

---

## INDUSTRIAL AND CIVIL ENGINEERING AND ECONOMICS

---

DOI 10.15826/rjcest.2021.1.002

УДК 69.05

V. Alekhin<sup>1</sup>, H. Abdullah<sup>1</sup>

<sup>1</sup>Ural Federal University, Yekaterinburg, Russia

E-mail: hussein.abdallah.1996@gmail.com

### GIS AND BIM INTEGRATION IN BUILDINGS AND INFRASTRUCTURES CONSTRUCTION

**Abstract.** Building information modeling (BIM) is one of the most promising recent developments in the architecture, engineering, and construction 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. Unfortunately, a lot of critical data gets lost in-between the different stages of the build process, from conceptualization to construction and maintenance. This is the result of converting and translating data between other software solutions and formats. This problem is preventable. By integrating GIS data into BIM models. This article will demonstrate how GIS and BIM can be applied to the construction workflow for buildings and infrastructure, and which benefits can provide this integration for improving the quality of the construction process.

**Keywords:** GIS, BIM technology, buildings construction, infrastructure construction

Алехин В. Н.<sup>1</sup>, Абдуллах Хуссейн<sup>1</sup>

<sup>1</sup>Уральский федеральный университет имени первого Президента России Б. Н.

Ельцина, Екатеринбург, Россия

E-mail: hussein.abdallah.1996@gmail.com

### ИНТЕГРАЦИЯ ГИС И ВІМ В СТРОИТЕЛЬСТВЕ ЗДАНИЙ И ИНФРАСТРУКТУР

**Аннотация.** Информационное моделирование зданий (ВІМ) - одно из самых многообещающих последних достижений в области архитектуры, машиностроения и строительства. С помощью технологии ВІМ в цифровом виде создается точная виртуальная модель здания. Эта модель, известная как информационная модель здания, может использоваться для планирования, проектирования, строительства и эксплуатации объекта. К сожалению, многие важные данные теряются между различными этапами процесса строительства, от концептуализации до строительства и обслуживания. Это результат преобразования и перевода данных между другими программными и форматами. Эту проблему можно предотвратить. Путем интеграции данных ГИС в модели ВІМ. В данной статье рассматривается интеграция ГИС и ВІМ и как можно их применить к рабочему процессу для строительства зданий и инфраструктуры, и какие преимущества могут дать эту интеграцию для повышения качества процесса строительства.

**Ключевые слова:** ГИС, BIM технология, строительство зданий, строительство инфраструктуры

## **Introduction**

With the concepts of Smart City attracting the industry, the method of managing spatial information has become a hot research topic. Relating to this topic, GIS and BIM are two critical technologies. Although the application of GIS has a long history and BIM has also developed for over 10 years, their integrated application starts a new direction and is still at the early exploration stage.

BIM and GIS integration is the process of blending the BIM model into layers of the geospatial context. So, designers can use GIS to get the most accurate information about some areas where construction is to take place. If the area is prone to flooding, designers will learn about it and influence a structure's construction materials, orientation, location, etc.

## **The BIM and GIS Integration and Benefits**

An unfortunate fact of the AEC (architecture, engineering, and construction) industry is that, between every stage of the process – from planning and design to construction and operations – critical data is lost.

For example, when you move data between phases of the usable lifecycle of a bridge, you end up shuttling that data back and forth between software systems that recognize only their own data sets. The minute you translate that data, you reduce its richness and value. When a project stakeholder needs data from an earlier phase of the process, planners, designers, and engineers often have to manually re-create that information, resulting in unnecessary rework.

The good news is that a disruption is brewing in the GIS (Geographic Information System) industry as it rapidly moves toward 3D modelling. This evolution mirrors the

transformation that the design and construction industry is experiencing as it moves from 2D to 3D BIM (Building Information Modelling), and it signals the emergence of GIS and BIM integration into one holistic environment [1].

GIS data is necessary for planning all operations regarding any infrastructure such as rail networks, airports, bridges, roads, and so on. It helps put this infrastructure in the context of its surroundings.

While GIS helps understand how to put the infrastructure in that context, BIM information is the vital element that allows for the designing and building process of that infrastructure to take place.

BIM and GIS integration is the process of blending the BIM model into layers of the geospatial context. So, designers can use GIS to get the most accurate information about some areas where construction is to take place. If the area is prone to flooding, designers will learn about it and influence a structure's construction materials, orientation, location, etc.

GIS adding makes the entire picture bigger by adding a smarter and larger environment context, meaning that the object will become a part of the roads, utilities, and land in that environment.

Also, Integrating GIS and BIM data allows design and construction companies to collect accurate and valuable data that will lead to much more effective and efficient design and project management [2].

Most communities that are considered smart already use GIS. Many of these smart communities are already actively investigating BIM-GIS integration because they realize that a more streamlined flow of information between operational and construction life cycle data will allow them to more accurately plan, fund, and maintain community infrastructure assets [3].

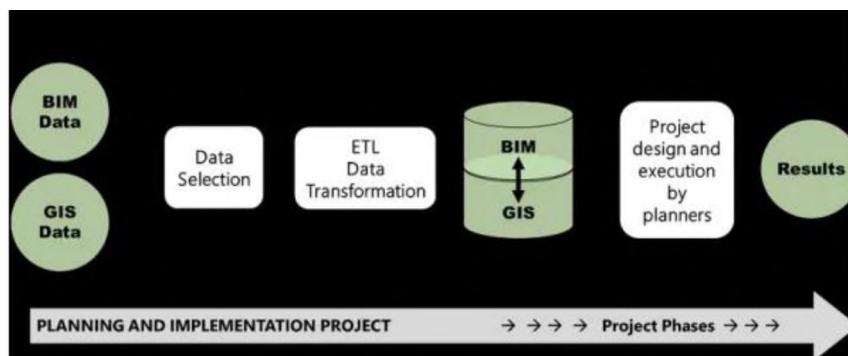


Figure 1. A scheme for GIS and BIM integration project process

### Long-Term Savings and Efficient Design

Regardless of what the contractors' goal is, to turn some object into an open-air construction site or scale the entire process down to the factory-level prefabrication, minimizing data losses and time as well as improving logistics scheduling, become a top priority.

The use of BIM and GIS introduces a whole new spatial element to this smart and innovative industrialized construction process with one simple goal in mind – to increase the efficiency of the entire design and construction process.

Companies that provide geospatial services use geographic information systems and BIM modelling to enable better design, making every process, operation, and construction project much more efficient in terms of effort, time, and resources.

The integration and synthesis of these advanced technologies can be applied to any design and construction project at hand. The digital work that comes as a direct result of the integration is a very effective way to retrieve, store, and index and record vital data. The necessary information can be used to support any project and see it through to a successful end [2].

Maximizing the long-term value of new roads, bridges, and facilities means delivering better designs to solve many of the sustainability and resiliency issues facing cities today. This will require optimizing dynamic data interchange between BIM, CAD (computer-aided design), and the geospatial information provided by GIS.

Placing a digital design in a real place, within real geography, eliminates much of the front-end risk of designing and building. The biggest delays in large infrastructure projects come from the planning and permitting phases, which involve a lot of assessments of social, economic, and environmental impacts. Engineers and planners do much of that assessment outside of the design process using geospatial data; that's how they look at floodplain maps or locate underground utilities [1].

### Post-Construction and GIS/BIM Integration

Aside from being useful in pre-construction, geospatial services, BIM modeling, and geographic information systems can be used in post-construction too. Since facilities management requires data, too, the flexible GIS/BIM model ensures the operations get every piece of information needed.

The integration is particularly useful to the clients as well. They can use the integrated GIS/BIM solutions to retrieve and reuse vital data through each stage of the structure's lifecycle [2].

This GIS and BIM integration is equally useful once a structure is built. Rather than oversimplifying the end data provided for facilities management, the flexible model—connected to GIS—delivers everything operations need. Customers have the ability to reuse that data throughout the structure's lifecycle.

For example, operating a road in the real world means managing utilities, managing

guardrail installation, maintaining striping, and overseeing maintenance crews. There's a lot of retrofitting and renovation. When GIS, CAD, and BIM are connected, you're improving operability and eliminating errors. This technology convergence will play an important role in predictive maintenance, too [1].

### **BIM-GIS Integration Pain Points**

Since the dawn of digital mapping and computer-assisted drawing technology, the need to integrate BIM and GIS has been recognized. There are many classic pain points that practitioners encounter when attempting to combine design and operational data. On the design side, architects and engineers typically have difficulty accessing up-to-date GIS information for accurate context or current conditions. They often discover problems with data duplication and conflicting data because file-based workflows are used to exchange data.

On the operational side, GIS staff frequently deal with difficult workflows and significant data loss that occurs when converting BIM information into GIS data layers. Differences in spatial scales and the graphical richness required in BIM environments mean that GIS staff are often asked to perform heroic feats of integration. They must attempt to merge many dense BIM models with GIS data into a single visualization and analysis experience. AEC projects typically generate large quantities of documentation during construction and after assets are commissioned that will be useful during the life cycle of assets. This documentation is often not accessible to users through GIS dashboards and analysis tools [3].

### **What is waiting for BIM and GIS in the perspective?**

BIM and GIS together have the potential to lead to smarter outcomes for communities and more efficient projects for AEC services providers. This will require more than just the collaboration of software vendors. Local governments and asset management organizations will need to establish

specifications for BIM information that introduce attributes early during the design process to be used later in operations and management workflows.

For major urban areas, this will mean creating multiple standards across transportation, utilities, and architecture projects that may impact many agencies. Designers will have to build workflows that allow users to reliably access, update, and use standardized BIM data in spatial context throughout the life cycle of assets [4].

### **Summary**

The need for GIS/BIM integration has risen from the initiative to take the most innovative infrastructure design and construction approach toward building smart cities by eliminating data redundancy, moving data seamlessly between the stages of the design and construction process, adding more effective geospatial context to the BIM process, reducing costs and saving money, making better and improved designs, storing in the cloud to improve data management in any environment, reusing and repurposing data if necessary, and eliminating the need to convert data for use in other contexts.

### **References**

1. GIS and BIM Integration Will Transform Infrastructure Design and Construction. URL: <https://redshift.autodesk.com/gis-and-bim-integration/>
2. GIS and BIM Integration in Infrastructure Design and Construction. URL: <https://www.gislounge.com/gis-and-bim-integration-in-infrastructure-design-and-construction/#:~:text=BIM%20and%20GIS%20integration%20is,construction%20is%20to%20take%20place.>
3. GIS and BIM Integration Leads to Smart Communities. URL: <https://www.esri.com/about/newsroom/arcuser/gis-and-bim-integration-leads-to-smart-communities/>
4. BIM and GIS. URL: <http://bimarabia.com/%D8%B9%D9%85%D8%B1-%D8%B3%D9%84%D9%8A%D9%85-bim-and-gis/>