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A Review on Application of Integration of BIM and GIS

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A B S T R A C T

This paper conducts a comprehensive technical review of Building Information Modeling (BIM) and Geographic Information Systems (GIS), evaluating their respective strengths and weaknesses in the context of highway construction, to enhance the Building facility operation and maintenance, investigates the transformative impact of Building Information Modelling(BIM) in conjunction with Geographic Information System (GIS) on civil facility planning, with a focus on airfield infrastructure, noise mapping, building and transportation related energy use. By using GIS maps for external details and BIM for internal information, the study presents a method for Earth work cut and filling, 3D visualization of subsurface pipelines critical for efficient maintenance workflows, civil urban planning, Transportation energy and building energy consumption. . The paper suugest a novel data integration approach, utilizing the BIM-based Industry Foundation Classes (IFC) system to store road components data and GIS for importing land boundaries and topographic data. The proposed approach aims to empower field workers, even without extensive GIS and CAD expertise, to visualize and analyze complex pipe networks, facilitating effective facility infrastructure management. Traditional 2D GIS mapping is extended to 3D, enabling simultaneous evaluation of traffic noise in both outdoor and indoor environments. Finally a systematic literature review identifies parameters affected, benefits of integrating both BIM and GIS, valuable tools.

Keywords: BIM (Building Information Modelling), GIS (Geographic Information System); Data Integration; IFC (International Foundation Class) File GML (geography markup language) File

INTRODUCTION

Building Information Modelling (BIM) is a digital representation of the physical and functional characteristics of a building or infrastructure. It involves creating a collaborative 3D model that integrates data and information about the project throughout its life cycle. It Improved Collaboration, Enhanced Visualization and Analysis, Cost and Time Efficiency. GIS is a technology that helps collect, study, and show information about places on Earth. It is used in things like planning cities, taking care of the environment, and managing transportation systems.

Normally, people use two different tools: one for creating detailed 3D models of buildings (BIM), and another for handling maps and location data (GIS). But now, these tools are teaming up to create something even better called BIM+GIS.BIM is great at making detailed 3D models, and GIS is awesome at handling maps and location information. This paper addresses the crucial aspect of cut and fill earthwork in highway construction, bringing the significance of optimum design for minimizing total earthwork. Engineers typically use various data formats to share project information when calculating the cut and fill for construction projects. The system collects project Information smartly and combines it using a semantic web method, that calculates earthwork for roads better.

Facility Management needs information about both the inside of buildings and the pipeline network outside. Currently, building details are in 3D models (BIM), and pipeline data is in maps (GIS). Access to 3D models of underground pipes is crucial to avoid accidents during maintenance. Workers may accidentally damage pipelines due to lack of precise information.

Buildings and transportation are major contributors to greenhouse gas emissions, making up 75%. Energy use in buildings includes residential and commercial spaces, while transportation involves moving people and goods. Combining both sectors in a comprehensive model is crucial for understanding their interaction and impact on energy consumption trends.

To plan buildings well, we use geospatial data with tools like GIS. Another technology called Building Information Modelling (BIM) is making a 3D model. Even though BIM doesn't handle location information well, combining it with GIS helps managing airports. As more people live in cities, the noise from busy roads and traffic becomes a big problem, affecting people's health. To manage this, standards like the 'Environmental Noise Directive EU, 2002/49/EC' require countries to create noise maps showing noise levels. While current maps are 2D and don't consider height differences, using 3D maps in GIS helps show how traffic noise affects different parts of buildings, aiding in better design.

Literature Review

- Hyun Joo Kim Et al (2015) reports that ,There are several on-going efforts in the integration of BIM and GIS systems. Input Building Information Modeling (BIM) model data file is extracted in describing the infrastructure geometric information such as road shape, centerline, cross section, elevation, curb, and embankment. Secondly, raw project data (triangle coordinates and group, geographical reference, soil type, infrastructure data, terrain data, etc.) are collected as GIS input information. Industrial Foundation Class (IFC) file implemented for BIM model and Geography Markup Language (GML) file stores GIS data. Semantic web integration gives the earth work analysis. The goal of the earthwork simulation is to minimize the earthwork by balancing the cut and fill operation.

- R Liu and R.R.A Issa (2012) focused that, As Facility Management requires building information including mechanical, electrical and plumbing (MEP) from both insides the building and the pipeline network information outside the building. This paper, which proposes a method to use data from BIM and GIS data for 3D visualization. The research methodology is divided into 4 main steps: data collection, Data processing and model building, different platform integration, clean up final visualization result.The Authors used 3 tools i.e., Arc GIS 10, Revit, Auto CAD softwares. The major advantage is the Excavation and other workers will understand the underground environment much better in this format.

- Ebrahim Karan Et al (2015) investigate that, Energy is related to energy consumed in building and transportation. They develop a network infrastructure model to determine the transportation energy as well as building energy consumption based on building life style. The methodology includes data collection, Built environment model, Evaluation and Scenario Analysis. The real benefit of this research will be more useful in large-scale application, for example, energy planning of a university campus. The results of the case study show the current trend in energy use. In addition, the system does not consider the time or cost required to implement energy saving scenarios.

- T. Park Et al (2014) discusses the importance of economic feasibility in the preliminary feasibility stage of road projects in Korea. It highlights that traditionally, only construction costs are considered in the financial viability assessment of national road projects. The paper introduces a system that combines building information modelling (BIM) and geographic information systems (GIS) for estimating the cost of building a national road in the preliminary feasibility stage. The system provides project reports with detailed design information, floor and longitudinal image information, structural specifications, earthwork details, land acquisition costs, O&M costs, and total project costs. The proposed system offers advantages such as flexibility in route changes, 3D visualization for better project understanding, and consistent project cost estimation. The system reduces time and resources in the engineering process and facilitates the selection of the best route.

- Alessandro Di Graziano Et al (2022) reports that, how Geographic Information Systems (GIS) and Building Information Modelling (BIM) can work together for better planning and management of airport facilities. The main idea is to show the advantages of combining these systems. The study introduces a new method to assess potential obstacles and hazards for air navigation by integrating models within GIS and BIM. For the case study, GIS data is used to represent obstacles using points and polygons, with QGIS software and OpenStreetMap data being employed. The interoperability between BIM and GIS is achieved through Autodesk InfraWorks software, which can handle different data formats. The focus of the study is on visually representing GIS objects within the BIM system.

- Yichuan Deng Et al (2016) presented that, to provide a general framework for building detailed 3D noise maps using BIM–GIS integration. The four modules described in that paper are generic for noise mapping in 3D GIS environment The reflection analysis in that model is based on the assumption that we are simulating an A-weighted average value of noise levels at different locations of cities, so we did not consider the travel time of sound or diffraction of sound , the open-sourced nature of the platform allows users to modify the prediction models in the outdoor and indoor noise calculation module The development of the noise-mapping BIM–GIS platform based on ArcGIS. Two use cases were analysed to show the role of such platform in the decision-making process of both urban planning and interior design.

- Mehdi Asgari siahboomy et al (2021) proposed that, after building the parametric model and including all the data concerning the historic building and the Building's File, the .IFC file was exported and then converted into a GDB (geodatabase) file. Inside Arc Scene it was possible to execute complex queries which could not be performed inside Revit.Starting from the identification of the physiological limits of each methodology, we worked on the structuring of the relationship interfaces between 3D GIS and BIM with the implementation of Building's File data.

- Melica Honic Et Al (2022) presented that, Frame work for the assessment of the existing stock through BIM and GIS.The researchers used various methods and technologies, including on-site investigations, spatial data, laser scanning, and BIM, to assess material quantities and calculate material intensities. However, there are some limitations to the study. One of the limitations is that the assessment of material quantities within the city was not conducted because with one case study, the natural variation between buildings of the same type cannot be evaluated.

- Bo Zhang Et al (2020) investigates that, solving security risks caused by bridge damage, they proposed a cloud platform for bridge health monitoring based on BIM+GIS. The cloud plat form establishes the self-diagnosis, monitoring data visualization and real -time warning. Bridges are affected by corrosion, oxidation, deflections under the long-term static loads. Sensors are used to monitor the bridge data.it connects the acquisition instrument and passes the data processed by the acquisition instrument through the DTU (data transfer unit). the user can view specific, real time monitoring data for one of them.

CONCLUSION

This study employed a specialized computer model to manage information about highways and the nearby environment. It integrated infrastructure data (such as roads and pavement) with geographic details (like boundaries and landscapes) using an intelligent data system. It helped optimize the calculations for handling soil and made planning the road construction much more efficient.

The study shows that using 3D views helps visualize underground systems accurately, making it safer and more efficient for workers to plan and execute tasks like digging for infrastructure pipes. Using a special software called Autodesk Infra Works, they integrated data from different systems and showed it can enhance understanding of digital models, especially in larger contexts like airport operations

This new model is one of the first to combine how much energy buildings use and how people travel to understand current and future trends in energy and CO2 emissions. It looks at the connection between people's activities and their travel.

A new system combining BIM and GIS helps construction teams plan and estimate costs for national road projects more efficiently. It's particularly useful in the early planning phase. This system stands out because it allows easy route changes, offers a clear 3D view with detailed information, and ensures consistent cost estimates. Overall, it saves time and resources in the planning process, making it easier to choose the best route for a national road.

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