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Statistics, Advantages, Challenges and Designing of buildings using Building Information Modeling (BIM)

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Abstract*: Building information modeling (BIM) is one of the most promising recent developments in the architecture, engineering, and construction (AEC) industry. With BIM technology, an accurate virtual model of a building is digitally constructed. This model, known as a building information model, can be used for planning, design, construction, and operation of the facility. BIM represents a new paradigm within AEC, one that encourages integration of the roles of all stakeholders on a project. In this paper, current trends, benefits, possible risks, and future challenges of BIM for the AEC industry are discussed. The findings of this study provide useful information for AEC industry practitioners considering implementing BIM technology in their projects.The architecture, engineering, and construction (AEC) industry has long sought techniques to decrease project cost, increase productivity and quality, and reduce project delivery time*
Keywords: *BIM, virtual building, energy consumption analysis, green building design*

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I. Introduction:

Building Information Modeling (BIM) is a Trans formative approach to design, construction, and facility management in the architecture, engineering, and construction (AEC) industry (Aound G et. Al., 2005). It represents a fundamental shift from traditional 2D drafting and design methods to a comprehensive 3D digital modeling and data-driven process. BIM has gained significant prominence in recent years due to its ability to enhance collaboration, improve project efficiency, and optimize the entire life cycle of a building or infrastructure project (Azhar, S, 2008).

At its core, BIM involves the creation and management of a digital representation of a building or infrastructure project. This digital model is much more than just a 3D visualization; it contains rich data about the project's components, materials, geometry, and relationships. This data can include information on structural elements, mechanical and electrical systems, plumbing, finishes, and more. BIM facilitates the integration of these various aspects into a single, coherent model (Aound G et. Al., 2005).

II. Materials and methods:

In recent years, scientist metrics has gradually become one of the common methods used by researchers and universities to evaluate scientific research performance. This work adopts the method of bibliometric analysis and scientist metric analysis. Firstly, the appropriate database and related literature are selected through bibliometric analysis, and then the scientific econometric analysis is carried out. Before the scientometric analysis, the significance of bibliometric analysis is to evaluate the relevant journals and find the appropriate literature, so as to make the results of scientometric analysis more credible. The present study will use scientometrics methods to analyze the application of BIM technology in the field of building energy consumption. Based on series analysis, the research hotspots, the most updated research, and historical changes of the use of BIM in the field of building energy consumption will be analyzed. The research process adopted in this paper is shown in Figure 1.

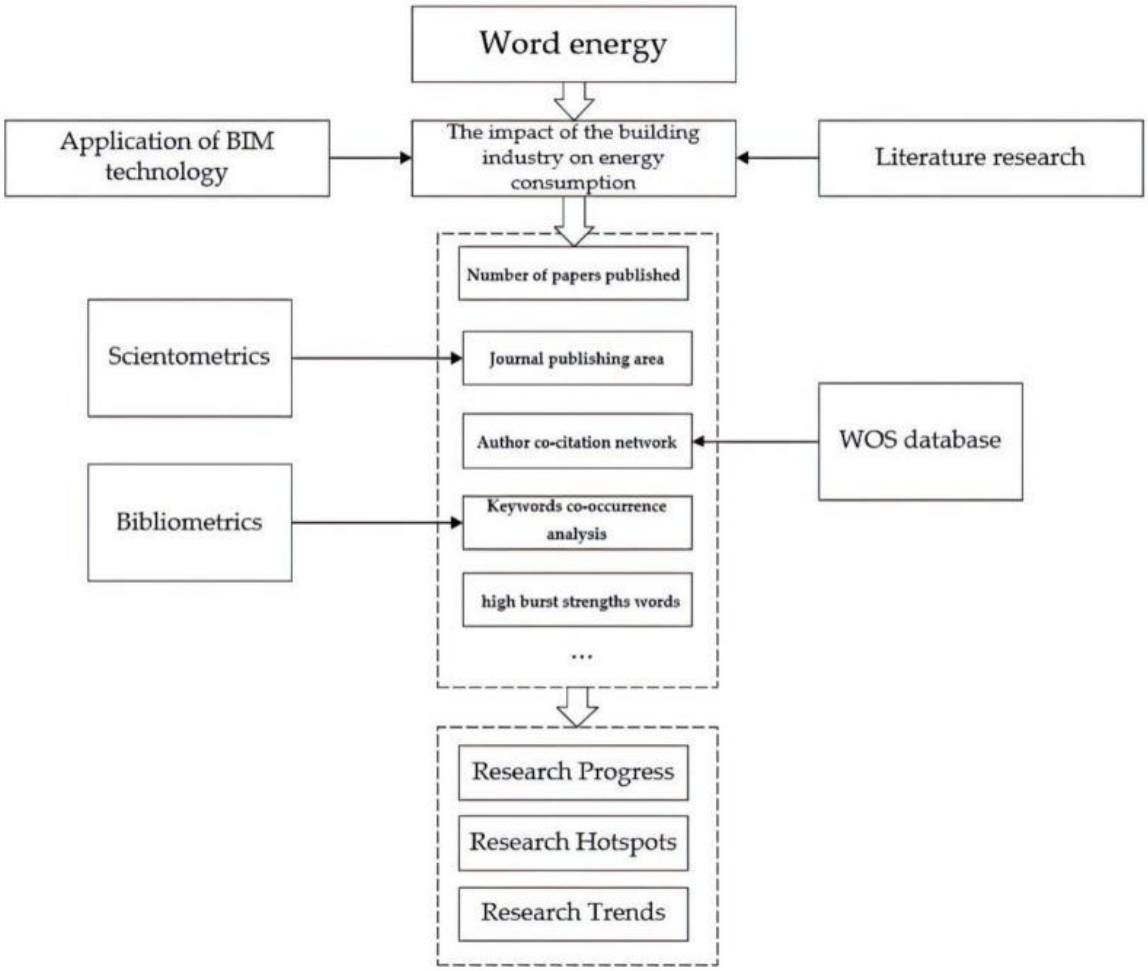


Table:1 Flow chart of the methodology adopted for this paper.

2.1. Research Methods

Sciento metrics is an emerging subject of quantitative research. Its research content describes the process of scientific development, reveals the internal mechanisms of scientific development, predicts the trend of scientific development, and provides a support basis for scientific management. The research method is mainly quantitative analysis. For research and analysis, Cites pace and Vos viewer software are used in this study. Cite Space software was developed by Dr. Chaomei Chen, a Chinese scholar at the School of Information Science and Technology at Drexel University (Azhar, S., 2008) It is used to assess the prospective knowledge in scientific analysis. By using visualization, it may demonstrate the internal logic, structure, and distribution of scientific information. In this study, Cite space was used to export a picture network of keyword cluster analysis and journal publishing areas and so on, so that the quantitative results based on data analysis could be used for subsequent qualitative research. Vos viewer is a document analysis and visualization software developed by the Technical Research Center of Leiden University in the Netherlands. The main advantage of Vos viewer over other document metering software is its powerful graphical display capability. This makes it suitable for processing large amounts of data. This paper uses Vos viewer to derive visual images of quantitative analysis including keyword co-occurrence analysis and author co-citation networks. By combining Cites pace with Vos viewer, BIM technology in building energy consumption is comprehensively discussed and analyzed.

2.2. Data Sources

The current favorite source of cited data by many researchers is the Web of Science (WOS) database, which covers more than 10,000 topics and more than 10,000 subfields. WOS covers the majority of pertinent papers written by top academics and has high impact and a broad international scope. In order to ensure the reliability and comprehensiveness of data sources, this study uses the WOS database as a data source.

In this paper, building energy consumption and BIM were selected by the keyword retrieval method, 491 search results were obtained from the WOS database. Keyword search results were not filtered, and journals, conferences, and books were all included to allow for a more comprehensive study of the subject area. There was no limit on the collection period, but the collected articles are from 2010 to 2022, demonstrating that the first

publication on how BIM technology is being used to reduce building energy usage began in 2010. To further guarantee the validity of data sources, the language was set as English, the WOS core collection was screened out, and the repetition was screened out through Citespace. Finally, 377 WOS retrieval results were obtained.

Table :2 Summarized Table of published data sources

Journal Title	Number of Published	Percentage
Sustainability	36	9.549
Journal of cleaner production	19	5.04
Automation in construction	17	4.509
Procedia engineering	16	4.244
Energies	14	3.714
Energy and buildings	14	3.714
Journal of building engineering	13	3.448
Iop conference series earth and environmental science	12	3.183
Buildings	10	2.653
Applied sciences basel	7	1.857
Building and environment	7	1.857
Renewable sustainable energy reviews	7	1.857
Energy	6	1.592
Energy reports	6	1.592
Sustainable cities and society	6	1.592
Applied mechanics and materials	5	1.326
Ework and ebusiness in architecture engineering and construction	5	1.326

III. Results:

This study carried out publication analysis, author co-citation network, and keyword analysis. Through these analyses, the current state of the application of BIM technology in the areas of building energy consumption, defective parts, and future trends is explained.fig 1 is drawn

Enhanced Visualization: BIM provides detailed 3D visualizations of projects, making it easier for stakeholders to understand the design intent and functionality. This visual clarity aids in decision-making and stakeholder engagement.

Error Reduction: BIM's clash detection capabilities help identify conflicts and errors in design and construction early in the project life cycle. Addressing these issues proactively reduces rework and minimizes costly construction delays.

Cost Savings: BIM enables accurate cost estimation by linking materials, quantities, and costs. This leads to better budget control and cost savings throughout the project.

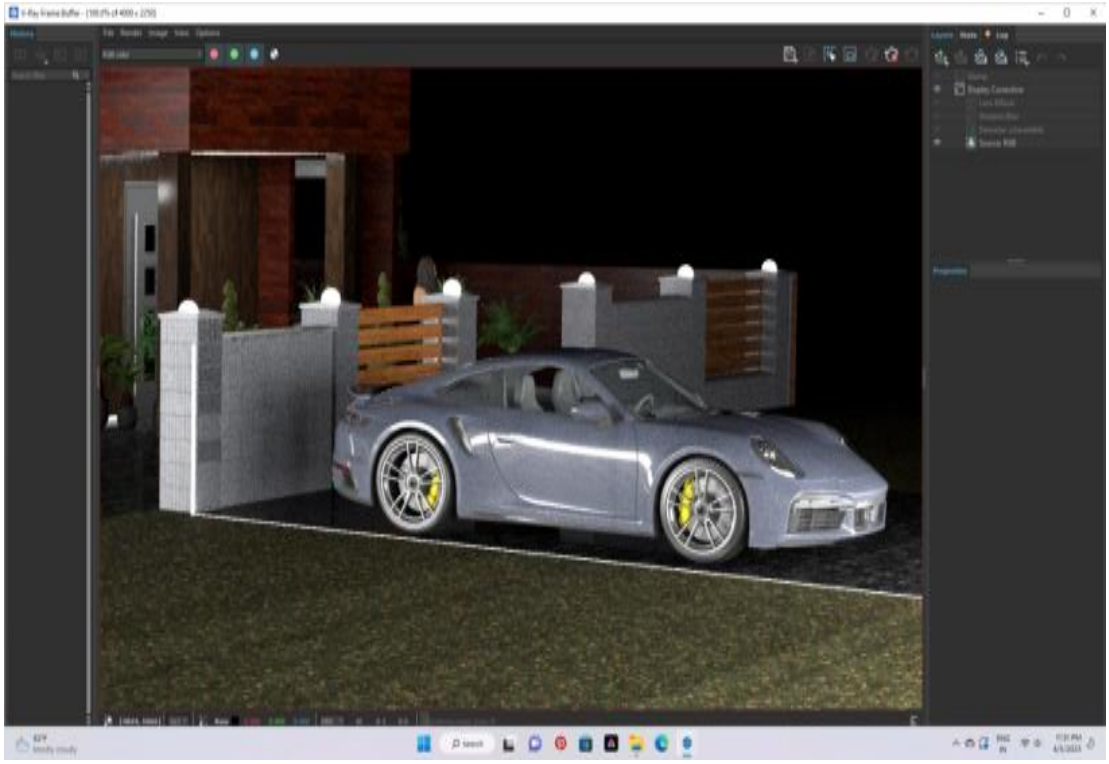


Figure 1: Working drawing using software sketch-up and v.ray

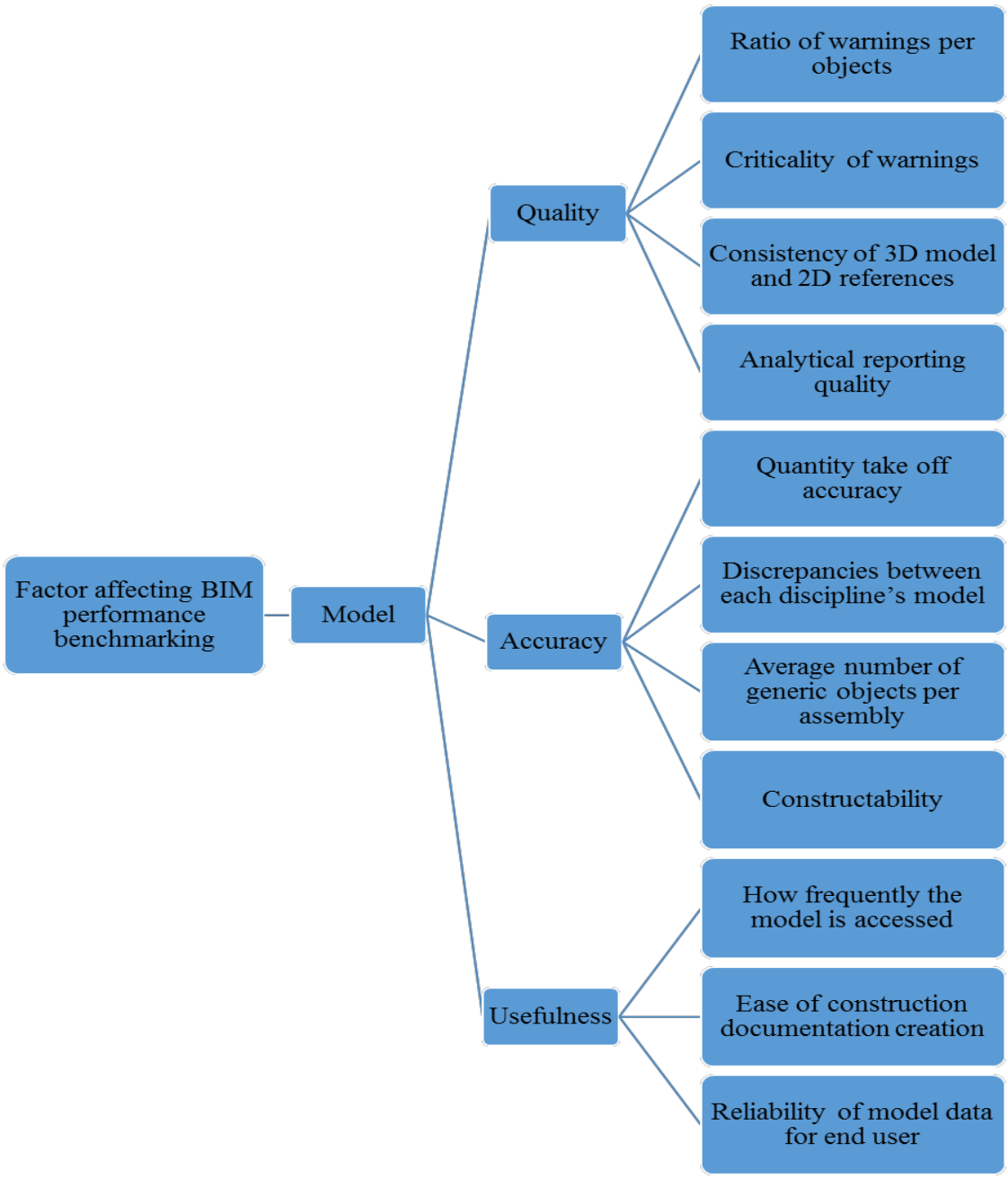


Figure 2(a): Integrated Framework for Factor Affecting BIM Performance Benchmarking

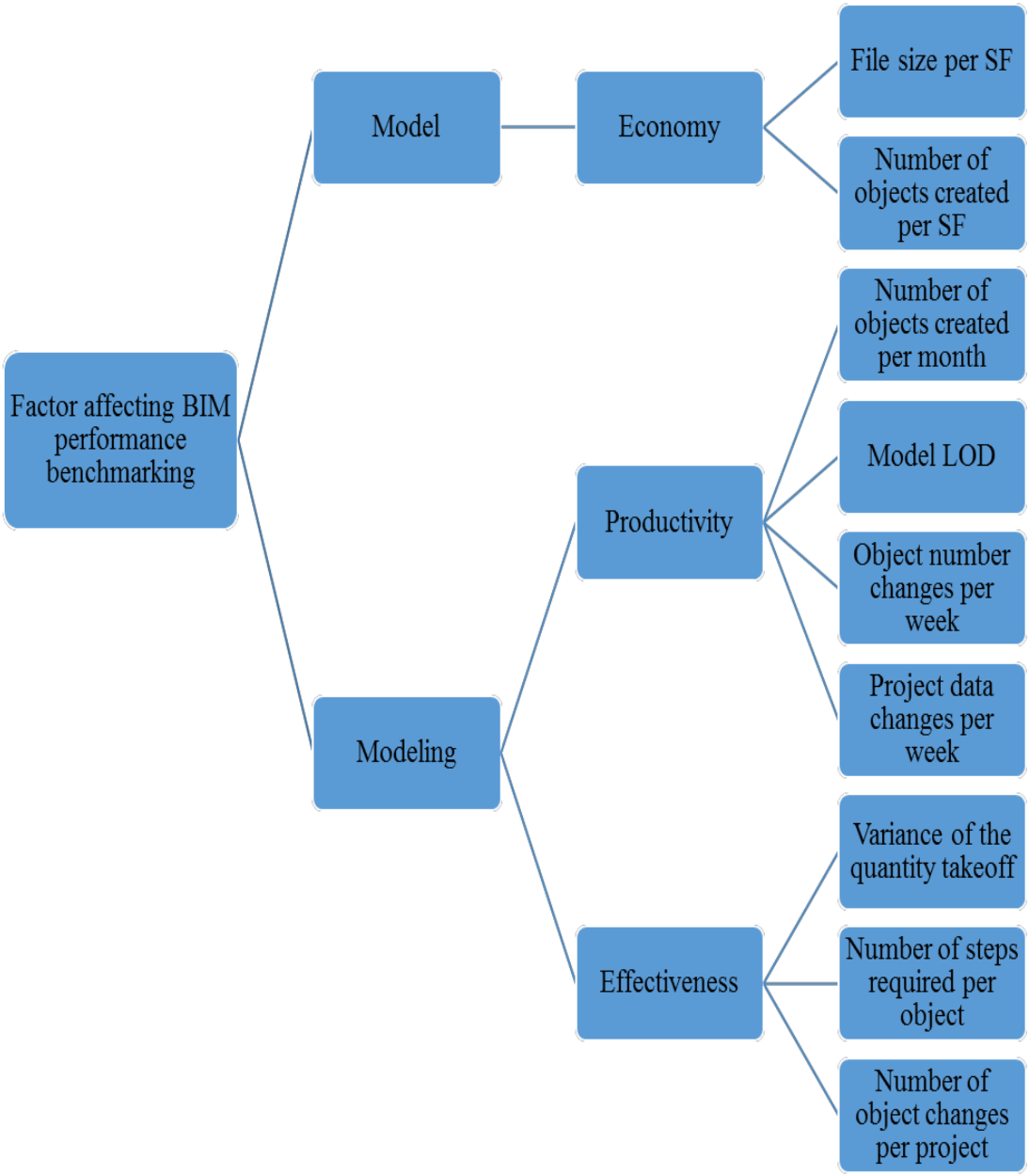
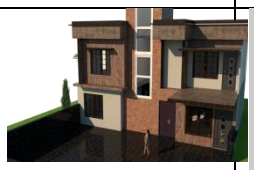


Fig. 2(b): Integrated Framework for Factor Affecting BIM Performance Benchmarking

Table 3: Summarized chart of material estimation of the designed building

Option/aspect	**specification**	**option A**	**option B**	**option C**
Front elevation				
Stories	not specified	2	2	1
Construction funding Max cost pr (sqft)	$100000000 3000 pr(sqft) Its also depend upon consumer			

Area (sqft) Net area Net to gross ratio		5000 sqft 3000sqft 60%	8000 sqft 5000sqft 62.5%	4000 sqft 2500sqft 62.5%
Cost sectioin Budget Mid range High range	 1900sq/ft 2500 sq/ft 4000 sq/ft	 57,000,00 75,000,00 12,000,000	 95,000,00 12,500,000 20,000,000	 47,500,000 62,500,00 10,000,000
Building skin Primary materials Skin articulation Floor to floor height Base to floor ratio %glass % brick	 Brick/concrete/motar/steel N/a N/a N/a N/a	 Brick/glass/motar/ Concrete Articulated,trim 12'@1;12@upper 60% to 66% 20%glass, 80%brick	 Brick/glass/motar/ Concrete Articulated,trim 12'@1;12@upper 60% to 66% 25%glass, 75%brick	 Brick/glass/motar/ Concrete Articulated,trim 12'@1;12@upper 60% to 66% 28%glass, 72%brick

Figure 3: Front Elevation of the designed building using sketch-up and v.ray Software

Figure 4: Back Elevation of the designed building using sketch-up and v.ray Softwear

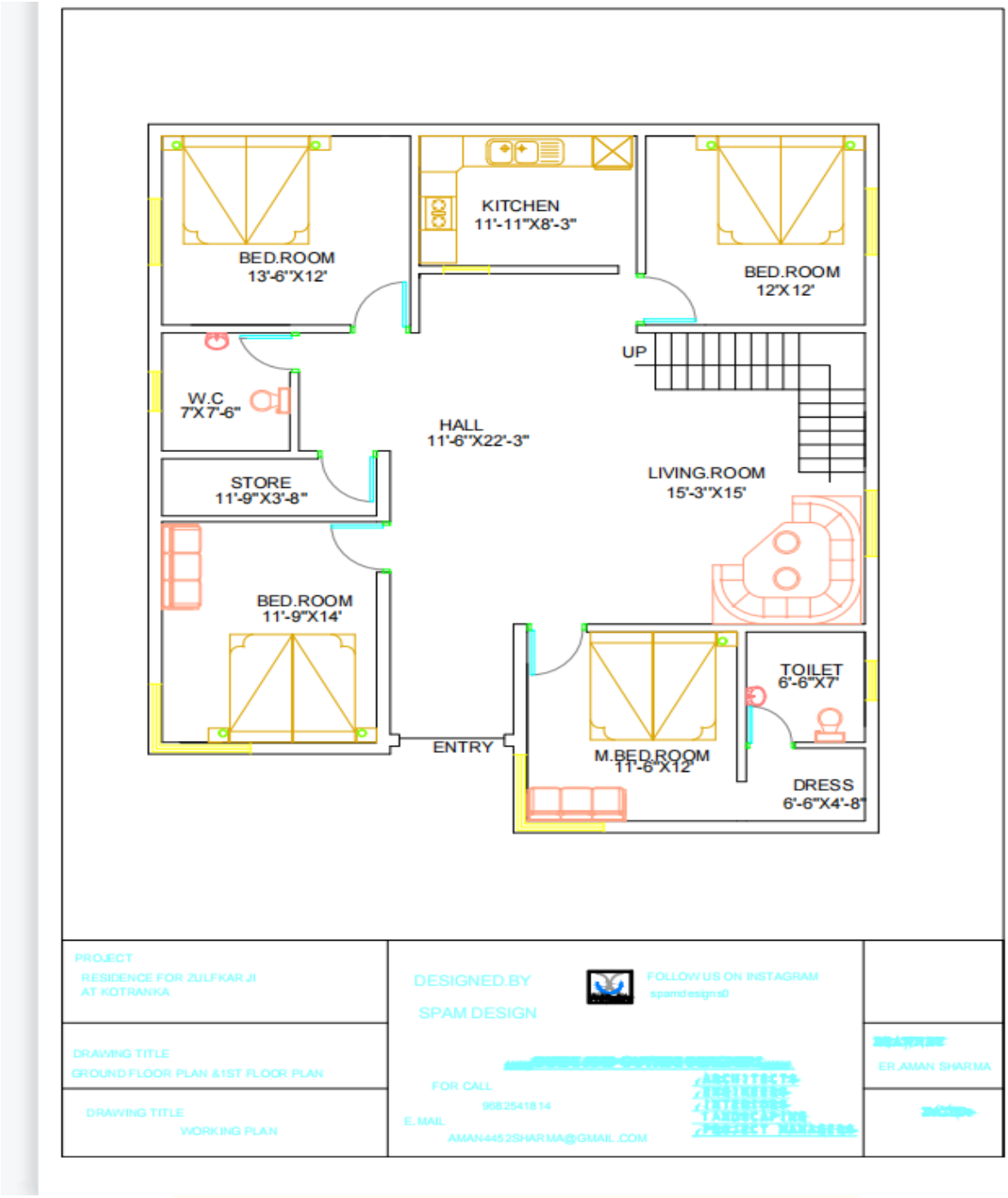


Figure 5: Floor Plan of the designed building using Auto-cad Software

IV. Conclusion:

In conclusion, Building Information Modeling (BIM) is not merely a software or a design tool; it represents a profound transformation in the way we conceive, plan, construct, and manage buildings and infrastructure projects. BIM's ability to create a detailed and data-rich digital representation of a project has far-reaching implications for the construction industry and beyond. Here are some key takeaways:

Enhanced Collaboration: BIM fosters collaboration among stakeholders, breaking down traditional silos in the construction process. Architects, engineers, contractors, and owners can work together seamlessly, reducing misunderstandings and conflicts.

Improved Efficiency: BIM significantly improves project efficiency by allowing for early clash detection, accurate cost estimation, and streamlined decision-making. This results in reduced rework, cost savings, and shorter project timelines.

In summary, BIM has emerged as a game-changer in the construction industry, offering a holistic approach to project design, construction, and management. Its capacity to combine 3D modeling with comprehensive data integration makes it a powerful tool for improving efficiency, reducing costs, and promoting sustainability in construction projects. As the industry continues to evolve, BIM will remain at the forefront of innovation and transformation.

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