

# Automation of Information Flow between BIM and QR Code

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**Abstract** — With advent of Building Information Model (BIM) in architecture, engineering and construction three dimensional (3D) model has become an interface tool for accessing building's information. BIM provides a framework to develop data rich product models and facilitates easy and fast access to the information stored in a database through the 3D model. Accessing the information using BIM is a two-step process. The first step includes the identification and selection of the appropriate 3D element from the digital model and second step includes the retrieval of the information. Currently, the first step is accomplished by navigating the model manually. This step becomes tedious depending upon the size and complexity of the model. This identification and selection process can be automated by integrating Quick Response (QR) code technology with BIM. This integration facilitate easy element selection and improves information retrieval from BIM. This paper discusses about the BIM and QR code framework which facilitates seamless information exchange between real world object and BIM.

**Keywords:** *BIM, QR code, 3D, object hyperlinking*

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## 1. INTRODUCTION

Building Information Modeling (BIM) is a process that provides a framework to develop data rich product models and facilitates the realization of integrated benefits. In this process, the real-world elements of a facility such as walls, doors, windows and beams are represented as objects in a 3D digital model. In addition to modeling, facility information from conception to demolition is integrated into the model. Thus, the model serves as a gateway to provide anytime access to insert, extract, update, or modify digital data by all the project participants involved in the facility's lifecycle.

Accessing the information using BIM is a two-step process. The first step includes the identification and selection of the appropriate 3D element from the digital model and second step includes the retrieval of the information. Currently, the first step is accomplished by navigating the model manually. This step becomes tedious depending upon the size and complexity of the model. Additionally manual errors in element's selection negatively affect the information retrieval process. This identification and selection process can be automated by integrating Quick Response (QR) code technology with BIM. The goal of the study is to develop BIM+QR environment that provides a seamless flow of information. This reduces manual errors and improves information retrieval efficiency. In this environment, when the user reads the QR code through smart device, the respective 3D element will be highlighted in BIM automatically and provides access to retrieve the information. The paper presents an overview of the BIM+QR code framework and illustration of the proposed framework using a construction technology

demonstration lab project. The following sections discuss about BIM+QR environment components and automated information flow among them.

## 2. BIM + QR code Framework

The different components of BIM+QR code framework includes: BIM knowledge repository, Object hyperlinking, and Interactive display unit.

### *BIM Knowledge Repository*

This section discusses the methodology adopted for the development of a knowledge repository through BIM. The two steps in the development process include: (a) 3D model development and (b) integration of information to the 3D model elements. The ease of integration depends on the availability and type of parameters in the BIM software. The information associated with the 3D model elements can be retrieved through parameters of the elements. These parameters establish the links between respective files and elements in digital format. Information used to develop the knowledge repository can be data files such as Microsoft Word, plain text files, and multimedia files (photographs, audio, and video files). Since BIM requires information in a digital format, the information repository development duration can vary and depends upon its availability form. For example, when the information is available in paper format, it needs to be converted into digital format.

### *Object Hyperlinking*

The process of extending the internet to real world objects is called object hyperlinking (Wikimedia, 2014a). This can be achieved by attaching tag with URL to the real world object.

The QR code with URL can be used as a tag. QR code stands for Quick Response Code. It was invented by Denso Wave in 1994 (Wikimedia, 2014b). It is a two dimensional bar code. It can be read by using smartphone or touch pad or computer camera. QR code is used to store text, URL, and contact information. When the user reads the QR code depending upon the type of information stored, it may display text, opens URL, and saves the contact information to address book. QR codes are now used for wide range of applications such as commercial tracking, product marketing, product labeling, and storing organizational and personal information. QR code can be static or dynamic (Admin, 2014). In static QR code the initially created information cannot be changed, whereas in dynamic QR code the information can be edited after creating the code. With the advent of smart phones QR codes became popular as each smartphone can read the QR code with appropriate QR reader app. An object hyperlinking system involves four components shown in the Figure 1. *QR code tagged Object*: QR code with URL is tagged to the object; *Smartphone*: Smartphone which has means to read the QR code and display the information; *Open Wireless network*: An open wireless network such as 3G or 4G network for communication between the smartphone and server containing the information linked to tagged object; *Server*: A server to store the information related to the real world object.

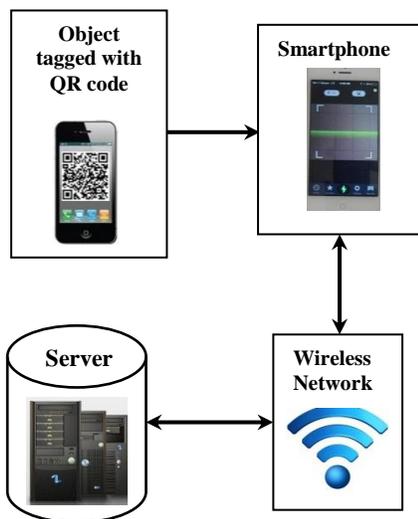


Figure 1: Components of hyperlinking system *Interactive Display System*

The display system can be desktop display unit, large format unit, or smart device display unit. Desktop display unit includes monitor and can be made interactive by using mouse and keyboard. Large format display unit includes non-interactive screen or interactive screen and projector. The non-interactive screen can be made interactive by using mouse and keyboard. An interactive screen includes touch sensitive

interactive whiteboard units. Smart device display unit devices include touchpad or tablet or smartphone screen.

*Information Exchange in BIM+QR framework*

The different components of an integrated BIM+QR Environment include real world object tagged with QR code, BIM knowledge repository, and display unit. An automated flow of information among different components of the BIM+QR environment is shown in Figure 2. Smartphone scans the QR code of the real world object. When the scanning is completed a web page is displayed and prompts the user to click the image. Once the image is clicked, an identification code of the element of the 3D digital model is stored on server and the user is prompted to go to the interactive display unit. Based on the data from the server, the BIM knowledge repository is searched and the results are reflected on the display unit, through 3D model by highlighting the corresponding 3D digital element of the real world object. This element will in turn facilitate to query the required information from the BIM knowledge repository.

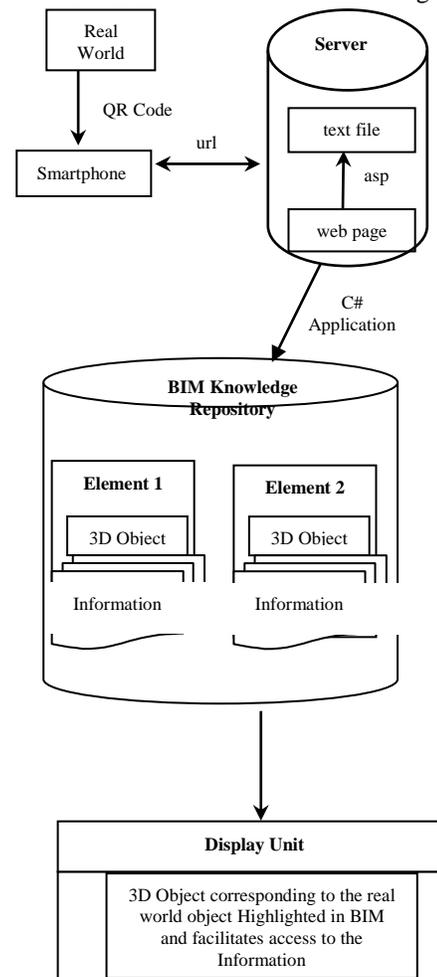


Figure 2: Automated information flow in BIM+QR environment

### 3. PILOT STUDY

A prototype of the above discussed BIM+QR code framework was implemented for construction technology laboratory by using QR codes and Autodesk's Revit software. For this study a large format display system is used as desktop display unit. The study included five steps: (a) BIM knowledge repository development; (b) demo units' hyperlinking; (c) interactive display unit set up; and (d) automation of information flow. Overviews of these steps are discussed below.

#### *BIM Knowledge Repository Development*

BIM knowledge repository of the lab was developed using Autodesk's Revit software. The steps included for the repository development process were 3D model development, creation of new parameters and association of the information to these parameters.

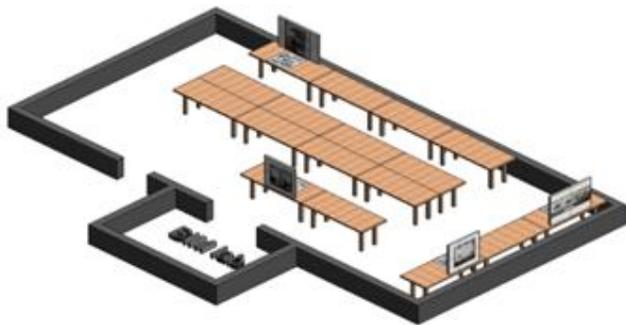


Figure 3: 3D Lab Model

#### *Demo Units' Hyperlinking*

In this step, webpages for each demo unit in the lab were developed and these pages were hosted on a server. Various static QR codes with URL for different demo units in the lab are created. These QR codes are tagged to the physical objects in the lab as shown in Figure 4.



a) Refrigeration and Air conditioning unit



b) Friction Losses unit

Figure 4: Demo Units' tagged with QR code

#### *Interactive Display System*

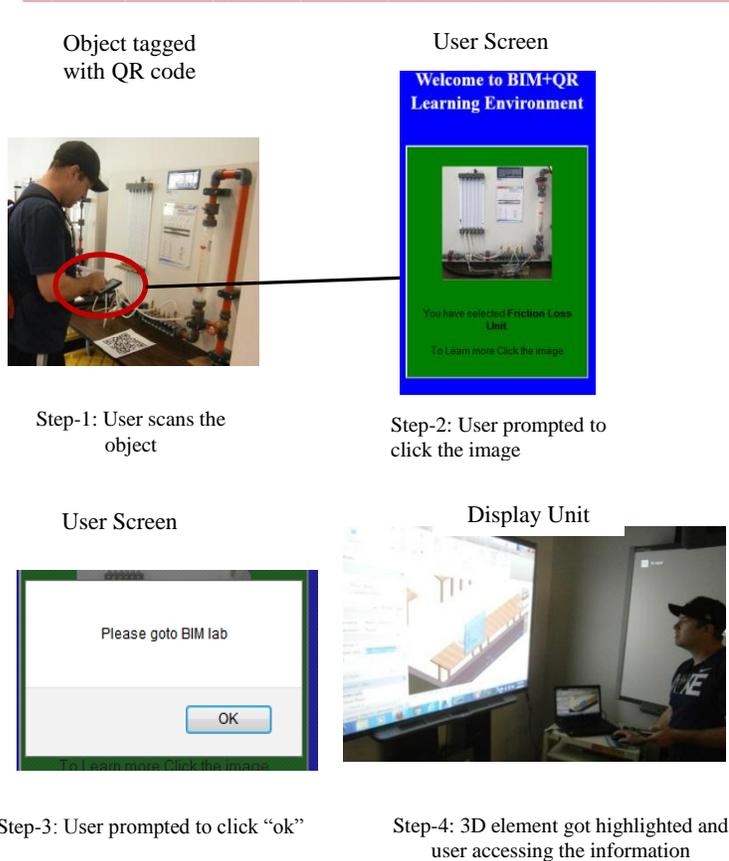
The interactive display system shown in Figure 5 is used for this study. It consists of three SMART Board 600i2 interactive whiteboard units. Each unit is equipped with interactive whiteboard and SMART Unifi 45 wall mounted short throw projector. Each unit interacts with host computer through USB interface [SMART, 2014]. The whiteboard has durable hard coated polyester touch sensitive surface. These three units interact through single host computer connected to the server through the Ethernet port.



Figure 5: SMART Board Interactive Display System

#### *Automation of Information flow*

In this step, the communication among real world object, server and BIM knowledge repository was established. The tagged real world object establishes communication with the server through the smartphone using the wireless network. When the user scans the QR code a webpage prompts the user to click the image on the page. Once the user clicks, an event is triggered to store the identification code of the element on the server. This data storage was triggered by using ASP. The communication between Revit Architecture and server was established by using Revit APIs through C# programming language. Once the communication is established the data from server is retrieved and corresponding 3D element gets selected and highlighted on the one of the interactive smart board display units. This element will in turn facilitate to query the required information from the BIM knowledge repository and the user has option to rearrange the information windows on other two smart board display units. The interactive smart board screen facilitates user friendly access to the required information. Figure 6 shows the steps followed by the user to access the information using the BIM+QR environment.



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Figure 6: User interacting in an integrated BIM+QR environment

#### 4. CONCLUSION

BIM+QR codeframework automates the element identification and selection of real world object in BIM. It provides a seamless flow of information between real world objects and BIM elements. This automation reduces the identification and selection time, and reduces manual errors. This helps the facility manger to increase their efficiency and enhance their contributions towards value added tasks. As the number of smart phone users is on rise, BIM+QR framework has the potential to make a paradigm shift in facility maintenance .

#### 5. REFERENCES

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