ELECTRONIC WASTE EXCHANGE FOR JUST-IN-TIME BUILDING DEMOLITION

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Abstract
Waste exchange is as a facilitator for construction and demolition waste deduction by reuse and recycling in construction projects. The just-in-time philosophy, which has been well cultivated in the manufacturing industry, is highly adoptable for demolition projects. Particularly, waste exchange that is usually performed after the actual demolition process can be shifted forward so that waste inventory from demolition is eliminated or reduced to facilitate waste reuse and recycling. A web-based waste exchange system is an ideal platform to enable communications among project participants before a demolition project commences so that waste materials can be sold before they are produced. Therefore, the productivity of the demolition project could be improved. This research paper aims to investigate and analyse the adoption of just-in-time philosophy in building demolition project management. It also describes the development of the proposed web-based waste exchange system that implements just-in-time demolition in detail, including its functionalities, information flows and major components.

Keywords
Building demolition, just-in-time, inventory control, reuse and recycling, waste exchange, Web-based system, e-commerce

INTRODUCTION
The increasing problem of waste disposal has recently challenged various industries worldwide. Most industrialised countries have high levels of consumption and correspondingly high levels of waste disposal. For example, Australia has the second highest domestic waste production per capita among all member nations of the Organization for Economic Co-operation and Development (NSWEPA 2003). Nearly one tonne of solid waste is sent to landfill per person each year. The whole country’s waste stream is about 14 million tonnes, of which about 30%-40% is construction and demolition waste (ABS 2003). The demolition of building structures produces enormous amounts of waste materials that in most countries result in significant waste streams (Poon et al. 2001). The construction industry, particularly in the demolition of constructed facilities, is the top contributor among all industry sectors. On the other hand, due to the lack of supply of usable second-hand materials on the market, new and high quality materials are used in construction projects whose design standards can be fitted by secondary or used materials. As a result, reuse and recycling of demolition waste poses huge potential in the construction industry. This could contribute significantly to ecologically sustainable development for both construction industry and the built environment as a whole.

Sensing the situation aforementioned, building demolition is undergoing revolutionary development. In addition, there is tightening environmental standards, by both governments and the industrial governing bodies (e.g. in Hong Kong) (Poon et al. 2001). The advances in innovative building demolition techniques result not only in increased cost-efficiency, but
also in improved safety and environmental performance. A number of philosophies that have originated in the manufacturing industry including just-in-time (JIT) production system, supply chain management and transportation logistics management, have been studied widely in construction material management (Shakantu et al. 2002; Akintoye 1995; Ibn-Homaid 2000). The findings generally indicate that the manufacturing oriented management approaches can improve productivity in the construction industry remarkably.

Following the rapid development of the Internet technology, web-based waste-exchange system development is an increasingly widespread solution to the waste material exchange problem (Chen et al. 2003; Liu et al. 2004). In the construction industry, waste exchange systems have been utilised to deal with construction and demolition wastes. However, due to limited improvement on management that can match the engineering advancement, many current waste exchange systems have limited functionality and poor performance. Systematic approach is therefore needed to involve the generation stage of waste materials. Information technologies, in particular the Internet, have demonstrated these are able to drive the development of new demolition techniques such as deconstruction (Liu et al. 2004).

This research paper aims to describe the development of a web-based waste exchange system that embraces JIT management philosophy. The paper is organised to firstly examine current situations and waste problems of building demolition, waste problem developments in techniques, and emergence of JIT demolition. The next section explores waste exchange as a solution for reduction of demolition wastes with the enhancement of JIT.

EMERGENCE OF JUST-IN-TIME DEMOLITION

Conventional Demolition Approaches
Being regarded as the last stage of a building lifecycle after planning, design, construction and maintenance, demolition is usually disregarded for its simple and straightforward approaches. In the past decade, labour cost climbed significantly faster than material and equipment costs during this period of economic development which made the manual dismantling of builds more expensive in terms of time and cost. This factor, along with other factors such as massive mechanisation, has lead to the dominance of mechanical building demolition (Gordon Engineering 1997). The notion of building deconstruction motivated the rejuvenation of the ancient building demolition technique. Under deconstruction, building structures are carefully dismantled into components and materials so that they can be reused in other construction projects whose design can incorporate secondary building materials (Rathmann 1999).

Several demolition methods are commonly in use by the demolition industry, namely explosive/implosive demolition, mechanical demolition, and deconstruction. Explosive demolition is the fastest method (Abdullah and Anumba 2002; Dolan et al. 1999). However, it produces a mass of mixed materials very difficult to separate for salvaging or recycling. Mechanical demolition, which uses heavy machines such as excavators to destruct the building, has similar problems that material salvage is hard to implement. However, waste from mechanical demolition is more likely to be recycled. On the other hand, waste material reuse, which is more beneficial for the environment than waste recycling, is hard to be achieved after an explosive or a mechanical demolition project. Deconstruction, as an emerging demolition technique, which manually dismantles a building structure so that materials can be more easily salvaged for reuse, is becoming a fashion in building demolition and is likely to become the major demolition method in the future (Kibert et al. 2001).
Development in Demolition Techniques
Demolition techniques are evolving rapidly. Particularly, building deconstruction has caught remarkable attention during the last decade. Deconstruction is defined as “a process of selectively and systematically dismantling buildings to reduce the amount of waste created and generating a supply of high value secondary materials that are suitable for reuse and recycling” (Macozoma 2001). The deconstruction process is regarded as the opposite of the construction process. Building materials are therefore easier to be classified and salvaged. An analysis of the composition of waste from various industrial or commercial demolition projects found that more than 90 percent of it was reusable or recyclable and less than 10 percent should be sent to landfills (Franklin Associates 1998). The reusable building materials mitigate the environmental pressure that demolition projects face. Moreover, while deconstruction is becoming more developed and popular, the secondary material market generated from the demolition industry can foster the economics for a chain of production, supply, logistics, and consumption of building materials from demolition waste salvage.

To further facilitate deconstruction industry in the future, currently many research efforts have been focused on design for deconstruction, that is, to construct a building in the way that it will be easily dismantled in the future. A number of researchers have attempted in this area. Crowther (2000, 2001; 2002) states that the disassembly of a building might logically be just the opposite of its assembly but in practice it hardly ever occurs this way. He also argues that if the design of construction is conducted in a way that is easy to assemble for the project team, it will also allow the building to be easily disassembled. In addition, the buildability, which refers to the design for assembly above, can also decide the sequence of disassembly that is reverse to assembly in construction. Several principles are suggested for better buildability, namely simplicity, standardisation, and clear communication. Design for deconstruction, or design for disassembly, is still relatively new in the field of construction management, or architectural technology. However, more and more information is available. Guidelines and standards are being developed by researchers and the industry.

The evolving building demolition technologies enable and promote building material salvage for reuse. Nevertheless, building materials reuse is hardly guaranteed. It is not easy to locate demands for secondary building materials either before or after a demolition project. Furthermore, the requirements of materials from potential users are not known prior to the commencement of the demolition project which can lead to unsatisfactory materials for their next usage (Pun et al. 2003).

Opportunities of JIT in Demolition Project Management
Problems that occur in demolition waste management are caused by many factors. Apart from the lack of technical advancements such as machinery and techniques, difficulties of management approaches are also evident. A long-lasting waste building material inventory could deter both material producer and users from achieving waste material transactions. On the one hand, extra storage space is needed to store waste building materials, which obviously imposes financial burdens on material producers. On the other hand, stored waste building materials do not necessarily satisfy demands due to possible inferior quality or unmatched specification. The nature of the problem naturally leads to a JIT philosophy which is ideal for managing inventories. The JIT philosophy was introduced and promoted by Toyota Motor Corporation in the 1950s (Ansari and Modarress 1990). It aims to improve quality, reliability and productivity of the manufacturing production. The use of the JIT philosophy in the manufacturing industry has proven to be successful (Low and Mok 1999). There is a possible opportunity that waste building material inventories from building demolition projects can be effectively managed through JIT.
JIT has been applied in construction projects to minimise construction waste (Low and Choong 2003). The workflow and procedures of demolition projects differ from the typical manufacturing process. The manufacturing process starting from the customer order, raw material purchasing, producing final product, to delivery, is a continuous and repeated process (Ibn-Homaid 2000). Conversely, the demolition of a building can only be done once. A building to be demolished is analogous to raw material for manufacture. Meantime, the waste materials generated from the demolition activity can be seen as the products of demolition. Both demolition wastes and manufactured products are delivered through transportation. Considering a building structure as a final deliverable that is produced by a construction project team, the construction and manufacturing processes are comparable (Pun and Liu 2003).

There are advantages in utilising a JIT philosophy in demolition projects. One of the initial objectives of JIT philosophy is to eliminate the stocked raw materials and/or final products in the manufacturing process. In a demolition project, the final products that are actually the wasted materials can be sent to material buyers without stocking. Therefore, there is no long term storage space necessary for holding waste materials. Moreover, transportation can be ordered or arranged in advance, and carried out simultaneously with the demolition process. If the schedule of the demolition process is optimised and transportation implementation is organised accordingly, the transportation process and demolition activities can be connected well and therefore the site can be cleaned up and prepared for the next usage straight after demolition is completed.

Usually, waste exchange activities, if they occur, are carried out after the production of the waste materials. Web-based information systems, or conventional communication channels such as the phone and newspaper, can be used to perform information exchange between waste material suppliers and users. Regardless of the platform on which waste exchange runs, the generated waste materials need to be stored at the demolition site or other depositories for the period of time that is taken for publishing information to enable waste exchange and waste buyers to be found. Considering waste exchange is a stage of a demolition project, the project duration is stretched long.

By applying the JIT philosophy in demolition projects, the delivery of demolition materials to their buyers can be carried out straight after they are produced from the demolition process. In order to achieve this, waste exchange needs to be performed before the actual demolition process. The potential benefits are savings of time and space to handle the waste materials. Moreover, it makes the project compact and releases some of the burdens of management and control. Figure 1 shows both the conventional demolition practice and the proposed JIT demolition model.

As illustrated in this figure, both conventional processes and JIT demolition process comprise identical procedures yet different working sequences. In the JIT demolition model, after a building demolition is decided, waste exchange is performed first. In both conventional and JIT demolition, demolition technique selection and demolition design follow early demolition planning. Demolition implementation is the next step for both demolition models. In the course of demolition implementation, waste material produced in a conventional demolition project can be stored on site temporarily, or transported to additional storage space. Demolition waste can be delivered to buyers in a JIT demolition project identified through waste exchange. Demolition waste transportation can be completed straight after the completion of dismantling activities. Therefore, in a JIT demolition case, the project is completed after demolition project implementation and site clearance. As a result, JIT demolition is more intensive in
the demolition planning phase than conventional demolition. Yet, conventional demolition contains considerable post-demolition processes.

DESIGN OF A JIT WASTE EXCHANGE SYSTEM

JIT Waste Exchange Principles
Waste exchange enables waste transactions among waste producers who carry out building demolition projects and waste buyers who utilise secondary building materials in new construction projects. However, the reuse and recycling are not guaranteed due to various issues. For example, it is difficult to find material buyers and fulfil their requirements in a short period. Web-based waste exchange systems are playing a significant role in information exchange to achieve effective and efficient waste production and exchange (Chen et al. 2003).

Under a JIT building demolition model, information of waste material requirements needs to be collected prior to the actual demolition project (Pun et al. 2003). Firstly, the information of the building to be demolished should be published on the waste exchange system along with general information such as location and history of the building, additional information including brief building waste estimation, engineering and architectural characteristics, and possible applications of reuse for waste materials. All published information should be made available for potential waste material users. Waste material buyers then express their perspective on the demolition project by giving the amount, date, quality and detailed requirement of the building materials against a certain building demolition project. The collected entries by material buyers form a technical specification for the building demolition project, after all requirements are evaluated and organised within the system by the building owner. As a result, the building demolition project can be conducted in a way so that outcome of waste production activities can satisfy waste material buyers. The proposed waste exchange system serves not only as a platform of information exchange to acquire waste material availability but also a data collector for demolition project owners in order to generate a demolition specification, that is, a detailed list of materials to be produced.

System Environment Identification
The process of a JIT building demolition project is in some ways more complicated than an ordinary mechanical building demolition. In addition, a number of project participants are involved. Some of the project participants are collaborative such as a demolition contractor and demolition designer while others are competitive such as secondary building material buyers. The success of a demolition project depends on the communication among all participants.
project participants. Due to the rapid development of Internet technology and the fact that a web browser is the most available computer software (Kurose and Ross 2003; Abduh and Skibniewski 2004), efficient web-based information systems are the ideal tools to carry out communication activities.

Theoretically, in a demolition project, the processes of demolition planning, demolition design, implementation, waste building material production, transportation, waste reuse and recycling are sequential. The flow of waste material from a building demolition project forms a reverse waste material supply chain. Reverse logistics have been identified to play an important role in construction and demolition waste management (Shakantu et al. 2002). The information flows among demolition project owners, demolition contractors, and waste material buyers who determine the procurement issues of the demolition project, namely demolition contractor selection, contracting and waste building material marketing. As a result, information transparency among parties of the demolition material supply chain is crucial to the results and effectiveness of demolition waste exchange.

Several parties are identified as direct users of the proposed waste exchange system in the reversed waste building material supply chain. Firstly, the owner of a demolition project, in most cases the building owner, should be the main user group of the system. Secondly, secondary building material users should be allowed to access the waste exchange system and express their interests on building materials. This will allow the project owner to determine the sale of dismantled building materials to achieve maximum benefits. Thirdly, demolition contractors could benefit from accessing the system to seek job opportunities. The information about material requirements then determines demolition designs. Fourthly, tippers can also browse the system to seek transportation jobs that are outsourced, including moving materials to buyers or landfills. Fifthly, government and industrial representatives and the general public should also have access to the aggregated data for the purpose of environmental education or statistical information. Consequently, they can gain environmental awareness and issue financial value from building demolition on their future projects. Finally, due to the complex information involved, an administrator is necessary to coordinate integrated information and data. Given the fact that potential users come from such a large span within the society, information communication plays an important role to achieve integrity and collaboration.

System Functionality Identification
After identification of potential users of the demolition waste exchange system and their perspectives on the system, functions of the system can also be identified. Since perspectives on the system are diversified, functions for all potential users need to be identified before the development of the proposed Web-based demolition waste exchange system. Table 1 shows major potential users for the JIT waste exchange system and system functionality on their perspectives.

DEVELOPMENT OF THE JIT WASTE EXCHANGE SYSTEM

A web-based waste exchange for JIT demolition projects was created to demonstrate the functionalities by different potential users that are identified in the last section. The current URL of the developed system is http://www.deakin.edu.au/~skpu/DMMS.

A three-tier server-client architecture was designated for the system which has been popular
Electronic Waste Exchange for Just-in-time Building Demolition

Table 1  JIT waste exchange system functionality identification

<table>
<thead>
<tr>
<th>System user</th>
<th>Required functionality from the waste exchange system</th>
</tr>
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<tbody>
<tr>
<td>Building owner or demolition project owner</td>
<td>To release information of demolition projects on the system, including photos and drawings</td>
</tr>
<tr>
<td></td>
<td>To receive assistance on waste building material identification and estimation</td>
</tr>
<tr>
<td></td>
<td>To inspect requests on waste building material to be produced</td>
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<tr>
<td></td>
<td>To determine and announce deals of waste building materials and select suitable requesters</td>
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<tr>
<td></td>
<td>To gain information on financial gain and environmental assessment on a particular demolition project</td>
</tr>
<tr>
<td>Secondary building material demander</td>
<td>To search availability of a certain type of secondary building material against various criteria and to list all materials from a certain demolition project</td>
</tr>
<tr>
<td></td>
<td>To express interest in building materials from a demolition project onto the system including delivery time, location and price to pay</td>
</tr>
<tr>
<td></td>
<td>To access the system to check the result of material requisition</td>
</tr>
<tr>
<td>Demolition contractor</td>
<td>To access the system to search demolition projects against criteria such as location, size, type of building, etc.</td>
</tr>
<tr>
<td></td>
<td>To browse the approved requests of building materials for a particular project and to initialise demolition specification in order to produce required building materials during the project</td>
</tr>
<tr>
<td>Tipper</td>
<td>To browse the approved requests of building materials for a particular project to acquire delivery time, demolition site, transportation destination, types of materials, etc.</td>
</tr>
<tr>
<td>Government or industrial representative</td>
<td>To gain access to the system at a data warehouse level in order to collect and analyse building and demolition at industrial, regional or national level</td>
</tr>
<tr>
<td>Public</td>
<td>To browse the general information and past demolition project information as case studies</td>
</tr>
<tr>
<td>Data administrator</td>
<td>To maintain the database that stores all the information about a demolition project</td>
</tr>
<tr>
<td></td>
<td>To maintain and update information that is changing according to the economics such as price of building materials</td>
</tr>
<tr>
<td></td>
<td>To maintain a knowledge base that helps demolition project owner on waste identification and estimation</td>
</tr>
<tr>
<td></td>
<td>To archive and extract information into statistical data</td>
</tr>
</tbody>
</table>

among current construction material management systems (Kong et al. 2000; Li et al. 2002). A database server stores database tables that describe demolition projects, system users, and material characters. A web server acts as a bridge to connect the database server and clients' computers. It receives requests from the client and accesses the database server, retrieving and manipulating information accordingly. Then, it returns the results to the client through the presence of web pages. The selection of tools, systems and programming languages are based on currently available technologies. PHP, which is a common developing language for web servers, was chosen for the development of the server component of the system. The data was stored in an Oracle database server. While on the client side, traditional HTML and JavaScript were utilised for client side programming. In addition, Java Applets, which were developed in Java Developer Kit 1.4, were employed for interactive client-server communication.

Distributed Database System Development

The database is the core of the system to provide a convenient and transparent way to access raw data. As for the JIT demolition projects, data necessitated for the system is of substantial scale. Moreover, there are different levels of permission on the data from various users. As shown in Figure 2, after normalisation, data is mainly divided into seven tables.
Figure 2 Essential entity-relationship diagram of the JIT waste exchange database

The entity and relationship defined reflects major components of the waste exchange scenario occurring in the system. A member table stores information about users who have access to the system including identification, contact information, address, identity of access, and authentication information. A member whose identity is a project owner can release multiple demolition projects on the system or a member whose identity is a material demander can have multiple requests. Each request can be identified by three elements, namely the member who requests the material, the demolition project that produces the requested material, and the type of material. Consequently, three attributes act as a combination key for a request entity. A project table stores information about its name, description, location. A product table presents a single type of building material that comes out of a demolition project. Therefore, combination of the project and the material is the key of the database table. In addition, the amount of materials and date of availability are also included. A materials table is used to describe the type of building materials that might come from a building's demolition. Necessary characters that can describe the type of material include its physical characters, market price of brand new material, and suggested second-hand price, which could help potential users to calculate financial benefit.

In addition, the system will allow users to upload multiple photos to help describe the project, and thus the photo table is needed to store the information of filename and directory of the image file related to a particular project. Similarly, the system allows users to draw customised structural illustrations for the building to be demolished. The drawing can then be stored on the system as a picture. As a result, drawings are also extracted as an entity to the system database. In practical database implementation, more tables must be created to further simplify and normalise the database.

System Components
Besides front-end database operation provided in the system that allows users to insert, retrieve and manipulate data, two system components were developed to assist in waste estimation for demolition project owners.

A Java Applet based client side canvas was developed to allow end users, especially a demolition project owner, to illustrate the structural characteristics of the building to be demolished. The structural characteristics of a building, mainly the dimensional figures, can be collected from users through extracting information from the drawing on the canvas. Dimensional figures,
along with other necessary information, can be used to calculate amounts and types of waste building materials that can be dismantled from the demolished building. Additionally, knowing the structure of the building enables building material buyers to attempt more economical and environmental approaches. For example, there could be reuse of a whole wall that is structurally stable rather than reuse of dismantled and cleaned bricks, or even cracked bricks.

Waste estimation based on structural and dimensional figures of the building to be demolished is rational. However, there are barriers that deter the project team from salvaging all reusable and recyclable from the demolition. For example, many old buildings require asbestos removal before the actual demolition process can commence (Macozoma 2001; NOHSC 2002). The extra process leads to sacrifice of a certain amount of building material. Moreover, the portion of building materials that can be salvaged depends on a number of factors. On most occasions, the factors are not structural or dimensional, and include issues such as age, pervious usage, local climate, reuse and recycling facilities, and even traffic conditions (Pun et al. 2003). There needs to be an intelligent system to assist on multi-factor waste material estimation. Therefore, a software component needs to be built to take input from project owners on the factors that produce waste estimation. The factors and their influences on building material salvage for a demolition project are likely gained from experimental study and statistics, and, evolving reuse and recycling technology.

**System Information Flow**

On the developed waste exchange system, a thorough process of waste exchange takes place over a large period of time within demolition planning and design. During the process, substantial information exchange occurs. Effective and efficient communication determines the usefulness of the system. An information flow diagram is shown in Figure 3.

The information flow starts with demolition project release from a project owner. After searching the database for suitable waste building materials, demolition material buyers acquire the project information that is of interest. The very next moment, demanders request those materials through the system. Within a certain exchange period before the demolition project owner analysts receive requests and make decisions on waste material production. The requests are approved and acknowledgements are sent back to material buyers. Meantime, information collection for the database is complete. Users include demolition contractors and tippers who can assess the system for seeking potential work. General public can also search completed demolition project as case studies. Finally, on a regular basis, the data administrator maintains the system.

![Figure 3](http://example.com/f3.png)  
*Figure 3* Information flows to the JIT waste exchange system
IMPLEMENTATION OF THE JIT WASTE EXCHANGE SYSTEM

Navigational layouts allow different users to access the web-based system from the Internet. While identities of users and their perspectives on the system are different, their interfaces to the system are diversified to suit various user groups. The web page is divided into three frames. The upper frame gives the title banner to the page. The left frame is the main menu area. Content regarding a particular menu item appears in the right frame. The first and default menu item is a notice board. It gives up-to-date information about recent changes. The member area is the core of the system and the main source of data. If a user has not logged into the system, the login screen will be shown to authenticate the member by username and password. A relevant Internet user has the choice of registering as a member which needs contact information. After logging into the system, submenu items are shown. Changing profile and password allows members to edit their personal details. Adding projects involves a wizard-style procedure that allows members to add a project into the database using a step by step procedure.

Figure 4 shows a screen shot of the interface for demolition project owners. A project owner is able to release information of a demolition or construction project through a wizard style guide, including relevant text, photos, and drawings. A function is also provided allowing a project owner to skip waste estimation process and provide information on building materials directly. As a project owner is able to create multiple demolition projects on the system, tasks also belong to the project owner to manage created demolition projects, including modification and deletion of projects.

Figure 5 shows the system interface for a secondary material buyer. A material buyer could be a construction project owner, material recycler, or secondary material broker. The interface provided allows searching building materials against certain criteria, such as type and amount of material, location of available demolition sites, and available dates. Demolition projects are then listed as results. In addition, the contact information of the owner of projects that are shown as search results is supplied to material buyers. Bargaining and negotiation could happen beyond the web-based system, which provides more flexibility and capability for project

Figure 4 A layout of the JIT waste exchange system for a project owner
owners. Furthermore, while projects that satisfy search criteria are listed, an interactive facility allows material demanders to select building materials and submit their requests. In addition, the address of a found project is hyperlinked to corresponding map, which helps material buyers to gain geographic information of demolition site and thus adjust their decisions on purchasing. Quick searches are also available and several commonly used building materials are listed at one click.

There are also interfaces enabling potential users to perform various tasks. Particularly, demolition contractors, tippers, and the general public are given a customised interface to allow them to search against the interest of the group. On the other hand, the data administrator is given comprehensive permission and interface to perform management, maintenance, archiving, and extraction of data.

CONCLUSIONS

Demolition wastes cause severe environmental impacts. Employment of JIT philosophy in demolition projects, in particular waste exchange for salvaging, potentially promotes waste reuse and recycling by improving effectiveness of waste marketing and production. A web-based waste exchange system for demolition projects is developed that includes the notion of JIT demolition. In the system, waste exchange occurs prior to the actual demolition process. To technically enable JIT demolition, intelligent components were included in the system to help project owners in waste estimation and planning. The electronic waste exchange system helps implement the JIT philosophy in building demolition projects in order to enhance productivity and ensure quality, be environmentally friendly, and result in efficient demolition projects. In addition, information on the system provides an educational channel for improving public awareness and statistical data for authorities overseeing the construction industry.

Web-based waste exchange systems facilitate recycling and reuse by empowering communication among demolition project participants. Various potential barriers and risks could deter the demolition industry from the implementation of JIT building demolition. Factors that could
cause concern include slow adoption of information technology in the industry, classification systems for secondary building materials, and environmental awareness of demolition project participants. In addition, waste materials that cannot be sold before a demolition project could cause trouble for the project owner. From an environmental perspective, the unsold waste can be stored for potential future demand, or donated to charity and non-profit organisations. To do so, financial incentives must be provided.

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