State-Of-Practice Of BIM Use For Clash Detection In Pakistan

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Abstract
Building Information Modeling (BIM) has emerged as one of the most beneficial platform in the construction industry. It offers various capabilities throughout the project lifecycle, among which clash detection is one prominent feature. Clash detection through BIM helps to check the model for any interference in various disciplines such as architecture, structure and MEP by integrating these designs into a virtual environment. Studies show that using BIM for clash detection is advantageous and is linked with reduction in time, cost and rework in a project.
This research assessed the current state of practice of BIM use for clash detection in Pakistan's construction industry. Findings have shown that overall BIM penetration in the local industry is very low and the use of BIM for clash detection is even less. Young professionals were found to be users of BIM for clash detection. All users agreed that unavailability of BIM outside of their organization was the major factor preventing the use of BIM for clash detection. Resistant to change, internal procedure of the company, and increased designing time required to model for reliable clash detection are some other reasons which do not allow the implementation of BIM for clash detection in construction projects.

Keywords
Building Information Modeling, Clash Detection, Barriers, Benefits

1. Introduction

In designing of construction components, various disciplines have to work together intensively and are responsible for contributing their part to the overall design process. When each of these individual or partial design is integrated together, the components from different disciplines might end up consuming the same position or space- this is termed as a 'Clash'. If a clash is overlooked or missed in the design, it would eventually be revealed during the construction phase, resulting in corrections that may lead to cost overruns and delays in project deadlines (Berdeja, 2014).

Although clash detection is practiced during preconstruction phase, in Pakistan's construction industry, the

methods used are either not appropriate or efficient enough to minimize the problems. Research reveals that manual method of overlapping drawings to identify clashes is still most commonly used with most of the actual clash detection being left for on-site detection.

With the rapid progress in the field of technological development, Building Information Modeling (BIM) has emerged as one of the most beneficial platform to solve this issue along with many other capabilities that it offers throughout the project lifecycle. However, in Pakistan, its utilization is at infancy stage with only a few organizations using BIM. The BIM users for clash detection in particular, are even rarer. There is a need to probe the issue in detail. This paper is a part of ongoing research on The Effectiveness of using BIM for Clash Detection in Pakistan. The aim of the paper is to assess the state of practice of BIM use for clash detection in Pakistan.

The following section will scrutinize the literature published in this area, followed by a brief research methodology that was adopted to prepare and disseminate survey questionnaire. Succeeding sections will discuss the survey results and analysis. Conclusions are presented in the last section based on the analysis of results.

2. Literature Review

2.1 Clash Detection

A clash occurs when items of the different disciplines intersect or overlap one another or when items utilize the same space or are incompatible with one another (Berdeja, 2014). In the design phase of a project, the structural, electrical and mechanical departments, all design systems independently of each other, based on the Architect's main design. When the designs are integrated or combined, there is always a high probability of conflicts arising. For example, a pipeline coming in the way of a beam or an air conditioning unit blocking an electrical line.

2.2 Traditional Methods of Clash Detection:

Clash detection is the core of interdisciplinary coordination. In the traditional design, clashes were identified with help manual methods involving overlapping of 2D drawings over well-lit tables or through overlapped designs on tracing papers to identify the occurring visual intersections. CAD 2D systems were based on the same principle as the manual method but involved the visual comparison of different colored layers on the computer screen (Czmoch and Pękala, 2014). Advancements in technology resulted in the introduction of 3D CAD, due to which identification of clashes became easier (Van den Helm et al, 2010) and also made the manual method obsolete as overlaying of sheet drawings was time consuming, lacking in visibility and contained missing information (Fatima et al, 2015).

2.3 BIM Use for Clash Detection

BIM serves as a great asset for clash detection in the design phase as it combines all the separate designs and integrates them into a virtual environment. Clash detection through BIM helps to check the model for any interference against various disciplines such as architecture, structure, MEP. Figure 1 below shows how clash detection through BIM assists in the easy identification of clashes like pipelines clashing with beams or ducts and walls (Azhar et al., 2008). Using BIM for automated clash detection helps the designer to generate efficient designs that have a reduced number of conflicts occurring (Guangbin et al., 2011).

A case study done previously on "One Island East Project, Hong Kong" shows that BIM managed almost all coordination issues and its utilization for clash detection resulted in identification and resolution of more than 2000 clashes prior to its construction (Azhar et al., 2008). Through BIM, a considerable amount of

cost was saved as compared to the incomplete design information of traditional 2D process. Another case study on "Aquarium Hilton Garden Inn, Atlanta Georgia" shows that application of BIM helped detect and resolve 590 clashes between the structure and MEP designs. As a result, an estimated cost of about $200,000 was saved along with 1,143 hours of time (Azhar, 2011). Added benefit of BIM is that it helps in the reduction of rework during the construction stage, which can be related to avoiding rework through effective clash detection during pre-construction phase. BIM has facilitated in reducing 40 to 90 % of rework before start of the project (Talebi, 2014).

Despite the advantages BIM brings, there is still some reluctance in the construction market for BIM adoption. Established by a survey done in the United States, lack of skilled personnel, high cost to implementation, interoperability issues and reluctance of stakeholders were termed as key obstructions to implementation of BIM (Azhar et al., 2008). Moreover, it was found that hesitancy to train staff, unwillingness to pay for new software and technology and the cost of implementation of BIM not outweighing its benefits were primary barriers that hinder adoption of BIM in UK (Arayici et al., 2009).

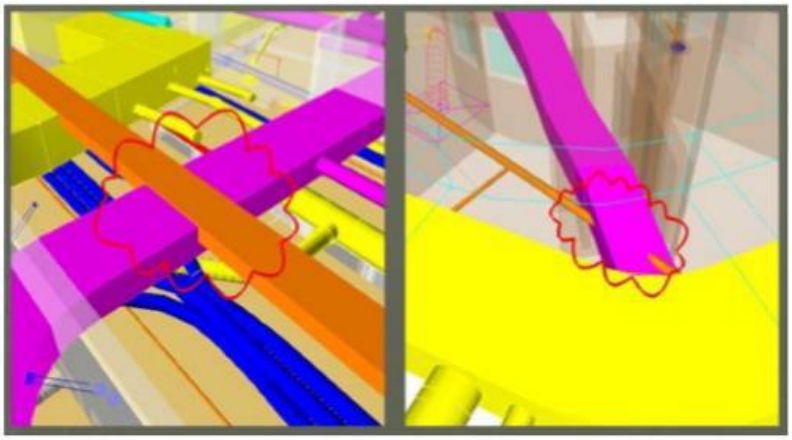

Figure 1: Clashes Detectd by BIM (Azhar et al., 2008).

Methodology

The research began with a detailed literature review to understand BIM and clash or conflict detection, tools that are being used along with the types of clashes and their detection before construction.

Based on the existing literature on the topic, a questionnaire was developed to collect information on the extent of usage of BIM for clash detection. Arayici et al., 2009; Azhar et al., 2008 served as some major resources to shape the survey.

The survey was piloted by two experts from the construction industry and was designed as an e-survey on Qualtrics for the ease of distribution and response collection. The design made it easier to procure the relevant responses by allowing several gates at different sections. Only respondents that fulfilled the requirements (mostly experience related) were allowed to move forward.

After being distributed to more than 120 renowned construction firms of Pakistan, 47 responses were successfully recorded.

The results from the survey are discussed in the paper and are aimed to assess the condition of Pakistan's construction industry regarding BIM use for clash detection.

4. Survey Results and Analysis

The questionnaire was divided into four main sections. The first section was aimed to collect some basic information about the respondents and their organizations. Section B was about general awareness of BIM and also included questions regarding clash detection through BIM. Section C and D were based on the advantages and obstructions to clash detection with BIM respectively.

4.1 Data Set Description

This section discusses the trend in general information collected from the respondents. A total of 47 responses (39.1 % response rate) were received from renowned organizations in the main cities of Pakistan. Majority of responses were received from Karachi (36). Equal amounts of responses (17) were from contracting firms and consulting firms while there were also a few (13) from "other" firms like clients, owners and project managing firms. The majority of the respondents, 35 (74.47%) were young professionals having experience of 1 to a maximum of 5 years.

Next set of questions enquired about the clash detection practices of all users. Results are discussed below.

4.2 Clash Detection Technique Being Utilized

Respondents were requested to select all methods that are used by their firms for clash detection. Results shown in Table 1 depict that the majority (47 %) of the firms are performing clash detection by manually superimposing drawing sheets on top of a well-lit table along with using AutoCAD 3D Software (43%), but only a few organization are utilizing BIM for clash detection (13 %). This establishes that pre-BIM methods are still predominantly in use for construction projects in the local industry.

Clash Detection Techniques	***%***	***Count***
Manually by superimposing drawing sheets on top of a well-lit table	47%	22
AutoCAD 3D software	43%	20
With Building Information Modelling (BIM)	13%	6
Other	13%	6
Total		48

Table 1: Clash Detection Technique Used in Construction Projects

4.3 BIM Knowledge

The respondents were asked about awareness of BIM and use of BIM. Results showed that almost all of the respondents (90 %) had knowledge about BIM, and half of those that had knowledge on BIM, had also used BIM while the other half had no experience on BIM. On further analysis, it was found that the respondents that do not have knowledge on BIM (10%) were people with the most field experience. People with expertise on BIM were asked to what extent they have used BIM and whether or not they have used BIM for clash detection. From the response, it was seen that out of the 21 respondents that had experience on BIM, 17 have used BIM for clash detection, however, there was a variation in use. The frequency of BIM use for clash detection is classified in Figure 2 below. It shows that even those who have indicated that they have experience on BIM for clash detection, they have used it only a few times.

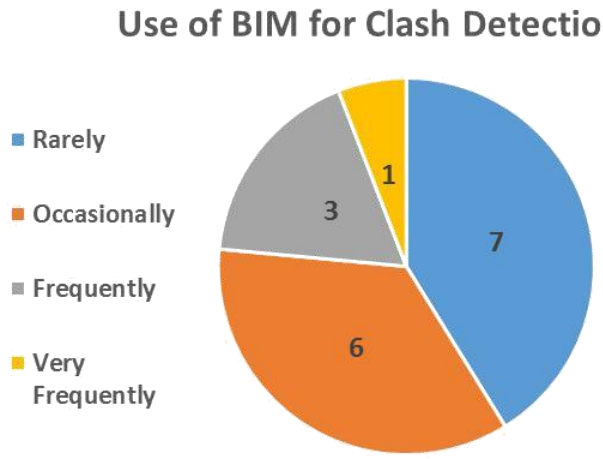

Figure 2: Frequency of use of BIM for Clash Detection.

Before screening the users from non-users *(BIM based clash detection)*, it was enquired what they believed hinders BIM use for clash detection. The BIM users that had not yet used BIM for clash detection all agreed on "Unavailability of skilled personnel" and "Intra-organization unavailability of BIM" as main reasons for not being able to use it for clash detection yet. Majority of non-users also agreed that "Cost of training staff" and "Inter-organization unavailability of BIM" were a hindrance. One respondent commented that "I would say lack awareness of clash detection being performed by BIM and having just started to use BIM, I have not been able to explore its capabilities fully yet". This again reflects that the true potential of BIM is yet to be theorized by the local industry users.

Next three sections are focused on the professionals that were found to be users of BIM specifically for clash detection. A total of 17 (36 %) respondents were found to meet all the criteria and were scanned further. *'Users'* in the coming sections means "users of BIM for clash detection".

4.4 Clash Detection through BIM

Cross-sectional analysis of respondents revealed that respondents that had utilized BIM for clash detection purposes; all had experience of 1-5 years in the field. This shows that BIM users are majorly young professionals rather than seasoned professionals of the field. Additionally, their experience is limited to only 5-10 projects with just two respondents who had used it on 6-10 projects and only one had used BIM for clash detection on 10-15 projects. Autodesk Revit and Autodesk Navisworks Manager were most utilized tools for the purpose for all except for one respondent who chose Solibri Model checker as a response.

4.5 Advantages of Clash Detection through BIM

When asked about reliability of BIM for clash detection, majority of users (12 of 17) agreed that it's reliable and the rest (5 of 17) found it to be moderately reliable. Many (11 of 17) of them also strongly agreed and some (5 of 17) slightly agreed that the cost of implementing BIM is balanced out by the rework saved by automated clash detection. Generally speaking, the combined response showed that almost half the users felt that clash detection through BIM helps reduce rework by 41-80% with an equal number (4 of 17) of users agreeing to the 40-60% and 61-80% respectively. The responses related to rework can be observed by yellow bars in Figure 3 below along with time and cost benefits indicated by blue and green colors respectively.

When asked about amount of time saved by clash detection through BIM, users showed a scattered response but the majority favored the idea of BIM saving more than almost half the time. However, when the same question was asked regarding reduction of total project cost, the response was titled towards the left of axis with many respondents believing that clash detection ranges between the 1- 60 % max in cost. It is significant cost saving, however these claims need to be verified by further in-depth analysis of projects.

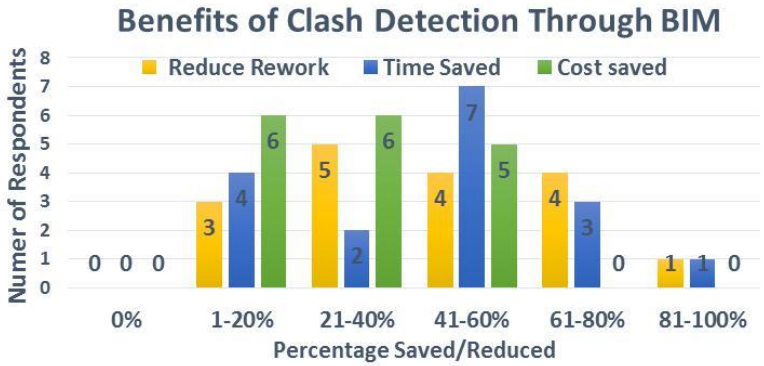

Figure 3: Benefits of Clash Detection through BIM.

4.6 Obstructions to Clash Detection through BIM

Lastly, the users were questioned about the obstructions they faced when using BIM for clash detection. All of the users (17) agreed that the "Unavailability of BIM outside of their organization" was a major hindrance when using BIM for clash detection. Since clash detection is multi-disciplinary affair, it causes a major setback to the exercise if not all trade consultants are on board.

Second main reason highlighted by experts was the "Unavailability of the skilled personnel". Moreover many also believed that "Unavailability of BIM within the organization" and "Cost of training staff" obstructs clash detection through BIM. The overall results can be seen in Table 2.

Obstructions to BIM Use for clash detection	***Yes (Count)***	***No (Count)***	***Not Sure (Count)***
Lack of software compatibility	53% (9)	41% (7)	6% (1)
Setup cost (i.e. software and hardware cost)	59% (10)	41% (7)	0 % (0)
Availability of skilled personnel	94% (16)	0 % (0)	6% (1)
Cost of training staff	71% (12)	24% (4)	6% (1)
Unavailability of BIM within the organization (e.g. MEP to Structure department)	82% (14)	18% (3)	0 % (0)
Unavailability of BIM outside of your organization (e.g. MEP contractor to sub-contractor)	100 % (17)	0 % (0)	0 % (0)

Table 2: Shows the obstructions of Clash detection through BIM.

The respondents were also asked to specify any other obstructions that they think hinders the use of BIM for the purpose. The responses reveal the following. One respondent said "There is a mind barrier which does not allow the implementation of BIM in construction Projects." It shows that the human nature that resists the change overpowers the potentials of the BIM process.

One respondent indicated the organizational barriers to change being a bottleneck. “Internal procedure of the company for each department often prevents BIM process to work the way it should”. Thus in order to see BIM in future, industry wide awareness and orientation is required.

Another important barrier indicated by the respondents is “The amount of time required to model to such level after which reliable clash detection can be performed”. It highlights the technical issues related to BIM use. It is true that the amount of efforts required to model clashes through BIM during the design phase are greater than the non-BIM methods. Also, it requires more coordination and communication among the designers. All this adds up in a detailed design phase. Due to disintegration among the construction phases and professionals it is hard to realize the benefits (such as less rework) of construction phase by the designers who have little to no direct responsibility of construction. Thus it indicates a change required in the overall delivery method of the construction projects. Recently more collaborative delivery methods such as integrated project delivery (IPD) have been introduced in U.S. and some other developed countries (Azhar et al. 2014) and it is found to be more productive in aligning the interests of all project stakeholders by sharing risks and rewards of the project.

5. Conclusions and Way-Forward

The following three major conclusions can be made from the survey findings and analysis;

Although majority of respondents are aware of BIM, not many have actually put it into practice. The local industry is predominantly using the pre-BIM methods for many processes that BIM had researched to show improved processes and efficiencies. This shows that the local industry is not tech savvy and resistant to change. Coupling this with the fact that most of the users are found to be young professionals with 5 years or less experience in the field, it highlight the need of exercises to increase awareness of BIM and it potential advantages and challenges to the potential users.

Users were found to be claiming significant rework reduction and time and cost savings in the projects. Since these claims are based on little experience, (previously mentioned) the claims need to be validated and shared with the local industry. Research needs to be done that can authentically relate these claimed benefits of clash detection through BIM with the use of actual improvements and savings. Action based research is suggested as a way forward where the researchers can be involved in the project and administer and document the BIM process and benefits.

While talking about the obstructions to BIM use for clash detection in the local industry, it was found that the hindrances were human, organizational a technical related. This signifies that BIM cannot be taken as an off the shelf solution. It requires research and application of human and organizational theories such as 'technology acceptance model' (TAM) and organization readiness assessment for BIM processes. This opens several research opportunities itself in these lines where academicians and industry participants can actively collaborate.

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