Analysis of Designs - A comparative Study of BIM and AutoCAD

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Abstract. Building information modeling (BIM) is software for the efficient designing of the structures, which provides the advanced level designing of the structures along with the quantity takeoff required for the construction of the respective structure. On the other hand, AutoCAD is the traditional drafting software which is not enough efficient as compared to the building information modeling software. This research also focuses on the visual as well as featural differences of the building information modeling software (BIM) and AutoCAD, by the qualitative design analysis of the same structure from both AutoCAD and BIM, and also by quantitative analysis technique for this research which incorporates the questionnaire online survey, to collect the responses from various experts such as civil engineers of different years of experience and BIM experts of the different levels and years of experience. According to the design analysis result, by using BIM and AutoCAD Models and drawings, to visualize the difference between the features and level of advancement and efficient modeling. The BIM allows us to design structures that are more attractive as well as well-structured along with the quantity takeoff for the specific drawing. While AutoCAD is just the drawing software, it does not support the quantity takeoffs and finished look better than that of BIM, according to the quantitative results, it can be concluded that implementing BIM could reduce human error and also provides user-friendly ease to work, and also to perform necessary variations without reworking on the model from the beginning.

Keywords: AutoCAD, BIM, Modelling.

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1. Introduction to BIM

BIM (Building Information Modeling) has the potential to be a game-changer in the architectural, and civil engineering business. Building Information Modeling technology generates a precise virtual picture of a digitally constructed building. The computer-generated model, once completed, will include flawless drawing components and also the important details for the structure to construct, commercially or for residential purposes. Building information modeling software also provides the support to model the lifecycle of the building, which provides a framework for the entire project for execution, designing modeling, and drawing of the entire structure. The building information model (BIM) also provides the advanced level designing of the structures along with their quantity takeoff and the project schedules to work effectively during the execution stage. BIM technology can help with a range of business activities. Although BIM adoption is still in its early stages in the AEC/FM (Facilities Management) business, while the software named "AutoCAD "is being used widely to produce the

drawings unable to create an efficient and smart model of the building (AutoCAD, 2020), AutoCAD is works based on the basic level of drawings techniques, though the advances are being incorporated in the software but still not efficient enough as compared to the building information modeling software (Eastman, Teicholz, Sacks, & Liston, 2008).

1.1. BIM Strategy

BIM is the advanced level software for building modeling, which incorporates the modified, realistic, and rendered visualization along with the efficient and advanced structural modeling of the developed drawings (Dunston & Wang, 2005). The advancement in building information modeling is also being approached by the various modeling developer companies to improve the level of a building and structural simulations (Eastman C, Teicholz P, Sacks R, & K, 2011). Following are the strategies to make the 3d models of buildings, being adopted widely throughout the world:

By using the building information modeling software, such as the “Revit” supported by Autodesk, to create the user-friendly building modeling, in the sense of changing the design parameters, structural components, to identify the flaws and mistakes in the designs, and the ease to make the changes and variation if required, without changing the entire design (Building SMART, 2010).

The three-dimensional building construction models can also be developed by using AutoCAD software supported by Autodesk. The AutoCAD 3d models or the drawings are usually considered a lower-level design for the drawings, which is called the level”0”, in the BIM technology. as the AutoCAD lags in providing Real-time environments to the drawings, and also the visualization difference of the drawings being produced by the AutoCAD, as compared to the building information modeling software (Li, et al., 2014).

1.2. Building Information Modelling levels

Building an information model provides the access to visualize a three-dimension model of the drawings that serve as the project's sole source of data. According to Mark Bew and Mervyn Richards' model (Mark & Mervyn, 2013), four levels of the drawings can be distinguished, either prepared by the AutoCAD or by Building Information modeling software. Any sort of paper documentation, whether created by hand or using computer-aided design (CAD) software, falls under Level 0. Level 1 refers to digital files that contain 2D and 3D content that is not backed up by a comprehensive database. Building information modeling might be considered to begin at Level 2. It appears to be comparable to Level 1 from before. The library management and file-based communication tools employed in the project are the most significant differences. As a result, the essence of BIM is a project-wide shared database, linked to the object's 3D model, from which we may create comprehensive project documentation. Currently, the majority of engineers work at Level 1 or 2 positions. BIM proponents have set a goal of preparing all projects in BIM at Level 3 (intelligent BIM, or BIM), which allows for construction management throughout the design life cycle. They also expect ISO standards to be introduced, as well as the widespread adoption of BIM formats like IDM, IFC, and IFD (Hietanen, 2008).

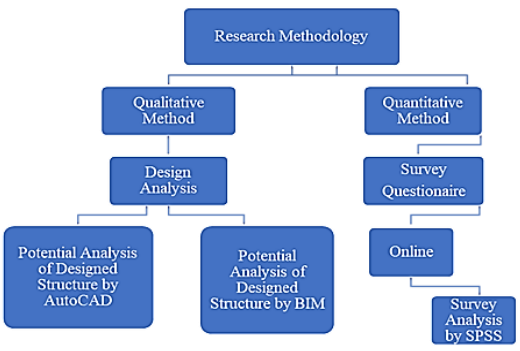
1.2.1. Collision detection

Collision detection is the essence of interdisciplinary cooperation in the old design when collisions were found visually by tracing all crossings with overlapped drawings on tracing papers. A similar approach is used in CAD 2D systems, where layers

of different colors are visually contrasted on a computer screen. The next stage was to use a CAD 3D model to help detect collisions. There is, however, a significant distinction between CAD 3D and BIM 3D. Collision detection in BIM is based on technologies created for the gaming and computer graphics industries. Collision detection techniques in BIM should be precise rather than quick. As a result, BIM systems employ computer graphics techniques as well as sound engineering practices and standards. BIM distinguishes three types of collisions:

- Severe Collisions occur when two objects clash in the same space.
- Physical collisions: verifying the assembly sequence and delivery schedule; verifying the number of workers and time required to complete the construction phase.
- Technological collisions: verifying the assembly sequence and delivery schedule; verifying the number of workers and time required to complete the construction phase. The ability to detect collisions is a significant advantage of building information modeling in general. During both the design and construction phases, it offers significant cost reductions (Ireneusz Czmoch & Pekala, 2014).

2. Methodology Flowchart



3. Results and Comparative Analysis of BIM and AutoCAD drawings and models

3.1. Qualitative Method Results

3.1.1. Analysis of Design

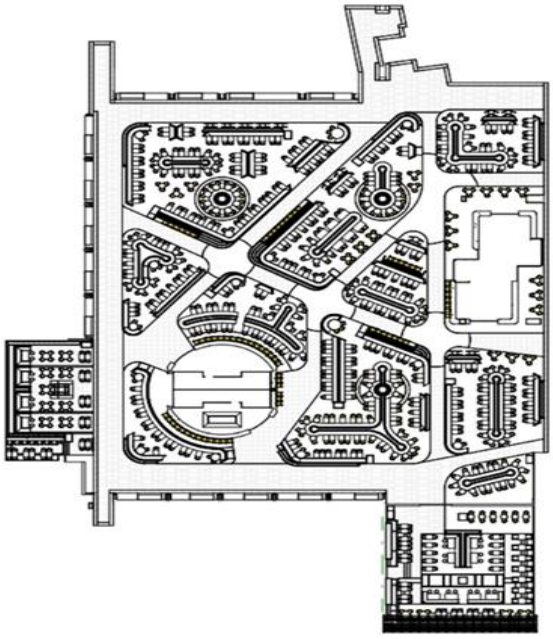


Fig. 1. Food Court Plan in Mall of Oman (AutoCAD)

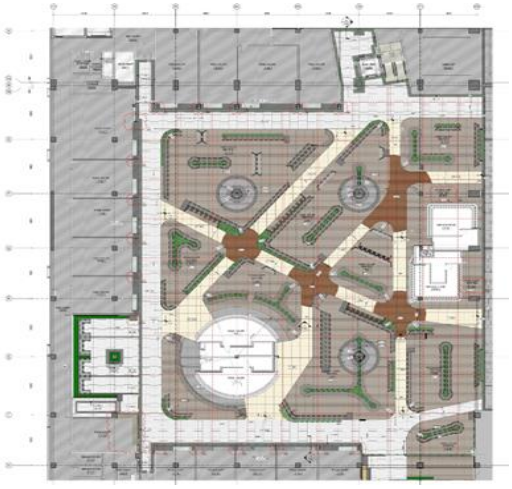


Fig. 2a. Food Court Finish Plan in Mall of Oman (BIM)

Fig. 1 and Fig. 2, show the visual difference in the same plan designed on AutoCAD and modified on BIM. The difference between the software, BIM, and AutoCAD is can be visualized from the output drawings. The BIM allows us to design structures

that are more attractive as well as well-structured along with the quantity takeoff for the specific drawing. While AutoCAD is just the drawing software, it does not support the quantity takeoffs, and the finished look better than that of BIM.

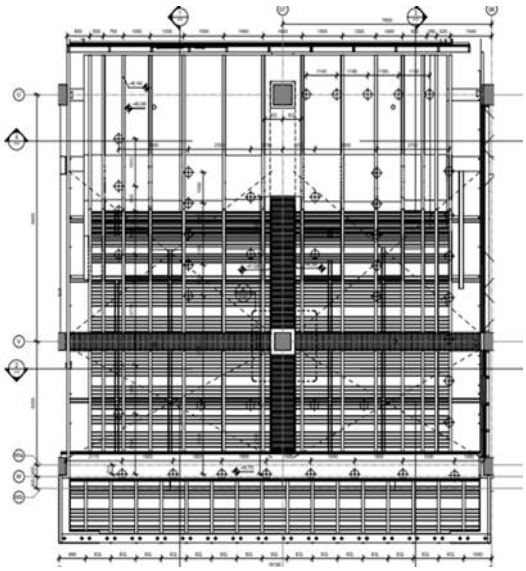


Fig. 2b. Food Court Finish Plan in Mall of Oman (BIM)

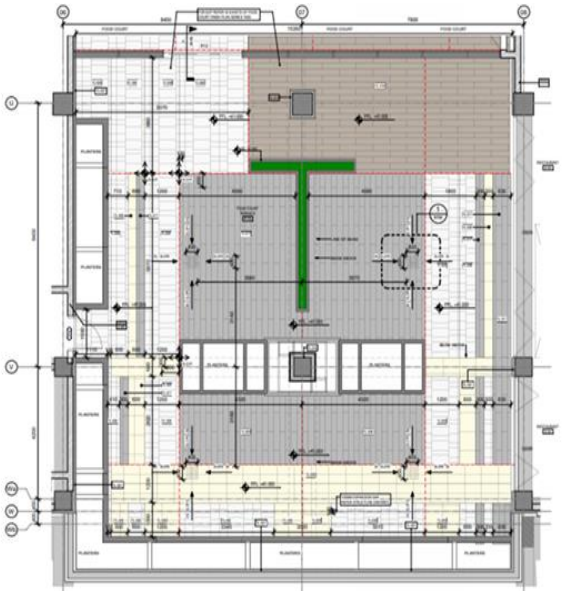


Fig. 2c. Food Court Terrace Ceiling Plan Mall of Oman (BIM)

Figs. 3-5 shows the basic architectural plan for the sitting area made by AutoCAD and the modified plan by using BIM with sitting arrangement to provide a real look by using the filled rendered objects for the previously created features, respectively.

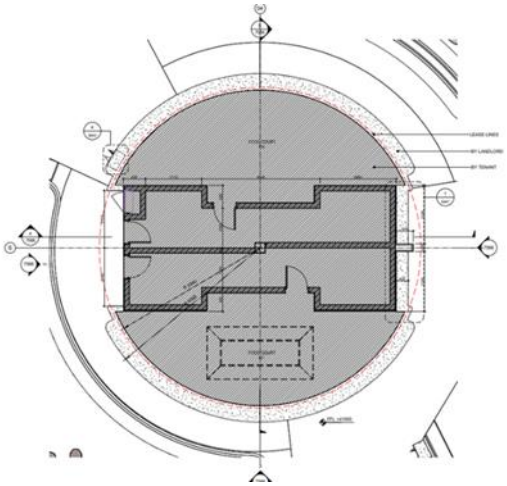


Fig. 3. Food Court Column Architectural Plan Mall of Oman (BIM)

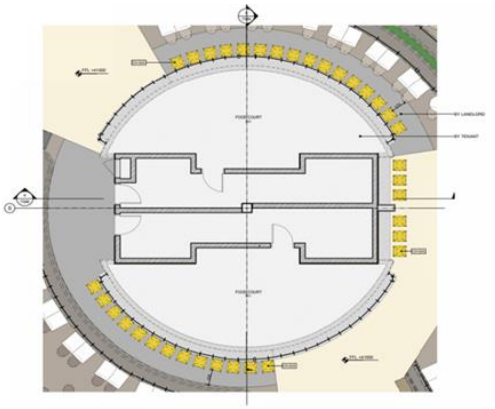


Fig. 4. Food Court Modified Plan in Sitting Area in Mall of Oman (BIM)

Fig. 5. Food Court 3D plan, Mall of Oman (AutoCAD)

Figs. 6-8 shows the 3D model of the interior design of the food court located in the Mall of Oman developed by using AutoCAD and BIM respectively. While, Fig. 7, and Fig. 8 show the columns and special features in the food court by using AutoCAD and BIM, respectively.

Fig. 6. Food Court 3D plan, Mall of Oman (BIM)

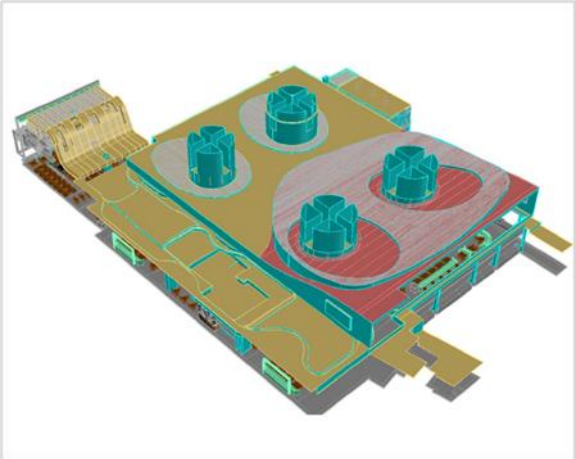


Fig. 7. Food Court 3D plan with Column and Special Features, Mall of Oman (AutoCAD)

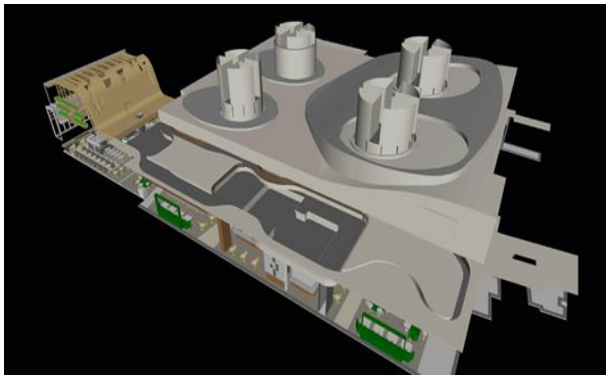


Fig. 8. Food Court 3D plan with Column and Special Features, Mall of Oman (BIM)

3.2. Quantitative Method Results

3.2.1. Correlation Analysis

According to the results, it is observed that "years of experience of BIM technology" has a strong relationship with the specialization. While the covariances observed for the "years of experience of BIM technology", "size of a company based on human resource", "specialization" is 0.24, 0.257, 0.69 respectively, For the (Implementing of BIM could reduce the human error due to incomplete, incorrect, and rework during design) with the demographic variables, it is observed that it has a strong relationship with the specialization and weak correlation with the size of the company based on human resource. And the covariance is observed to be about 1.667. (Adopting BIM can earlier detect the design errors and clashes among a variety of structural, mechanical, electrical and plumbing systems) with the demographic variables, it is observed that it has a positive correlation with years of experience of BIM technology variable while negative with other two variables. And the covariance is observed to be about 2.138. According to the results of the correlations for the (Drawing errors could be greatly adjusted through BIM implementation) with the demographic variables, it is observed that it has a negative correlation with all the demographic variables. And the covariance is observed to be about 1.720, while for the (BIM could enhance communication between design team) with the demographic variables, it is observed that it has a significant correlation with all the specialization variables. And the covariance is observed to be about 1.826. According to the results of the correlations for the (The financial aspect of BIM setup prevents its implementation i.e., software, training, and hardware) with the demographic variables, it is observed that it has a positive correlation with the size of a company based on human resource variable while negative with other two variables. And the covariance is observed to be about 2.202, while for the (High cost of recruiting BIM specialists) with the demographic variables, it is observed that it has a negative correlation with all the demographic variables. And the covariance is observed to be about 1.426.

According to the results of the correlations for the (lack of awareness of the capabilities of BIM tools)

with the demographic variables, it is observed that it has a negative correlation with all the demographic variables. And the covariance is observed to be about 1.168., while for the (Cultural resistance in companies is the greater challenge than any technological challenge) with the demographic variables, it is observed that it has a significant negative correlation with the size of a company based on human resource variable. And the covariance is observed to be about 0.993.

According to the results of the correlations for the (Lack of demand and disinterest of BIM) with the demographic variables, it is observed that it has a negative correlation with the specialization variable and a positive correlation with other demographic variables. And the covariance is observed to be about 1.402, while for the (An insufficient electronic standard, protocols, and coding system of BIM) with the demographic variables, it is observed that it has a negative correlation with all the demographic variables and the covariance is observed to be about 1.131.

According to the results of the correlations for the (Adopting alternative standards like New Rules of Measurement (NRM) can solve the lack of BIM standard) with the demographic variables, it is observed that it has a strong correlation with the size of a company based on human resource variable, And the covariance is observed to be about 1.128, while for the (Multi software of BIM lead to decrease the efficiency)with the demographic variables, it is observed that it has a significant positive correlation with years of experience of BIM technology variable, And the covariance is observed to be about 1.197, and on the other hand, for the (Few data/information could be lost while transforming between BIM software) with the demographic variables, it is observed that it has a positive correlation with the size of a company based on human resources variable and negative correlation with the years of experience of BIM technology, And the covariance is observed to be about 1.085.

According to for the (Engineers in the industry prefer AutoCAD for Structural Design instead of BIM) with the demographic variables, it is observed that it has a significant positive correlation with the size of a company based on human resources variable, And the covariance is observed to be about 1.275, while for the (BIM can be considered more suitable for the project planning according to design than AutoCAD) with the demographic variables, it is observed that it has a positive correlation with the size of a company based on human resources variable and negative correlation with the specialization, And the covariance is observed to be about 2.395, on the other hand, for the (AutoCAD 3D contains less realistic approach in structural designing than BIM) with the demographic variables, it is observed that it has a negative correlation with all demographic variables. And the covariance is observed to be about 1.430.

Fig. 9 responses based on Engineer's Specification for BIM Q1, as according to the results of the question regarding BIM implementation that could reduce the human error during designs, most civil engineers based on specialization about 16.67% of the total respondents agreed on it. According to the results of the question regarding the adoption of BIM that that can help detect errors and design mistakes within the drawings and provide a user friendly and easy variation in the specific part of the flawed design, on the other hand, as AutoCAD does not provide such easiness to the users, in AutoCAD the design mistakes are to be observed manually and also to be altered to change under the correct design standards all over again. Fig. 10 shows the responses that the drawing error could be greatly adjusted through the use of BIM technology under the year of

experience of the respondents. For both of the categories of the respondents, either less than five years or the experience of more than a year, all the respondents have scored 23 percent of the positive agreed responses.

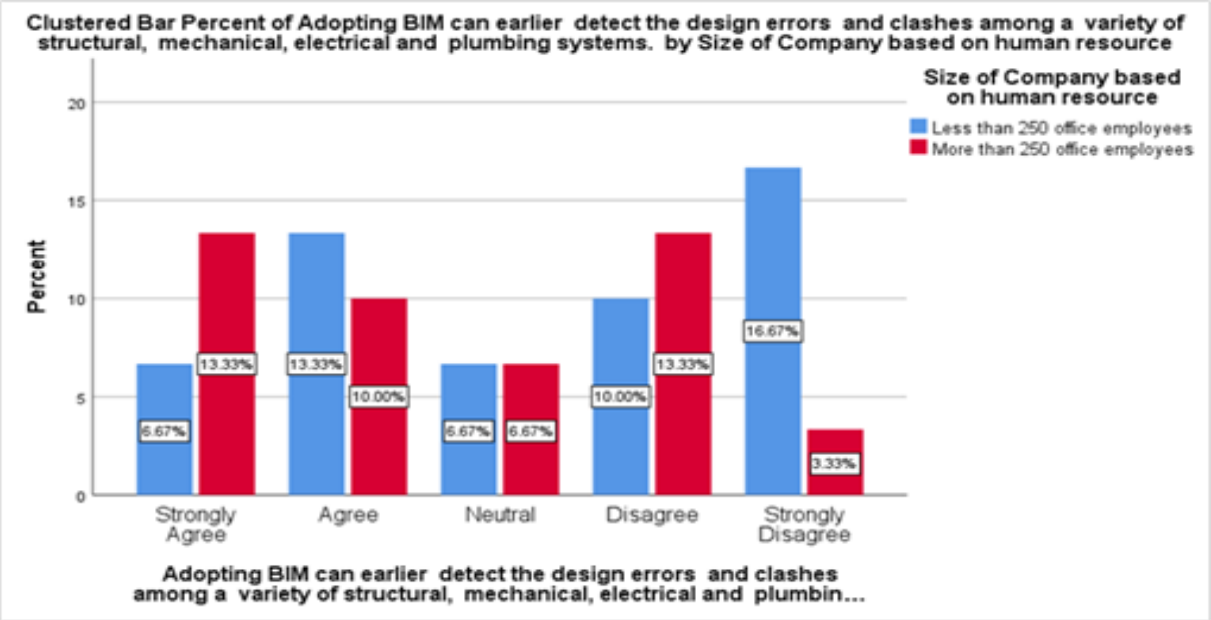


Fig. 9. Responses based on Company Size for BIM Q2

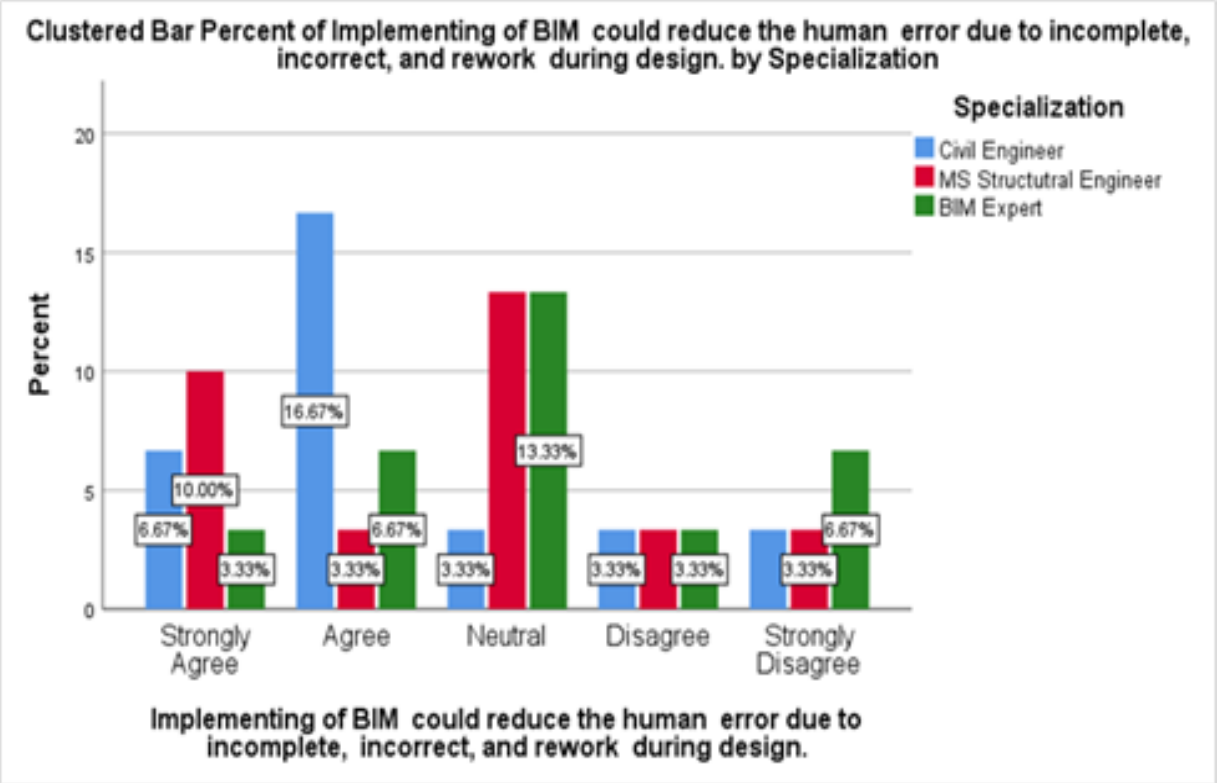


Fig. 10. Responses based on Experience of BIM technology for BIM Q3

4. Conclusions

a) From the observed results, it can be concluded that BIM provides more advanced-level drawing than that AutoCAD. BIM provides an improved and efficient environment for architectural designing and plans as well.

b) From the result, it can also be concluded that BIM involves 3D solid components designed in the well-mannered Revit modelling environment due to which very little time is required to produce drawings, while in AutoCAD every feature is to be designed manually which takes a lot of time.

c) According to the quantitative results, it can be concluded that implementing BIM could reduce human error due to incomplete, incorrect, and rework during design. As more than 50 of the respondents agreed to this statement.

d) From the quantitative results, it can also be concluded that BIM could enhance communication between design teams, as more than 50 of the respondents agreed with this statement.

e) From the quantitative results, it can also be concluded that drawings errors are to be greatly adjusted through BIM implementation, as more than 50% of the respondents agreed to this statement.

f) It can also be concluded that there is a lack of awareness of the capabilities of BIM tools in the industry, as more than 60% of the respondents agreed to the statement.

g) It can also be concluded that multi-software of BIM does not lead to a decrease the efficiency.

h) It can also be concluded that BIM can be considered more suitable for the project planning according to the design than AutoCAD as more than 53% of the respondents agree to the statement.

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