The Analysis of BIM Modeling Level Considered as Building Greenhouse Gases Assessment

Sung-woo Lee[1, a], Sung-ho Tae[2, b]

[1] Dept. of Sustainable Architectural Eng., Hanyang Univ., Seoul, Korea, 426-791

[2] School of Architecture & Architectural Eng., Hanyang Univ., Ansan, Korea, 426-791

[a] dltjddn03@hanyang.ac.kr, [b]jnb55@hanyang.ac.kr

ABSTRACT

The purpose of this study is to analyse BIM Modeling level evaluating Building greenhouse gases emission to exploit greenhouse gases assessment tool viewed on Building Life cycle.

Around the globe BIM guidelines are developed for syntagmatically maintaining Building from early design phase. In this study an assessment method for the greenhouse gases was drawn by analysing internal and external BIM guideline and organizing the BIM request items to support evaluating building greenhouse gases emission.

Consequentially, it was possible to evaluate the amount of greenhouse gases emission in buildings from LOD 200. About 50 percent of whole greenhouse gases emission in buildings on the LOD 200, 75 percent of it on the LOD 300 and 100 percent of it on the LOD 400 could be evaluated.

KEYWORDS: BIM, CO_2, LOD, Greenhouse gases

1. INTRODUCTION

The concern about environment are gradually increased. As well as integrating BIM with green building construction also. Around the globe BIM guidelines are developed to maintain building from early design phase syntagmatically based on BIM. Internal guidelines were produced by modifying 3D BIM process on the basis of the existing 2D development data and therefore users associated with architectural field lacked understanding parametric modeling. Meanwhile, the growing interest in evaluating for greenhouse gases by using BIM in Green Building Certification System is reflected in architectural field and researches about BIM guidelines development have increased in phase.

In this study, The BIM request information and LOD (Level of Detail) standard which is connected with evaluation of greenhouse gases emission according to major construction materials that is emitted from building greenhouse gases were organized. In accordance with integrating BIM model formation, the efficient evaluation method about building greenhouse gases is presented. The scope of this study

was limited to the architectural design phase and then international BIM guidelines are compared and analysed toward the centre of LOD.

The purpose of this study is to suggest the assessment method for evaluating Building greenhouse gases.

2. BIM GUIDELINE AND LOD FOR BUILDING GREENHOUSE GASES ASSESSMENT

2.1 The Definition of LOD

The LOD is defined as next two kinds that are 'Level of Development' and 'Level of Detail' per the AIA Document E202-2008. However this two definitions is similar in meaning, LOD(Level of Development) denote step-by-step work classified by Modeling level LOD(Level of Detail) denote Modeling level classified by design process step.

On the LOD 100 phase, for example, mass and zoning Model should be generated. At this time, Model that is created according to architect task is LOD (Level of Development). Basic morphogenesis making mass/zoning modeling to select level of Data model is LOD (Level of Detail).

2.2 The Analysis of International BIM Guidelines

By Notice of Land, Ministry of Land, Infrastructure and Transport(2009) Article 5 of the work scope of the architect, design processes are divided into Business planning, architectural design works, and post-design management duties and others. In this process, architectural design works is once again divided into conceptualization, criteria design, detailed design and Implementation documents and construction.

In this study domestic and international BIM guidelines were analysed and organized. LOD standards were compared and reviewed for supporting to building greenhouse gases evaluation applying domestic design work process. As a result of data analysis about domestic and international guidelines, Table1 was derived as follows.

However LOD separates were represented to difference by design process in guidelines, BIM information, the expression level of information, Major achievement standard by LOD were derived as follows Table1.

Table 1. The definition of LOD

(1) Building SMART Korea (KOREA/2010)

Conceptualization (LOD100)	-
Criteria Design (LOD200)	- overview of the quantity, shape, location and direction combination - design modeling - representation of location, height, volume, area and direction
Detailed Design (LOD300)	
Implementation Documents (LOD400)	- modeling for quantity, shape, location and direction - specialization of materials and equipment
Construction (LOD500)	- modeling for quantity, shape, location and direction - construction actualization

(2) Korea Land & Housing Corporation (Korea/2012)

Conceptualization (LOD100)	-
Criteria Design (LOD200)	-selecting properties space function and geometric information(location and area), geographic information
Detailed Design (LOD300)	- function of Major construction elements(wall, slab, stair etc.) and properties of geometric information
Implementation Documents (LOD400)	- selection of properties for infrastructure(roadway, parking lot, underground structure)
Construction (LOD500)	- physical information and properties selection of assembly line

(3) AIA (USA/2009)

Conceptualization (LOD100)	- the whole project composition of area, volume, zone, major materials
Criteria Design (LOD200)	- representation to 3D for building basic object - rough schedule plan, basic object estimate
Detailed Design (LOD300)	- representation to 3D for building specific object - specific schedule plan and estimation sheet
Implementation Documents (LOD400)	- shop drawing - specific representation for construction and manufacture
Construction (LOD500)	- Completed construction estimation sheet

(4) Cooperative Research Centre (Austrailia/2009)

Conceptualization (LOD100)	- planning and conceptualization about volume, area
Criteria Design (LOD200)	- probable cost based on measurement of general component - specific properties information about additional materials
Detailed Design (LOD300)	
Implementation Documents (LOD400)	- specific model including properties dimensions, volume
Construction (LOD500)	- construction drawing/ structure manufacture and installation - specific method of construction

3. LOD LEVEL SELECTION AND UTILIZATION

3.1 The Analysis of BIM Modeling Level for Evaluating Building Greenhouse Gases

The LOD classification was organized by international guidelines as mentioned earlier and focused especially on invigorating the use of BIM progressing design project for evaluating building

greenhouse gases classified by major construction materials. Because BIM component standard should be differently prepared according to design project purpose, the generalized composition standard has its limit. In this study, based on apartment house, the modeling standard in accordance with LOD standard was organized as follows Table2.

On the LOD 100(Conceptualization) phase, BIM of mass-dimensional design through architectural components are prepared. The data are represented about dimension, area, volume, location but structure, MEP (Mechanical, Electrical and Plumbing) are excluded.

On the LOD 200(Criteria Design) phase, the types about major architectural components are decided by supposing to general components and making data which should be possible to describe design concept. The stand surface design through vertical and horizontal moving line including inside walls according to spatial relationship should be represented. It is reasoned that the simplicity assessment through material takeoff about ready-mixed concrete and glass are possible in which major construction materials are extracted from evaluating building greenhouse gases.

Table 2. BIM materials information for evaluating the building greenhouse gases by LOD

Field			LOD100	LOD200	LOD300	LOD400	LOD500
1. LOD Modeling level			Conceptua-lization	Criteria Design	Detailed Design	Implementation Documents	Construction
Architectural	Wall	Rebar				○	○
		Steel Frame			○	○	○
		ready-mixed concrete		○	○	○	○
		Brick		○	○	○	○
		Insulation			○	○	○
		Mortar			○	○	○
		Finishing Material				○	○
		Plaster board			○	○	○
		Paint				○	○
	Curtain Wall	Glass		○	○	○	○
		Bracket			○	○	○
		Frame			○	○	○
	Window	Glass		○	○	○	○
		Coating Material				○	○
		Frame			○	○	○
	Slab	Rebar				○	○
		ready-mixed concrete		○	○	○	○
		Mortar			○	○	○
		Insulation			○	○	○
		Finishing Material			○	○	○
		Paint			○	○	○

Machine	Duct	Diffuser		○	○	○
		Access hole		○	○	○
		Holder		○	○	○
	Plumbing	Pipe		○	○	○
		Lagging			○	○
	Equipment	Pump		○	○	○
		Boiler		○	○	○
		Conditioning Equipment		○	○	○
Electronics	Cabletray			○	○	○
	Boothduct			○	○	○
	Lighting apparatus				○	○
2. Greenhouse Gases Assessment Level		N/A	Simple	Optimum	Complex	Very Complex
3. Greenhouse Gases Assessment Method		N/A	Simplicity Assessment	Detailed Assessment		

On the LOD 300 (Detailed Design) phase, the modeling for architectural field along with structure field are represented and the properties information about machinery, electronica and architecture are inputted also.

As LOD 400(Implementation Documents) phase is to prepare drawing and specification, the properties about not only majored architectural elements but structure, equipment, material object selected from a level of drawing and specification should be inputted. On the LOD400 modeling, it could be the accurate assessment of building greenhouse gases by accurately calculating the amount of materials on the construction phase.

On the LOD 500(Construction), it is building object of completion concept that all information about operation and maintenance should be included to BIM modeling object. All of property information about building as well as anticipated operation cost including operation, maintenance and Building element actually constructed are included.

Through the property information of the architectural, structural and MEP fields, major construction materials could be extracted from BIM so It could be possible to evaluate building greenhouse gases accurately from LOD300 to LOD500

3.2 Major Construction Materials by LOD for The evaluation of Building greenhouse gases

Through the LOD suggestion evaluating the amount of greenhouse gases, using seven materials of thirty major construction materials which comprise ninety percent of whole building greenhouse gases extracted from existed study, the ratio that can evaluate greenhouse gases emission following LOD step was extracted that is as follows Table 3.

Table 3.The ratio of building greenhouse gases evaluation by LOD step (major materials targeted)

Input data	LOD Information				
Major Construction Materials	LOD 100	LOD 200	LOD 300	LOD 400	LOD500
ready-mixed concrete		○	○	○	○
Rebar			○	○	○
Steel				○	○
Glass		○	○	○	○
Paint			○	○	○
Insulation			○	○	○
Concrete products			○	○	○
The ratio of assessment possibility	0%	52%	75%	100%	100%
Assessment method	N/A	Simplicity Assessment	Detailed Assessment		

In case of LOD 100, greenhouse gases evaluation was not available. Because the LOD 100 is mass modeling level. In case of the LOD 200, stand surface design including inside wall represented for spatial relation was reflected, so the quantity of ready-mixed concrete, glass etc. could be calculated by BIM information. On the LOD 300, except for rebar that is a structure material, it is possible to evaluate the amount of 75percent of whole building greenhouse gases emission. It should be making this a detailed assessment from LOD 300.

Because Major architectural elements and object properties as well are selected, more quantifiable assessment for building greenhouse gases is possible on the LOD 400 and LOD 500. To raise the accuracy of assessment about building greenhouse gases emission on the LOD 300, the rebar quantity should be considered indirectly through additional input data about the material properties information. On the other hands, it is possible to extract cost information for material property information as well as operation and maintenance so it is assumed that this information will be utilized as data for 4D schedule plan and detailed cost estimation.

4. CONCLUSION

This study was progressed in a bid to develop the assessment technology about building greenhouse gases emission through BIM modeling level and purposed for the analysis of BIM modeling level. The results are listed below.

1. In this study, Existing international guidelines were analysed. The Modeling levels by LOD are analysed through additional input data about the material properties.

2. The assessment level about Building greenhouse gases was analysed by LOD from domestic and international guideline organized in this study. On the LOD 200 phase, about 50percent of whole greenhouse gases emission were possible to be evaluated.
3. It was analysed that about 75percent of whole greenhouse gases emission were possible to be evaluated on the LOD300. Above LOD 400 modeling level, It is considered that detailed assessment about building greenhouse gases is possible through quantity information about major construction materials extracted from BIM.

ACKNOWLEDGEMENT

This work was supported by Sustainable Building Research Center of Hanyang University which was funded the SRC/ERC program of MOST/KOSEF. (No.2005-0049719).

REFERENCES

AIA, AIA Document E202, 2008 American Institute of Architect
LH Corporation, 2012, BIM Guideline for Design, Korea Land & Housing Corporation
Lee Byeong ho, et. Al 2010 Integrated Assessment System of Sustainable Communities using BIM Technology, Vol.1, No1, pp.64-73, International Journal of Sustainable Building Technology and Urban Development
Choo Seung Yeon, et. Al 2012 A Study on LOD (Level of Development) for Development of Green BIM Guidelines, Vol.28 No6 pp.37-47, Architectural Institute of Korea
Cho Hyun Jung, et. Al. , 2013 A Study of LOD(Level of Detail) for BIM Model applied the Design Process, Vol3, No1, Korean Institute of BIM(Building Information Modeling)
Roh Seung Jun, et. Al. 2013 A Study on the Deduction of Main Materials of Construction Work Centered on the GHG Emissions using LCI DB, V.33 n.1 pp.469-470, Architectural Institute of Korea