Develop a Revit-Enabled Integrated tool for the Inspection and Condition Assessment of Building Components

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LIST OF ABBREVIATIONS :

AHU	-	Air Handling Unit
FAHU	-	Fresh Air Handling Unit
AR	-	Augmented Reality
BIM	-	Building Information Modelling
VU	-	Ventilation Unit
OU	-	Outdoor Unit
SAD	-	Supply Air Diffuser
RAD		Retur n Air Diffuser

ABSTRACT

The coordination of mechanical, electrical, and plumbing (MEP) systems is a major challenge for complex buildings and industrial plants. The process involves locating equipment and routing connecting elements for each building system. This multidiscipline effort is time-consuming and expensive and requires knowledge regarding each system over the project life cycle. Current practice requires representatives from each MEP trade to work together to identify and resolve interferences. Effective MEP coordination requires recalling and integrating knowledge regarding design, construction, operations, and maintenance of each MEP system. Currently, designers and *constructors use tailored CAD systems to design and fabricate MEP systems, but no knowledge-based computer technology exists to assist in the multidiscipline MEP coordination effort. This paper describes results from a research project to capture knowledge related to design criteria, construction, operations, and maintenance of MEP systems and apply this knowledge in a computer tool that can assist designers and builders in resolving coordination problems for multiple MEP systems.*

Keywords*:Revit,MEP,CAD,HVAC*

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1. INTRODUCTION

Mechanical/Electrical/Plumbing (MEP) is the core segment of the architectural engineering industry, similar to the blood, nerves, and digestive system of the human body. These core tasks play the most critical role in the entire architecture/ construction business, by providing a comfortable, safe living environment. MEP systems comprise multiple working categories and activities that sustain numerous complex arrangements of pipes throughout the entire industrial unit. Problems are frequently encountered when interfaces are improperly integrated, resulting in delays in the project and reduced product quality.

The major MEP installation interface integration (MEP III) projects require the identification of separate arrangements for HVAC (Heating, Ventilation and Air Conditioning), power supply, plumbing, fire protection, telecommunications, and other related systems. Hence, the purpose of integrating the interface is to recognize problems, resolve conflicts, and perfect the layout of the system for these mechanisms to serve their functions fully. We conducted interviews with experts, field investigations, and a review of research papers. This study combined construction management elements, gathered pertinent knowledge, and analyzed information to attain: interface integration principles, solutions to interface conflicts, and a logical work sequence. Moreover, the complete integration of the interface reduces the numbers of changes in the design, decreases the work requiring demolition, addresses problems resulting from installation error, and increases the overall problems.

HVAC systems possibly will harm the atmosphere by superfluous use of energy which results in diminution of non-renewable energy resources, mainly fossil fuels, moreover by the production of electricity or thermal energy, together of which add to environmental pollution. Environmental destruction by HVAC systems may also be rooted by outer shell or noise, and by the emancipation of unhygienic water and air be filled with lubricating oils, chemicals, refrigerants, particulate or gaseous matter, heat transfer fluids, or microbiological organisms. In the majority state of affairs, HVAC systems will radically impact how "green" a building is. Consequently, the project team is supposed to not ignore the potential and influence when escalating the design . HVAC engineers are capable of taking part in a decisive role in environmental design by being the technical or analytical resource for the team, and by heartening the expansion of more meticulous assessment tools that are fitting, practical and friendly, and justifiable. To make dissimilarity for the green design goal, they should thrust architects to design enhanced envelopes, support HVAC decisions based on life-cycle costing, interleave their authority previous in the process and prop up the appropriate commissioning of buildings. They ought to try and to edify building owners and developers the value of a green and sustainable design so that the green process can be carried out effectively.

2. LITERATURE REVIEW

Decisions made and approaches taken in Mechanical, Electrical and Plumbing (MEP) design coordination largely depend on knowledge and expertise of professionals from multiple disciplines [1]. Furthermore, the use of Building Information Modelling (BIM) in MEP design coordination has greatly increased the amount and quality of available data. However, what information should be pulled from the model and what approaches should be taken to perform various coordination tasks still largely relies on expert knowledge [2]. This study compares the behaviors of experienced BIM coordinators with at least three years of experience on model-based design coordination with novices who are tech-savvy but have limited project experience when performing certain coordination tasks [3]. A scenario-based experiment which includes a series of clashes in MEP models was designed to examine the information used, actions taken and questions asked during the coordination activities by experts and novices, so as to compare the differences of these two groups [4]. Results provide insights on what experts' knowledge needs to be captured during MEP design coordination, and furthermore, how to improve novices' performance by reusing captured knowledge from experts [5].

Anumba et al. and Bouchlaghem et al. created a visualization and communication environment to assist design teams in the communication of design details. Hartmann and Fischer analyzed how 3D and 4D models support communications and scheduling.

Mckinney and Fischer Fischer *et al*., and Anson *et al*. discussed the application of 4D models in practical casesdescribed the set of initial requirements for interactive workspaces to support the development and coordination of 3D design.

Akinci *et al*. formalized time-space conflict analysis as a classification task. Fischer *et al*. developed virtual design and construction (VDC) technologies for coordinating MEP systems in a large healthcare project; however, this article failed to detail their working sequence arrangements or planning methodologies.

Fard *et al*. Khanzode and Staub-French provided guidelines to help project teams implement 3D and 4D modeling in building construction projects. As previously mentioned, although 3D and 4D software can facilitate the integration of interfaces and escalate the construction process, this software cannot resolve all of the problems in a multi-disciplinary and multi-organizational environment. The products of architecture are unique and non-repetitive, and MEP projects are varied and complicated. This makes it is impossible to clearly distinguish the boundaries between structures, between the structure and the MEP job, and between MEP systems

3. DRAFTING AND DESIGNING HVAC SYSTEM

Observe load evasion strategies such as condensed lighting power, high-performance glass and skylights, cool roofs, and enhanced roof insulation techniques in the by and large building design. Size units appropriately using acceptable methods that account for the load evading strategies implemented in the design and use rational assumptions for plug load power and freshening air quantities when sizing equipment.

Select the unit size and airflow based on deliberate levelheaded loads devoid of over sizing. Regard as escalating unit flow rate to advance reasonable capacity in dry climates. Stipulate units that meet Tier 2 efficiency standards reputable by the conglomeration for Energy Efficiency; incorporate first-rate effectiveness fan motors, thermostatic expansion valves, and factory-installed and run tested economizers with disparity rather than single-point switch control.

3.1 Under Floor Air-Supply Systems

This is a theme that has established a bunch of coverage recently. Figure.4 illustrates an uncomplicated schematic of an under floor air-supply system. Similar to most systems, there are both extremely fitting and less than idyllic applications. Some pace-setting and sustainable designers locate it appealing since all of the exterior air is delivered to the building volume in secure propinquity to the occupants. Perhaps the most undeniable applications are huge, high spaces like gathering centers and airport terminals where the main drafty air flows will be of negligible apprehension to what is a persistently fleeting occupancy. This notion of delivering cooling and ventilation air downward low is suitably known as displacement ventilation.

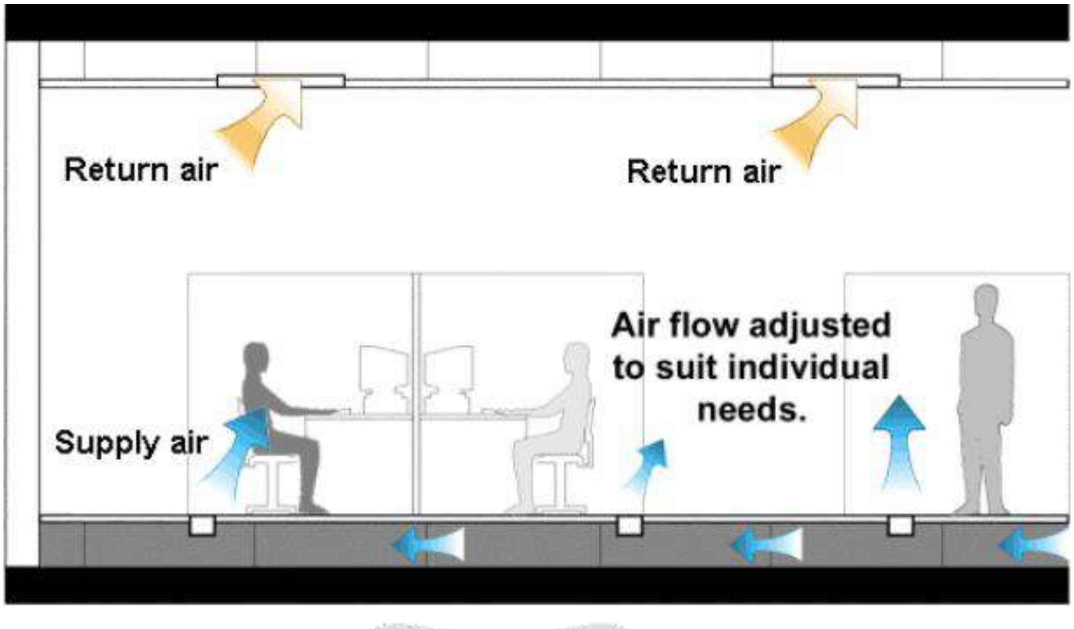

Figure 3.1: Under floor air supply system (Credit: Center for the Built Environment, University of California, Berkeley)

3.2 DRAFTING THE HVAC SYSTEM

Project design team is divided into 2D CAD team and BIM team, and they collaboration with each other throughout the whole implementation process. BIM team mainly uses Autodesk Revit software to create Architecture and Structure models and Magi CAD to create MEP models. 2D CAD team use the traditional way to design and later BIM team create 3D BIM model based on its design drawings. At the design development phase, the architect generated two-dimensional CAD drawings. The construction manager, Berry, developed base Building Information Model from 2D drawings. Every three to four weeks, modeling of two floors were completed. Then, the two teams cooperation to do clash detection and optimization about MEP design and layout.

The Figure 3.2 . Show Drafting Model of the HVAC System (to using AutoCAD & AutoCAD(MEP) Softwares)

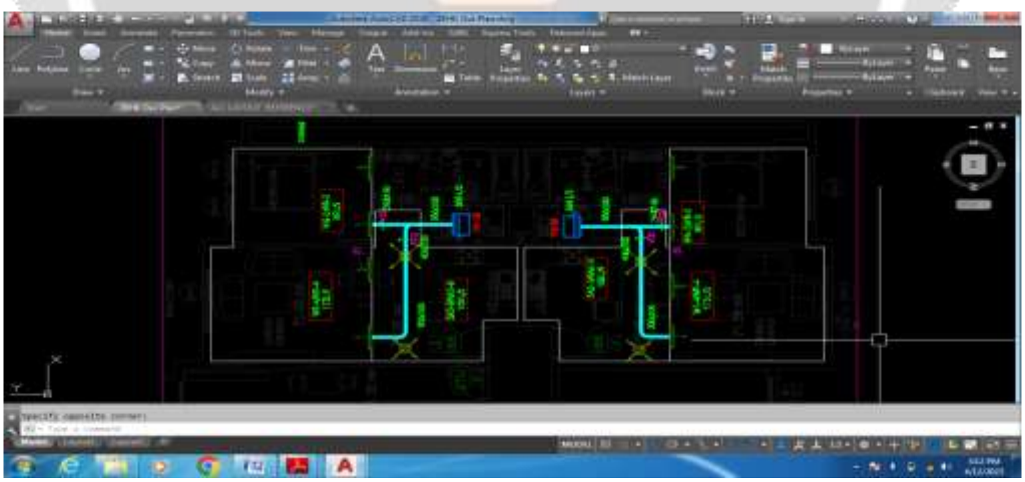

Figure 3.2. Drafting Model of the HVAC System .

3.3 DESIGNING THE HVAC SYSTEM

First, a new Revit file was created and saved. Then, the perimeter walls were created. Once the perimeter walls were completed, the interior walls are created. Then, the foundation walls, flooring, doors windows, roof, stairs, deck were created. Furthermore, the rooms were tagged. No mechanical, electrical, plumbing elements were created for this study. The differences of 3D modeling and 2D drafting were reviewed. Furthermore, the granularity of objects including the decomposition of the elements was explored. Converting the files from 2D to 3D models using software like AutoCAD, Revit and Navisworks. Etc. We additionally create Revit 3D models with required level of detail (LOD 100-LOD 500) for documentation, accuracy in construction, scheduling, quantity estimates, facility management.

- ❖ Conversion of 2D drawings to 3D Models for architecture, structure and MEP systems
- ❖ Collaborate the 3D models to identify the clash detections
- ❖ Detailing of shop drawings
- ❖ Customized family creation for architectural, Structural and MEP products
- ❖ Detailed 3D modelling to achieve 4D BIM

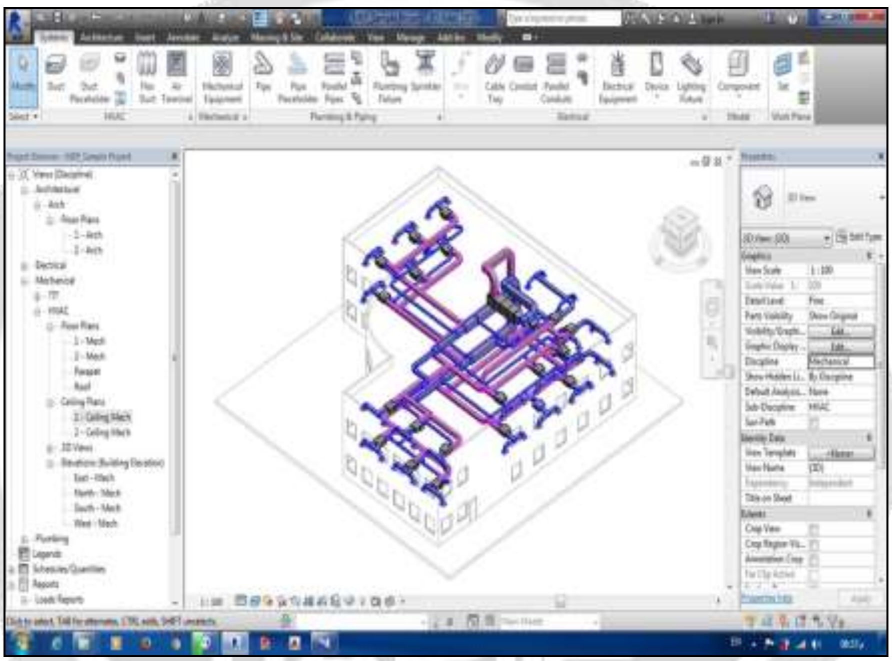

Figure 3.3. Drafting Model of the HVAC System .

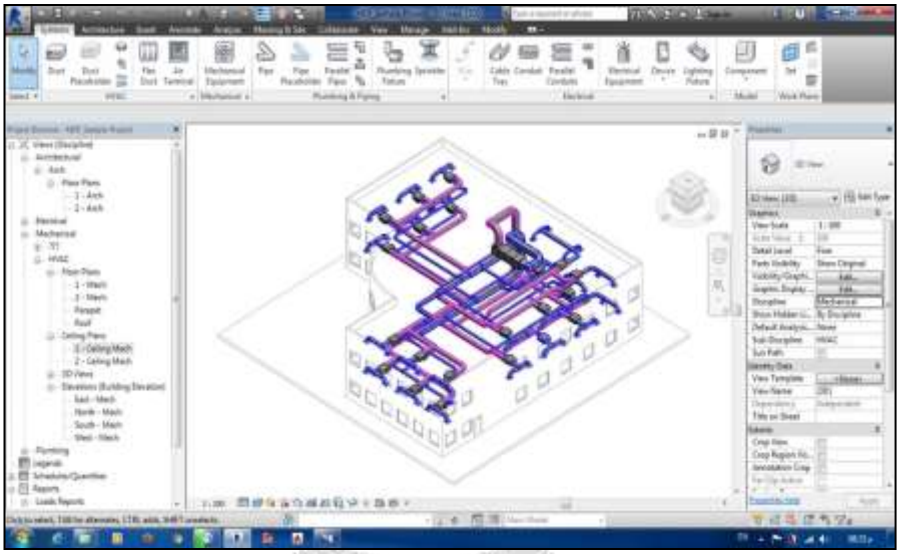

Figure 3.4 CAD Drawing

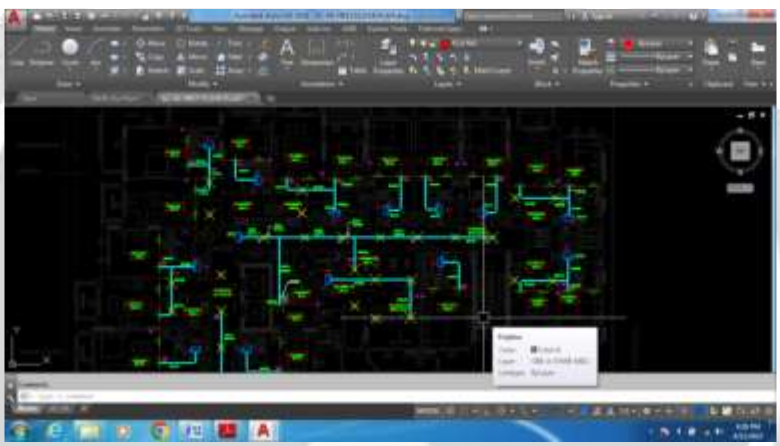

Figure 3.5 Revit 3D View

4. METHODOLOGY

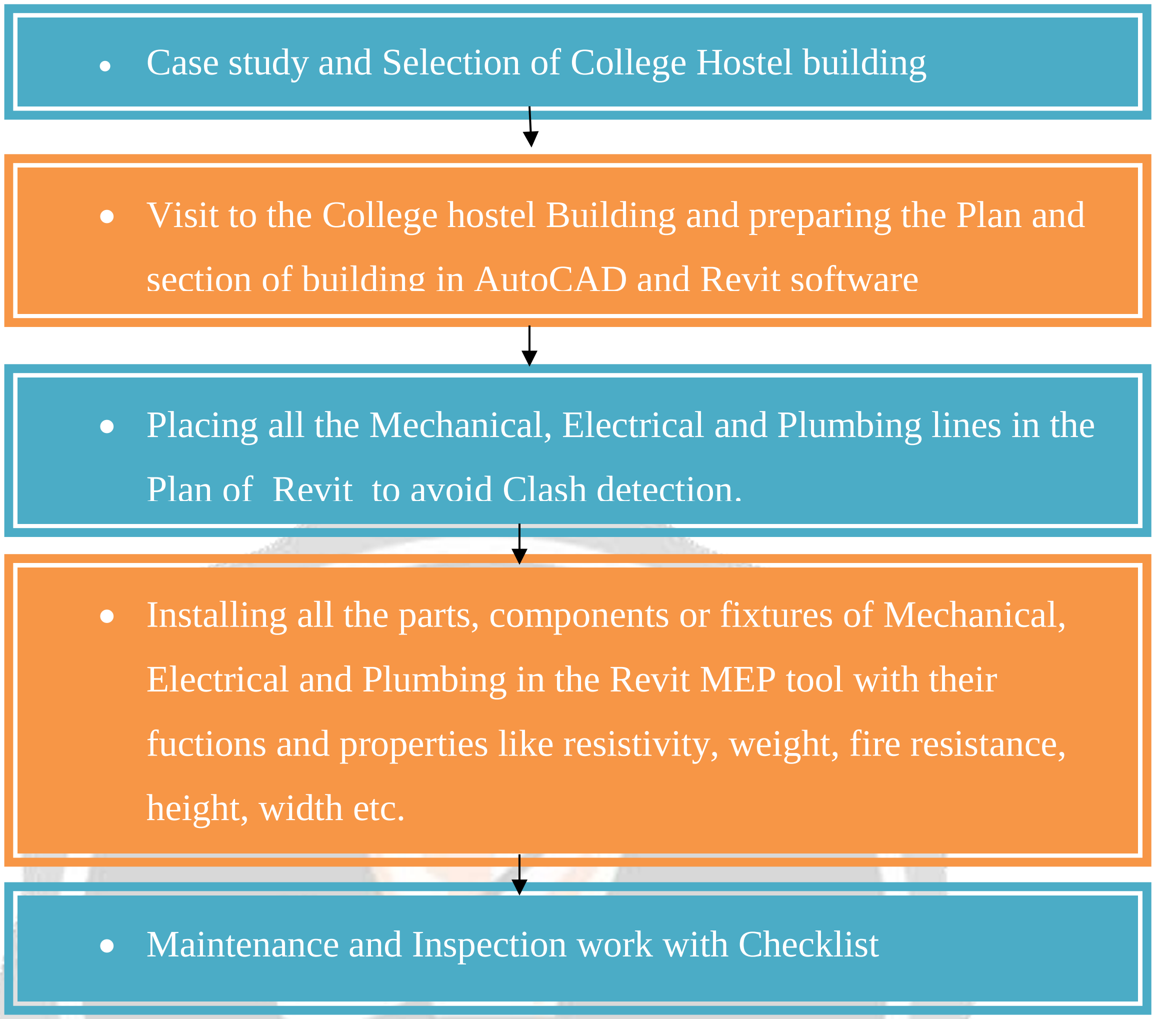

Figure .4.1 . Flowchart of Methodology

4.2 CLASH DETECTION

A series of federated models are created in a Level 2 BIM process, and coordinated data are used to generate the master model. BIM modelers check for incompatibilities in their models and when models are collaborated utilizing BIM integration tools and software.

A 'clash' is the result of two elements in your design taking up the same space. In Building Information Modeling (BIM), clash detection is the technique of identifying if, where, or how two parts of the building (e.g., plumbing, walls, etc.) interfere with one another.

This study is focuses at research for the easy and cost effective maintenance and inspection of the hostel building in order to avoid serious defects and problems occurring in the future and avoid deterioration of components or parts of the building of MEP system. Also, it aims at spreading the use of technology like Revit software to make it easy for the maintenance team and provide immediate position and the requirement of material in the process of maintenance. It also provides fast detection of leakages at precise point in the building which helps in easy locating of the defect and can consume less time and energy. It also avoids clash detection of MEP system

(Fig.no.4.5) which helps the management team for maintenance work, about the advantages and also the long term cost savings through the use of technology and software.

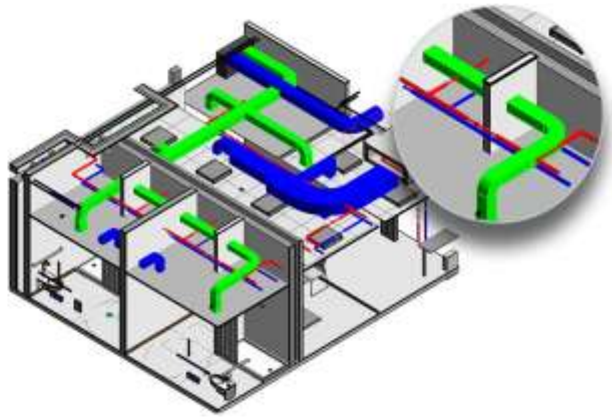

Figure .4.2 . Clash Detection

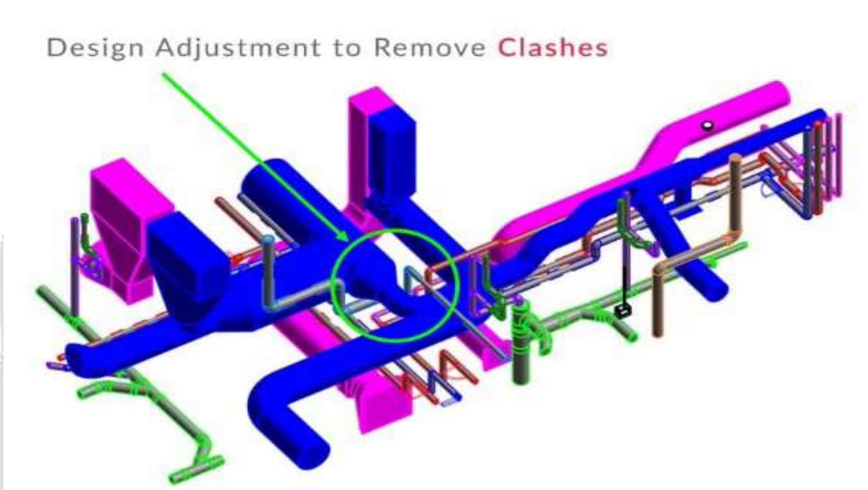

Figure . 4.3 Remove Clash Detection using Revit Software

5. CONCLUSION

This paper aimed to develop a Revit-enabled integrated tool for the inspection and condition assessment of building components that can overcome the drawbacks of the manual traditional practices of such processes.

The MEP tools used the common Revit architecture as a platform to manage the inspection process for different building components. The tool adds-in menu contain all corresponding options that enables the inspector to enter data and make the proper judgment. It also helps in locating the defect easily due to 3D modelling of the plan and prepare a report in the boxes given in the MEP tool, as when it was defected, what was defected and material required.

- The presence of preliminary estimated cost for the defect repair makes it easier to assign more definite budgets.
- The tool reports help for proper repair decisionmaking and improve the process with ease.
- Improved site planning and coordination with ongoing operations.

- This method can improve communication among project stakeholders and help to avoid planning failures.
- This construction project 4D visualization model requires the integration of a 3D geometrical model with associated schedule of activities.

REFERENCES

1. Lance Kirby, Eddy Krygiel and Marcus Kim (2017): "Mastering Autodesk Revit ", *John wiley and sons.*.
2. . A.H. Oti, J.H.M Tah, and F.H Abanda (2018): "Integration of lessons learned knowledge in BIM", *Journal of Construction Engineering and management, ASCE, Volume 144, Issue 9*
3. . Fernanda Leite, Burcu Akinci and James Garett, Jr.: Identification of data items needed for the automatic clash detection in MEP design coordination, *Building a Sustainable future, ASCE*
4. Current schedule of Rates by Municipal corporation and Public Work Department 2017-2018
5. Infiniteskills learning Autodesk Revit Architecture 2015(Mumbai).
6.. Alinaitwe, H.; Nyamutale, W.; Tindiwensi, D. Design Phase Constructability Improvement Strategies for Highway Projects in Uganda. Journal of Construction in Developing Countries, Penerbit University Sains Malaysia, v. 19, iss. 1, p.127-140, 2015. <http://goo.gl/LjnoNN>.
7. LEITE, F. et al. Analysis of modelling effort and impact of different levels of detail in building information models. Automation in Construction, v. 20, issue. 5, p.601-609, Aug. 2011. Elsevier BV. DOI: 10.1016/j.autcon.2010.11.027.
8. Sacks, R.; Barak, R. In: Joint International Conference On Computing And Decision Making In Civil And Building Engineering, 2006, Montréal - CA. Proceedings of the Joint CIB W78, W102, ICCCBE, ICCC, and DMUCE International Conference on Computing and Decision Making in Civil and Building Engineering. p. 1186 - 1195.