which I belong tends to be very interested in managing and improving the department Web page • The head of the department to which I belong tends to emphasize Internet-based communication between citizens and officials • The head of the department to which I belong thinks of online civic suggestions as an integral part of decision making
Seriousness of environmental pollution	1	<ul style="list-style-type: none"> • How would you evaluate the level of environmental pollution (air, water, and others) in your city, compared with that of other cities?
Environmental activism	3	<ul style="list-style-type: none"> • Activities of environmental groups in our city are much stronger than those of other cities • In our city, demonstrations or rallies by citizens or environmental groups on pollution issues frequently occur • Citizens in our city have much stronger interest in environmental issues than those in other cities
Political importance of environmental issues	1	<ul style="list-style-type: none"> • Compared to other issues, environmental issues especially have a pivotal impact on political elections in our city
Web-aided decision intelligence	2	<ul style="list-style-type: none"> • Online civic suggestions via the city government Web site help officials better understand the background of a given environmental agenda and its decision context • Online civic suggestions via the city government Web site help officials better understand different opinions of diverse stakeholders
Decision quality	2	<ul style="list-style-type: none"> • Online civic suggestions via the city government Web site help increase the number of policy options for environmental agendas • Online civic suggestions via the city government Web site help develop rational, better policy options to address environmental issues
Decision speed	2	<ul style="list-style-type: none"> • Online civic suggestions contribute to delaying environmental decisions • Online civic suggestions contribute to speeding up environmental decisions

Note: Five-point Likert scale from strongly disagree to strongly agree.

APPENDIX 4

Table A4
Comparison of Estimates under Nonnormality and Bootstrapped Estimates

Parameter	Bias Caused by Nonnormality in SE Estimate					Parameter Estimate by MLE under Nonnormality				Bootstrap Bias-Corrected Estimate	
	SE	SE-SE	Mean	Bias	SE-Bias	Estimate	SE	CR	<i>p</i> Value	Estimate	<i>p</i> Value
Web quality ← IT leadership	.908	.045	4.233	-.079	.064	***4.312	.843	5.115	***	**4.312	.004
Decision intelligence ← Web quality	.003	.000	.011	.000	.000	***.011	.003	3.548	***	*.011	.021
Decision intelligence ← IT leadership	.055	.003	.406	.004	.004	***.402	.048	8.351	***	*.402	.011
Decision intelligence ← environmental activism	.041	.002	.101	-.003	.003	**.104	.040	2.617	.009	** .104	.006
Decision intelligence ← environmental pollution	.035	.002	-.022	-.003	.002	-.019	.031	-.614	.539	-.019	.620
Decision intelligence ← political importance	.032	.002	.018	-.001	.002	.018	.033	.552	.581	.018	.660
Decision quality ← decision intelligence	.059	.003	.460	.001	.004	***.460	.057	8.074	***	** .460	.008
Decision quality ← IT leadership	.052	.003	.171	.000	.004	***.171	.052	3.268	.001	** .171	.010
Decision quality ← Web quality	.003	.000	.010	.000	.000	** .010	.003	3.173	.002	*.010	.012

****p* < .001, ***p* < .01, **p* < .05.

APPENDIX 5

Table A5
Comparison among Path Coefficients of Different Web Quality Dimensions

Causality \ Web Quality Dimension	Overall Web Quality		Administrative Service Delivery		Democratic Participation		Vertical Interactivity		Horizontal Interactivity		Hypothesis Test
	Standardized Estimate	<i>p</i>	Standardized Estimate	<i>p</i>	Standardized Estimate	<i>p</i>	Standardized Estimate	<i>p</i>	Standardized Estimate	<i>p</i>	
Web quality ← IT leadership	***.280	.008	***.220	.004	***.277	.009	***.283	.006	***.208	.007	Supported
Decision intelligence ← Web quality	**.176	.025	**.131	.025	**.177	.012	.093	.108	***.207	.006	Supported
Decision intelligence ← IT leadership	**.434	.018	**.453	.018	**.435	.015	**.454	.014	**.445	.016	Supported
Decision intelligence ← environmental activism	***.129	.007	***.144	.005	***.119	.006	***.135	.006	**.108	.013	Supported
Decision intelligence ← environmental pollution	-.030	.620	-.037	.541	-.030	.586	-.038	.557	-.032	.509	Rejected
Decision intelligence ← political importance	.028	.642	.025	.612	.033	.729	.039	.545	.026	.668	Rejected
Decision quality ← decision intelligence	**.432	.012	***.444	.007	**.436	.012	**.455	.011	**.433	.013	Supported
Decision quality ← IT leadership	***.173	.009	***.179	.009	**.178	.013	**.175	.012	**.191	.011	Supported
Decision quality ← Web quality	**.153	.012	***.143	.010	**.131	.015	*.107	.074	**.118	.027	Supported

****p* < .01, ***p* < .05, **p* < .10.

APPENDIX 6

Table A6
Goodness of Fit of Path models with Different Web Quality Dimensions

Goodness of Fit Indices	Level of Acceptance	Overall Web Quality	Administrative Service Delivery	Democratic Participation	Vertical Interactivity	Horizontal Interactivity
GFI	.9≤	.992	.994	.990	.994	.986
NFI	.9≤	.974	.978	.967	.981	.954
CFI	.9≤	.991	.996	.984	.999	.971
RMESA	≥.08	.038	.024	.053	.010	.070
Chi-square	$p > .01$ or .05	8.27 ($p = .190$)	7.07 ($p = .314$)	11.1 ($p = .083$)	6.17 ($p = .403$)	15.13 ($p = .019$)

Note: NFI, normed fit index; CFI, comparative fit index.

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