

# A Study on Visual Manual Framework for Construction Quantity Takeoff

[Hyo-Seok Lee, Ji-Yune Soh, Chang-Hoon Choi, Junbok Lee and Choong-Hee Han]

**Abstract** — According to the improvement of IT technology, an enhanced efficiency of management system in the construction industry is expected since a quotation system with BIM technique effectively estimates construction materials. For an enhanced efficiency of management system, related guidelines, standards, and manuals based on BIM are required, but the lack of this information causes difficulty to utilize in practice. In this paper, to apply for a quotation system with BIM, a visual manual and configuration including manual's components and types and notation of information are studied by analyzing basic knowledge through theoretical study and by surveying from both professionals and amateurs.

**Keywords**—Visual Manual, Quantity Takeoff

## I. Introduction

Quantity takeoff is the most essential process for construction project cost estimation in the preconstruction stage. Takeoff begins with measure plans and blueprints. It is so complex and time-consuming work that human errors are frequently found out. (Rick R 2006)

BIM can integrate design and takeoff process. The integration is beneficial in saving time in quantity takeoff and cost estimation and receiving rapid feedback from design change.(BIM Handbook) However, it has no manual including sufficient guideline or instruction.

The Visual Manual in this paper indicates the manual that provide practical guidelines and teaching aids for BIM based quantity takeoff.

This paper aimed to establish a configuration for Visual Manual before its development. User and expert survey was carried out for elements, types and information form of the manual.

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## I. BIM based quantity takeoff

Trouble of tedious repetition, unavailability of automation and difficulty in building database is the most difficult in cost estimation. The difficulties can be relieved by using BIM. Information extraction from 2D based drawings does not allow efficient management and application of information in each stage. But 3D based BIM makes it possible. Also, change in quantity caused by design change can be easily measure. In BIM based quantity takeoff, the takeoff can be carried out in any design stage required as well as the initial design stage. It is better than conventional takeoff work, which requires whole revision at every interim takeoff. BIM takeoff can manage drawing information of final design, construction and maintenance stage as well as design progress and develop a database.(Ryu, 2009)

## II. Survey

### A. Survey outline

The survey asked cost estimation experts and amateurs (undergraduate students) to develop Visual Manual. The outline of expert survey is like Table 1. The survey questions were organized based on consultation of cost estimation experts.

**Table 1 Outline of expert survey**

Type	Contents
Purpose	Draw out reform plans through Investigating difficulties in the current cost estimation work
Method	Survey by E-mail
Questions	
1	Importance of task
2	Frequency of error
3	Check of manual or textbook
4	Improvement of manual and textbook
5	Possibility of BIM based quantity takeoff
6	Understanding of BIM based quantity takeoff
7	Prerequisite for BIM based quantity takeoff
8	Contents of visual manual for BIM based quantity takeoff

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The outline of amateur survey is like Table 2. The survey questions were organized based on interview of 4th year graduate students who attended a lecture on cost estimation.

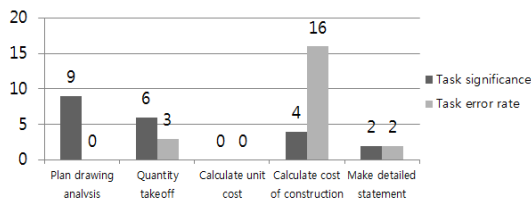
**Table 2 Outline of amateur survey**

Type	Contents
Purpose	Draw out reform plans and configuration of electronic manuals through investigating the learning pattern and difficulties in studying cost estimation
Method	Questionnaire and interview
Questions	
1	Learning method
2	Effective learning media
3	Understanding of quantity takeoff
4	Difficulty in learning
5	Necessity of manual and textbook

### B. Survey conclusions

The results of a survey aimed at experts are as follows. We carry out a survey targeting 50 quantity takeoff experts. Question response rate was 42% for 21 people and a total of 57.1% of the respondents had more than six years of experience in the quantity takeoff.

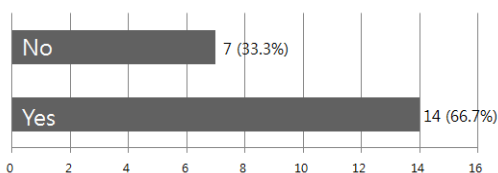
In figure 1, quantity takeoff of estimate tasks is high task significance and task error rate.



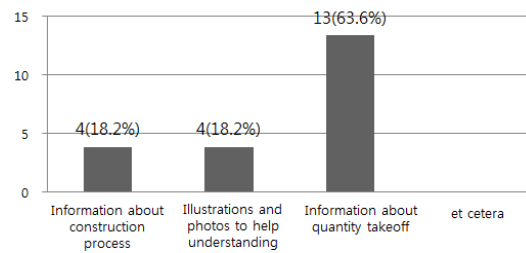
**Figure 1 Importance of task & Frequency of error**

33.3% of the answerers stated that the errors are caused by absence of manual for reference as shown in Figure 2. Though other 66.7% stated that they have reference manuals, the manuals are short in information such as outline, procedure, and formula, as shown in Figure 3.

Moreover, all of the answerers stated that the cost estimation can be more efficient through making use of good manual and textbook. Therefore, developing better quality of manual and textbook is required.

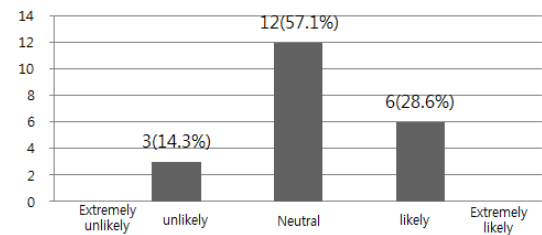


**Figure 2 Check of manual or textbook**

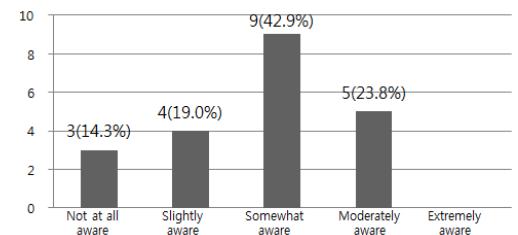


**Figure 3 Improvement of manual and textbook**

85.7% of the answerers stated that BIM based takeoff will be carried out with not low possibility as shown in Figure 4. But 76.2% of the answerers stated that they don't have high awareness about BIM based takeoff as shown in Figure 5.

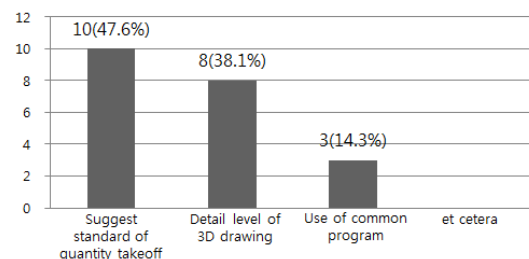


**Figure 4 Possibility of BIM based quantity takeoff**



**Figure 5 Understanding of BIM based quantity takeoff**

The low awareness about BIM based takeoff could make the ratio of answerers the highest as 47.6%, who chose suggestion of guideline as prerequisite for BIM based takeoff, as shown in Figure 6. 52.4% of answerers stated that Visual Manual for BIM based takeoff shall include photos and models for better understanding of users.



**Figure 6 Prerequisite for BIM based quantity takeoff**

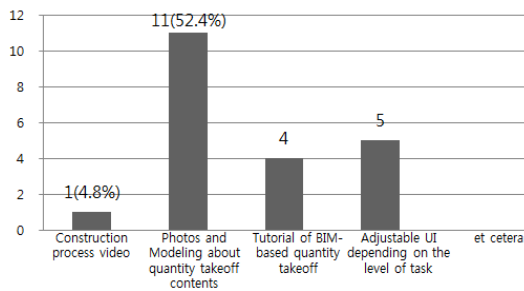


Figure 7 Contents of visual manual for BIM based quantity takeoff

The result of amateur survey is like below. The survey asked 56 people. 78.6% of the answerers stated that they learn through textbooks as shown in Figure 8. However, 50.0% of the answerers, the most common answerers chose video as the most effective learning tool, and text with illustration and 3D simulation was chosen as the second common answer by 21.4% as shown in Figure 9. Base on the survey, multimedia learning tools are easier to understand than text based printed media though they are not enough available. Therefore, multimedia type of manuals including video and 3D simulation shall be sufficiently provided for learning quantity takeoff.

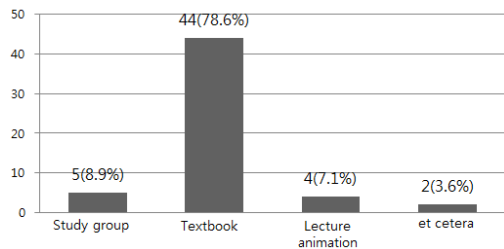


Figure 8 Learning method

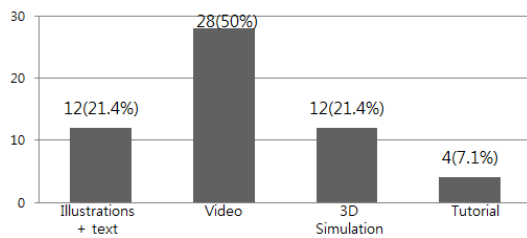


Figure 9 Effective learning media

76.5% of the answerers stated that they have low understanding of quantity takeoff as shown in Figure 10. 55.9% chose their poor understanding for drawings as an obstacle for learning as shown in Figure 11.

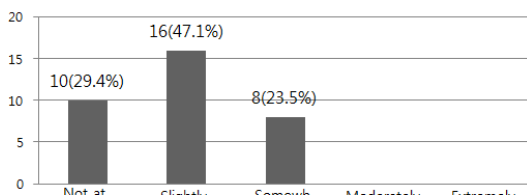


Figure 10 Understanding of quantity takeoff

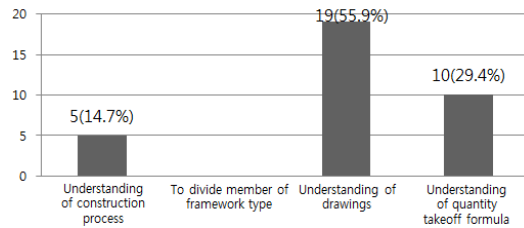


Figure 11 Difficulty in learning

To clarify their difficulty in reading drawings, the 19 students who had the choice were interviewed with. They had difficulties in interpreting drawings and catching information of the building from conventional 2D drawings. Visual Manual will include 3D modeling and simulation for easy interpreting and understanding of drawings. It will cover the demand for manual and textbook shown in Figure 12.

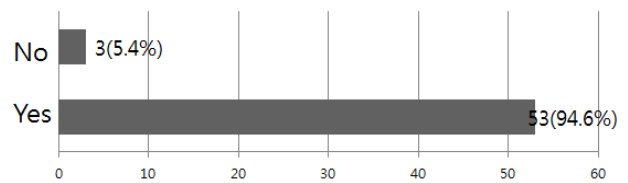


Figure 12 Necessity of manual and textbook

### III. Configuration of Visual Manual

As mentioned above, non-standardized instruction of takeoff and restricted contents of conventional takeoff manual makes the takeoff work less efficient. Visual Manual will be developed to enhance the efficiency of takeoff work. Construction process, quantity takeoff outline, quantity takeoff procedure and quantity takeoff formula were adopted as contents of Visual Manual based on a manual that analyzed before, like Figure 13. Contents of construction process enable the user to understand overall construction process and know what item will be used and when the item will be used. Content of quantity takeoff outline, procedure and formula make the work more efficient by providing the clear reference guide.

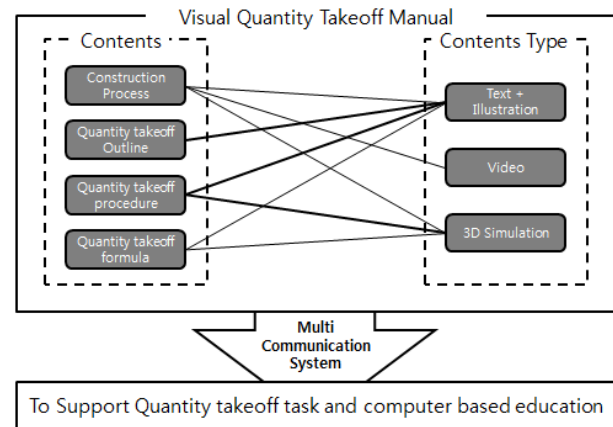


Figure 13 Visual Manual Concept



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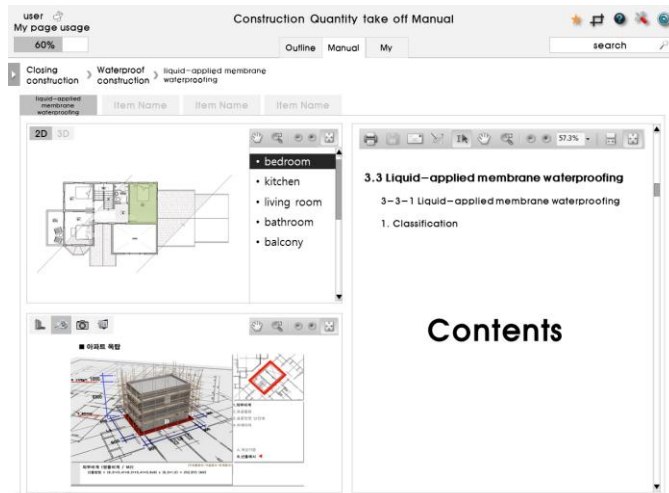


Figure 14 Visual Manual Development Framework

## iv. Conclusion

This is the preliminary study for developing Visual Manual and aims to suggest system configuration of the manual. The current state of quantity takeoff and BIM was investigated. System configuration of the manual was established through expert and amateur survey.

Visual manual is developed to support quantity takeoff work in which human errors are frequent and learning quantity takeoff which needs help in interpreting and understanding drawings. The manual is based on 3D BIM and includes text, illustration and multimedia such as video and simulation for better understanding.

Based on this study, developing the Visual Manual system including contents and interface will be carried out as a future work. The initial system will target one unit of apartment house which is most common building in Korea. The developed system will become a framework to make an expanded system applicable overall construction work, through supplement and expand of contents, configuration and communication measure verified by experts and amateurs. Visual Manual will make takeoff work and education more efficient.