Environmental Benefits of an Electronic Bidding System

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Abstract

NTT Service Integration Laboratories is developing a secure (encryption-based) electronic bidding system to enable local governments to replace their paper-based procedures for public works bidding by electronic ones based on personal computers and the Internet. This article explains how the introduction of this electronic bidding system can reduce the effects on the environment.

1. Introduction

In January 2001, the government announced the e-Japan strategy and presented "the realization of e-government/e-local government" as one of four top-priority policies. Well before this date, in 1999, NTT Service Integration Laboratories started to study ways to achieve e-government/e-local government. We have developed an electronic bidding system and an electronic application system. The bidding system was first introduced by Yokosuka city in 2001. Now 30 local governments and about 9000 bidders are using this system (including shared use), and the number of installations is increasing with the penetration of e-government/e-local government. Moreover, the application scope of this system is not limited to public works, but is spreading to purchasing, subcontracting, and public works tenders under the control of the waterworks department [1].

Using the know-how of electronic bidding system introduction/operation gained through supporting local government, we quantitatively evaluated the effect that introducing the system had on reducing the environmental burden. This article introduces the results of the evaluation.

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2. Electronic bidding system

2.1 Configuration and features of electronic bidding system

The electronic bidding system consists of three components—a Web server, tendering application server, and database server—used in conjunction with a trusted third-party (TTP) system consisting of an electronic authentication system and an electronic notary system (**Fig. 1**). This system has two main features:

(1) electronic bidding procedure using hashing to achieve fair bidding
(2) third-party certification utilizing the electronic notary system

As shown in Fig. 1, we can construct a shared electronic bidding system center that can be shared by multiple local governments [2],[3]. Municipal employees and bidders can easily conduct the bidding using personal computers (PCs) via Internet access from their offices or homes, so the efficiency of bidding is vastly improved. Moreover, the system can deal with a large number of bidders, so bidding can be more competitive. This will lead to greater price competition and hence lower contract prices. In addition, electronic bidding reduces paper consumption and the amount of travel required for attending meetings, so the environmental burden will also be reduced.

2.2 Conventional bidding flow

The main flow of public works managed by local

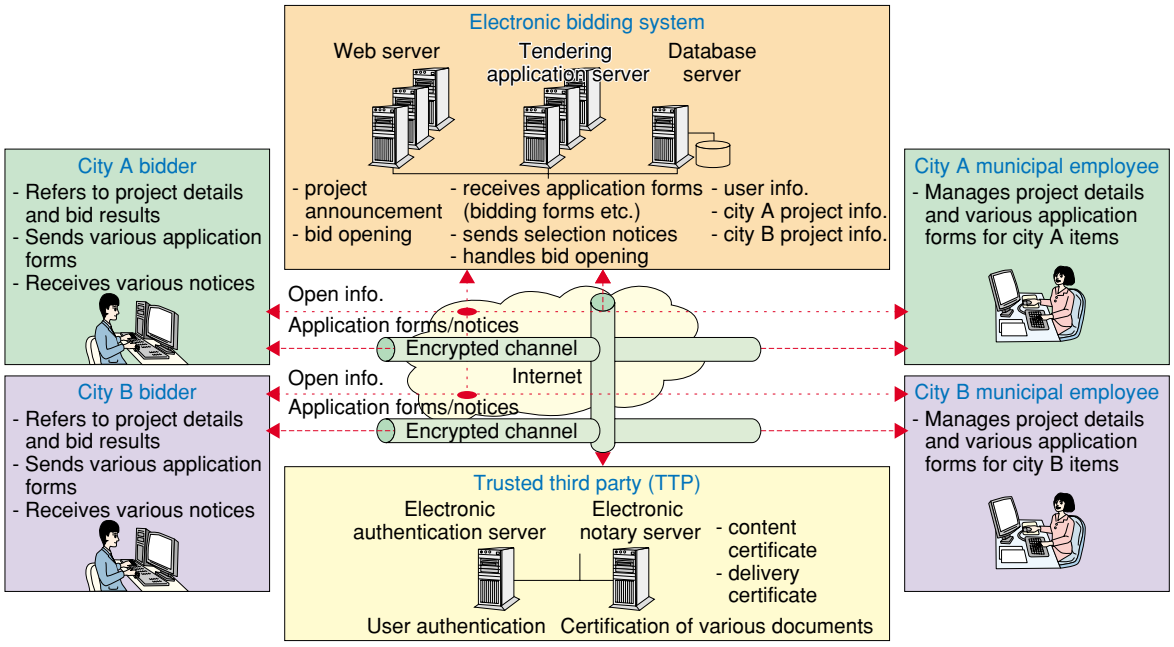

Fig. 1. Configuration of electronic bidding system.

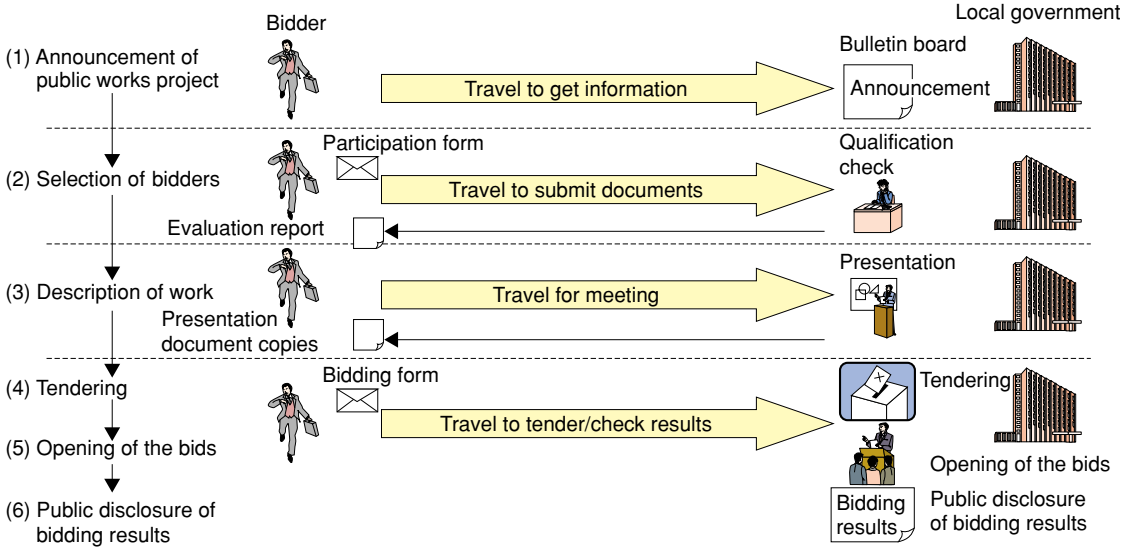

Fig. 2. Flow for conventional bidding.

government is: planning (design), tendering, bid opening, contract issuing, work management, and delivery (completion). The scope of the electronic bidding system is the bidding process. By using PCs and the Internet, the system implements all bidding processes from the initial distribution of information, through tendering and the opening of bids to public disclosure of the bidding results. An example of the conventional bidding process is shown in **Fig. 2**. Each step requires meetings, which involve travel and consume a lot of paper.

2.3 Bidding flow in electronic bidding

Electronic bidding digitizes the conventional system of paper bidding documents and replaces the distribution of paper (by hand or mail) by data transmission via the Internet. NTT's electronic bidding system implements channel encryption and user authen-

tication by an electronic authentication system/electronic notary system, protection against tampering, and certification by a third party to prevent fraud. In addition, it incorporates a hash function to ensure that the bidding procedure is fair. The bidding flow is shown in **Fig. 3**.

2.3.1 Bidding procedure with hash function

Phase 1 (tendering):

The bidder sends both a plain text bid value and a hash value of the bid. All bids (plain text) are held at the notary system until the tendering deadline, but the hash values are immediately forwarded to the local government, which publicly discloses all the received hash values.

Phase 2 (bid opening):

When the tendering deadline arrives, no more bids are accepted. The notary system sends all the bidding forms (plain text) to the local government, which calculates the hash value of each and checks whether it matches the hash value received in phase 1. If it does, the local government regards the bidding form as being valid. It opens all the bids and determines the winning bidder. Then it publicly discloses the bidding results.

The procedure for phase 1 (tendering phase) keeps the value of the bids confidential until the tendering deadline and prevents this information leaking to other bidders. The values are read for the first time in phase 2 (bid opening phase). The local government validates each bid by matching it to the hash value received in phase 1 to ensure that no substitution has taken place. This leads to fair bidding among bidders. Although strictly speaking the bidding procedure involves two operations, the second operation in the bid opening process (step (5) in Fig. 3) is performed automatically by the electronic notary system, which stands between the bidders and local government.

3. Environmental burden evaluation model

To quantitatively evaluate the effect of the electronic bidding system on reducing the environmental burden, we modeled its introduction and operation and compared the energy consumption and CO_2 emissions of the conventional and electronic bidding processes.

3.1 Introduction model

When they introduced the electronic bidding system, many local governments shared it with others to

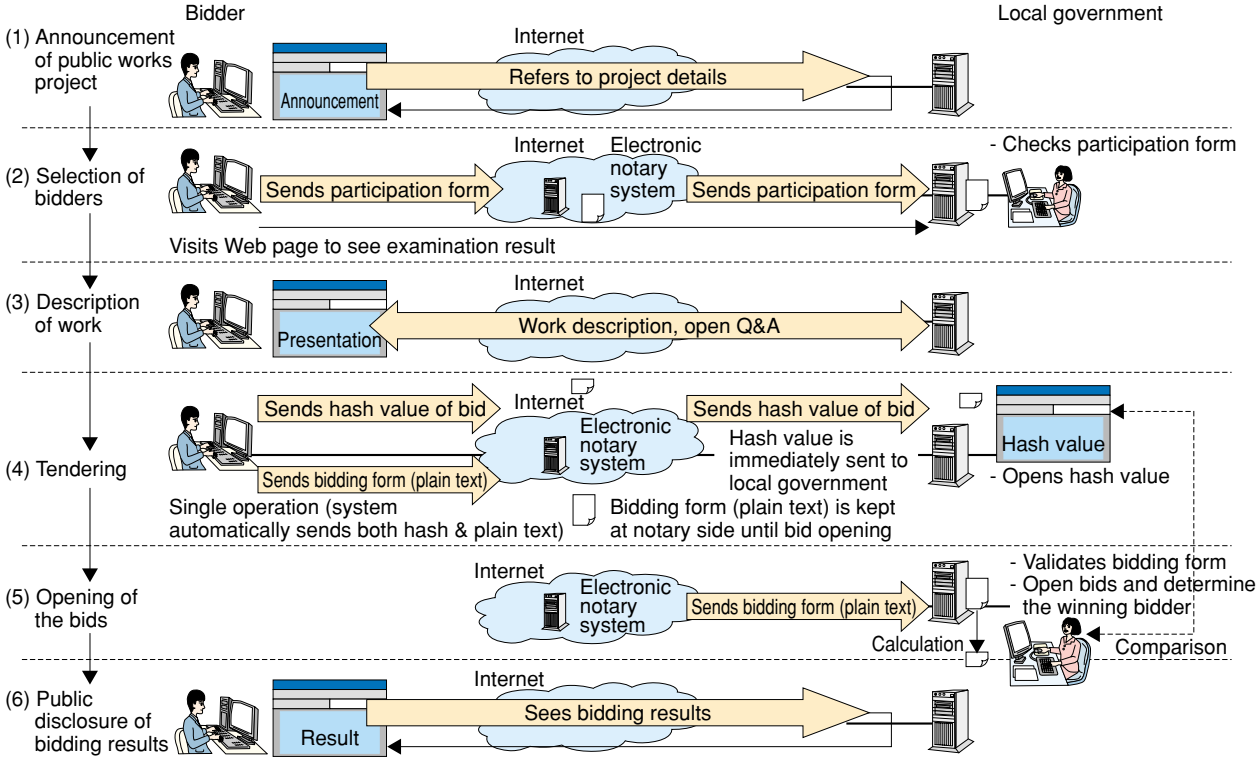

Fig. 3. Flow for electronic bidding.

Table 1. Models for introducing the electronic bidding system.

	Model A (exclusive use)	Model B (partial sharing)	Model C (full sharing)
Bidding system	exclusive use	exclusive use	shared use
Electronic authentication and notary systems	exclusive use	shared use	shared use
No. of local governments	1	5	91
No. of registered bidders	1000	5000 (1000 per local government)	15,000
No. of bidding items (per year)	200	2500 (500 per local government)	18,000

reduce the cost of system development/operation. Therefore, we evaluated the reduction in environmental burden using three models:

(1) Model A (exclusive use)
(2) Model B (partial sharing)
(3) Model C (full sharing)

The number of local governments, registered bidders, and bidding items for each model are shown in **Table 1**.

3.2 Operation model

We assumed that the bidding system was "the general competitive bidding process" and the number of bidders per item was 20. In models A and B, the bidders submit bids only to their own local government. In model C, they submit bids to all local governments in their prefecture. For models B and C, we designed the local government operations to balance the loads on the shared servers.

3.3 Conditions for environmental evaluation

In calculating the environmental burden, we considered the following conditions based on an analysis of conventional business.

(1) travel distance: We assumed that a bidder visits the local government four times per bid and approximated the area of a local government as a circle with radius R, so the average travel distance is R/2.

(2) paper consumption: We assumed that the local government uses 20 pages of paper per bid to announce a public works project and disclose the bidding results and that bidders use 60 pages to submit a bid.

(3) power consumption: We estimated the required hardware configuration (server, PCs, and network equipment) based on number of bids to be handled by system and calculated the power consumption. We assumed 24/7 operation for the servers handling the electronic bidding, i.e., they are available all the time every day. We calculated the energy consumption and CO_2 emissions for each item and evaluated them assuming that the period of use was one year.

4. Evaluation results

The reduction in environmental burden achieved by using the electronic bidding system in the case of models A, B, and C is shown in **Fig. 4**, where the values are normalized by those for the conventional system.

In model A, the energy consumption exceeds 1, meaning that introducing the electronic bidding system leads to an increase in energy consumption compared with conventional bidding. In model A, about 85% of the energy consumption of the electronic bidding system is attributable to the power consumption of the servers. The 24/7 operation provided for user's convenience produces very high energy consumption. In addition, as the system is designed to handle peak loads, the overall system utilization is low, which also worsens the energy efficiency.

In model B, the electronic authentication and notary systems are shared by multiple local governments, and the system operation is designed to balance the loads. As a result, the system utilization is higher and the energy consumption lower, below 60%; the CO_2 emission is below 40%.

In model C, the local governments share not only the electronic authentication and notary systems, but also the electronic bidding system. The system utilization factor is even higher, so the environmental burden is much lower. In addition, electronic bidding eliminates the need for travel and hence its environmental burden.

Thus, the electronic bidding system decreases the environmental burden by increasing the system utilization factor. We calculated that over the lifecycle of system equipment, model C would lead to a 2300-ton

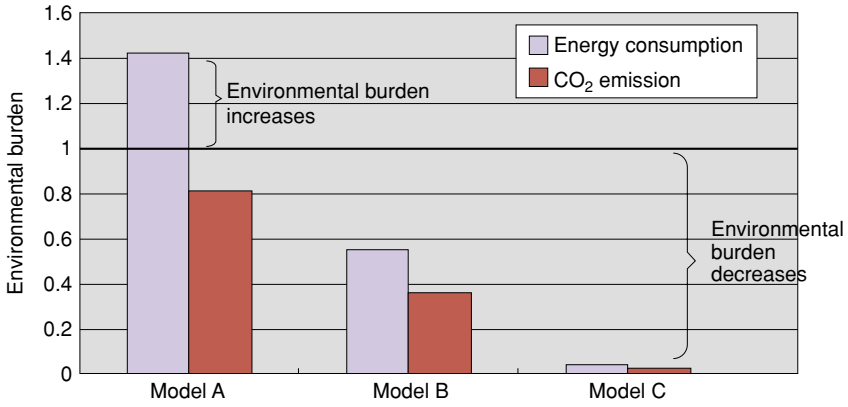

Fig. 4. Reduction of environmental burden by using electronic bidding system. (normalized by conventional system)

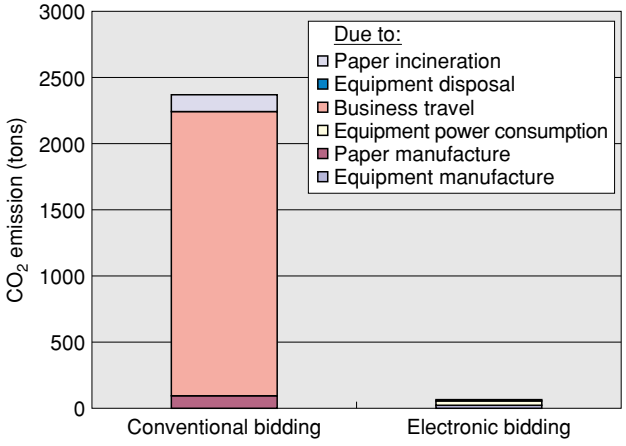

Fig. 5. Reduction of CO_2 emissions in model C. (result of manufacture/use/disposal life cycle evaluation)

decrease in CO_2 emissions per year (**Fig. 5**). This corresponds to the annual CO_2 emissions from 450 family homes.

5. Conclusion

Our analysis shows that our electronic bidding system will be convenient for users like bidders and municipal employees and will increase the efficiency of business processes. It will also reduce the environmental burden. In future, we will improve the system to make it more flexible to match the processing volume and operating conditions present not only at the time of introduction but also later on. We will strive to reduce the environmental burden even further.

References

[1] Y. Kamei, Y. Adachi, H. Kuroki, K. Morimura, and H. Kitou, "NTT's R&D Approach to Electronic Government/Electronic Local Government," NTT Technical Journal, Vol. 14, No. 7, pp. 6-12, 2002 (in Japanese).

[2] S. Takahashi, M. Urata, and Y. Adachi, "Design and Construction of Electronic Bidding System Allowing Third Party's Certification," Information Processing Society of Japan, 61st National Convention, 6R-9, 2000.

[3] S. Takahashi, K. Morimura, M. Urata, and H. Kuroki, "Design and Construction of ASP Type Electronic Bidding System Using Electronic Notary System," IEICE General Conference 2002, D-17-4, 2002.

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