International Journal of Smart Home
Vol. 9, No. 2 (2015), pp. 133-142
http://dx.doi.org/10.14257/ijsh.2015.9.2.12

WBS-based Hierarchical Classification and its DB Modeling of All Construction Information for Apartment House

Hong- Tae Park[1] and Boo- Hyung Lee[2]

[1] *Department of Civil Engineering, Kongju National University, 275 Budae-dong, Seobuk-gu, Cheonan-si, Chungnam 331-717, Republic of Korea*
htpark@ kongju.ac.kr
[2]*Department of Computer Science & Engineering, Kongju National University, 275 Budae-dong, Seobuk-gu, Cheonan-si, Chungnam 331-717, Republic of Korea*
bhl1998@ kongju.ac.kr(Corresponding Author)

Abstract

In this paper, WBS-based hierarchical classification and its DB modeling structure of all construction information for apartment house are proposed. The proposed WBS-based construction information classification system divide all construction information of apartment house into 4 hierarchical levels that are construction zone classification, building classification, work classification, and work item classification. These hierarchical construction information are DB modeled using a relational data model. The computer aided processing of the construction management by this DB modeling of the construction information is possible. The proposed WBS-based hierarchical classification and its DB modeling structure will be applicable to an effective and scientific cost estimation system

Keywords: *construction information, WBS-based hierarchical classification, relational data modeling.*

1. Introduction

In general, a cost estimation system, or construction cost computation, is composed of construction classification system information, resource classification system information, breakdown cost information, and yield statement of construction information [1]. All of this information is used comprehensively to calculate the final construction cost. From this information, the construction classification system is the uppermost information and the most important information. However, the existing cost estimation system requires the person in charge of the cost estimation to classify, input, and analyze the construction information[2]. Such system requires the person in charge to have sufficient knowledge of the related cost estimating system. The process of linking the cost estimation system and the construction classification system modeled as a DB structure is necessary for accurate and systematic construction cost estimation [3][4].

In The Korea Institute of Civil Engineering and Building Technology has conducted years of comprehensive research on the construction classification system and proposed a standard construction information classification system. The research classified construction information into 5 classification facets of facility classification, part classification, space classification, work classification, and resource classification [5][6].

Kim[7] pointed out that it is difficult to efficiently use the component information if the information on the particular components of a construction site is not categorized in an identical system. In addition, emphasized that a standard classification system is required for information classification in an identical system, and he also supported the necessity to link specifications and statements.

ISSN: 1975-4094 IJSH

Baek[8]applied the construction information classification system to the construction site information management system in order to unify the vertical management system between the employer, builder, and subcontractor to enable the reuse of information.

Kang[9] composed and proposed an integrated code for specifications as a way to integrate the standard method of measurement and specification item codes from construction standard specifications. The proposed integrated code was applied to the representative items of standard specifications to verify the possibility of the composition of an integrated code based on the standard method of measurement.

Various research has been conducted on the construction information classification system. However, no research has been done on the work cost estimation using the information classification system.

This paper newly classified WBS-based cl all construction information for apartment houses based on WBS, and represented it in a relational DB structure to implement the automation of the cost estimation system. Such WBS-based work information classification system and DB modeling resolve the inconvenience of the existing cost estimation systems, which require the establishment of basic materials related to cost estimation by hand. These systems could be widely used in the cost estimation system of apartment house construction sites.

2. WBS-based Hierarchical Classification of all Construction Information for Apartment House

Construction refers to a work on a vertically extended structure. 3~4 buildings are built simultaneously in each construction zone, and each building is constructed in the order of foundation, framework, and finishing in apartment house construction. In addition, the construction processes of unit price items such as the foundation, framework, and finishing are differentiated according to the materials and processes used. Therefore, a apartment house structure could be classified into a construction zone component, a building component, a work component, and a work item component. The four types of classifications could be hierarchically integrated to systemize the work information classification of an apartment house

2.1 WBS-based Work Information Classification System Structure

Fig 1 show the WBS-based hierarchical construction information classification of an apartment house

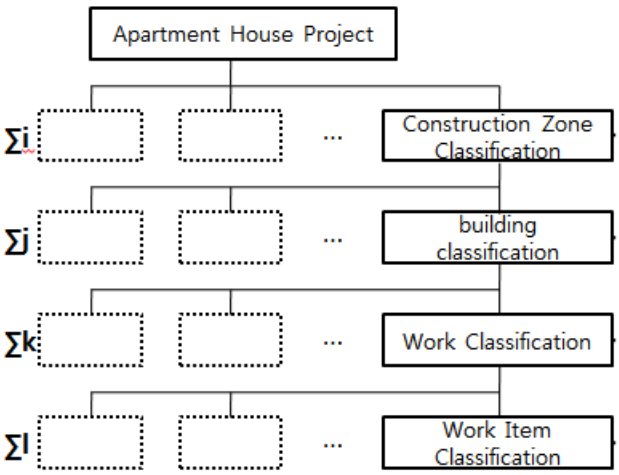

Figure 1 WBS-based Hierarchical Construction Information Classification

Construction zone which is level 1 is the highest level and classified into several construction zone and core works according to work cost. Building classification is second high level and classified in terms of building 1, building 2, and so forth and common necessary work in each building. Work classification is third high level and means work packages such as temporary work, reinforced concrete work which are accomplished in a building of level 2. Level 4 which is work item classification consists of unit price items executed after above work packages on the construction sites and the lowest level

. The lowest unit of the work classification system, work item classification, is related to the estimate code from the estimate system for its use in the construction cost estimation of an apartment house.

2.2 Detailed Structure of Work Information Classification System by Level

This section describes the structure of the work information classification system presented in the previous section as a relational database. Instead of using a hierarchical structure, a relational database expresses data in the form of a simple table, and the items in the rows and columns of the table could be accessed freely. Therefore, a user could freely split or combine the 「table, which is also advantageous because the additions and alterations to the table are also free from other influences.

In order to model the components of each level constituting the WBS-based work information classification system, as shown in Fig 2, in the form of a relational database, the components should be executed and managed as independent components. It is also advisable to designate a systematic code number for each component.

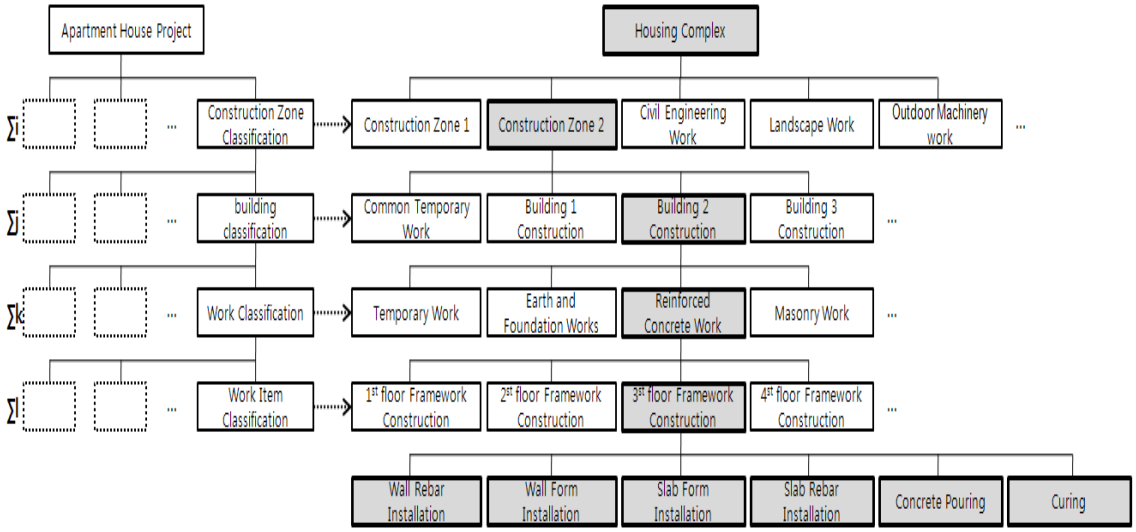

Figure 2. Detailed Construction Information by Level

(1) LEVEL 1 Construction zone classification – the highest level

Construction zone classification is the upper most level in the classification system constituted as an apartment house, and it is composed of two fields: ACODE and DES.

The CODE field represents the sequence number of each construction zone, and DES represents detailed contents. However, the code number and number for each construction zone were composed to be identical to each other.

ACODE DES
1. Construction zone 1
2. Construction zone 2
3. Construction zone 3
4. Construction zone 4
.
.
.
n. Construction zone n

(2) LEVEL 2 Building classification- Second high level

Building classification deals with the construction conducted within each construction zone. It is also composed of the construction of each building and common temporary work necessary to construct each building. LEVEL 2 building classification is composed of two fields: BCODE and DES.

BCODE DES
1. Common temporary work
2. Building 1
3. Building 2
4. Building 3
.
.
.
n Building n

(3) LEVEL 3 Work Classification-Third high level

Work classification is the classification of work conducted within each building, and it is classified in the unit of work package. Work classification is comprised of 18 work packages and composed of two fields: CCODE and DES.

CCODE DES
1. Common temporary work
2. Temporary work
3. Earth and foundation construction
4. Reinforced concrete work
5. Masonry work
6. Plaster work
7. Furniture and carpentry works
8. Waterproof work
9. Tile work
10. Window work
11. Glass work
12. Interior finishing work
13. Wallpaper work
14. Painting work
15. Metal work
16. Miscellaneous work
17. Transportation work
18. Operation equipment by-products

(3) LEVEL 4 Work Item Classification-The lowest level

Work item classification refers to the work conducted on the construction sites and it is comprised of 52 types of work. Work item classification is structuralized in DCODE and DES fields. The floor frameworks of the 3rd ~ 25th floors are represented as DCODE 13. Work item classification is further classified into unit price items based on work packages, and the unit price items are structuralized as ECODE and DES. For example, the floor frameworks of the 3rd ~ 25th floors are represented as work item classification 13 and only the floor framework of the 3rd floor will be represented as unit price item 13.10 3rd floor floor-framework. It will be further classified into 13.11 wall rebar installation, 13.12 wall form installation, 13.13 slab form installation, 13.14 slab rebar installation, 13.15 concrete pouring, and 13.16 curing, which are the unit price items of 13.10 3rd floor floor-framework. Other work item classification components could be classified in the similar manner.

DCODE DES

1. Site construction
2. Temporary equipment
3. Material tests
4. Maintenance
5. Disassemble
6. Earthwork foundation
7. Foundation framework
8. Underground floor floor-framework
9. 1st floor floor-framework
10. 1st floor floor-framework back filling
11. Outer scaffolding
12. 2nd floor floor-framework
13. 3rd ~ 25th floors' floor-frameworks
    - 13.10 3rd floor floor-framework
        - 13.11 Wall rebar installation
        - 13.12 Wall form installation
        - 13.13 Slab form installation
        - 13.14 Slab rebar installation
        - 13.15 Concrete pouring
        - 13.16 Curing
    - 13.20 4th floor floor-framework
        - 13.21 Wall rebar installation
        - 13.22 Wall form installation
        - 13.23 Slab form installation
        - 13.24 Slab rebar installation
        - 13.25 Concrete pouring
        - 13.26 Curing
    - 13.30 3rd floor floor-framework
    - 13.40 4th floor floor-framework
    - 13.50 3rd floor floor-framework
    - 13.60 4th floor floor-framework

.
.
.

14. Roof finishing work
15. Exterior wall plastering work
16. Exterior wall painting work

17. Standpipe installation
18. UBR installation
19. Masonry work
20. Electric masonry piping work
21. Communication masonry piping work
22. Window frame installation
23. Ondol insulating material
24. Ondol pebble placement work
25. Ondol heating piping work
26. Ondol floor masonry work
27. Wall masonry and remaining masonry work
28. Gypsum board installation
29. Liquid waterproofing and mortar
30. Tile work
31. Artificial stone
32. Staircase handrail
33. Interior carpentry work
34. Interior painting work
35. Doors and hardware
36. Balcony guardrail
37. Wallpapering work
38. Mechanical and electric un-embedded piping
39. Gas piping work
40. Machine equipment installation
41. Electricity wiring work
42. Communication wiring work
43. Elevator
44. Furniture
45. Kitchen
46. Mechanical equipment mounting work
47. Electrical equipment mounting work
48. Communication equipment mounting work
49. Gas equipment mounting work
50. Other architectural facilities
51. Test run
52. Completion and defect

3. Relational Database Modeling of WBS-based Construction Information

3.1 Relational Data Model

The relational model for database management is a database model based on first-order predicate logic, first formulated and proposed in 1969 by Edgar F. Codd. In the relational model of a database, all data is represented in terms of tuples, grouped into relations. A database organized in terms of the relational model is a relational database. In the relational model, related records are linked together with a "key". The purpose of the relational model is to provide a declarative method for specifying data and queries: users directly state what information the database contains and what information they want from it, and let the database management system software take care of describing data structures for storing the data and retrieval procedures for answering queries [10].

The basic relational building block is the domain or data type, usually abbreviated nowadays to type. A tuple is an ordered set of attribute values. An attribute is an ordered pair of attribute name and type name. An attribute value is a specific valid value for the type of the attribute. This can be either a scalar value or a more complex type. A relation consists of a heading and a body. A heading is a set of attributes. A body (of an n-ary relation) is a set of n-tuples. The heading of the relation is also the heading of each of its tuples. A relation is defined as a set of n-tuples. In both mathematics and the relational database model, a set is an unordered collection of unique, non-duplicated items, although some DBMSs impose an order to their data. In mathematics, a tuple has an order, and allows for duplication. E.F. Codd originally defined tuples using this mathematical definition. Later, it was one of E.F. Codd's great insights that using attribute names instead of an ordering would be so much more convenient (in general) in a computer language based on relations[citation needed]. This insight is still being used today. Though the concept has changed, the name "tuple" has not. An immediate and important consequence of this distinguishing feature is that in the relational model the Cartesian product becomes commutative [11].

3.2 Relational database modeling of WBS-based construction information

Figure 3 shows a partial hierarchical construction information marked blue in figure 2. In figure 2, Acode of construction zone 2 in first level is 1, Bcode of building 3 in second level is 3, Ccode of reinforced concrete work in third level is 04.

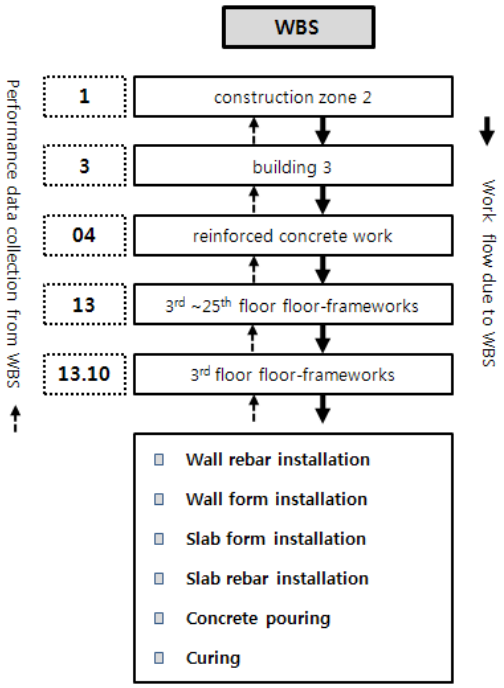

Figure 3. A Partial Hierarchical Construction information Marked Blue in Figure 2

In this section, example of relational database modeling for the hierarchical construction information in figure 2 is shown. Table 1 ~ Table 7 represent the DB structure shown in Fig. 2 as a relational database. Table 1 show that ACODE 2, a construction zone classification, is linked to BCODE 3, a building classification.

Table 1. Construction Zone Classification (ACODE) Information Database

ACODE	DES	BCODE
1	Construction zone 1	
2	Construction zone 2	3
3	Construction zone 3	
4	Construction zone 4	

BCODE 3, a building classification, in Table 2 is linked to CCODE 04, a work classification.

Table 2. Building Classification (BCODE) Information Database

BCODE	DES	CCODE
1	Building 1	
2	Building 2	
3	Building 3	04
4	Building 4	

Table 3 shows that CCODE 04, a work classification, is linked to DCODE 13, a work item classification.

Table 3. Work Classification (CCODE) Information Database

CCODE	DES	DCODE
02	Temporary work	
03	Earth and foundation work	
04	Reinforced concrete work	13
05	Masonry work	

Table 4 shows the link between DCODE 13, a work item classification, and ECODE 13.10, a unit price item.

Table 4. Work Item Classification (DCODE) Information Database

DCODE	DES	ECODE
.	.	.
12	2^{nd} floor floor-framework	
13	3^{rd} ~25^{th} floor floor-framework	13.10
14	Roof finishing	
15	Exterior wall plaster work	
.	.	

4. Conclusion

In this paper, WBS-based hierarchical classification and its DB modeling structure of all construction information for apartment house are proposed. The proposed WBS-based construction information classification system divide all construction information of apartment house into 4 hierarchical levels that are construction zone classification, building classification, work classification, and work item classification. These hierarchical construction information are DB modeled using a relational data model. The computer aided processing of the construction management by this DB modeling of the construction information is possible. The proposed WBS-based hierarchical classification and its DB modeling structure will be applicable to an effective and scientific cost estimation system.

This paper newly classified WBS-based cl all construction information for apartment houses based on WBS, and represented it in a relational DB structure to implement the automation of the cost estimation system. Such WBS-based work information classification system and DB modeling resolve the inconvenience of the existing cost estimation systems, which require the establishment of basic materials related to cost estimation by hand. These systems could be widely used in the cost estimation system of apartment house construction sites.

References

[1] J. Y. Lee, "Conceptual Principles and Structure Analysis Based on the Construction Information Classification System", Dongguk University Ph.D. Thesis, vol. 2, **(1998)**, pp. 1-108.
[2] H. G. Lee, " A Study on the Estimate System Construction Utilizing Construction Information Classification System", Hanyang University, Master's Thesis, **(1999)**, pp 1-55.
[3] J. W. Lee, "Design of Document Profile Database for Browsing in Information Retrieval Systems", IJSEIA vol. 1, no. 1, **(2007)**, pp. 79-88.
[4] I. Lkhagvasuren, J. M. So, J. G. Lee, J. Kim and Y. W. Ko, "Design and Implementation of Storage System Using Byte-index Chunking Schema", IJSEIA, vol. 8, no. 1, **(2014)**, pp. 33-42.
[5] S. M. Ghosh, H. R. Sharma and V. Mohabay, "Analysis and Modeling of Change Management Process Model", IJSEIA, vol. 5, no. 2, **(2011)**, pp. 123-134.
[6] B. H. Lee, "Relative Importance Analysis of inter-evaluation items in Korean IS Standard Audit Checklist Using Decision making", IJSIA, vol. 7, no. 5, **(2013)**, pp. 365-376.
[7] D. H. Kim, "Construction Planning Process Utilizing Work Breakdown Structure", Hanyang University, Master's Thesis, vol. 2, **(1996)**, pp. 2-10.
[8] S. H. Baek, "Construction for Site Information Management System Utilizing Project Breakdown Structure", Korea Journal of the Architectural Institute, vol. 15, no. 6, **(1999)**, pp. 60-67.
[9] L. S. Kang, "Integrated Code Classification System for Work Sections in Standard Method of Measurement and Construction Standard Specifications", Korean Journal of Construction Engineering and Management, vol. 2, no. 4, **(2002)**, pp. 1-8.
[10] E. F. Codd, "A Relational Model of Data for Large Shared Data Banks". Communications of the ACM, vol. 13, no. 6, **(1970)**, pp. 377–387.
[11] http://en.wikipedia.org/wiki/Relational_model#cite_note-USDT01-3.

Authors

Hong-Tae Park. He received his M.S. and Ph.D. degrees in Civil Engineering from Chung-Ang University, Korea, in 1990, 1995, respectively. He has been professor in Department of Civil & Environmental Engineering, Kongju National University. His research interests include construction information classification system, construction project management, cost estimating.

Boo-Hyung Lee. She received his B.S., M.S. and Ph.D. degrees in Electrical Engineering from Soongsil University, Korea, in 1983, 1991 and 1998, respectively. She has been professor in Department of Computer Science & Engineering, Kongju National University. She is CISA and CISSP and has been included in Marquis Who's Who in the World since 2011. Her research interests include 3D object recognition, computer vision, image processing and IT Governance.