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Creating Innovation in the Construction Industry

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Creating Innovation in the Construction Industry

I. Overview

Looking ahead towards the impending decline in the population, the result of an aging society combined with a falling birthrate, Japan is striving to create innovative new possibilities and inspire new vitality in the socioeconomic arena. The construction industry is using information and communication technology (ICT), the tools of innovation, to further develop construction production systems and to improve the networking capabilities of the construction industry, as described below. The industry is:

(1) Developing electronic commerce transaction systems (structures for exchanging the estimates and order sheets needed for placing and accepting orders) using the Construction Industry Network (CI-NET), a standard for the exchange of electronic data formulated in cooperation with the construction industry. The industry is also furthering the digitization of the public works ordering process through the Continuous Acquisition and Life-cycle Support/Electronic Commerce system, CALS/EC.

(2) Promoting facility maintenance using IC tags.

(3) Concentrating the tasks conducted by individual companies, such as customer service, design, material procurement, and project management over the Internet, and promoting collaboration between small and medium-sized construction companies using local information networks.

The industry is striving to measure natural disaster information in real time using IC tags, and to work with broadcast media to share accurate disaster prevention and damage information via mobile phone networks. The industry is also determined to achieve a safe transportation structure by further developing intelligent transportation systems (ITS) that enable vehicles and infrastructural components to communicate with one another. Innovations like these have the potential to significantly change people’s everyday lives. It is essential that the construction industry see these developments as new business opportunities, that it stays up-to-date with technological innovations in ICT and other sectors, that it takes the socioeconomic situation into account, and that it aggressively takes advantage of rising opportunities.

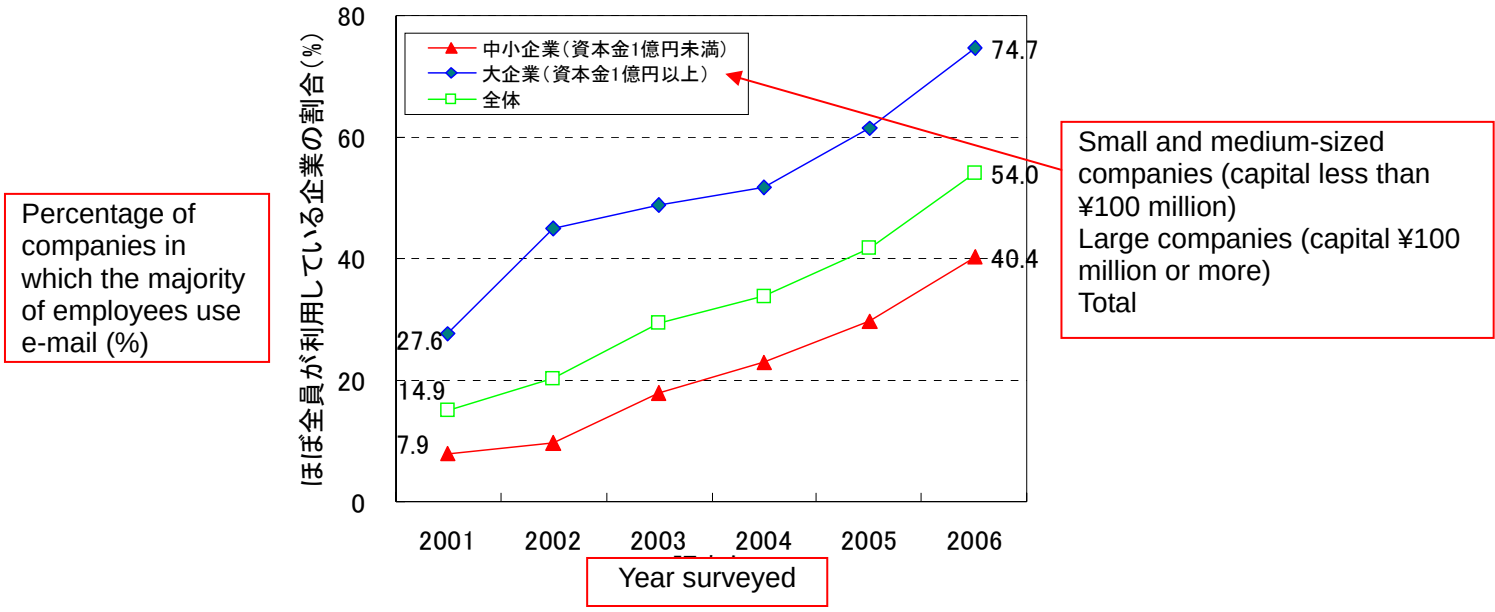
II. Innovation in the Construction Industry

Today, Japan is facing a serious decline in the population due to an aging society and falling birthrates. It is therefore extremely important that the construction industry discovers and creates new possibilities, inspires new vitality in the socioeconomic arena, and achieves sustainable development despite the population decline. One way to do this is to recognize that innovation means using new technology to reform and renovate social systems and the entire institutional structure, thereby allowing the consistent production of new value. Japan's effort to achieve such innovation is evidenced by the establishment of the Innovation Promotion Headquarters within the cabinet.

Information and communication technology (ICT) is expected to play a major role in the future, serving as an important tool of innovation. In response to the rapid development and dissemination of information-related technology, Japan is promoting the expanded use of ICT. The government established the IT Promotion Headquarters within the cabinet in January 2001, and has since then been promoting the e-Japan strategy, as well as its more developed version, the u-Japan strategy, and a series of plans to implement both.

It is against this backdrop that the construction industry has been trying to expand the use of ICT. Although progress is being made at different rates depending on the size of the company, efforts to expand the use of ICT in the construction industry are steadily moving forward. For example, in 2006, the majority of employees used e-mail in 74.7% of large companies (with capital of ¥100 million or more) and 40.4% of small and medium-sized companies (with capital of less than ¥100 million). These percentages are steadily rising. Also, although the construction industry is lagging behind other industries, efforts to use electronic forms of transaction, such as electronic bidding, are moving forward. 89.9% of companies now have an electronic bidding system.

Figure 1　Percentage of companies in which the majority of employees use e-mail



Source: Research Institute of Construction and Economy (RICE)

The use of IT by service providers can improve operational efficiency and reduce costs. For service consumers, it can increase the value-added of the services they consume and contribute to improved customer satisfaction. The construction industry in Japan tries to use IT in every stage of its business operations, including sales activities, design and estimate calculations, the receiving and placing of orders, material procurement, project implementation, and maintenance activities. The construction industry also strives to develop more advanced construction production systems, and to improve its networking capabilities. The following sections will provide several examples of how innovation is being achieved in the construction industry through the use of IT. These examples will be divided into those related to construction industry policy and those that reflect the ambitious and creative efforts of private companies.

1. Promoting the Use of IT Through the Development of Common Platforms

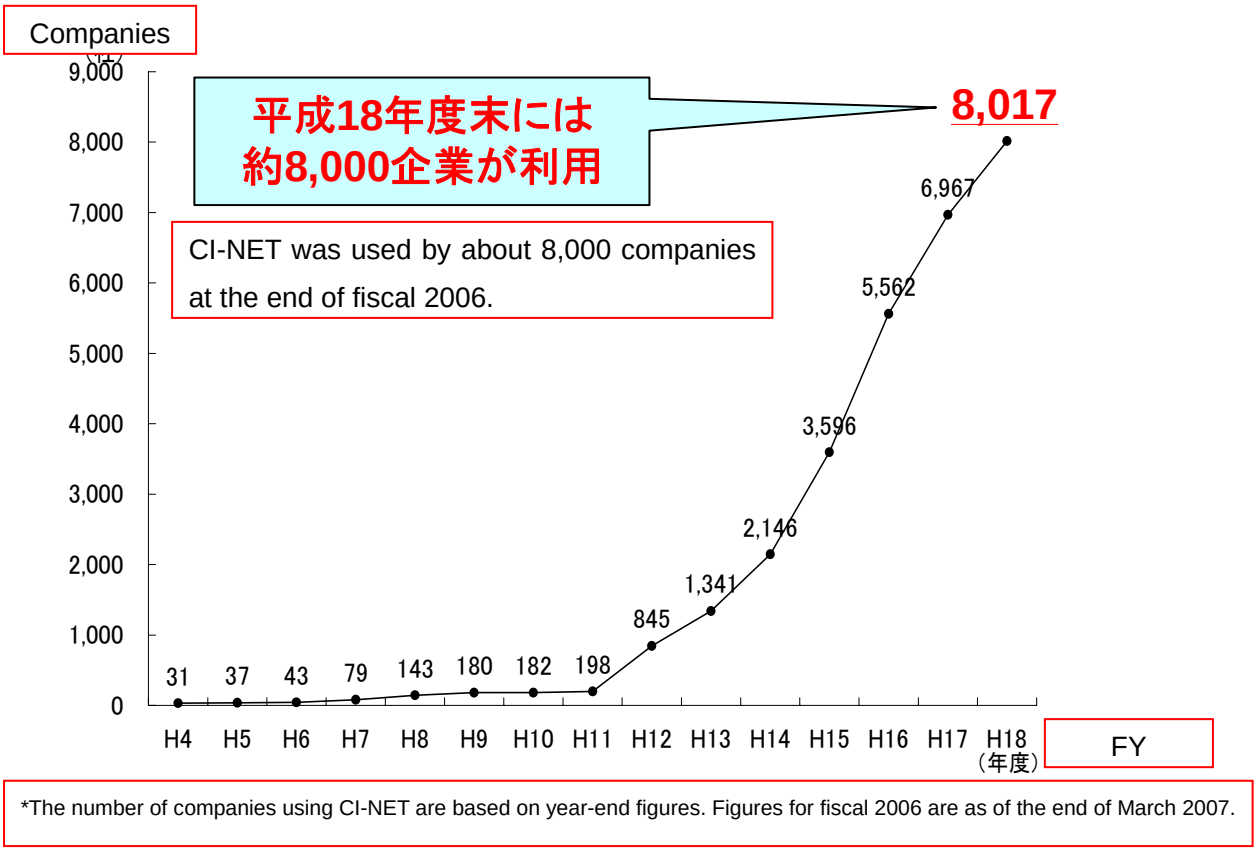
(1) Development of the Construction Industry Network (CI-NET)

It is important to avoid problems that can arise from a lack of compatibility between electronic commerce services, such as redundant investments and administrative complications resulting from the installation of multiple terminals by our business partners. Toward this end, the Ministry of Land, Infrastructure and Transport (MLIT) adopted the Guidelines Regarding the Cooperative Use of Computers in the Construction Industry in 1991. Based on these guidelines, the

Fund for Construction Industry Promotion worked in cooperation with construction companies to formulate standards for electronic data interchange in the construction industry (CI-NET). These standards stipulated standardized information exchange procedures and agreements for electronically exchanging accounting data, such as estimates and orders sheets, between construction companies. They covered such details as the procedures for transmitting purchase orders and order receipts, data formatting, and product codes. At the end of March 2007, as many as 8,017 companies were participating in CI-NET. The use of CI-NET makes it possible for companies to electronically exchange relevant documents and technological information, using common procedures and methods, with other CI-NET-participating companies. This reduces the costs associated with the documentary stamp tax, document production, and delivery, and improves management efficiency by providing numerical data that can be utilized in cost control measures. It is also expected to create efficiencies related to the promotion of more systematized relationships with subcontractors, which are often not governed by written contracts.

With the environment for electronic transactions between construction companies becoming more developed, the five leading construction companies; Kajima Corporation, Taisei Corporation, Shimizu Corporation, Obayashi Corporation, and Takenaka Corporation, in partnership with NTT Data Corporation and Oracle Corporation Japan, established Construction-ec.com Co., Ltd. Using CI-NET, Construction-ec.com offers an ASP service known as “CIWEB.” The system has 6,209 companies that receive orders (as of March 31, 2007), and facilitated 133,598 contracts in fiscal 2006.

Figure 2　Trends in the number of companies using CI-NET



*The number of companies using CI-NET are based on year-end figures. Figures for fiscal 2006 are as of the end of March 2007.

(2) Promoting the digitization of administrative tasks related to public projects (CALS/EC)

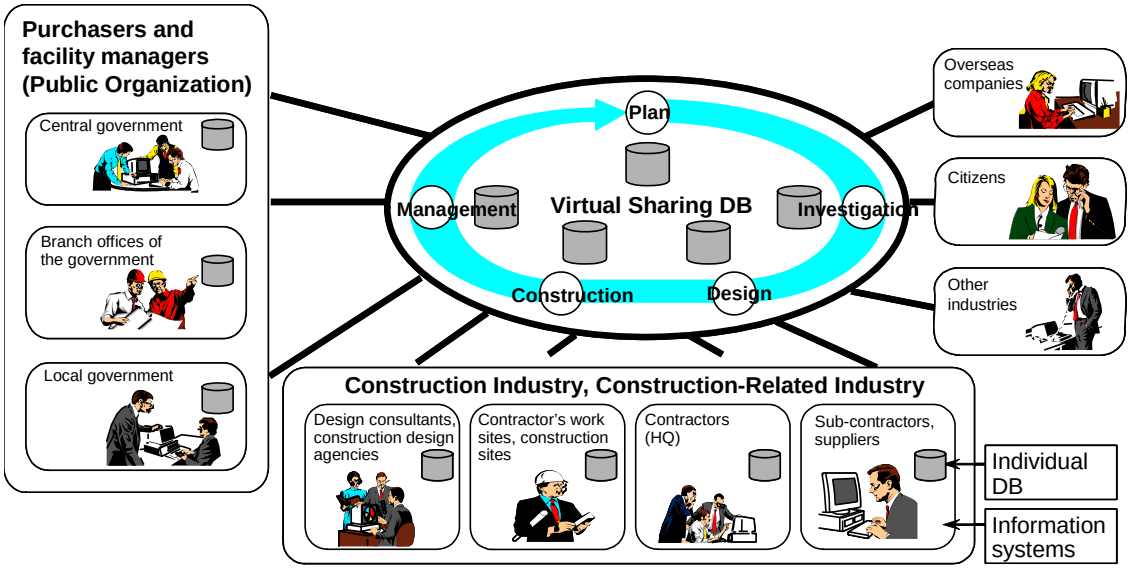
The Ministry of Land, Infrastructure and Transport (MLIT) formulated the Basic Concept Regarding the Development of the Construction of CALS/EC, and is promoting the Continuous Acquisition and Life-cycle Support/Electronic Commerce (CALS/EC) system, a comprehensive information system for supporting public works projects. CALS/EC uses digital information technology in public works projects to achieve electronic bidding (a structure in which bidders can participate in the bidding process over the Internet), electronic contracts (a structure for concluding contracts using internal computer networks or the Internet) and electronic delivery (a structure for delivering results in electronic files). CALS/EC also enables electronic acceptance, which prevents fraudulent bids and modifications to bid content, thereby ensuring the safety of transactions done over the Internet. The system is designed to improve and promote the efficiency of document and information exchange between parties involved in public works projects, thereby improving the quality.

The MLIT has promoted CALS/EC by developing a specific Action Program based

on the basic concept and trends in the e-Japan strategy. The CALS/EC Action Program was formulated in March 2006 with a target implementation date of March 2008. It includes 18 goals, such as “improving the efficiency of procurement procedures through the distribution of bidding information over the Internet.” The CALS/EC approach is gradually being adopted for projects that are directly managed by the MLIT.

In fiscal 2006, 36,920 of the approximately 40,000 bids (or nearly 90%) for both national construction and administrative projects were handled electronically. However, electronic bidding at the municipal level had only been implemented by 22% of municipalities as of June 2007. Introducing electronic bidding among local public organizations, particularly municipal governments, is the next challenge to be addressed.

Figure 3　CALS/EC Conceptual Diagram



2. IT-Derived Innovations by Companies in the Construction Industry

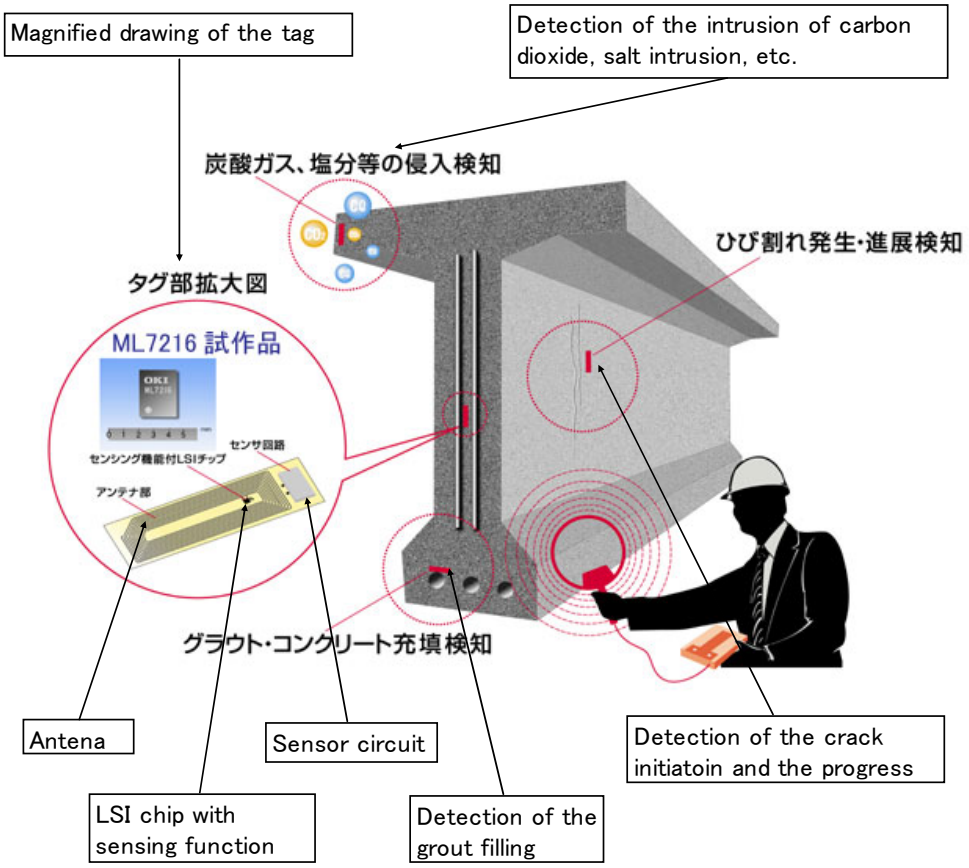
(1) Facility maintenance and management using IC tags

Because much of the social capital built in Japan after World War II is now facing the need for renovation, efficient facility maintenance is a key factor in decreasing life-cycle costs. There are great expectations for innovations in this area.

Company A has built a system in which it embeds IC tags (radio frequency identification, RFID, tags) into its concrete structures. The IC tags allow the company to check conditions such as grout filling, the appearance and growth of cracks, and the penetration of carbon dioxide gas and salt, after the structures

have been built, without having to destroy them. The RFID is a passive tag that is not battery-operated, and is equipped with a large-scale integration (LSI) chip. Inspection results are recorded in the rewritable memory of the LSI chip, and a read and write device can be used to obtain information from the electromagnetic waves emitted from the RFID.

Figure 4　Diagram of facility maintenance and management using IC tags



http://www.oki.com/jp/Home/JIS/New/OKI-News/2005/06/z05019.html

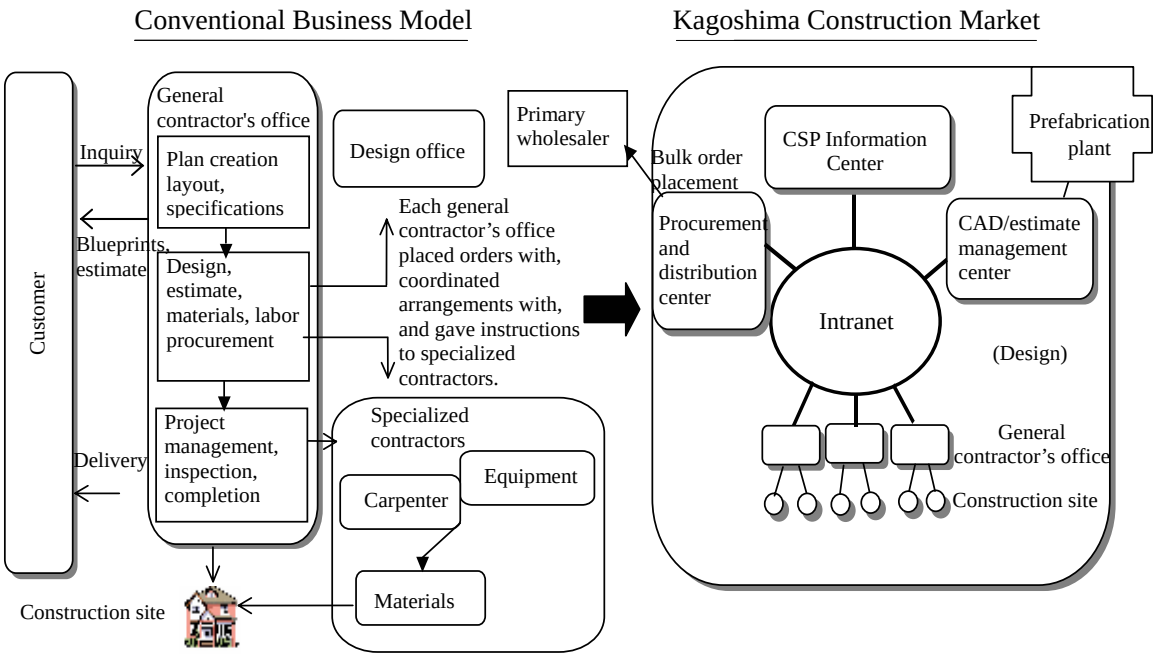
The advantages of this system are as follows. When expressway management corporations (taking over the responsibilities of the Japan Highway Public Corporation) perform construction work on bridge piers, they insert a wire to confirm the chemical grouting status of the structure. After the chemical grouting status has been confirmed, the wire is cut off, leaving a portion of the wire embedded in the mortar. However unlikely, it is possible for moisture to penetrate the structure from this location,. Also, once this wire is cut off, it becomes impossible to ascertain the level of deterioration of this section later. This new system is superior to the wire method insofar as it does not allow the penetration of moisture and because the RFID can be used for about 10 years. At present, the

RFID system is not in use because it costs about twice that of the wire method. However, if further efforts are made to promote the u-Japan strategy (a more developed version of the e-Japan strategy promoted by the Ministry of Internal Affairs and Communications) and to expand the use of RFID tags, and if the devices become mass-produced, the costs will drop. This would make the implementation of this system more practical.[1]

(2) Promoting collaboration among small and medium-sized companies
Sensing the tough economic environment and the need to improve both management efficiency and customer satisfaction, 150 small and medium-sized general contractor's offices and specialized contractors in Kagoshima Prefecture have launched a collaborative project using IT to form a local information network. The multiple tasks that were once handled by each general contractor's office, such as customer service, estimating services, design work, placing orders with specialized contractors, material procurement, and project management, are now being assigned to separate centers established to perform a single function. Under this system, these centers are connected via an intranet and the network members can view blueprints, specifications, construction schedules, and procurement information over the Web. This system has allowed the joint purchasing of equipment and materials, the sharing and integration of estimation procedures, and the introduction of CAD design services, which are often difficult for small and medium-sized contractor's offices to offer. This has led to a dramatic increase in efficiency. Also, Web cameras have been installed at construction sites, allowing offices to get an overview of construction progress in real time. This has significantly reduced the preparation time needed by specialized contractors, resulting in an increase in both work efficiency and productivity. Specifically, the average construction period has been shortened from 90 days to 60 days. Costs have likewise been reduced from ¥420,000 per *tsubo* (a unit of land measurement equivalent to about 3.95 square yards) to ¥320,000 per *tsubo*.

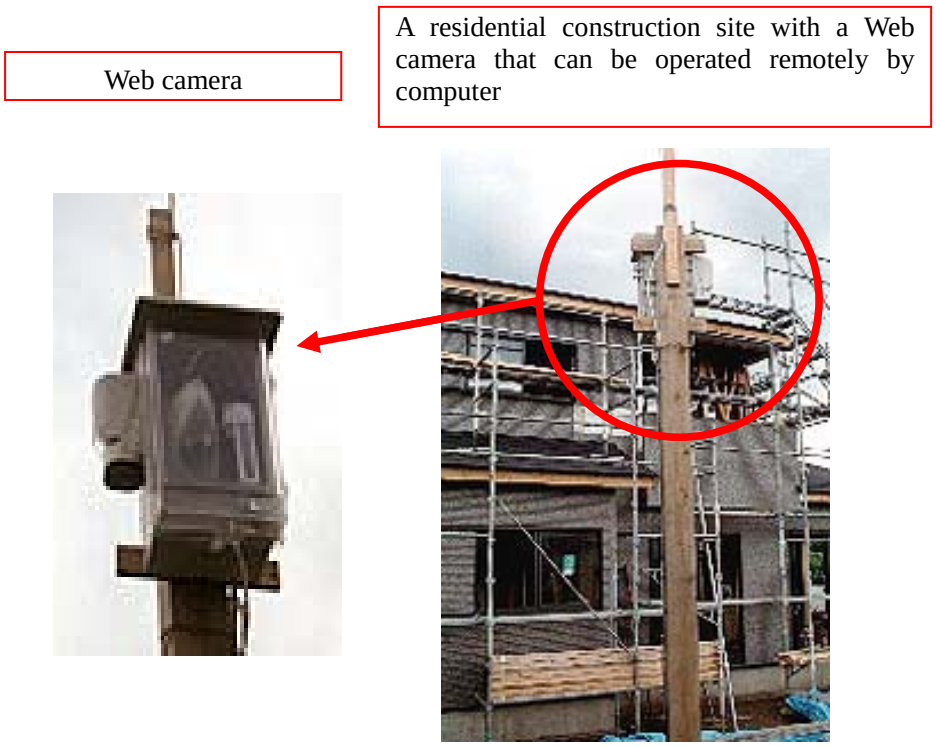
[1] The "u" in the u-Japan strategy has three meanings: (1) Ubiquitous: Information networks can be accessed any time, anywhere, by anyone, for any purpose. (2) Universal: Networks can be universally used by anyone. (3) Unique: Networks are unique systems. By 2010, the u-Japan strategy envisions the use of RFID tags in systems where, for example, an RFID is placed in a refrigerator, allowing the consumer to ascertain what items are in their refrigerator from their mobile phones before they go shopping.

Figure 5　Diagram of the Kagoshima Construction Market Business Model



Source: *Promoting e-Construction Management Among Small and Medium-Sized Companies*, Research Institute of Construction and Economy (March 2004).

Figure 6　Residential construction site with a remotely operated Web camera



Source: Kagoshima City (http://www.minaminippon.co.jp/kikaku/it/000915.htm)

III. Future Projections and Conclusions

Needless to say, information and communication technology (ICT) is expected to play a major role in the construction industry by serving as an important tool in promoting innovation. ICT not only has significant potential in terms of its ability to overcome geographical and spatial restrictions by transcending time and distance, but also has the inherent potential, by virtue of the extremely fast pace at which technological innovation occurs, to dramatically change existing social structures and lifestyles in a very short period of time.　Japan is becoming one of the world's leading ICT countries in terms of its infrastructural developments, such as its optical fiber network, as well as in its personal Internet usage rates. Japan will have to take full advantage of the potential offered by IT developments in the future so that it can ensure high productivity despite population decline, consistently produce new value, and find ways to solve its various socioeconomic

issues.
The MLIT announced its Innovation Promotion Outline in the Land and Transportation Fields on May 25, 2007. This outline contains examples of ICT projects that need to be promoted in the future, and a construction schedule for implementing them. Among them, the following projects will provide society with advanced disaster prevention capabilities and the world's safest transportation systems using ITS, which are related to the construction industry.

Every year, Japan experiences natural disasters such as earthquakes and typhoons that cause significant loss of life and property. To dramatically decrease this loss, an initiative using IT to raise the nation's level of disaster response capabilities is being investigated. Specific examples include:

(1) Creating a network of sensors, including IC tags to be placed in important public facilities, such as levees, breakwaters, and sewerage systems, and ensure that these are constantly monitored. Damage can thus be measured in real time and information can be collected from residents using mobile GPS devices.
(2) Combining and utilizing different monitoring technologies that take advantage of airplanes and satellites, and detecting the early signs of disasters by automatically monitoring movements in the earth's crust.
(3) Ensuring the dissemination of accurate disaster information, strengthening partnerships with broadcast media, enabling car navigation devices to provide vocal disaster information announcements, and enabling the visual monitoring of road information using mobile phones.

Several intelligent transportation system (ITS) tools, such as car navigation systems, now in 25.32 million vehicles, and electronic toll collection systems (ETC), now in 16.98 million vehicles with an average national use of 67.3%, are in widespread use. These provide a major benefit in people's lives, increasing convenience for drivers and improving the traffic environment by reducing congestion. In the future, the challenge will lie in finding ways to organically link these systems to make roads safer. For example, efforts are already underway to create a safe driving support system using collaborative infrastructural communication. One system, using an intra-auto communication system, can transmit the position of an oncoming vehicle to a car that is trying to take a right turn so as to avoid collision, while another system uses roadway-to-auto communication to provide information regarding obstructions in the roadway. These systems are being empirically tested in 2007. There are also initiatives to

use ETC technology to ease parking lot entry and exit, and to use vehicle information to settle transactions by credit card. Vehicles and the infrastructure are being linked through information technology, and this is creating a chain reaction throughout the business world.

To promote these kinds of innovations, national and local government bodies, industrial experts in the construction industry and other sectors, and experienced scholars need to work closely to construct common foundations that can keep up with rapid developments in ICT. As this happens, various parties will make efforts aimed at promoting innovation. It is particularly important that the construction industry recognize these developments as new business opportunities, that it watch for technological innovations in ICT and other sectors while also keeping an eye on the socioeconomic situation as a whole, and that it aggressively take advantage of opportunities as they arise. These innovations have applications for overcoming the challenges that all nations face, such as improving disaster response and traffic safety. It is therefore important that efforts be made to share this information with people around the globe.