Identification of Reusable Information in Construction Firms

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ABSTRACT: Nowadays most construction firms are using information systems as management tools and enormous information is being accumulated in the systems with time. This study aims to identify the reusable legacy information through investigations in the form of literature reviews and an expert workshop to facilitate decision-making. Major reusable legacy information items and the relevant activities are identified and the items are graded into three levels according to their reusability based on a proposed criterion. The result lays down a sound foundation for reusing the legacy information in the decision-making in construction firms.
KEYWORDS：Construction firms, Information reuse, Construction management, Expert workshop

1 INTROUDUCTION

Construction firms are the main participants in the construction phase of projects and have project-oriented nature. Management of construction firms includes two aspects, i.e. project management and enterprise management. The former is to control unit projects, while the latter is to coordinate the resource assignment between unit projects and to manage daily work of construction firms. Nowadays most construction firms are using information systems as management tools and enormous information is being accumulated in the systems with time, relating to such productive elements as labor, machine and material etc., and covering such managerial subjects as schedule, cost and quality, etc. It is obvious that by making full use of the legacy information accumulated in the systems, the decision-making in the management could be improved, which will thus enhance the competitiveness of construction firms. However, the amount of legacy information is enormous even for a single construction project while construction firms carry out up to hundreds of projects each year. Hence the first thing to do for reusing the legacy information in construction firms is to effectively identify the reusable information.

Researches on information reuse have been conducted in other areas. For example in the manufacturing industry, the information of product parts, principle of design, client request information, product function information, design knowledge and design experience are reused (Qi, 2004). In the construction industry, studies were conducted to reuse information in some aspects to meet certain research needs. Rujirayanyong et al. pointed out that the legacy information in construction firms could be reused through data warehouse to help the manager and a data warehouse structure was established containing structured information about cost and schedule (Rujirayanyong, 2006). Fruchter et al. tagged the legacy design drawings / documents and developed a system to help users to find quickly the similar design knowledge to be reused for reference (Fruchter, 2006). Soibelman et al. applied decision tree algorithms and artificial neural network technique to reuse the legacy schedule information and process information accumulated in the databases in order to analyze the factors for construction delay (Soibelman, 2002). Dzeng et al. standardized legacy schedule information as cases to generate automatically rough plans for similar highway projects through case-based reasoning method (Dzeng, 2004). Caldas et al. applied support vector machines method and clustering algorithms to classify legacy documents based on the similarity of documents vectors (Caldas, 2003, Ng, 2006), and integrated the documents with IFC components for easy browsing (Caldas, 2005). But no research has been reported on the identification of reusable legacy information.

This study aims to identify the major reusable legacy information through investigations in the form of literature reviews and an expert workshop, to lay down a sound foundation for the further studies on information reuse in construction firms.

2 MAJOR INVESTIGATION STEPS

2.1 *Classifying Major Legacy Information Items*

The major legacy information is classified by analyzing the major information management systems that are being used by construction firms in China and the related literatures. As a result, two groups of legacy information were identified, i.e. the legacy project information and the legacy enterprise information. The former includes 37 information items in 6 categories such as design information, bidding information etc. and the latter includes 26 information items in 8 categories such as plan information, business information etc. Each information item is coded and the details are listed in the Table 1 and 2. Four forms of information are included, i.e. the attributive data, data record, detailed information and documents. The last word in the name of most information items has indicated the forms, i.e. "information" means attributive data, "record" means a number of data record and "detail" means more detailed of information, and most of the rest information is in the form of documents.

2.2 *Classifying Major Activities*

The major activities in which decision-making is carried out in construction firms are classified by referring PMBOK, the Code of Construction Project Management in China and other related literatures etc. These activities can be divided into two groups, i.e. project management activities and enterprise management activities. In the former, there are 22 activities within 5 phases such as the bidding phase, the preparation phase etc. In the latter, there are 21 activities in 8 aspects such as plan management, business management etc. Each activity is coded and the details are shown in Table 3.

2.3 *Preparing Questionnaire*

Based on the above-mentioned two steps, a questionnaire was designed to identify the reusable legacy information. It consists of two parts. The first part is used to collect the general evaluation on the reusability of the legacy information items. The second part is used to collect that for each pair of information item and activity, indicating the reuse of the information item in the activity. Thus a matrix of reusability of 'information item vs. activity' can be obtained. After the primary design, the questionnaire was surveyed as a trial in a construction firm which has conducted well in the application of information technology. Then it was modified. Since the questionnaire is too complex and takes too much time to fill in, it was decided to hold an expert workshop to deal with it.

2.4 *Holding Expert Workshop*

Five experienced experts were invited to attend the workshop. They are all from different top class construction firms in China and their details are listed in Table 4. The expert workshop was divided into two parts. In the first part, the questionnaire was explained by the authors and then the experts spent one hour to fill in the questionnaire. In the questionnaire, the experts were asked to evaluate the reusability by selecting among sequential options from A to E, where A represents 'very reusable', and E represents 'little reusable'.

In the second part, the experts took 1.5 hours to give comments on the contents of the questionnaire and the potential patterns of information reuse in construction firms.

Table 1. Classification of major legacy project information.

Category	Code	Project information items	Category	Code	Project information items
Design info.	PI1	Abstract info. of design	Construction	PI20	Quality control plan detail
	PI2	Design change record	plan info.	PI21	Construction plan document
	PI3	Design document / drawing		PI22	Construction layout drawing
Bidding info.	PI4	Abstract info. of bidding	Schedule info.	PI23	Planned schedule detail
	PI5	General schedule		PI24	Actual schedule detail
	PI6	Project bidding detail	Labor info.	PI25	Labor work record
	PI7	Bidding document	Material info.	PI26	Material procurement record
Sub-contractor /	PI8	Certificate info.		PI27	Material in/out record
supplier info.	PI9	Cooperation record		PI28	Material consumption record
Contract info.	PI10	Abstract info. of contract		PI29	Material inspection record
	PI11	Claim record	Equipment info.	PI30	Equipment procurement/rent record
	PI12	Contract change record		PI31	Equipment in/out record
	PI13	Contract document		PI32	Equipment consumption record
Construction plan	PI14	Abstract info. of constr. plan		PI33	Equipment inspection record
info.	PI15	Schedule detail	Cost info.	PI34	Direct cost record
	PI16	Cost plan detail		PI35	Indirect cost record
	PI17	Material plan detail	Quality info.	PI36	Quality inspection record
	PI18	Equipment plan detail	Safety info.	PI37	Safety method record
	PI19	Labor plan detail			

Table 2. Classification of major legacy enterprise information.

Category	Code	Enterprise information items	Category	Code	Enterprise information items
Plan info.	EI1	Long-term plan	Material info.	EI14	Material transportation record
	EI2	Annual plan	Equipment info.	EI15	Equipment procurement / rent record
	EI3	Quarter plan		EI16	Equipment use record
Business info.	EI4	Project bidding record		EI17	Equipment maintenance record
	EI5	Project contract record	Human resource	EI18	Employee performance record
	EI6	Project schedule record	info.	EI19	Deployment of staffs record
	EI7	Project cost record	Finance info.	EI20	Cash flows record
	EI8	Project quality record		EI21	Income and expenditure record
	EI9	Project safety record	Client /	EI22	Cost accounting record
Technology info.	EI10	Construction method	sub-contractor	EI23	Client record
	EI11	New tech./material record	/supplier info.	EI24	Client cooperation record
Material info.	EI12	Material procurement record		EI25	Sub-contractor / supplier record
	EI13	Material in/out record		EI26	Sub-contractor / supplier cooperation record

Table 3. Classification of major activities that involve decision-making.

Project phase	Code	Project management activity	Managerial subject	Code	Enterprise management activity
Bidding	PA1	Decide construction method	Plan	EA1	Develop plan
	PA2	Develop general schedule	Business	EA2	Control project bidding
	PA3	Decide bidding price		EA3	Control project contractor
	PA4	Prepare bidding document		EA4	Control project schedule
Contracting	PA5	Select sub-contractor		EA5	Control project cost
	PA6	Assess risk		EA6	Control project quality
Preparation	PA7	Decide construction layout		EA7	Control project safety
	PA8	Develop detailed schedule	Technology	EA8	Decide construction method
	PA9	Develop cost plan		EA9	Update enterprise quota
	PA10	Develop material plan	Material	EA10	Decide material procurement
	PA11	Develop equipment plan		EA11	Coordinate material
	PA12	Develop labor plan	Equipment	EA12	Decide equipment procurement
	PA13	Develop quality control plan		EA13	Coordinate equipment
	PA14	Prepare constr. plan document	Human resource	EA14	Predict labor need
Construction	PA15	Control project contract		EA15	Deploy employee
	PA16	Control project schedule		EA16	Assess employee
	PA17	Control project cost	Finance	EA17	Estimate cost
	PA18	Control project quality		EA18	Account cost
	PA19	Control project safety		EA19	Evaluate client
Maintenance	PA20	Evaluate sub-contractor / supplier	Client/sub-contractor	EA20	Evaluate sub-contractor
	PA21	Evaluate project	/ supplier	EA21	Evaluate supplier
	PA22	Decide maintenance method			

3 RESULT AND ANALYSIS

In this section, the result of the questionnaire that was filled in by the experts is presented and analyzed, and then the patterns of information reuse are summarized based on the experts' comments.

Table 4. Detail information of the experts.

No	Years of experience in IT application	Firms' annual turnover (billion $)	Post in firms
A	16	2.93	Manager of information office
B	35	2.93	Senior advisor
C	31	117.1	Head of information center
D	17	43.92	Director for tech. & quality
E	12	4.39	Head of info. manage. office

In the analysis, the Likert scale was used to calculate the mean rating of the reusability of legacy information items evaluated by the experts'. A five-point Likert scale was adopted, where '5' represents 'A' (very reusable), and '1' represents 'E' (little reusable). The mean rating is calculated by Equation 1 as following,

$$M = \frac{1 \cdot nE + 2 \cdot nD + 3 \cdot nC + 4 \cdot nB + 5 \cdot nA}{nE + nD + nC + nB + nA} \quad (1)$$

where M is the mean rating of the reusability and *nA*, *nB*, *nC*, *nD*, and *nE*, represent the number of the experts' evaluation of A, B, C, D and E respectively.

3.1 *General Evaluation on Reusability of Information Items*

The mean ratings of the reusability of the legacy project information items and legacy enterprise information items are shown in Figure 1 and 2 respectively. The corresponding legacy information items whose mean rating is higher than 4 are selected and listed in Table 5 and 6 respectively, with their mean ratings and all ratings given by the experts.

It is indicated that the information items with high ratings are mainly concerned with cost, contract and material etc. and the ratings evaluated by the experts on these information items are very close.

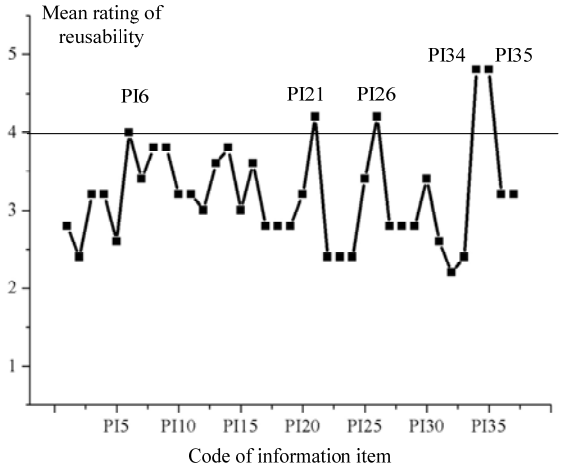

Figure 1. Mean rating of reusability of legacy project information items.

Besides, the number of the selected information items of legacy enterprise information is more than that of the legacy project information. It indicates that the legacy enterprise information is more reusable than the legacy project information. Further, all forms of information items are included in the two tables.

3.2 *Evaluation on Reusability of Information Items in Activities*

The number of the activities in which legacy information items can be reused (reuse activity hereafter) and the corresponding mean ratings of the reusability are shown in Figure 3 and 4 for legacy project information items and legacy enterprise information items respectively. Since the more activities is an information item reused in, or the higher is its mean rating of the reusability, the more reusable the information item is, the legacy information items with the number of reuse activities being larger than 10 or the mean rating of the reusability being higher than 3.5, are listed in Table 7 and 8 respectively.

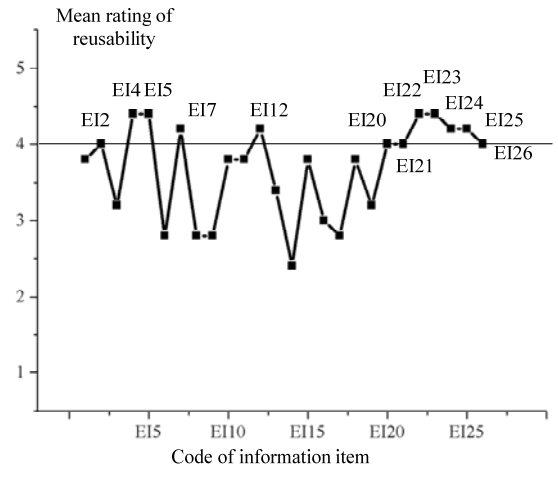

Figure 2. Mean rating of reusability of legacy enterprise information items.

Table 5. Legacy project information items with high rating of reusability.

Code	Legacy project information	Reusability	
		Mean rating	Experts' selection
PI6	Project bidding detail	4	BBBBB
PI21	Construction plan document	4.2	ABBBB
PI26	Material procurement record	4.2	ABBBB
PI34	Direct cost record	4.8	AAAAB
PI35	Indirect cost record	4.8	AAAAB

Most of the information items in Table 5 also appear in Table 7, except for 'construction plan document' (PI21, M=3.2, N=9), because its number of reuse activities is less than 10. Most of the information items in Table 6 also appear in Table 8, except for 'project bidding record' (EI4, M=3.4, N=2), 'cash flows record' (EI20, M=3.3, N=4), 'income and expenditure record' (EI21, M=3, N=7), 'cost accounting record' (EI22, M=3.4, N=7), which have relative lower reusability. It reveals that the evaluation on the reusability of information items in activities in this section agrees with the general evaluation on the reusability for most legacy information items in section 3.1.

Besides, the number of the selected information items of legacy project information is more than that of the legacy enterprise information. It implies that the legacy project information is reused in more activities than the legacy enterprise information.

It deserves to add that the information items and activities in the questionnaire were examined in the second part of the expert workshop and no addition, deletions or modifications on them were proposed.

3.3 *Analysis of Information Reuse Pattern*

Based on the experts' comments, the major information reuse patterns are summarized in Table 9.

Table 6. Legacy enterprise information items with high rating of reusability.

Code	Legacy enterprise information	Reusability	
		Mean rating	Experts' selection
EI2	Annual plan	4	AABBD
EI4	Project bidding record	4.4	AABBB
EI5	Project contract record	4.4	AABBB
EI7	Project cost record	4.2	AABBC
EI12	Material procurement record	4.2	AAABD
EI20	Cash flows record	4	AABCC
EI21	Income and expenditure record	4	AABCC
EI22	Cost accounting record	4.4	AAABC
EI23	Client record	4.4	AAABC
EI24	Client cooperation record	4.2	ABBBB
EI25	Sub-contractor/supplier record	4.2	ABBBB
EI26	Sub-contractor / supplier cooperation record	4	BBBBB

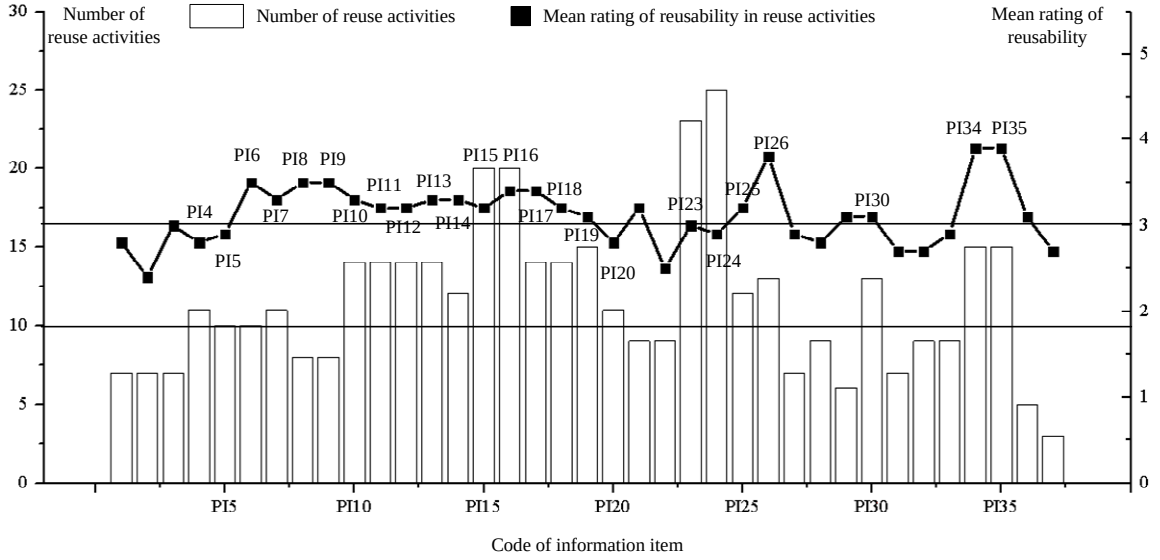

Figure 3. Evaluation of legacy project information items in activities.

Table 7. Legacy project information with large number of reuse activities or high mean rating of reusability.

Code	Legacy project information items	Reuse activities		Code	Legacy project information items	Reuse activities	
		M	N			M	N
PI4	Abstract info. of bidding	2.8	11	PI16	Cost plan detail	3.4	20
PI5	General schedule	2.9	10	PI17	Material plan detail	3.4	14
PI6	Project bidding detail	3.5	10	PI18	Equipment plan detail	3.2	14
PI7	Bidding document	3.3	11	PI19	Labor plan detail	3.1	15
PI8	Certificate info.	3.5	8	PI20	Quality control plan detail	2.8	11
PI9	Cooperation record	3.5	8	PI23	Planned schedule detail	3	23
PI10	Abstract info. of contract	3.3	14	PI24	Actual schedule detail	2.9	25
PI11	Claim record	3.2	14	PI25	Labor work record	3.2	12
PI12	Contract change record	3.2	14	PI26	Material procurement record	3.8	13
PI13	Contract document	3.3	14	PI30	Equipment procurement/rent record	3.1	13
PI14	Abstract info. of constr. plan	3.3	12	PI34	Direct cost record	3.9	15
PI15	Schedule detail	3.2	20	PI35	Indirect cost record	3.9	15

Note. 'M' represents mean rating of reusability in activities and 'N' represents the number of reuse activities.

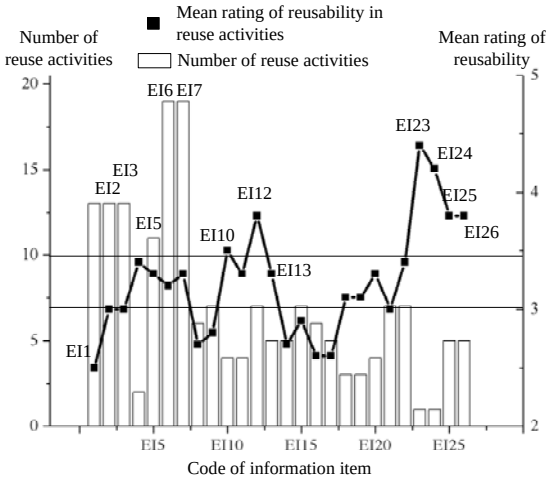

Figure 4. Evaluation of legacy enterprise information items in activities.

Since the information items that are reused only for "simple check" are rarely reused although they are very important, they are excluded in the following discussion from the reusable information by assuming that they will be stored properly anyway.

Table 8. Legacy enterprise information with large number of reuse activities or high mean rating of reusability.

Code	Legacy enterprise information items	Enterprise management	
		M	N
EI1	Long-term plan	2.5	13
EI2	Annual plan	3	13
EI3	Quarter plan	3	13
EI5	Project contract record	3.3	11
EI6	Project schedule record	3.2	19
EI7	Project cost record	3.3	19
EI10	Construction method	3.5	4
EI12	Material procurement record	3.8	7
EI23	Client record	4.4	1
EI24	Client cooperation record	4.2	1
EI25	Sub-contractor / supplier record	3.8	5
EI26	Sub-contractor / supplier cooperation record	3.8	5

Note. 'M' represents mean rating of reusability in activities and 'N' represents the number of reuse activities.

4 IDENTIFICATION AND GRADING OF MAJOR REUSABLE INFORMATION ITEMS

From the above two sections, it is known that the experts could give consistent evaluation on the reusability of legacy information items and it is understood that the reusability of legacy information items

varies from item to item. In order to distinguish the information items with high reusability from those with lower reusability, a three-level criterion for evaluating the reusability of legacy information items is proposed as shown in Table 10, in which the general evaluations on the reusability (general reusability hereafter), the evaluation of the reusability of information items in activities (reusability in activities hereafter) and the number of reuse activities are used in a union way to measure the reusability. Although the threshold values for the criterion are determined rather roughly, the criterion can serve its purpose well as seen in the following Table 11. The criterion is applied to the questionnaire data of the entire information items, and the obtained reusable legacy information items are summarized in Table 11 with reuse pattern and major reuse activities by the reusability level. For example, 'project bidding detail' (PI6) could be reused in 'decide bidding price' (PA3) in the pattern of 'in-depth browsing' (RP2) or 'trend prediction' (RP5). This table should be very much helpful for determining the priority for extracting the reusable legacy information, and for implementing the reuse of the legacy information.

There are 11 items of legacy project information and 13 legacy enterprise information graded into level 'A' in Table 11. Major types of them are data record and detailed information. It is also known that the cost related information items (direct / indirect cost record, project bidding detail, project cost record etc.) and the schedule related information items (planned schedule detail and actual schedule detail etc.) have high reusability and is widely reused in activities. Besides, many important documents, such as construction plan document and contract document etc. are of great reusability.

Table 9. Information reuse pattern.

Code	Pattern	Description	Example of information
RP1	Simple check	To browse the original information when problems such as quality problems occur in the completed projects	Safety method record, Quality inspection record
RP2	In-depth browsing	To browse some import legacy information with user's own experience to learn knowledge to deal with the current issues	Construction plan document, Contract document
RP3	Statistic induction	To find the regulation on the basis of the statistics of similar legacy information and give some advice on how to deal with the problems in current projects	Quality inspection record
RP4	Evaluation selection	To select contractors or construction methods etc. by means of qualitative or quantitative indicators from the legacy information combined with current information	Cooperation record, Construction method
RP5	Trend prediction	To predict the important index / process in current situation based on legacy information	Schedule related information, Cost related information
RP6	In-depth analysis	To analyze some legacy information or important management information record through methods such as data warehouse, OLAP and data mining in order to discover knowledge	Material procurement record, Cost accounting record

Table 10. Evaluation criterion of reusability level.

No.	RL	Criterion
1	A	General reusability >=4 or Reusability in activities >=3.5 or Number of reuse activities >=15
2	B	General reusability >=3.5 or Reusability in activities >=3 or Number of reuse activities >=10
3	C	General reusability >=3 or Reusability in activities >=2.5 or Number of reuse activities >=5

Note. 'RL' represents reusability level.

Table 11. Major reusable legacy information and activities.

RL	Code	Information items	G	RA	N	RP	MA
A	PI6	Project bidding detail	4	3.5	10	RP2/RP5	PA3
	PI8	Certificate info.	3.8	3.5	8	RP2/RP4	PA5/PA20
	PI9	Cooperation record	3.8	3.5	8	RP4	PA5/PA6
	PI15	Schedule planning detail	3	3.2	20	RP2/RP5	PA8
	PI16	Cost planning detail	3.6	3.2	20	RP2/RP5	PA3/PA9
	PI21	Construction planning documents	4.2	3.2	9	RP2/RP4	PA8//PA14
	PI23	Schedule performance planning detail	2.4	3	23	RP2/RP5	PA2/PA8
	PI24	Actual schedule detail	2.4	2.9	25	RP2/RP5	PA2/PA8
	PI26	Material procurement record	4.2	3.8	13	RP5/RP6	PA9
	PI34	Direct cost record	4.8	3.9	15	RP5/RP6	PA3/PA9
	PI35	Indirect cost record	4.8	3.9	15	RP5/RP6	PA3/PA9
	EI2	Annual plan	4	3	13	RP2/RP5	EA1/ EA17
	EI4	Project bidding info.	4.4	3.4	2	RP2/RP5	EA1/EA2
	EI5	Project contract info.	4.4	3.3	11	RP2/RP4	EA5
	EI7	Project cost info.	4.2	3.3	19	RP5/RP6	EA1/EA5
	EI10	Construction method	3.8	3.5	4	RP2/RP4	EA8/ EA9
	EI12	Material procurement record	4.2	3.8	7	RP5/RP6	EA5/ EA10
	EI20	Cash flows record	4	3.3	4	RP5/RP6	EA5

Note. 'RL' represents reusability level, 'G' represents general reusability, 'RA' means reusability in activities, 'N' represents number of reuse activities, 'RP' represents reuse pattern and 'MA' represents major reuse activities.

Table 11. Major reusable legacy information and activities (continued).

RL	Code	Information items	G	RA	N	RP	MA
A	EI21	Income and expenditure records	4	3	7	RP5/RP6	EA5
	EI22	Cost accounting record	4.4	3.4	7	RP5/RP6	EA5
	EI23	Client info.	4.4	4.4	1	RP4	EA19
	EI24	Client cooperation record	4.2	4.2	1	RP4	EA19
	EI25	Sub-contractor / supplier info.	4.2	3.8	5	RP4	EA20/EA21
	EI26	Sub-contractor / supplier cooperation record	4	3.8	5	RP4	EA20/EA21
B	PI3	Design documents / drawings	3.2	3	7	RP2	PA3/PA6
	PI4	Abstract info. of bidding	3.2	2.8	11	RP2	PA4
	PI5	General schedule planning	2.6	2.9	10	RP2/RP5	PA1/PA2
	PI7	Bidding documents	3.4	3.3	11	RP2/RP4	PA1/PA4
	PI10	Abstract info. of contract	3.2	3.3	14	RP2/RP4	PA3/PA15
	PI11	Claim record	3.2	3.2	14	RP2/RP4	PA3/PA15
	PI12	Contractor Change record	3	3.2	14	RP2/RP4	PA3/PA15
	PI13	Contract documents	3.6	3.3	14	RP2/RP4	PA3
	PI14	Abstract info. of constr. planning	3.8	3.3	12	RP2	PA8/PA9
	PI17	Material planning detail	2.8	3.4	14	RP2/RP5	PA9/PA10
	PI18	Equipment planning detail	2.8	3.2	14	RP2/RP5	PA9/PA11
	PI19	Labor planning detail	2.8	3.1	15	RP2/RP5	PA9/PA12
	PI20	Quality control planning detail	3.2	2.8	11	RP2/RP5	PA13
	PI25	Labor work record	3.4	3.2	12	RP2/RP5	PA9/PA12
	PI29	Material inspection record	2.8	3.1	6	RP1/RP5	PA22
	PI30	Equipment procurement/rent record	3.4	3.1	13	RP5/RP6	PA9/PA11
	PI36	Quality inspection record	3.2	3.1	5	RP1/RP3	PA13
	EI1	Long-term plan	3.8	2.5	13	RP2/RP5	EA1
	EI3	Quarter plan	3.2	3	13	RP2/RP5	EA1/ EA5
	EI6	Project schedule info.	2.8	3.2	19	RP2/RP5	EA4/EA5
	EI11	New tech./material info.	3.8	3.3	4	RP2/RP4	EA8/ EA9
	EI13	Material in/out record	3.4	3.3	5	RP5/RP6	EA5/ EA11
	EI15	Equipment procurement / rent record	3.8	2.9	7	RP5/RP6	EA5/EA12
	EI18	Employee performance info.	3.8	3.1	3	RP5/RP6	EA16
	EI19	Deployment of staffs recorded	3.2	3.1	3	RP2	EA16
C	PI1	Abstract info. of design	2.8	2.8	7	RP2	PA6
	PI2	Design change record	2.4	2.4	7	RP2	PA22
	PI22	Construction layout drawing	2.4	2.5	9	RP2	PA7
	PI27	Material in/out record	2.8	2.9	7	RP5/RP6	PA9
	PI28	Material consume record	2.8	2.8	9	RP5/RP6	PA9
	PI31	Equipment in/out record	2.6	2.7	7	RP5/RP6	PA11
	PI32	Equipment consume record	2.2	2.7	9	RP5/RP6	PA11
	PI33	Equipment inspection record	2.4	2.9	9	RP1/RP5	PA22
	PI37	Safety method record	3.2	2.7	3	RP1/RP3	PA19
	EI8	Project quality info.	2.8	2.7	6	RP4/RP5	EA6
	EI9	Project safety info.	2.8	2.8	7	RP4/RP5	EA7/ EA8
	EI14	Material transportation record	2.4	2.7	5	RP5/RP6	EA5
	EI16	Equipment use record	3	2.6	6	RP5/RP6	EA5/EA13
	EI17	Equipment maintenance record	2.8	2.6	5	RP5/RP6	EA1/EA5

Note. 'RL' represents reusability level, 'G' represents general reusability, 'RA' means reusability in activities, 'N' represents number of reuse activities, 'RP' represents reuse pattern and 'MA' represents major reuse activities.

5 CONCLUSION AND FUTURE WORK

This study summarized the major legacy information items and decision-making related activities and identified the major reusable legacy information items through literature reviews and an expert workshop, and the items are graded into three levels according to their reusability based on a proposed criterion. The result is expected to be helpful for further studies on information reuse.

This study is a part of the research for developing an information reuse system for construction firms. Subject to the result as mentioned above, future studies will concentrate on the way in which the reusable information could be reused efficiently and effectively and then to develop the system.

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