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An Overview of Construction Management by Using Building Information Modelling Software with Integration of Augmented Reality

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Abstract: Construction management is an effective approach to facilitate services for giving out effective results to the projects' schedule, cost, and quality for the purpose of completing the project at a given time. Building information modeling (BIM) has given tremendous up-gradation to the construction industry by providing data with accuracy to the customers. With the advent of technological advancement, BIM (Building information modelling) is gaining more interest, possessing the capacity to advance project facilitation through 3D modeling, 3D viewing, and other means. This research implies the benefits of construction management using BIM alongside the integration of construction management using BIM with Augmented Reality (AR) to establish transparency in design, costing, and progress visualization for the inclusion of 3D-live viewing in order to remove the time-lapse as well as on-site data hindrance. Also, this research provides future directions to cope with the technology trends that could effectively help right significant on-site productivity.
Keywords: Building Information Modelling (BIM), Site management, 2D/3D data, 3D modelling, Augmented Reality (AR).

I. INTRODUCTION

Construction is a prominent and productive industry in countries all over the world; it has worked to advance as other corporate sectors have, but its productivity has decreased in comparison to the industry's evolution [1]. Buildings appear to be stuck in time, whereas other industries such as retail, manufacturing, and construction have expanded their knowledge, increased their yield, and accepted the digital age. Around the world, labor potential in the construction business has been unstable [13]. There are numerous provincial differences, including excellence. For example, in the United States (US), labour productivity has declined since 1984. Indeed, the construction sector in the United States accounts for one-third of the likelihood of increasing global productivity.

China and South Africa are rapidly increasing their construction productivity, despite starting from low starting point, while countries like Brazil and Saudi Arabia are falling further behind **Error! Reference source not found.**. A few smaller countries, most notably Australia, Belgium, and Israel, are combining high measured productivity levels with relatively rapid growth automation. Companies can begin by creating 3D data in the company using Building Information Modelling (BIM) in tandem with the use of digital collaboration tools, drones, and other essentials for proper execution at the sites [4]. Many times, plans lack a sufficiently detailed schedule to allow owners to efficiently govern activities on-site, and supervisors must rely on past experience and intuition. According to various studies, only 25% of a project activity's budget should be spent on planning. A compelling monitoring of construction performance and development is required to distribute projects on time and within budget [5]. It is extensive to introduce efficient monitoring methods that are continuously verifiable of a project's relevant data on project execution and progress. Site managers are frequently lacking in field tools that enable automated monitoring and control of construction work. Aside from construction process monitoring, quality control of completed work is an important aspect of performance [8].

On large construction sites, information is still managed using paper-based documents such as construction drawings, construction logs, and scheduling. This situation frequently leads to misunderstandings between stakeholders, construction errors, and does not provide a comprehensive view of the current situation, which impedes informed decision-making. On construction sites, a lack of information or incorrect information increases the likelihood of errors, which can lead to a reduction in building quality [6]. In recent years, the adoption of information and communication technologies (ICTs) in the construction industry has had a significant impact on both productivity and economic growth for construction firms. However, in comparison to other industries, the use of ICT to automate processes is relatively low.

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A. Augmented Reality using BIM features

BIM models of the project site are used to facilitate process control, and some of them incorporate Augmented reality (AR)/ Virtual Reality (VR) technology to visualise interactive 3D models on site. Increasing the automation of on-site processes through BIM and AR technology can improve decision-making and provide real-time access to information. AR is the term used to determine when an additional data is added to the user's view of real scene. With this the user is able to interact with the virtual data in presence of the real environment. The basic example we can take of AR here is Snapchat, Pokémon GO, Lenskart, where the user is allowed to scan the physical environment and the 2D/3D virtual data is displayed onto the user's screen. It is gaining more importance in various sectors such as, manufacturing, design, education, shopping, industries, and construction. The models being developed in BIM during designing phase can be merged with the AR visualization phase in order to view the 3D models in live-direct or indirect display. The 3D data can be used to put to display on the device in the real environment, The researchers' central goal in this research study is overview of the methodology and technologies that was used in the creation of the application, as well as its principal functionalities and system integration [7].

We can describe augmented reality in the context of BIM as a system in which a BIM model is utilised to complement a real-world environment. It's also possible to imagine an AR-enhanced BIM modeller, where BIM model data is changed in an artificial world. AR is currently being referred to as a "New Age" of knowledge through modern technology by academics and practitioners in the field of knowledge based on the positive impact of its digital competencies on the construction industry, particularly during the construction phase, where it has a significant impact on project efficiency, quality, health and safety, and, as a result, project cost and duration. However, merging real-world and virtual items might be difficult. The tracking system's origin is not aligned with the reference frame; the transformation from source to object is not accurate; the position of the virtual camera is not correct – usually due to inertial and motion-based sensor errors; and virtual screen mapping somehow doesn't accurately model the real camera. The mobile AR application utilises geolocation to recognise the current location of the user and, as a result, be capable of creating information related to the viewed object, geospatial properties for each BIM object must be generated. Second, when the information displayed in mobile AR refers to a user's position, several points surveyed within BIM must also be identified. Users will be able to stay in a real area and do mobile AR tasks using BIM data sets connected to that location at these points.

Table1. Comparison of different software's for construction management using AR.

SOFTWARE → FEATURES ↓	Oracle Latista	Autodesk BIM 360 Plan	Autodesk BIM 360 Doc	Trimble Vico office	Oracle Aconex
Visualization of 3D modelling	YES	YES	YES	YES	YES
3D object filtration	YES	YES	YES	YES	YES
3D model visualization with Augmented Reality(AR)	NO	NO	YES	NO	NO
Superimposition of 3D Data in real-world using AR.	NO	NO	YES	NO	NO
Visualization of attached documents with BIM objects.	NO	NO	YES	NO	YES
Tracking of data	NO	YES	NO	NO	NO
Task list related to locations.	NO	YES	NO	YES	NO

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II. LITERATRE REVIEW

It is critical to create and manage drawings in a BIM-based information system. The construction document (CD) stage, in particular, draws and documents the subjects determined during the project planning stage so that actual construction can take place [9]. The information to be shared in the database includes not only the physical appearance of the building, but also the specifics of each component. "BIM is the progression from traditional 2D design to a dynamic 3D model built around a database of a project's physical and functional characteristics," Scottsdale says. It means that, rather than relying on traditional paper-based 2D design, BIM provides a model built from a database containing all relevant project information for discussion [10]. The ability to improve overall project quality and efficiency, improve the ability to simulate building performances and energy usage, and facilitate better design products and multi-design alternatives were the three most important benefits. [12] According to the industry survey, 72% of businesses use Revit for architectural modelling, 50% use AutoCAD for architectural modelling, and 67% use Revit for structural modelling. Over 40% of professionals from all three AEC industry sectors said BIM was critical during the design development and construction documentation phases **Error! Reference source not found.**. BIM can assist contractors in reducing waste by improving the planning stages. As a result, it may result in cost savings. Creating new lightweight materials and building methods, such as prefabricated pre-finished volumetric construction, can help **Error! Reference source not found.**. Off-site fabrication can be aided further by the development of new lightweight materials and construction methodologies such as prefabricated pre-finished volumetric construction [14] On-site execution can be sped up with advanced automated equipment and tools such as bricklaying and tiling robots. The use of BIM with Augmented Reality (AR) will increase the chance of more reliable and quick access to the data over the site. AR will allow the users to view the 3D data or models created in CAD/BIM software effortlessly. It simply places the virtual construction on top of the real environment, this merging of virtual data and physical environment can take place in a device where AR system already exists or has potential to view and amend the data via AR accordingly. According to the report, 80 percent of medium practises (16 to 50 employees) and 78 percent of large practises (51+ employees) have implemented BIM. [10] BIM is a hot topic in both the public and private sectors. In the public sector, the Nagpur Metro Rail project is the best example of how 5D BIM technology was used to successfully complete the project. BIM is popular in both the public and private sectors in India. In the public sector, the Nagpur Metro Rail project is the best example of how 5D BIM technology was used to successfully complete the project **Error! Reference source not found.**.

Table 2. Inference of the Literature Review

AUTHOR	YEAR	TCHNOLOGY USED	FINDINGS
Eissa Alreshidi, Monjur Mourshed, Yacine Rezgui	2016	BIM solution in construction projects	Although ICT and collaboration practises are prevalent in construction projects, the industry's current level of ICT and collaboration practises somehow doesn't benefit from the implementation of collaborative BIM.
Jin, Ruoyu, et al	2017	A Questionaire-based survey based on BIM implementation	It was found from the questionnaire survey that both internal and external collaborations should be the BIM investment priority, together with the interoperability among multiple BIM software tools. Improved multiparty communication and understanding was the highest recognized return from BIM investment.
Sepehr Alizadeh Salehi, İbrahim Yitmen	2018	Analysis of the impact of BIM	The outcome suggests having automated project progress monitoring, unlike the traditional monitoring methods based on manual data collection, which is imprecise and error-prone, is very accurate and has high quality.
James S. Vaux, and W. Max Kirk	2018	Relationship conflict on performance and productivity in construction	Loss of performance from relationship conflict was identified when the schedule lengthens and the budget increases. Separating the data at each stage of the construction might help in

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		management.	stabilizing the management conflicts.
Nikolay Garyaev	2018	Analysis of risks arising in the implementation of BIM 5- technologies in construction organizations	The use of BIM-technologies positively influences the management of risks, helps mitigate threats and open up new opportunities.
Daniel Heigermoser , Borja García de Soto, Ernest, Leslie Sidney Abbott , David Kim Huat Chua	2018	Integration of BIM with Last Planner System (LPS)	This study shows that, when combining Lean Construction practices with BIM, a collaborative environment that genuinely minimizes both tangible and intangible wastes in a construction project can be created. This helps to promote an informed use of BIM and a more efficient transformation, flow, and value generation for the different project participants
Cristina Moreno, Svetlana Olbina, and Raja R. Issa	2019	A Survey study	A survey was sent to the members of five disciples, architects, site engineers, structural engineers, MEP engineers, and contractors. And found out the obstacles of using BIM as the lack of BIM Standardization, disruption in workflow to implement new BIM Processes. fast-paced and small-sized projects not justifying the use of BIM
Y. Kima and S. Chinb	2019	Problems of BIM-Based Drawings and Implementation During the Construction Document Phase	Author concluded that, the BIM result in the construction doucment stage doesn't comprise of all the essential data for the construction stage and the practical use of the drawings extracted from BIM is low.
Julia Ratajczak Michael Riedl and Dominik T. Matt	2019	Bim based Augmented Reality (AR) prototype-named AR4C.	The author found out that the BIM technology has more advantage when integrated with AR (using Unity 3D) having some limitation of visualization while using the AR4C application.
Kristyna Pruskova , Jiri Kaiser	2019	Implementation of BIM Technology into the Design Process Using the Scheme of BIM Execution Plan	For proper usage of BIM Technology, many key issues still need to be solved, like, technical standards, content of BIM documentation, which may halt the process.
De Gaetani, Carlo Iapige, Mertkan Mert, and Federica Migliacci2	2020	Understanding BIM factors	The paper argues that interoperability issues prevail as the key practical barrier to BIM implementation.
Jun Gang, Chun Feng, and Wei Shu	2020	A Framework for BIM-based Quality Supervision Model in Project Management	A framework for a BIM-based quality supervision model is developed, and quality management tools such as causal analysis, histogram method, control chart method, correlogram method, and checklist method are used. The application point analysis of the BIM quality management system at each stage is insufficient.

Abbas Mahde Abd, Ali Hussein Hameed, Balqees Mohi Nsaif	2020	Integration of BIM and Geographic Information System (GIS) technique	The incorporation of BIM and GIS into all case study documentation allows all engineers to quickly access any information in the buildings. The application of BIM and GIS integration using InfraWorks software 12in the project design stage is one of the study's limitations.
Sun, Hailing, Miao Fan, and Ashutosh Sharma.	2021	Building information modelling and three-dimensional simulation technology in industry	The designed system creates high-definition 3D simulation images in a short amount of time and with excellent performance. The results are realised in terms of the engineering cost ratio, with energy consumption and efficiency values of 20% and 40%, respectively, which are significantly better than the traditional method. The proposed method improved efficiency by 76 percent over the traditional method, making it a strong platform for construction prediction and management in industries.
Mohsen Kameli, et al.	2021	BIM/RFID-based computer system	The developed system aided in the recording, distribution, and sharing of information on a server, allowing for quick and easy identification, filtering information on staff queries, and providing 3D modelling, which can impact productivity and maintenance process enhancement. However, the study has some limitations, such as ensuring that data in RFID applications is confidential during the operation phase to prevent unauthorised access and computing complexity.

III. PROPOSED SOLUTION

Since the review covers a large number of papers, it is critical that the methodology is based on a logical study that will help to focus and elicit valuable findings into the field of research. Many researchers have concentrated their efforts on developing, analysing, and debating various solutions for managing BIM data and information flow using digital enabling tools. This paper provides a review of specifications that may be useful, namely, Augmented Reality (AR) technology characteristics incorporating with BIM to easily evaluate the assessment in construction management.

This study presents a BIM-based AR solution for improving construction work flow performance and project control through rapid object identification. By displaying information for each construction task using 3D live models, construction information can be provided at any time and from any location. The term "AR system" refers to the hardware, software, and algorithms that comprise it. In order to effectively display a realistic live 3D view, hardware must include a processor, display, sensors, and input/output devices, while software and algorithms must include a camera through which the user interacts with the virtual world. The AR system examines user interactions and acts as an interface with the Input/Output (I/O) devices. For example, more processing power and a powerful graphics accelerator, or distributed computer systems interconnected via a high-speed communication network, could enable real-time calculation and generation of graphical models, object rendering, lighting, mapping, texturing, simulation, and display.

A. Compilation of BIM with AR

1) BIM enables a more integrated design and construction process, resulting in higher-quality buildings at lower costs and shorter project duration. Using Revit or other relevant BIM software, a 3D interactive model with geometrical and technical data

related to components and materials is first created in BIM. After developing 3D models with BIM, the file containing the 3D models can be transferred to augmented reality (AR) software.

2) An input device can be a Smartphone, a computer system, a headset, or VR/AR-based glasses that are used to view the AR attributes in conjunction with BIM. They can all be used effectively for AR. A tracking process module based on AR is used to manipulate the captured data using some lines of code; first, the object is identified, and then the texture extraction of the data is performed; after identification and extraction, the data is ready for display, and the user has a screen for viewing the contents of the identified AR data.

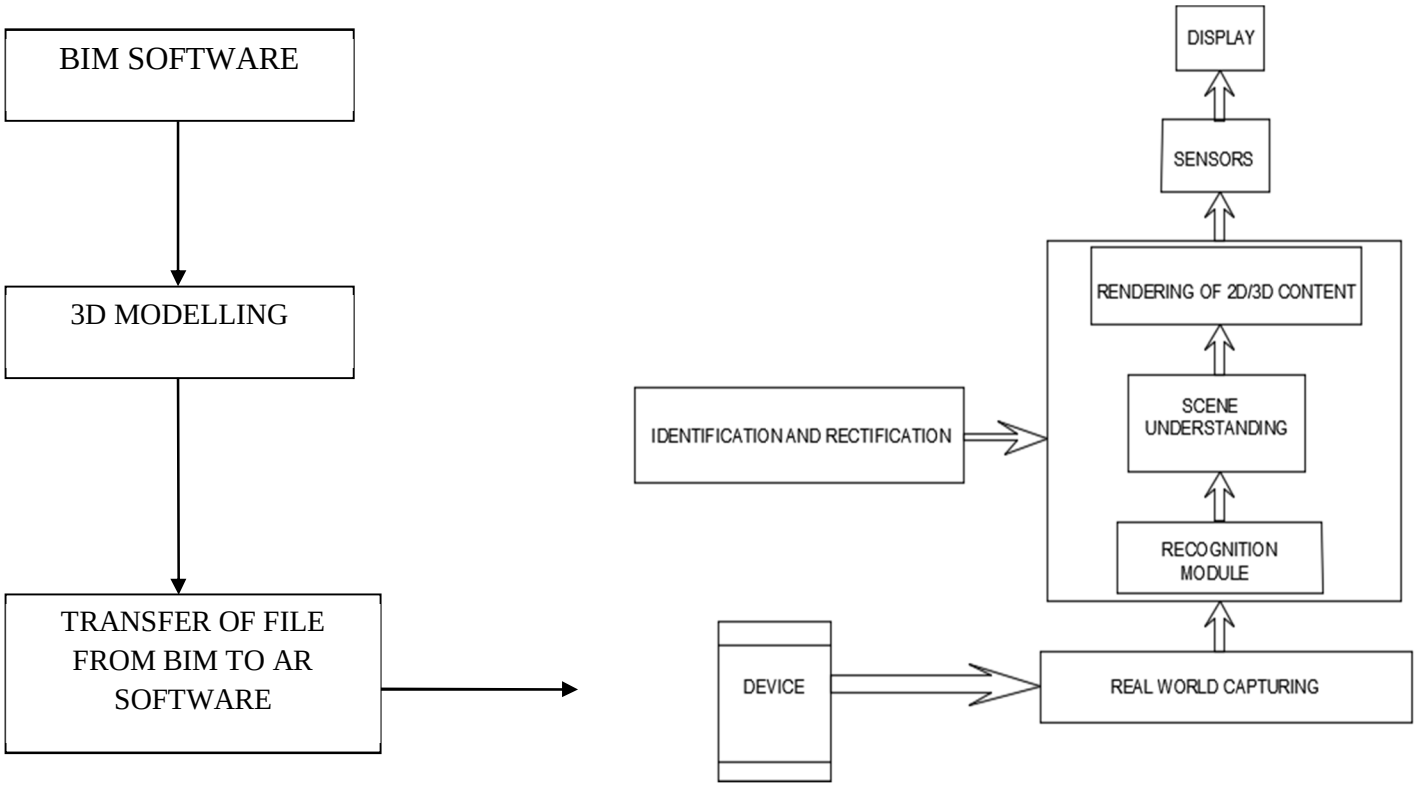


Fig. 1 BIM with Augmented Reality

Files containing the data of the models are needed to be exported in a FBX file format which is compatible with the HMD software application / AR algorithm for displaying. For the device to be able to view the 3D model, a marker and a scene needed to be prepared. Any good profile software like, 3DS Max/Revit can be used to generate the scene and to include the materials for the AR application.

IV. RESULT AND CONCLUSION

Construction management has the probable outcome to be an essential and has successful tools to improvise customer needs as well as deliver data with high productivity. In this research, we discussed about the values of both Construction management and BIM to improve the efficiency of data at the user end. This research implies the modelling of 3D data experience to remove the barrier of time management, budget constraints, poorly defined objectives, unrealistic expectation, hazard management, time management, etc. Resources of the project can be effectively used as the resources are planned, assigned and allocated to enhance every activity of the project.

V. FUTURE DIRECTIONS

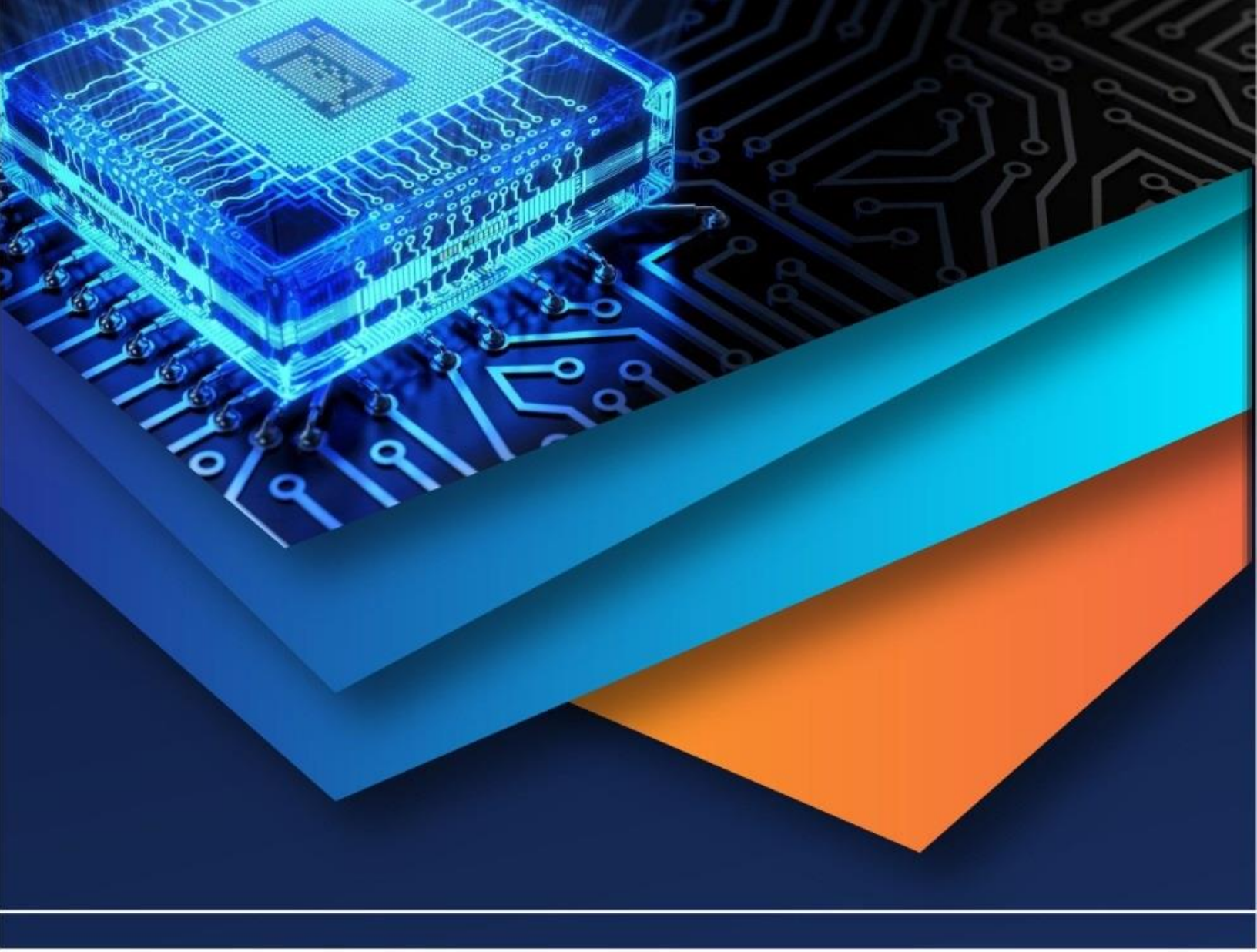
On-site productivity can be increased by as much as 50 percent by implementing a cloud-based control tower that rapidly assembles accurate data in near real time that is both backward looking and predictive (for example, using plan conformance and other variability and inventory metrics). Importantly, owners need to ensure that the right data flow through the various owner, contractor, and subcontractor systems. Big data also has a significant role to play. Techniques and data that are readily available today can produce large improvements in the accuracy of cost and schedule estimates as well as engineering productivity. Developing new

lightweight materials and construction methodologies such as prefabricated pre-finished volumetric construction can further facilitate off-site fabrication.

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