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BIM for Construction Quality Record

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***Abstract:** Building Information Modeling (BIM) encourages effective information share and utilization among project participants during entire life cycle of facility. This paper presents a method that keeps track of the historical quality records involved in construction operations and facilitates using BIM. The method is coded into BIM based Quality Record Traceability (BIM-QRT) System that makes use of historical records obtained from database administrating construction operations. This study is of value to practitioners because the method makes clear the project participants' responsibility relative to the quality of each and every element of the facility. The main objective of this research is to develop an accurate, fully automated method for construction Quality Record Tracking by using a BIM along with construction operations data obtained by information technology. Test cases verify the usability and validity of the methods implemented in the system.*

***Keywords:** Building information modeling (BIM), quality record, traceability, database, data acquisition*

I. INTRODUCTION

The complexity and dynamics of construction projects have been increased. To better response to this circumstance, construction companies are enforced to undertake a higher level of quality control and management. To comply with these needs, domestic construction companies have introduced an international standard for quality management system (Lee et al, 2010). However, the tardy adaption of a new technology makes project managers to lose the opportunity for utilizing the valuable information created by construction processes (Kim et al, 2010). To complement this problem, building information modeling (BIM) technique has been introduced and its application tends to be increased. This study proposes a system which enables to record and keep tracking the quality information relative to job-site activit by using the BIM. The risks inherent in the construction quality control can be effectively addressed.

II. LITERATURE REVIEW

A. Existing quality control researches

A reliable quality management system is an essential measure for securing reliability and safety of constructed facilities. The systematic and ongoing management systems have emerged in accordance with the requirements in the quality management system (i.e., ISO9001). Researches related to construction quality management are described as follow: Kim et al. (2013) proposed a method that enables to real-time documentation of the concrete quality (e.g., compressor strength). Kim et al. (2012) developed a standard for measuring temperature and humidity for quality management and monitoring the condition of concrete (Kim et al, 2012). Park and Ahn (2012) presented a quality control method considering the impact of construction cost and cost reduction in a construction process. Kim (2012) developed

a building information system assisting quality test reports and materials test. Lee et al. (2010) devised an expert system for quality audit. As stated above, many studies involved in quality assurance in the construction industry have been carried out in an attempt to satisfy the quality needs and expectations demanding on the construction process.

B. Existing BIM researches

As construction projects are bigger and more complex, the amount of information generated at a construction site is remarkably increased. This circumstance results in difficulties in managing information systematically. To complement this lack of management, BIM has been adapted as the counterpart. The BIM-related researches in the construction sector are as follows: Kang et al. (2010) proposed the BIM-based data sharing and effective equipment planning; Lee et al. (2009) developed a BIM-based construction simulation model; Kwon et al. (2012) presented a method for specific quality improvement for the BIM design services. Golparvar el al. (2012) devised a method for updating project schedule by using advantage of 4D BIM scene photos and information on each structural element. In addition, Kim el al, (2014) by utilizing the 3D data and 4D buildings information, developed a method which facilitates managing a construction progress. A number of researchers have accepted the usability and practicability of BIM in the construction domain. However, studies involved in recording /tracking construction quality histories generated from the construction process periodically is lacking.

III. METHODOLOGY

Existing studies related to quality management system were developed to manage historical quality records at the activity levels. However, quality records should be managed under operation levels to ensure the resources who are

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responsible for the quality of each and every element of the facility. Thus, this paper presents a BIM based quality record traceability system which enables users to access the historical quality records obtained during construction phase. The detailed procedure for implementing the BIM based Quality Record Traceability (BIM-QRT) model (Son et al. 2014) is presented as shown in Figure I:
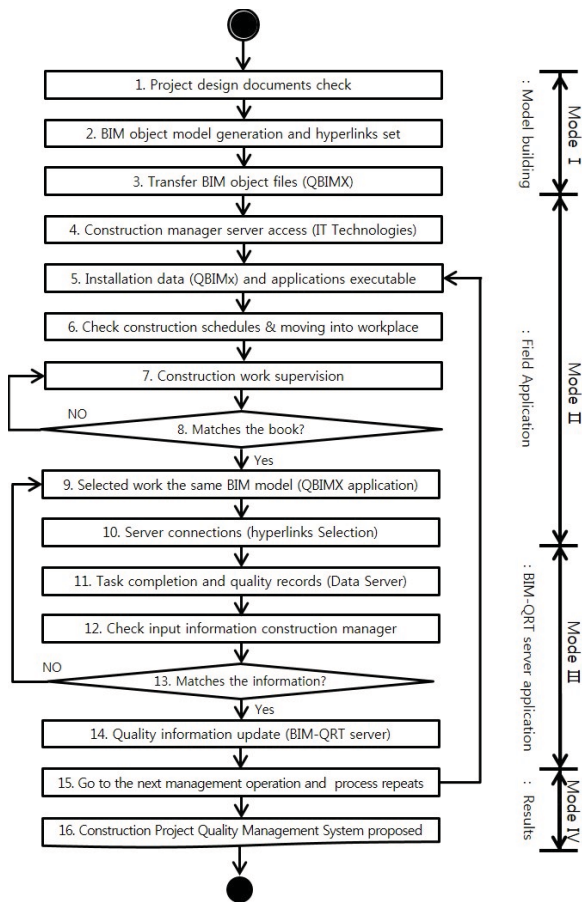

FIGURE I.
BIM based Quality Record Traceability Flow chart

- Step 1. Obtaining design drawing documents (e.g., floor plans, elevations, cross-section drawing, structural drawings, interior finish materials tables, etc.).
- Step 2. Creating a BIM model (Quality Record Traceability) linked Operation ID one by one.
- Step 3. Creating a QRT_BIMx file   including BIM objects (* BIMx_Commercial Program)
- Step 4. Transferring the QRT_BIMx file to a construction manager via IT (e.g., smart phones, laptops, etc.).
- Step 5. Launching the file on the commercial software (BIMx)
- Step 6. Combining the project schedule and obtaining the construction progress data.
- Step 7. Supervising construction operations.
- Step 8. Completing tasks in consideration, investigating the relevant quality history and review the same information on project drawings.

- Step 9. Implementing the corresponding object model (ID: QRT_BIMx) by utilizing IT devices.
- Step10. Confirming the information related to the model object in question, designated access the web server via predefined hyperlink
- Step 11. Recording the production history (e.g., job description, laborer ID, equipment ID, and quality requirements) relative to the completed item (e.g., column, beam, wall, etc.) .
- Step12. Investigating any quality unconformity via BIM coordinators and double-check the accuracy of input information created by the construction manager.
- Step 13. Determining if there is an error in the input information. If there is, proceed to the following action. Otherwise, notice the error to the construction manage
- Step 14. Updating construction information in the BIM-QRT web page update
- Step 15. Returning to Step 4 to deal with a next task on the project schedule.
- Step16. Generating quality control reports of the project.

Ⅳ. CASE STUDY

A case test is demonstrated to verify the usability of the proposed BIM-QRT. The survey was administered from November 25 to December 2, 2014. The outline of the case project is shown in Table I. It is a new apartment building of 29-storey with reinforced concrete structure; the site area accounts for $53,210.40 m^2$. The preliminary survey for associated practitioners was performed prior to application of the developed system in the workplace. During the field survey period, where reinforcement placing and concrete curing tasks were being conducted. .

TABLE I.
BUILDING SUMMARY

Division	Contents
Title	J heung APT new construction
Building site	○○ City Okgyedong ○○○ Address
District	House of Commons Paper
Plottage	53.210.40 ㎡
Size	B2F / 29 Ground floor
Main structural system	Reinforced concrete (Wall Structure)
Building coverage	46.65 %
Floor space index	256.95 %

The tasks under case study are installing reinforcing bars and formwork at the first floor. The QRT_BIMx was distributed to a construction manager with clear explanations of the operation procedures of BIM-QRT system. The manager was asked to perform the quality inspection. The system manages the historical production quality information of the construction operations in real

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time by utilizing the IT technologies. The system complements the limitations of existing PMIS. When the user have to determine who is responsible for the quality of a specific wall section at a specific location after project completion, the user may identifies the superintendent, workers, and equipments worked for the specific operation (e.g. reinforcement) by using an identification code of the wall. The quality records can be used for evaluating the performance of the crew. It provides a basis for improving the quality of the construction work.
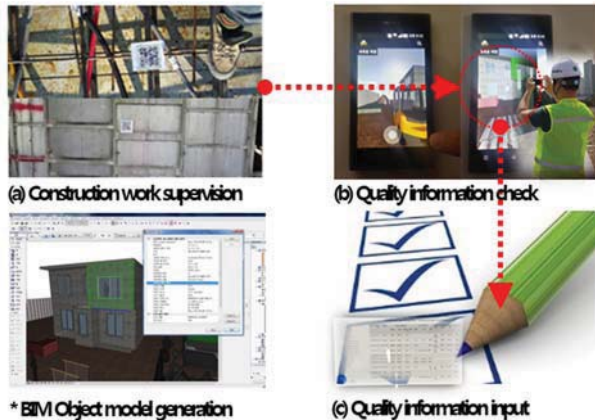

FIGURE II
CONSTRUCTION SITE DATA COLLECTION / RECORDING QUALITY

V. CONCLUSION

The study presents a BIM-QRT system that facilitates collecting and managing the construction quality information in real time. The case study confirms that the BIM-QRT system is capable of tracking historical quality records involved in tasks in real-time.

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