E-Voting in Japan: A Developing Case?

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Abstract: This paper aims to introduce the current situation of electronic voting (e-voting) in Japan and discuss its challenges. E-voting has gradually spread in Japan. It has been used a total of 25 times by 10 local governments since it was first introduced in 2002. Under the current law, e-voting can be used only for the election of the head of local government or council members. The paper first introduces the actual state of e-voting in Japan. Then the current status and challenges of the electronic voting system are analyzed based on data obtained from the experiences of Japanese cases. Finally, the paper discusses what challenges the Japanese e-voting has, and what could be given as prescriptions for them.

Key Words: electronic voting, e-voting, e-democracy, e-government, election

Current Status of E-voting in Japan

In 2002, the first electronic voting (e-voting) was realized in Japan. Since then, ten local governments conducted total of 25 cases of e-voting. In Japan, after "e-Japan Strategy[1]," which aims to build an electronic government (e-government[2]) was published in January, 2001,

many efforts toward an electronic government (e-democracy) and electronic democracy have been attempted[3]. E-voting can be considered within this trend[4].

This paper aims to introduce the current status of e-voting in Japan and discuss its challenges. The paper first introduces the actual state of e-voting in Japan. Then the current status and challenges of the electronic voting system are analyzed based on data obtained from the experiences of Japanese cases[5]. Finally, the paper discusses what challenges the Japanese e-voting has, and what could be given as prescriptions for them.

In Japan, "Act on Special Provisions Concerning Voting Method by Means of Electromagnetic Recording Voting Devices Used for Election of Council Members and Heads of Local Governments (hereafter 'E-voting Act')" was enacted in the 153rd extraordinary Diet session on November 30, 2001[6]. The Act was issued on December 7, and put into effect on February 1, 2002, which enabled e-voting for local elections. The E-voting Act is intended only to the elections for a head of a local government or a member of a local council. Each local government is required to establish its own ordinance before holding any e-voting.

For example, in the case of Niimi City, Okayama Prefecture, Niimi City Council enacted "Ordinance Concerning Voting by Means of Electromagnetic Recording Voting Devices Used for Elections of Council Members and Mayor of Niimi City" in March, 2002[7]. This enabled e-voting in the double election of Niimi City Mayor and the Council members on June 23 of the same year[8]. Since then, there have been total of 25 cases of e-voting by ten local governments[9]. This number indicates that the dawn of e-voting in Japan is over and the country is now in the phase of establishment.

Introductory Phase of E-voting

According to the E-voting Act, e-voting is defined as a means of voting that uses a device. The current procedures for such an electronic voting method in Japan are as follows.

· First, an elector goes to a designated polling station on an election day.
· The elector is required to bring an admission ticket to her/his polling station, which s/he has received in mail in advance.
· When the elector hands the admission ticket to the reception at the polling station, a staff person checks identification by comparing the name of the elector with the register of electors.
· When the personal identification was confirmed, a voting card is issued from a voting card issuing device by the staff, which is handed to the elector.
· The elector stands in front of a voting device and inserts the voting card; this initiates the device.
· The elector selects a candidate of her/his choice from a list of candidates shown in the touch-panel screen by touching the appropriate name using her/his finger or a touch pen (if not voting for any candidate, the elector touches a display that says, "Complete without Voting"; this will allow the elector to complete her/his vote without choosing any candidate).
· The elector confirms the selected candidate.
· The voting result is recorded in an electromagnetic recording medium inside the electronic voting device.
· The elector removes the voting card from the voting device.
· The voting process is now complete; the elector returns the voting

card at the exit, and leaves the polling station.

Contrary, the current procedures for a traditional paper ballot voting method in Japan (that is called "self-write voting") are as follows.

・First, an elector goes to a designated polling station on an election day.
・The elector is required to bring an admission ticket to her/his polling station, which s/he has received in mail in advance.
・When the elector hands the admission ticket to the reception at the polling station, a staff person checks identification by comparing the name of the elector with the register of electors.
・When the personal identification was confirmed, a ballot paper is handed to the elector by the staff.
・The elector writes a name of candidate from a list of candidates (if not voting for any candidate, the elector does not write a name of candidate; this will allow the elector to complete her/his vote without choosing any candidate).
・The elector votes the ballot paper to the ballot box.
・The voting process is now complete; the elector leaves the polling station.

Therefore, the e-voting in Japan is considered as an evolved form of self-write voting rather than a method completely different from the conventional self-write voting. The Study Group describes this aspect in detail in a report on Election System Using Electronic Devices within the Ministry of Internal Affairs and Communications[10].

On July 30, 1999, the former Ministry of Home Affairs established

the Study Group on Election System Using Electronic Devices. The Group released the final report on February 1, 2002, indicating that the introduction of e-voting has three phases described below. In Japan, the implementation of the first phase has been the focus.

・The first phase is when an elector votes using an electronic voting device at a designated polling station.
・The second phase is when an elector can vote at a polling station other than a designated one.
・The third phase is when voting at a polling station is not required, and an elector votes using a privately-owned computer terminal.

The first phase is the form that has been implemented in Japan. In this phase, electronic voting devices are not connected to any network; they are individually installed both in polling stations and vote-counting stations. An elector has to go to a designated polling station as one has always done.

The only difference from the conventional method is that an elector votes by using a voting device, not self-write voting, at a polling station.

When counting votes, the challenge is a method to deliver voting data to a vote-counting station. A recording medium that stores voting data is removed from a voting device at a polling station, and delivered to a vote-counting site. This is the same procedure as the one in self-write voting, where a ballot box holding ballot paper is delivered to a vote-counting station.

Currently, a recording medium that stores data is hand-delivered from a polling station to a vote-counting station by election staff. The other possible delivery method is to send the data through a network by

connecting a polling station and a vote-counting site. This method has not been adopted in the first phase since it still contains various issues including security.

The second phase networks voting devices installed at polling stations with a dedicated line. The line used in this phase is to be closed for security issues. The registers of electors need to be networked for personal identification of electors at polling stations. The network is also necessary for sharing the information of candidates.

In the second phase, voting at a polling station other than a current designated one becomes possible. In this case, either of the following will be chosen: (1) voting at any polling station within the same electoral district; (2) voting at any polling station within all the electoral districts of the same election; and (3) voting at any site including areas not having an election.

The voting at any polling station within the same electoral district enables an elector to vote at a nearby polling station in an area where s/he lives, rather than a current designated polling. For example, an elector can vote at the closest polling station when s/he goes out for shopping.

The voting at any polling station within all the electoral districts of the same election enables, for example, an elector to vote at any polling station within a prefecture, if it is for a prefectural election. For the election of Tokyo Metropolitan Mayor, an elector can vote in any ward other than Chiyoda Ward even if it is not her/his designated polling station.

The voting at any site including areas not having an election enables an elector to vote in Kyoto Prefecture, if there is any polling station, even when the election is for Tokyo Metropolitan. Also, an

elector can vote at a site other than a polling station if it is authorized for voting.

For all of the above three scenarios in the second phase, establishing a network for the registers of electors or for sharing candidate information will be necessary. The registers of electors are used for identifying if a person who comes to vote is a particular elector, and the list will be operable depending on the status of the Basic Resident Registers Network and Local Government Wide Area Network.

In the third phase, instead of requiring electors to vote at polling stations as a conventional system does, it is assumed that a computer owned by each elector would be used for voting. If all elections are conducted by the third phase method, a polling station itself may become unnecessary. In this phase, a standard Internet connection, not a dedicated line, would be utilized as each individual's computer is used. Thus security issues are unavoidable. Also, the issue of Digital Divide including if an elector can use a computer, or if s/he has a computer, becomes crucial.

The problem of identification at the time of voting also emerges. Since identification based on a register of electors at a polling station is not performed in the third phase, as the current system does, it is difficult to identify if a person sitting in front of a computer is a particular elector. Therefore, it is necessary to prevent impersonation by identity verification with public key cryptography as well as biometrics using fingerprints and irises.

In addition, since third parties such as observers at a polling station do not exist in the third phase, it becomes unclear if a voting individual is voting based on her/his true free will. For example, there could be a possibility that an elector is forced to vote for a particular

candidate under abduction/confinement. Considering that the existence of observers at polling stations in the current system guaranties the transparency of elections, it is crucial how to resolve the transparency issue in the third phase voting.

Judging from the evolution of ICT, it could be possible to implement the third phase e-voting. However, from the perspective of operating election, the third phase is quite unrealistic. The e-voting is still in the first phase in Japan, and it seems more likely that the situation continues as it is now. There are many issues to be resolved in order to shift to the second phase, and those issues are not easy to solve. It is crucial to steadily accumulate the implementation in the first phase[11].

Characteristics of E-voting in Japan

The intrinsic changes are overlooked if e-voting is viewed as a mere change from self-write voting to a method using devices. In fact, if one focuses only on e-voting, one's perspective would be that it is just a change of voting methods. However, e-voting indicates a new form of election in an ICT-prevailing society[12]. The newness of e-voting can be described from four aspects, which are voting, tallying, communication and vote-counting methods.

Table1 Self-write voting and E-voting in Contemporary Japan

	Self-write voting	E-voting
Voting method	Using a ballot paper	Using a voting device
Tallying method	Using a ballot box	Using a voting device
Communication method of voting data	Delivery of a ballot box from a polling station to a vote-counting station	Delivery of a recording medium from a polling station to a vote-counting station
Vote-counting method	Staff	Computer

First, the voting method differs significantly from conventional self-write voting in using a voting device, and the newness lies in voting by a device instead of voting by a paper ballot. A voter casts a ballot by operating a voting device at a polling station, and the vote is stored as it is in the device. Containing a recording medium that stores voting data, the device plays double role of writing down on a paper ballot and accumulating ballots in a ballot box as it was done in self-write voting. That is, in e-voting, a device itself has double function of casting ballots and storing voting data. This brings both advantages and disadvantages.

The advantages include the simplification of voting for voters due to the use of a device. As the currently-used voting device adopts a touch-panel, the act of voting is done with only a light touch on a screen. For example, it is easier for physically challenged voters to touch a device than self-write voting. It is clear that e-voting makes voting simpler than self-write voting does.

The second advantage is the accuracy of voting, which is related to the first advantage. In e-voting, as a voter chooses a candidate to vote from a list of candidates displayed on a screen, s/he can only vote for those on the list. However, in self-write voting, voters often write a name other than that of a candidate, or misspell a name, which results in invalid ballots. Voters may also write down only the last name or the first name. In self-write voting, a typical problem is when there are more than one candidate with the same last name; in such a case, votes are equally divided into both candidates. On the contrary, e-voting ensures the accuracy of voting by avoiding the above issue since a voter has no choice but to vote for candidates displayed on a screen for a certain election.

The third advantage is of barrier-free. E-voting leads to a

barrier-free system by making it easy for the elderly and the physically-challenged to vote. There are voters who have difficulty writing down on ballots with a pencil, and it is easy for them to vote using a device. For those who are optically challenged, voting with audio guidance becomes available by using an appropriate voting device. Such voters can vote at their own pace since they operate the device listening to audio guidance with headphones and can adjust audio speed. Such voting devices have already been developed in Japan. Although the current voting device supports optical challenges, promoting a barrier-free device for those who are both optically and aurally challenged, or those who are intellectually challenged is an issue to be resolved.

The disadvantages include failure of a voting device, errors in device operation, and distrust against a voting device such as leakage of privacy, and cost issue of a device. In other words, issues related to a device become the disadvantages. If a device fails, voting itself becomes impossible. While bringing many advantages by using a device, e-voting could cause disadvantages exactly because it uses a device.

In fact, there were several cases that voting discontinued due to the failure of a voting device or a device failed due to errors in operation. In the case of Kani City, Gifu Prefecture, the election itself became invalid as it was determined that the failure of their voting devices affected the result.

The possibility of privacy leakage can be noted in terms of distrust against a device. Voters often have variety of distrust such as: A device might record who voted for whom upon voting; or it is unclear if a ballot was truly casted on a candidate whom a voter has chosen. There is no other means of solution to clear as much distrust as possible than to improve the reliability of e-voting. It can be time

consuming, however it is indispensable to make efforts in establishing reliability.

Additionally, there is an issue that the cost of a voting device is high. Indeed, the E-voting Ordinance was abolished in Sabae City, Fukui Prefecture, due to a high cost[13]. However, a special local grant tax measures is applied when implementing e-voting, and financial support is available according to the number and size of polling and vote-counting stations. More specifically, the amount is provided based on calculation that multiplies designated unit price depending on the number of polling and vote-counting stations. The special local grant tax amount is the sum of polling station expenses and vote-counting station expenses.

Although there exists an image that e-voting is costly, assistance is actually available. It is necessary to inform the actual operational status, including the fact that the previous cases adopted rental devices instead of purchased ones. It is not necessarily the reality that it takes a tremendous cost and high risks in order to introduce e-voting from scratch.

Next, a tallying method is related to one that stores voting data to an electronic voting device. So far, there are two data recording methods for an electronic voting device: A standalone method and a client-server method. Most of the cases in Japan have adopted the standalone method, although there were two cases that used the client-server method. These methods differ in tallying methods of electronic voting devices. In simple terms, the standalone method is equipped with one recording medium per voting device, while the client-server method uses one recording medium per polling station. In the case of the standalone method, if there are five electronic voting devices at one voting station, five recording media will be delivered from the polling

station to a vote-counting station since each device has one recording medium. The client-server method uses one recording medium per polling station, thus there is one recording medium however many voting devices are installed at one polling station. One server is set up for each polling station, connecting multiple voting devices, and voting data is collected in the server. In delivering data from the polling station to a vote-counting station, the collected data on the server is transferred to a magneto-optic disk (MO), which will be delivered to a vote-counting station.

Although the two collection methods have their own advantages and disadvantages, there is a reason for the standalone method is more likely to be adopted when considering issues in reality. This method can minimize any damage in case a trouble occurs. Even if one voting device fails in a polling station, it can be immediately replaced with a back-up device. In this way, there will be almost no influence on voting that follows. As the recording medium equipped in the failed machine has the voting data up to the time of the failure, it is delivered to a vote-counting station. Obviously, the voting data reflects the will of voters, thus it cannot be made invalid or destroyed. The standalone method provides two recording media; one is original and the other is a duplicate. Therefore, if the original recording medium did not store data properly, or the medium was damaged, the duplicate can serve for the original.

On the other hand, since the client-server method collects voting data in one recording medium by a server regardless of the number of voting devices at a polling station, there is a possibility that all the voting devices at the polling station would be unusable if the server fails. Even if each voting device is operable, voting is no longer possible as voting data cannot be recorded. In fact, the trouble due to

server failure occurred in the e-voting in Kani City in July, 2003. Later, a lawsuit was initiated regarding the e-voting in Kani City, and the election itself was determined invalid.

Based on such history, the standalone method is more widely adopted[14]. The collection method for e-voting employs a voting device that stores voting data in a recording medium, which leads to a question: An indication that paper medium should also be used since recording voting data only in a voting device would cause difficulty if the device or its recording medium fail. This is a notion that self-write voting is applied for emergency along with e-voting. It is true that this would prevent from losing voting data at the time of any trouble. However, if both e-voting and self-write voting are to be conducted at the same time, it does not make any sense in terms of why e-voting is introduced.

Also, there is a proposal for countermeasures suggesting that paper ballots are prepared for device failure and self-write voting using the paper ballots replaces e-voting if there is any device failure. This proposal would result in higher costs since costs for providing voting devices and preparing paper ballots are both necessary for one election. This leads to a discussion if e-voting should be introduced with such costs.

At this moment, there are two methods for tallying, and no alternative method has been proposed or considered to be put into practice. It is worthy to examine various methods. However, voting methods or tallying methods that are significantly diverted from the implementation of e-voting would never facilitate any discussion, even if they were proposed.

Next, communication methods of voting data are discussed. They are the delivery methods from a polling station to a vote-counting

station. What is necessary when voting time on an election day is over and a polling station is closed is the delivery of voting data to a vote-counting station. In the case of self-write voting, ballot boxes are delivered to vote-counting stations as they are. In e-voting, a recording medium is removed from a device, sealed, stored and locked in a strong container, and delivered to a vote-counting station. Basically the delivery of voting data from a polling station to a vote-counting station is the same as the conventional method. The only difference is whether it is a ballot box with paper ballots inside or a recording medium storing voting data.

At this moment, the delivery of voting data is handled in the same way as the conventional method, since the implementation of e-voting is still in the first phase as it is defined in the report issued by the Ministry of Internal Affairs and Communications' Study Group of Election System Using Electronic Devices[15]. When voting time is over, a ballot box is closed and delivered to a vote-counting station by car. Thus the most important factor in e-voting is to deliver a recording medium quickly and safely to a vote-counting station. When e-voting is implemented in the second and third phases in the future, it is unnecessary to maintain the current delivery method. For example, in the second phase, each polling station would have a dedicated network. If security issues such as intrusion by hackers are resolved, voting data can be delivered to a vote-counting station through such network. Then the communication method of voting data will see a dramatic change. In the third phase, voting would be done from a work place or a computer at home. There will be security issues, but it will be significantly different from the current first phase in terms of data delivery. In this phase, further study is needed whether polling stations should be set up, and whether a means to collect voting data of

all voters to polling stations is necessary. Also, it is possible to collect all the voting data at each polling station and send them to a vote-counting station, or to send the data accordingly to a vote-counting station through a network.

If the second and third phases are implemented, the communication method of voting data could be transformed significantly while maximizing the advantages of ICT. Although there are mountains of issues to resolve before that, there are various possibilities for future communication methods. Since the current e-voting follows the same conventional method, the advantage of e-voting is not yet very clear in terms of its communication method. In other words, there will be more advantages depending on how communication methods are utilized in e-voting.

The fourth notable point is the vote-counting method. In e-voting, the important task is to read a recording medium delivered to a vote-counting station by a computer, not to take out paper ballots from a ballot box. The reading itself is the vote-counting process. In the standalone method, the more voters an area has, the more recording media will be, since one electronic voting device has one recording medium. Those who are in charge of vote-counting process would be one staff person who operates recording media on a computer, and the other who checks and confirms the computer operation, which means that only two people are necessary. Compared to self-write voting, this is a significant cutback in labor, and leads to the reduction of labor costs. When a recording medium is read in a computer, the data is quickly calculated and the voting result is displayed on screen. The vote-counting result is revealed when the displayed result is printed.

The E-voting Act defines that an electronic voting device shall not be connected to an electric communication line. Thus, this is the limit

of reducing vote-counting time. It is because there is a delivery from a polling station to a vote-counting station, and the current method cannot cut this delivery time. In the future, if a polling station and a vote-counting station are networked and the delivery of voting data is done in a second through the network, even further reduction of time will be possible. The reasons for prohibiting the connection to electric communication circuits include security issues. Since there is a possibility that unauthorized access from outside such as one by hackers, security measures must be thorough. For example, as security measures, using a closed, dedicated network is one option. By doing so, it is possible to prevent unauthorized access.

The advantages of vote-counting methods in the current first phase are as following: There is no illegible ballot; there is no equal division of ballots; reduction of vote-counting time; and reduction of labor in vote-counting tasks. All of these are significantly different from the conventional self-write voting. The voting, tallying, communication and vote-counting methods of e-voting have completely different features from those in the conventional self-write voting, thus could achieve significant effect depending on how they are used[16].

Issues in E-voting

In order to popularize e-voting, it is most important to prevent troubles due to mechanical failure. Some solutions have been gradually proposed, and the current measures are discussed below.

In November, 2005, the Ministry of Internal Affairs set up the Research Committee on E-voting System[17] as a "permanent research entity that provides advisory functions from a professional standpoint regarding a way of an e-voting system, bringing new structure for

improving reliability of the system into view." In March, 2006, the Committee put together a report "Basic Policy Regarding a Measure for Improving Reliability of E-voting System." The report stresses measures for trouble prevention in e-voting, addressing technical requirements of electronic voting devices and certification system of technical requirements for improving reliability. It notes that there were three factors in the past troubles: First, contents defined by technical requirements themselves were inappropriate or insufficient; second, prior confirmation of whether individual electronic voting device complies with technical requirements was not sufficient; and third, there were issues in operating voting devices. Solutions to the first factor include the analysis of troubles in the past and thorough investigation of the validity of technical requirements, as well as the reinvestigation of the necessity of legal binding power on technical requirements. For the second factor, it was suggested that the necessity of introducing certification system should be examined in order to confirm compliance with technical requirements by third parties. For the third factor, following through improvement measures and manuals for those in charge of conducting e-voting.

Traditionally, the confirmation of compliance to technical requirements only involves self-inspection by manufacturers and joint inspection with an election committee at a delivery to an implementing municipality. For self-inspection, manufacturers only have to submit a self-inspection certificate at the time of delivery. Thus, the report noted that "instead of commissioning inspections to manufacturers and local public agencies, it is necessary to introduce a system of confirming compliance by third parties in order to prevent further occurrence of mechanical troubles and ensuring reliability of e-voting system." The municipalities that have already conducted e-voting also

suggested the necessity of a certificate system by third parties.

In response to the above report, on December 18, 2006, the Ministry of Internal Affairs and Communications issued the revised technical requirements and "Implementation Guideline for Confirming Compliance Regarding the Technical Requirements of E-voting System." Upon request for inspection by a manufacturer, the confirmation of compliance to technical requirements is performed by a private inspection agency under contract with the Ministry, and the result is to be publicized. It is an advantage for manufacturers to have e-voting devices with confirmed compliance defined by the certification system. It is also true for each election committee or each municipality, since they can use devices of a certain technological level when choosing devices and implementing e-voting. Basically, it is not only that a certification system can prevent unnecessary trouble but also that it is indispensable. An inspection agency reports the result to the Ministry after the inspection, and submits a "Report on Inspection and Verification of Electromagnetic Recording Voting System" to the Minister of Internal Affairs and Communications. The Ministry publishes the result of verification upon receiving the report of inspection results.

After the certification system was introduced in December, 2006, Shiroishi City and Rokunohe Town held e-voting on April 22, 2007. It was the third implementation of e-voting for both municipalities. The certification system was put into practice for those two cases, and e-voting devices that complied with technical requirements were used in the two elections. Until today, a couple of other cases of e-voting have held, and no significant trouble has occurred.

Although the introduction of the certification system is useful for preventing troubles, what kind of incident happens and when it would be

always remain unknown as e-voting involves devices. Thus, manufacturers and governments are required to make constant efforts on research and development of e-voting, as well as measures that envision various situations. It is not completed once a system is established; revisions and improvements are required in e-voting, as in any other systems.

Lastly, the introduction of e-voting to national elections is mentioned here. As of December, 2007, the Liberal Democratic Party and the New Komeito, which are the ruling parties, and the Democratic Party of Japan agreed on the introduction of e-voting to national elections. They worked for enacting the bill in the Diet, and it passed the House of Representatives. However, it was withdrawn as an unfinished bill in the House of Councilors. At that time, the bill suggested that e-voting in national elections would be allowed only for municipalities with e-voting ordinances. However, the deliberation proceeded with difficulty around measures against failure of voting devices, and the time eventually ran out. Although the bill was withdrawn, it is notable that the introduction of e-voting was discussed officially. Furthermore, the fact that the bill passed the House of Representatives implies that there is some possibility of implementing e-voting in national elections. In Japan, the possibility of putting e-voting into reality seems to have been expanding gradually from local elections to national elections.

Notes
1. http://www.kantei.go.jp/jp/singi/it2/kettei/010122honbun.html
2. See Anttiroiko (2007); Hague (1999); Homburg (2008); Khosrow-Pour (2009); Norris (2001).
3. The concept of "electronic democracy" is a vague and it has various meanings. See Ferdinand (2000); Gibson (2004); Hague (1999); Hill

（1998）; Iwasaki（2005）; Toulouse（1998）; Tsagarousianou（1998）.

4．http://www.kantei.go.jp/jp/singi/it2/index.html

5．See Iwasaki（2004; 2009）.

6．http://www.soumu.go.jp/senkyo/senkyo_s/news/touhyou/denjiteki/pdf/houritsu.pdf

7．We can experience a demonstration of e-voting in the website of Niimi City. http://www.city.niimi.okayama.jp/?ID=10973

8．http://www.city.niimi.okayama.jp/?ID=9901

9．Total of 25 cases of e-voting by ten local governments are as follows:（1）Niimi City, Okayama Prefecture,（2）Hiroshima City, Hiroshima Prefecture,（3）Shiroishi City, Miyagi Prefecture,（4）Sabae City, Fukui Prefecture,（5）Kani City, Gifu Prefecture,（6）Otama Village, Fukushima Prefecture,（7）Ebina City, Kanagawa Prefecture,（8）Rokunohe Town, Aomori Prefecture,（9）Kyoto City, Kyoto, Prefecture, and（10）Yokkaichi City, Mie Prefecture.

10．See Iwasaki（2009）.

11．Cf. Kersting（2004）.

12．Cf. Ferdinand（2000）; Gibson（2003）; Gibson（2004）; Hacker（2000）; Hague（1999）; Oates（2006）.

13．See Iwasaki（2004）.

14．Exceptionally, two of 25 cases of e-voting in Japan were adopted a client-server method. Otama Village and Ebina City were used it.

15．See Iwasaki（2009）.

16．See Iwasaki（2004; 2009）.

17．http://www.soumu.go.jp/main_sosiki/kenkyu/denshi_touhyo/index.html

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