

# Enhancing the Visualization of Problems Tracking and Management Integrated BIM Technology for General Contractor in Construction

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**Abstract.** Recently, BIM (Building Information Modeling) technologies are utilized for general contractors in various applications of construction managements. The applications of BIM technologies become the most critical and useful tool for construction management during the construction phase. Despite many articles and much discussion in practice and academic literature, there is a lack of systematic approaches to enhance identified BIM-based problems illustration and tracking management for effective construction management. With the utilization of the API (Application Programming Interface) and web-based system development for BIM-based problems illustration and tracking management, this research proposes a new and practical methodology to apply BIM-based problems tracking and management. Using API and web-based system development, this study proposes a BIM-based tracking and management of identified problems for general contractors. Furthermore, the proposed system can enhance the effective of BIM-based tracking and management of identified problems integrated BIM technologies. The proposed system is then applied in selected case study of a building project in Taiwan to verify our proposed methodology and demonstrate the effectiveness in practice. Finally, this study summarizes the advantages, limitations, and suggestions for further BIM-based tracking and management of problems in construction management.

**Keywords:** Building Information Modeling, BIM, construction management, general contractor, system development.

## 1 Introduction

When the application of BIM models are adopted in the construction project, the amount of BIM models will be increased and necessary to be communicated and managed effectively. Many problems occur at the jobsite during the construction phase, all the tracking and management of identified problems are very important consideration for successful construction management. Effectively tracking and management of identified problems between project participants of the general contractor can improve construction management during the construction phase, thereby eliminating unnecessary mistakes and reworks. Conventional communication methods include face-to-face meetings, telephone communication, and virtual design

39 and construction (VDC). However, a typical problem encountered during  
40 conventional communication is that discussions may not be effectively tracked and  
41 shared with others.

42 During the construction phase, onsite engineers and BIM engineers typically  
43 communicate and respond BIM-related identified problem and problems thorough  
44 paper-based document or e-mail way. In order to assist involved onsite engineers,  
45 BIM engineers, and BIM managers in communicating and responding discussion  
46 information special related to BIM models, the primary objective of this study is to  
47 facilitate the visualization of tracking and management for identified problems among  
48 project participants of the general contractor during the construction phase.  
49 Identifying, tracking, controlling, and managing identified problems are critical tasks  
50 in the construction management. This study develops the BIM-based tracking and  
51 management for identified problems (BTMP) system for engineers to enhance sharing  
52 and tracking of tracking and management for identified problems efficiency. Notably,  
53 this study integrates novel web-based communicating platform and the 3D BIM  
54 approach to communicate and manage BIM-based tracking and management for  
55 identified problems in a 3D BIM environment.

56 The identified problems, which typically involve project engineers from different  
57 fields, often has numerous issue problems. The issue information and status of  
58 identified problems regarding the change or updated from onsite engineers' feedback  
59 is generally not transmitted effectively to related engineers or manager, or effectively  
60 exchanged among onsite engineers. Moreover, onsite engineers frequently change  
61 their own work and rarely feedback updated information of BIM model. BIM-based  
62 tracking and management for identified problems is currently not widely applied in  
63 the construction industry because no appropriate platforms exist that assist project  
64 participants in communicating and managing BIM-related identified problems during  
65 the construction phase. By utilizing the BTMP system, onsite engineers and BIM  
66 engineers can obtain records of previous and current discussion regarding to BIM  
67 models in a given project and manage BIM-based identified problems. Furthermore,  
68 Jobsite engineers and managers can track and access the most recent BIM-based  
69 tracking and management for identified problems during the construction phase. All  
70 responds from jobsite engineers and managers can be updated rapidly and made  
71 available to onsite engineers via the web-based environment for BIM-based  
72 construction management.

## 73 **2 Literature Review**

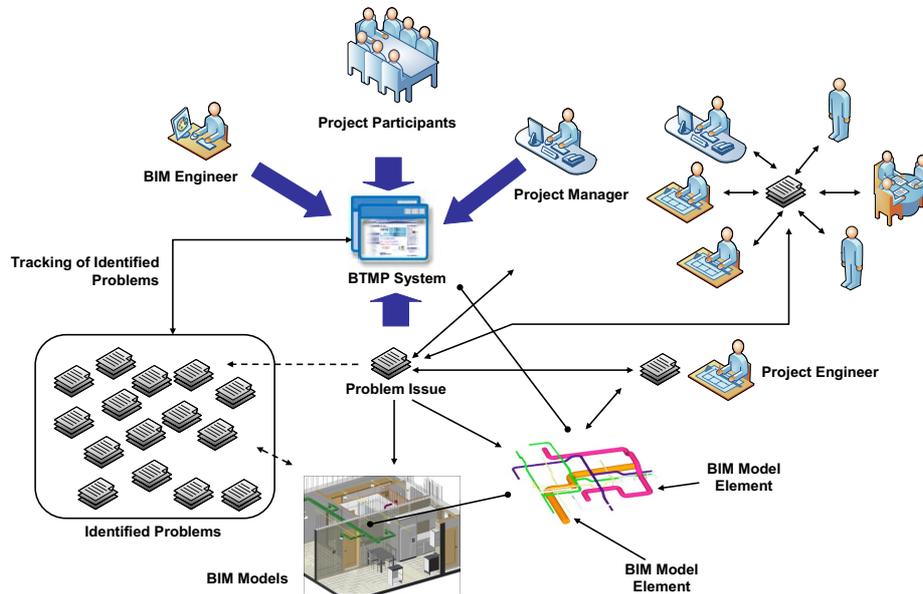
74 BIM is a digital tool that supports continual updating and sharing of project design  
75 information [1]. BIM digitally contains precise geometry and relevant data needed to  
76 support the design, procurement, fabrication, and construction activities to describe  
77 3D object-oriented CAD [2]. BIM is a revolutionary technology and process that has  
78 quickly transformed the way buildings are conceived, designed, constructed and  
79 operated [3]. Furthermore, there are previous researches regarding the system  
80 development integrated BIM technology in consturction. Choi et al. (2014) developed

81 an automated system that designers and owners can check the evacuation regulation  
82 compliance of BIM data [4]. Oh et al. (2015) presented an integrated design system  
83 for the improvement of BIM-based collaborative design [5]. Bortolini (2019)  
84 developed a logistics planning and control model for site assembly of ETO  
85 prefabricated building systems using BIM 4D modeling [6]. Li et al. (2018) designed  
86 an Internet of Things (IoT)-enabled platform integrated IoT and BIM for  
87 prefabricated public housing projects in Hong Kong [7].

88 Despite many articles and system developments in academic and practice literature,  
89 there is a lack of systematic approaches to BIM-based tracking and management for  
90 identified problems in the 3D visual environment. To solve this problem, this study  
91 BIM-based tracking and management for identified problems (BTMP) system for  
92 engineers to enhance sharing and tracking of tracking and management for identified  
93 problems efficiency. Notably, this study integrates novel web-based communicating  
94 platform and the 3D BIM approach to communicate and manage BIM-based tracking  
95 and management for identified problems virtually.

### 96 **3 System Developments**

97 Fig 1 shows concept framework of BTMP System. The BTMP system is based on  
98 the Microsoft Windows Server 2008 operating system with an Internet Information  
99 Server (IIS) as the web server. The BTMP system consists of three different user  
100 areas – project engineers, BIM manager, BIM engineer. Access to the BTMP system  
101 is controlled by passwords. In this study, BIM is used as an information model in the  
102 BTMP system. One purpose is to utilize BIM models as the visualization tool of  
103 identified problem issues. The BIM models are applied in the BTMP system to link  
104 and relate to identified problem issue information (such as identified problem issue  
105 descriptions and identified problem issue location). Autodesk Revit Architecture and  
106 Revit MEP were used to create the 3D BIM models. identified problem issue  
107 information integration with the BIM components in the 3D BIM models was  
108 achieved using the Autodesk Revit application programming interface (API) and  
109 Microsoft Visual Basic.Net (VB.Net) programming language. Visual 3D-based  
110 identified problem issue maps were developed in Autodesk Revit Architecture and  
111 Revit MEP by programming in VB.Net and using Revit API. The BTMP system was  
112 developed to integrate acquired data from different software programs and all  
113 identified problem issue information, such that BIM files can be exported to an  
114 ODBC database for connection with the BTMP system. This following section  
115 demonstrates the implementation functionalities in the BTMP system.



116

117

Fig. 1. Concept framework of BTMP System

#### 118 **Authority Management Functionality Module**

119 The authority management module is an access control mechanism preventing  
 120 unauthorized users from entering system or retrieving sensitive related information.  
 121 The BTMP system requires all project participants to register. There are four types of  
 122 users in this study. They are system administrator, BIM engineers, BIM managers,  
 123 and project participants (onsite engineers).

#### 124 **Identified problem Edition Functionality Module**

125 This identified problem edition module is let users edit related BIM-based  
 126 identified problem information associated with related perspective BIM information  
 127 (or attached files). Furthermore, the information includes the proposer name, related  
 128 responded participants and contact mail information. Users associated with specific  
 129 issues can post questions, responses and comments, thereby generating a permanent  
 130 record of discussions regarding specific issues.

#### 131 **Identified problem Alert Functionality Module**

132 This module helps all project participants setup an alert service for monitoring and  
 133 managing identified problem events via e-mail. Importantly, dates related to  
 134 notification of identified problem issue information are recorded systematically.  
 135 Furthermore, this module provides convenient access and a push-based function to  
 136 help engineers respond to situations before identified problem events are tracked and  
 137 others respond.

#### 138 **Identified problem Document Functionality Module**

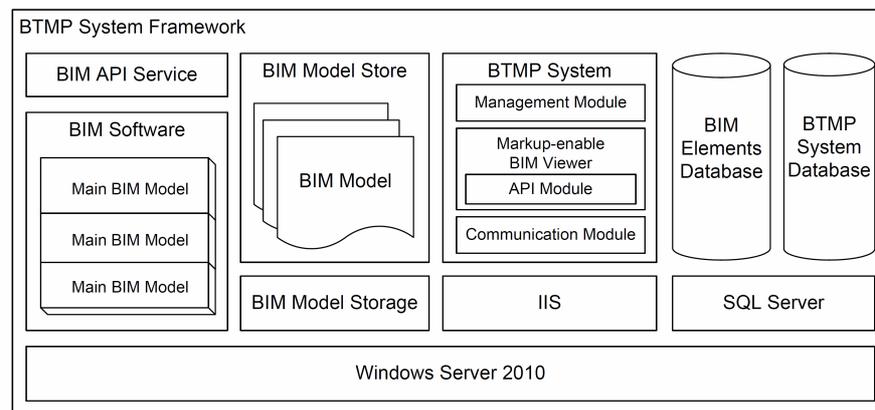
139 The identified problem document management module allows users to download  
 140 identified problem-related electronic documents from the BTMP system.

141 Additionally, the module provides identified problem issue document edition  
 142 management for identified problem issue tracking..

143 Table 1. illustrates description of each color for the BIM-assisted visualization for  
 144 problem management status usage. Furthermore, Fig 2 shows framework of BTMP  
 145 System

146 **Table 2.** Description of each color of status usage in the BIM-assisted visualization

| Color of status Usage | Description   |
|-----------------------|---|
| Blue Color            | To index identified problem regarding to pending status     |
| Yellow Color          | To index identified problem regarding to in progress status |
| Blue Color            | To index identified problem regarding to completion status  |

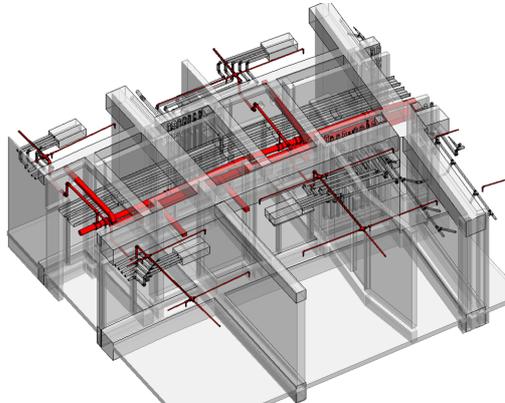


147

148 **Fig. 2.** Development framework of BTMP System

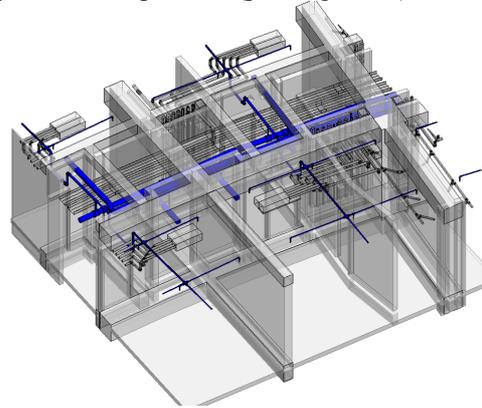
## 149 **4 Discussion**

150 The case study includes a contractor with over 20 years in developing office  
 151 buildings experience in Taiwan. During the construction phase, the projects generally  
 152 include a general contractor, two subcontractors, and seven suppliers. The general  
 153 contractor aims to improve construction management work and thus, encourages all  
 154 stakeholders to use the BTMP system to manage their respective identified problem  
 155 and consequently, improve construction management and the efficiency of identified  
 156 problems management work. Fig. 3 and Fig 4 present the use of the BTMP system to  
 157 track and manage MEP pipe system problems of the case study.



158  
159

**Fig. 3.** MEP Pipe system install problem (pending status) in the case study



160  
161

**Fig. 4.** MEP Pipe system install problem (completion status) in the case study

162 The following are illustrated major advantages and disadvantages based on the  
163 case study.

164 User feedback indicated that the primary advantages to using the BTMP system  
165 were as follows: (1) Track and manage identified problems effectively; (2) Illustrate  
166 different status of identified problems through 3D BIM models visually; and, (3)  
167 understand the current status of all identified problems in the project.

168 User feedback indicated that the primary barriers to using the BTMP system were  
169 as follows: (1) insufficient updated information related to various identified problem  
170 issues of BIM models; and (2) substantial amounts of time and assistance needed for  
171 BIM engineers to modify and update BIM model information.

172 In the case study, overcoming the resistance of project engineers to using the  
173 system during their work was important. Overcoming this resistance has been  
174 regarded as one of the major prerequisites for the successful implementation of a  
175 BTMP system. If resistance to use BTMP cannot be overcome, then the use of the  
176 system will be likely to end with its use by system development division, which may  
177 have been driving the system implementation.

178 If the whole BIM model is presented directly to the page on the BTMP system, it  
179 will affect the smoothness and effectiveness of the system operation. Therefore, the  
180 whole model is necessary to split into parts of BIM model based on the user  
181 requirement to review BIM models effectively. Fig. 5 present the system interface of  
182 the BTMP system using in the case study.



183

184 **Fig. 5.** The system interface of the BTMP system using in the case study

## 185 **5 Conclusions**

186 The application of BTMP integrated with the BIM approach for building projects  
187 during the construction phase is proposed in the study. This study proposes the novel  
188 web-based BTMP system for manager, jobsite engineers, and BIM engineers as an  
189 BTMP platform integrated with BIM models through the web browser. The web-  
190 based BTMP system enhances of tracking and management for identified problems  
191 effectively through 3D BIM environment. The BTMP system provides insight into  
192 factors impacting IC activities, which in turn assists projects participants and BIM  
193 engineers to improve BIM-related communication and management performance. The  
194 of tracking and management for identified problems by the BTMP system allows  
195 projects engineers and jobsite engineers to view 3D BIM models and identified  
196 problems in the 3D BIM environment.

197 The BTMP system updates the latest information of identified problems models  
198 automatically synchronized to the BIM elements database. All required information in  
199 the BIM models automatically synchronized to the BIM elements database based on  
200 required information for BTMP by the API development. The BTMP system will  
201 retain existing data and update only the changed data after synchronization if the  
202 exported information already exists in the BIM elements database. The main  
203 characteristic of the BTMP system is to provide topic description while  
204 communicating with components that are relevant to 3D BIM model and associated  
205 3D view for project engineers to quickly understand problems associated with BIM  
206 models through the web browser. The proposed solution can reduce the cognitive  
207 differences of tracking and management for identified problems among project  
208 engineers and managers. When issues problems all related to component selection,

209 making the issue topics and BIM models relevant, effective integration of the course  
210 of the discussion in the BIM model to improve the status of the tracking and  
211 management for identified problems.

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