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Construction Paradigms: A Review on Web-based Project Management

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Abstract: ***Project managers in the modern construction sector are working in an environment where their core duties and functions are gradually shifting. Project managers may use their knowledge and experience earned via experience and training to adapt to the ever-changing environment and keep their professional skills operating.***
The study focuses on a novel web-based project management technique. It illustrates the dangers in existing project management approaches, as well as the problems they are obliged to face as projects get more complicated. Currently, all levels of government, industry, and consumrs are attempting to make a difference in the construction sector to improve quality, competitiveness, profit, and customer value. The findings of this research will show how web-enabled project management and the features that come with it are inextricably linked to accomplishing the goals of all parties involved. However, it emphasises that to properly adopt web-enabled project management, technology, procedures, and people must all be given equal weight.
Construction businesses may enhance their overall project performance by enhancing their project's competences by understanding the relationship between the project's core capabilities and key performance indicators. The construction sector must examine the impact of technology on personnel and processes, as well as technology in addition to knowledge management, to incorporate web-enabled solutions for managing projects on a big scale. Existing procedures must be made more efficient and updated to take use of new technologies. Construction businesses will find it difficult to deploy web-based technologies if they do not fully understand the problems of change management and how to get everyone on board.
Keywords: Project Managers; web-based project management; Construction; Business advantages; Construction paradigm; Project management

I. INTRODUCTION

The notions of project management and projects are not new. Many huge undertakings of all proportions have been successfully accomplished by various generations throughout history. Large-scale defence programmes were the first to adopt project management in the 1950s (Peters, 1981). As the concept became more popular, smaller companies began to adopt it. Today, even the smallest construction companies can employ some form of project management. Project management is a lot about avoiding problems, dealing with new terrain, managing people, and achieving clear goals quickly and efficiently (Reiss, 1995).

A generic project is one that has a variety of statuses. It may be thought of as an idea, a concept, feasibility studies, implementation, and finalization (Peters, 1981). Projects are more complicated than they've ever been. These projects require greater capital investments, involve many disciplines, are distributed across multiple project participants, have tighter deadlines, and adhere to strict quality standards. Because of the fast advancements in information and communication technology (“ICT”), project management techniques are changing.

The last few years have witnessed many changes in business and organizational environments, including in project management (PM). This includes everything from daily operations to global project development. Digitization has been a tool to help you work faster, more collaboratively, and learn more. It also helps you produce unparalleled results. With the growth of global marketplaces and companies that are executing multiple projects simultaneously, the internet of things (IoT), would require the actualization of PM through project knowledge throughout the project's lifespan. Start From project launch to completion, IoT assures a smooth transition at all stages of the project's life cycle. As well as being tactically aligned with the organizational goals, these are the objectives (Lientz & Rea, 2011).

The problems of construction project management are briefly discussed in this article. The study then goes on to explore the impact of technology on project management, as well as the new internet-based project management paradigm. The study also contains case studies that show how the Internet can help with project management. Finally, it offers an assessment and suggestions for how to proceed.

II. PROJECT MANAGEMENT DIFFICULTIES

All stakeholders, including the government and industry, are working together to create a better construction industry. This will improve quality, profitability, and competitiveness, along with that clientele management will also benefit (Egan, 1998). These initiatives aim to create a culture that encourages cooperation, teamwork, as well as continuous improvement in performance within the industry. Traditionally, the focus was on controlling the client-project interaction. The emphasis is now on controlling the flow of activities across the whole project life cycle, with a higher emphasis on value-adding activities (Accordant, 2015).

Construction managers confront several obstacles, particularly when employing manual methods. Construction is a fast-paced and complicated industry. As additional subcontractors are added to the mix, the number of stakeholders grows. The plans and specs for a project are always changing. Every stakeholder is often isolated and not able to communicate with other companies. This is where outdated information can cause problems in a project. Budget overruns or profit drain can cause delays and other problems (Iyer, 2021).

A. Challenge 1: Communication/Keeping everyone informed

There are many types of documents that are necessary for today's construction environment. Sometimes it can be hard to keep up with all the new versions and find out if subcontractors have been updated.

B. Challenge 2: Accountability

Contractors often use inefficient manual processes to manage their projects. Get busy! These key tasks are shared by many people.

C. Challenge 3: Visibility

Project delivery is complicated. You need to track job costs, track jobs, and maintain project data. It can be overwhelming and time-consuming.

D. Challenge 4: Maintain projects within budget and on-time

Contractors today have higher expectations than ever. There are Increasing green considerations, increasing energy efficiency, and rising labour Material costs and many other issues require a fresh approach. Project management. Contractors must be more flexible and collaborative to succeed. Transactions from the office or on the job site. Design reviews can drag on for far too long without being completed. This could lead to missed inspections and delays (Accordant, 2015).

Other variables might also have an impact on the shifting building landscape. These elements are linked and interconnected(Transport Department of the Environment, 2000). Here are some examples of such elements:

1) Many sectors have been put under strain because of globalisation. Tariff barriers are eroding, and the workforce is becoming more mobile. Foreign firms' capacity to compete with local enterprises in terms of delivery, pricing, and quality is influenced by several variables.
2) Economic forces can have a significant impact on the client's organization and consequently may affect their initial goals for projects (Lientz & Rea, 2011).
3) Construction productivity has seen a significant increase in client sophistication. Customers expect higher-quality services and goods at reduced costs. As a result, a buyers' market has emerged in which companies compete for lower-margin projects. Clients want improved project management to guarantee that the project is managed successfully.

III. CURRENT PROJECT MANAGEMENT TECHNIQUE LIMITATIONS

The current project management methods are not able to effectively address these challenges. These limitations can be divided into the following categories.

A. Inadequate Communication

Current project management approaches are frequently siloed, focusing on difficulties that arise during certain stages of a project. The following are the consequences of this issue.

1) *Additional Costs Incurred Because of the Redoing:* Rework might be complicated by conflicting information or information that isn't obtained in a timely manner by the people concerned. The major reason is a lack of consistency in information flow between various stakeholders involved in a building project. According to the Built Environment and Transport Panel, process-related difficulties account for up to 30% of construction rework, or around a quarter of overall construction activity in the UK

(Egan, 1998)(Transport Department of the Environment, 2000). Clients and architects may make frequent changes to their designs and fail to communicate them effectively to subcontractors and contractors in time to ensure that they are implemented properly. This can lead to rework, & finally puts a pressure on the client's financial situation. On building sites, this is the most prevalent form of job.

2) *Inadequate Integration in the Supply Chain:* Ordering, buying, and billing processes now in use are prone to mistakes. They can cause supply delays, reduced coordination between manufacturers and suppliers, and a lack of connectivity between purchasing and accounting tools. Implementing current material procurement systems that are not compatible with project plans or schedules can lead to delays. Stock control policies, such as stock control policies, can be affected by a lack of an integrated procurement system. Due to the inability to accurately predict the resource requirements of a project, construction firms often have a large stock. This is due to a lack of integrated systems to fulfil this demand, as well as insufficient coordination and communication among supply chain participants.

B. Automation in Management

There have been many technological advances in the 1990s that have led to the development of powerful software packages for construction. Although these packages have been deployed as needed, they have not had much impact on the project level. These are just a few examples of such a problem.

1) *Culture and Electronic Communication:* Even though many construction companies are utilising technology to enhance processes/applications, the construction industry has historically preferred to provide hard copy paperwork over electronic forms for auditing and record keeping. (Deng, Li, Tam, Shen, & Love, 2001) demonstrates how structural issues impede communication in the construction industry. Revisions to drawings and instructions must be submitted in hardcopy form. The architect's signature or chop must be signed on the original drawings. Contractors must acknowledge receipt by writing. These endorsement procedures cannot be completed electronically. Project Managers have Difficulty processing the correct information when they need it because of the mix of hard and electronic copies within organizations.
2) *No Software Integration:* Today's IT system software solutions are geared toward specialised activities such as project planning, monitoring, estimate, and design. As a result, a large range of standalone apps with no or only “fixed” communication linkages have emerged. It is missing an integrated system that allows for seamless information flow across project stages (Mustafa. Alshawi, 2007).
3) *No Common Mechanism for Exchanging Information:* As previously stated, hardware and software incompatibility has caused a serious technical issue that has made it difficult for project managers to access and manage project data. These issues come from a lack of project information standardisation, which would allow for seamless information flow across diverse applications and hardware. The present IT solutions in use by the construction sector do not consider the demands and preferences of big construction project participants (M. Alshawi & Faraj, 2002).
4) *Inadequate Decision-making tools for Project Management:* Planning may be a time-consuming process that necessitates the participation of all members of the project team. It also depends on the situation. This procedure might be substantially improved if proper decision-making tools were included into the framework. This path has yet to be chosen.

C. No Conventional Project Management Methods.

Project managers' experience is what steers projects. Even inside an organisation, each project manager likes to rely on his or her own long-term experience. These behaviours can result in substantial differences in management practises, which can have a significant influence on the capacity to coordinate and regulate project data (Mustafa Alshawi & Ingirige, 2003).

IV. THE INTERNET'S AND BUSINESS MODELS' EFFECTS ON PROJECT MANAGEMENT

Factory-based manufacturing industries have enjoyed increased safety and economic benefits from automated data collection and management of production processes using robots. Because of the often-changing operations and harsh weather conditions, field-oriented sectors like construction have taken longer to adopt automation technology.

Many companies have noticed a significant improvement in their project management processes due to the introduction of new technologies. One of the most important technologies is the Internet. Many businesses use this technology to communicate and exchange information. Construction companies also use the internet to communicate with dispersed workers and multi-national teams. The Internet may be the solution to the problem of communication in construction (Mustafa Alshawi & Ingirige, 2003). Unfortunately, communication among project members has not advanced in the same way.

To make this possible, hardware and software implementations must follow a set of standards that provide open and simple access to a variety of vendor solutions. This necessitates the use of open systems.

Recent efforts to rationalize the industry Integrated planning and design have been reached. Manufacturing and assembly like Industries manufacturing. The former separated Information about design and construction Planning and integration are key components of a large project. Construction system. This conceptual progress is Considered as the catalyst for construction automation (Underwood & Alshawi, 1997).

Another reason the Internet is so popular is its ability to increase business performance. Many business models have changed. These business models include those that use the Internet to manage projects and improve internal processes. The next section will discuss these two issues in more detail.

A. Focus on Communication and the Internet

1) Communication: Even though there have been many improvements in project management techniques, it was not until then that people understood the importance of communication in solving these problems. (Scanlin, 1998) explains that communication takes up 75 to 90% of project managers' time. The information must always be accessible and up to date. He describes how the "Bell Atlantic project manager centre" for excellence uses their website to convey standard practises to customers, notify them about training classes, video conference possibilities, and networking opportunities, discuss lessons learned, and recognise exceptional performance. Most project failures, according to Biggs, are due to a lack of communication. Communication issues that might lead to project failure can be reduced using web-based solutions that are linked to email and collaborative software (Mustafa Alshawi & Ingirige, 2003). The distance between project participants, which spans across national borders, is the major cause for the delay in decision-making, according to (Deng et al., 2001). Construction project management is plagued by a slew of communication issues, including message delays and distortions. Due to the dismissive nature of long-distance calls and facsimile transmissions, construction project managers have found it difficult to identify suitable alternatives. Gartner Group found that middle-level managers are the most likely to interact across an organization (Wong, Mak, & Li, 2002). These middle-level executives are referred to as "knowledge workers." The greatest possible Return on Investment will come from interactions amongst knowledge workers using existing collaborative technologies (ROI). In Fig. 1, they illustrate the interaction at different levels. Even if senior executives have minimal communication, it is the knowledge workers that communicate more regularly on the project's day-to-day operations. Knowledge workers, according to Gartner Group, use most collaborative IT technologies like as email and online applications. New technologies have been created to facilitate communication and information sharing. The construction industry, however, has been slow to adopt web technologies. This contrasts with the retail and manufacturing industries which have seen the most recent developments. This is changing, though, as more construction businesses see the need of greater communication among project participants. This may result in improved cost efficiency and quality.

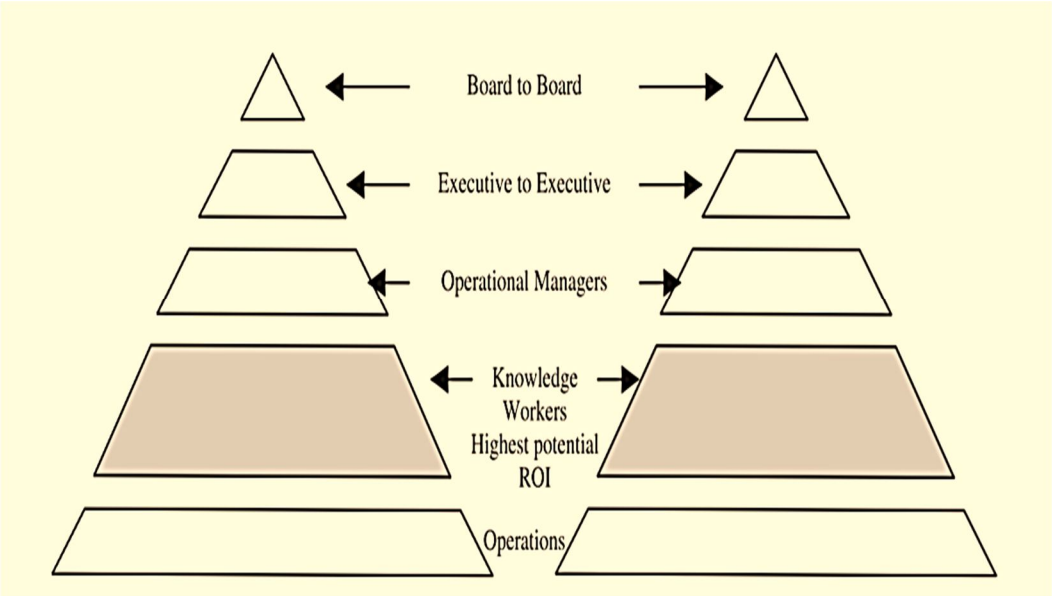

Fig 1: Interactions between people at various levels in two organisations

2) *The Internet:* The Internet is expected to be a huge advantage for project managers in the coming years. The internet facilitates the flow of data. This provides for speedier delivery of communications and the ability to track them down. Using the Internet to connect with building sites in other countries may save money for businesses. Maintaining and providing the Internet is less expensive than IDD and couriering. An Internet link between organisations is highly useful since it allows enormous volumes of data to be sent between sites, headquarters, and other firms. The Internet is a worldwide network that is unrestricted by geography, time, or computer operating system. Distributed projects are becoming more feasible due to the rapid advancement of communication technology. Project participants can be distributed across the globe but coordinated using sophisticated tools. Because of the increased accessibility and use of the Internet by small to large-scale construction businesses, project management may now be done online (Lientz & Rea, 2011). Many technological advancements have made it possible for companies to manage projects online. Teleconferencing and virtual meetings Audio-conferencing, and teleconferencing are examples of these advancements, which are now being employed by some project management software. Due of high starting expenses and transmission fees, teleconferencing systems were previously ineffective, according to Ellis. However, today it is possible to connect boardrooms to boardrooms with higher CPU speeds and faster modem speeds. Teleconferencing and other collaborative tools can make all parts of the project one. Audio-conferencing and teleconferencing allow the dispersed team to come together. Takaneka, Japan, created technology that allows people from all over the world to cooperate using the Internet as an information management tool, even if they are physically separated. The project website may be accessed using a user ID and password (Edum-Fotwe & McCaffer, 2000). You may also see all project-related material, such as pictures, progress reports, CAD data, minutes, and so on. There's also a virtual conference room where you can get all the details about the project.

B. Emphasis Placed on Business Models

Another aspect that has made project management more accessible online is the web's capacity to integrate project management with business models. (Scanlin, 1998) mentions global improvements in quality management systems like ISO 9000 and the Malcolm Baldrige programme, which are both important drivers of project management software adoption. Project management systems have been influenced by several business excellence models, such as the EFQM model.

The EFQM Excellence Model can be used to self-assess project management effectiveness. The project manager will be able to identify its strengths and areas for improvement. Project management online will help improve the process of a project, create a more focused strategy, and motivate project participants. Online collaboration is also beneficial, as it allows for project tracking online, quick access to current information, and increases the project's dynamism (EFQM, n.d.). This scoring system allows organizations to compare their performance with others and measure the improvements. The EFQM's core is the excellence model. This tool allows for self-assessment using RADAR (results, approach, deployment, and assessment). RADAR allows you to self-assess new approaches, such as web-based project administration. This is done by following the steps. These are the steps to follow:

1) The web-based software can be used to determine the organizational financial, operational, and stakeholder perception goals.
2) Plan and create a sound strategy to achieve the desired results.
3) You should systematically apply the methods so that you can get a full investigation.
4) Regular measurement allows you to evaluate and revise the methods. This promotes learning and encourages improvement (Oracle, n.d.).

(Jackson, 1999) also believes that the results must address all relevant areas within the organization. This improves the self-assessment exercise's score, indicating great organisation. As a result, (Jackson, 1999) feels the Internet may be a key performance driver.

V. LEVEL & TYPES: COMMUNICATION OVER NET

The Internet's potential to bring together construction workers in a collaborative environment is limited as a technology. The Internet by itself will not be able to foster interoperability among the participants. This is due to variances in software and hardware utilised inside companies, as well as changes in the content and format of data/documents that are transferred. This section will go through the various layers of data sharing that are required for project management (M. Alshawi & Faraj, 2002).

Data exchange refers to the act of exchanging information between construction parties to reach project goals. Data exchange helps reduce duplication and re-entry. Data can be sent across various apps and/or professions. These programmes are frequently used to enhance applications like planning, design, and estimating. Each department has its own set of hardware, which is frequently incompatible.

A. Data Exchange Across applications/organizations/industry

Drawings must be shared between designers during the design phase to meet the client's requirements. These drawings can be changed by printing them out, which means they need to be redrawn. Or, if the design software is compatible, it can read DXF or another standard data format, a disk/network will allow you to exchange them. This is also known as data sharing between organisations (Nikas & Poulymenakou, 2006). Designers might change the design drawing to fit the demands of the customer. Other members of the organisation may be affected immediately by these changes. They should be notified in this instance. If this isn't handled properly, it may have devastating repercussions. Application data exchange is the term for this. The design company sends the tender to contractors and, on occasion, the client during the tender stage. If the systems are compatible, this can be done via disk/networks. You may also utilise specialised communication protocols such as Electronic Data Interchange (EDI), which allows any application to be read in any format. This is referred to as "industry data sharing." (Underwood & Alshawi, 1997)

B. Data Exchange Types

The element/object and document groups are the two types of information that may be exchanged across apps. The data sent at the object or element level can have a big influence on the application's result. Information about a beam or a column can be shared across design programmes.

Changes to this data will have an impact on the program's other data. An image refers to the data delivered at the document level. Users are the only ones who can see, share, and annotate it. Information sharing at the object or element level is far more complex than at the document level. For the first, you'll need appropriate hardware and software that lets you read and transmit data across programmes.

It also necessitates the adoption of common standards that allow data to flow freely between apps. The industrial foundation classes are among them (IFC). Documents can be attached to web-based applications using standards like the Internet. The basis of all web-based project management software relies on the sharing and exchanging of documents. Information can be exchanged in the form of documents.

These documents can be stored in one database that users can track, view, and manipulate as they need. There is presently a plethora of software solutions available to help with various forms of document-based data exchange. They're all part of the web-based project management umbrella.

This software may be used to satisfy the requirements of many stages of the project lifecycle, including. Clients, contractors, subcontractors, and others exchange tender documents during the tender stage. Clients, contractors, subcontractors, and others exchange tender documents during the tender stage.

VI. THE MULTITUDE OF WAYS IN WHICH WEB-ENABLED SOFTWARE CAN BE USED

This section quickly describes the key aspects of currently available web-based software that falls under the category of web-enabled project management solutions (Ershadi & Goodarzi, 2021). These qualities are investigated in terms of their use at various stages of the project's life cycle.

A. Tender Stage

This programme is used to disseminate tender papers, choose and award-winning tenderers, and publicise the tender process. The programme may be used to streamline the distribution of papers and tenderer communications, as well as register tenderers online and electronically download work packages and tenders. They also make it simple for tenderers to reply by using common templates.

B. Construction & Design Stage

To guarantee that deadlines are fulfilled, project managers oversee and supervise communication between project personnel. The right papers, such as the most recent version of drawings, specifications, and requirements, should be sent to each member of the team at the appropriate time. This stage makes use of web-based tools to keep track of all current and previous versions in one place. To decrease the chance of mistakes and rework, make sure that everyone on the project team has the most up-to-date drawings and other documents. Allow team members to ask questions and then answer in an organised manner to improve team communication. Allow the design team to comment and mark up drawings online. This will save you time and allow them to track all communications (audit trail facility) (D'Aureliano, Costa, Júnior, & Rodrigues, 2019).

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C. Trading (eCommerce)

The process of purchasing materials can be complex and time-consuming. This entails locating important resources and possible suppliers, as well as evaluating and approving quotations. These are often received in a variety of formats. This stage can be reduced by using web-enabled software. It allows for document handling to be automated and communication to be done electronically.

VII. EXAMPLES OF WEB-ENABLED PROJECT ADMINISTRATION SOFTWARE

The construction industry has seen a rise in web-enabled software that allows for the monitoring, control, manipulation, and storage of project information (Faraj, Faraj, Dr, & Professor, 1999). This data can then be made available to everyone. As a result, software now offers a wide range of tasks and features that have improved the cost-effectiveness and efficiency of project management (Wong et al., 2002). Some software offers more complete solutions for project management throughout its lifecycle than others. Fig 2 depicts certain number of web-based construction project management Softwares that are on trend.

Fig 2: Web-based Construction project management software examples

VIII. RISKS INVOLVED IN WEB-ENABLED PROJECT ADMINISTRATION SOFTWARE'S

Other flaws exist in the existing internet-based project management systems (Andipakula, Senior, Nobe, & Skiba, 2017). The following are some of these flaws.

A. Security of Project Information

For any project team member to collaborate online, security is a critical issue. There have been new technological advances in providing security for sites to prevent unauthorized access. They do however create financial constraints for project teams, as they must be included in project feasibility studies (Iyer, 2021).

B. Integrated Databases

Providing integrated solutions at the object level using document-based interchange technologies can assist to create a better environment(van Hoff, 1997).

C. Drawings Ownership

Some designers believe that centralising data (e.g., design information) is infringing on their copyrights. They can download the files from the server as many times as they need and then print them when they get at their destination. Others may believe that if drawings are kept in a central location, they would lose control of the project.

D. Cultural Issues

Traditional procedures remain in force, such as “receipts of designs must be confirmed in writing” and “issues of drawings must go through the architect's cut.” These approaches are still utilised in the building industry. Electronically transmitting designs between participants isn't a standard technique, and it's not widely used in the business (Hass, Brunvoll, & Hoie, 2003).

E. Will Telepresence Take the Role of in-person Meetings?

Although a lot of Construction buzzwords such as "virtual meeting" and "teleconferencing’’ are being used, it is not yet possible to eliminate the need for the periodic site/project meetings.

IX. CONCLUSION

As a result of construction integration, suppliers will have a greater impact on design. This results in better-suited designs. Recent reforms have made it possible to integrate the design, fabrication, planning, and assembly processes. This is like what the manufacturing industry does. Engineering, management control, contract administration, and other managerial tasks are increasingly integrated. All stakeholders, including the government and industry, are working together to create positive changes in the Construction Industry. This will improve quality, profitability, and competitiveness as well as increase clients' value (Hass et al., 2003).

Electronic data interchange, particularly web-enabled Project Management and eCommerce is a strong instrument for improving an organization's internal performance, as well as the supply chain and, as a result, the customer. Unlike many IT solutions, web-based tools are focused on information exchange throughout the project lifecycle. It's critical to be ready for their deployment both within an organisation and among all stakeholders. As a result, planning and managing the proper use of these technologies is complex. Participants' unwillingness to share information and a lack of clear evaluations of business models best suited for the adoption and adaption of web-enabled Project Management Software further hinder the deployment of web-based solutions. Web-based development has frequently been driven by end-user products. They haven't been linked to any business processes. Resource waste and unrewarding expenditures have resulted from the lack of a strategic-driven implementation plan (Ghobakhloo, Hong, Sabouri, & Zulkifli, 2012).

Construction companies must be able to move at Internet speeds. The Internet is transforming the way construction firms conduct business. This industry was traditionally paper-intensive. Wireless Internet offers greater mobility and expands the possibilities for its use. This increases information exchange opportunities at all stages of the project and results in better project quality.

To integrate web-enabled project management solutions on a broad scale, the construction industry must evaluate the influence of technology on people, process, technology, and knowledge management. Existing processes must be made more efficient and redesigned to take use of new technologies. It will be difficult for construction businesses to use web-enabled technologies unless they thoroughly comprehend the challenges of change management and how to effectively get people on board.

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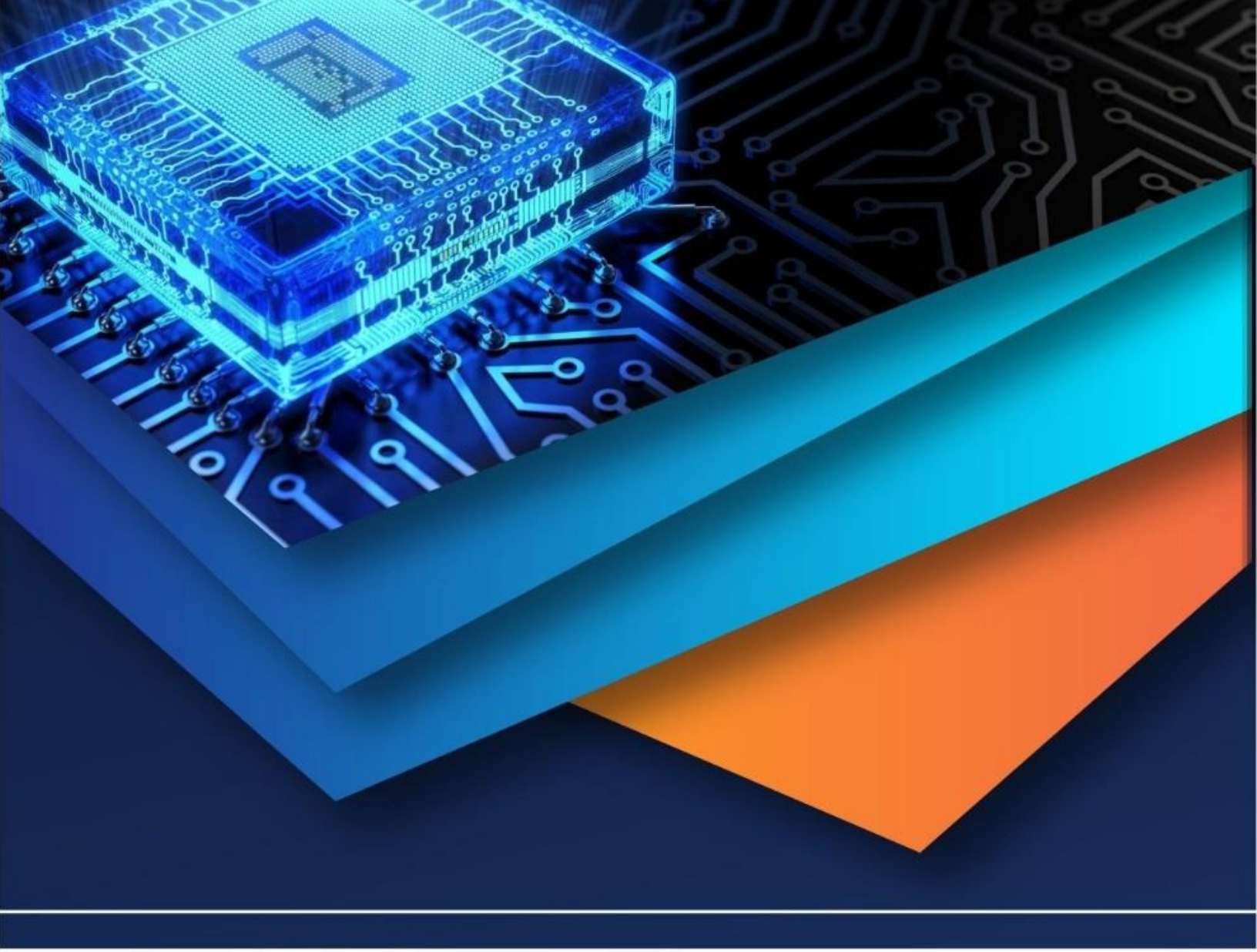

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