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Research Article

Application of Information Technology in Construction : A Case from Nepal

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ABSTRACT

This study aimed to identify the functions of information technology (IT) in the development of the construction industry in Chitwan and Nawalparasi. The study utilized a 5-point Likert scale questionnaire survey administered to ten contractors and ten consultants in the area. The survey included remarks about how IT is used in the construction industry, and four areas of IT use in construction were established. The identified outcomes were evaluated using Relative Importance Index (RII) and Ranking. The study found that the operational level, design level, and official level of management were the three most important levels of management by the relative importance index analysis. The mobile phone, laptop, and desktop computer were the primary hardware devices utilized on-site, and Microsoft Office applications such as Excel, Project, PowerPoint, and Word were determined to be the most important applications used in site administration. The study concluded that IT is a critical tool for the administration and management of construction projects. The findings of this study are consistent with other research that highlights the importance of IT in the construction industry. Information technology is streamlining operations in the construction sector, improving construction quality and safety measures, and maximizing efficiency and reliance on data in construction. The adoption of data-driven technologies such as building information modeling (BIM) is transforming the construction industry. Modern technologies and construction software are helping to control the information and disseminate it so it can be available and useful to project teams. Overall, the use of IT in the construction industry is becoming increasingly important, and its benefits are clear.

Keywords: *construction, data, industry, information technology (IT), RII index*

Introduction

The term "data processing" encompasses various steps involved in acquiring, organizing, transforming, transferring, utilizing, and trading information. To effectively process data, the use of information technology (IT) is crucial as it automates and standardizes these processes. Numerous studies have extensively documented the benefits of utilizing IT in various fields, including the construction industry (Sladowski et al., 2019).

In the construction industry, IT plays a vital role in the effective administration and management of building projects. The utilization of IT presents an opportunity to enhance organizational performance.

The construction industry is characterized by a significant amount of data, complex commercial and contractual relations, numerous participants, and unique project properties (Trimble Viewpoint, 2021; Mishra, 2020a & b).

Therefore, having good management is crucial for the success of projects and construction companies, considering their distinctiveness and special characteristics (Jonas Construction, 2020).

One method for ensuring consistent performance and high-quality output in construction projects is the adoption and usage of information technology. (IOP science, 2021) IT tools such as 3D modeling access, project management software, and collaboration tools have significantly transformed the construction industry (Plebankiewicz & Malara, 2020).

These tools enable builders to adjust drawings and designs, publish updates, reduce construction time, and minimize paperwork. Additionally, the adoption of data-driven technologies like building information modeling (BIM) has revolutionized the construction industry.

Overall, the integration of information technology in the construction industry has brought about significant changes and improvements. It streamlines operations, improves construction quality and safety measures, maximizes efficiency and reliance on data, and enhances project management and collaboration (Jonas Construction, 2020). The use of IT tools and software helps control and disseminate information, making it readily available and useful to project teams. (IOPscience, 2021) As a result, the construction industry can benefit from increased productivity, cost savings, and improved project outcomes.

Problem Statement

The study aims to enhance understanding of project operations, including sales strategies, aids, and returns, in the Nepali construction industry.

The findings contribute to improving project management practices and decision-making processes in construction projects.

Analysis of the operation of projects in Nepal, specifically in the context of infrastructure construction and contract administration (Mishra & Aithal, 2023b). Causes of time overrun and its impact on the cost of construction of small hydropower projects in Nepal (Premdilip & Uma, 2020; Mishra & Aithal, 2023a, b, c, d, e, & f; Ju & Fu, 2022). The study focuses on assessing the causes of time overrun and its impact on the cost of construction of small hydropower projects in Nepal.

The research highlights the importance of timely completion of construction projects, particularly in the context of small hydropower projects. Factors contributing to time overrun and cost escalation are identified, and strategies for reducing delays and controlling costs are explored.

Operational analysis of projects in Nepal, with a focus on features of sales aids and returns (Mishra & Aithal, 2023a). The research analyzes the operational aspects of projects in Nepal, specifically examining the features of sales aids and returns.

The research focuses on analyzing the operation of projects in Nepal, with a specific emphasis on infrastructure construction and contract administration.

The study aims to provide insights into the challenges and opportunities related to project operations in the Nepali construction industry.

The findings contribute to enhancing project management practices and optimizing contract administration processes.

The factors and impact of risk management practices on the success of construction projects of housing developers in Kathmandu, Nepal (Ju & Fu, 2022).

The research examines the factors and impact of risk management practices on the success of construction projects carried out by housing developers in Kathmandu, Nepal.

The study highlights the importance of effective risk management in ensuring project success and minimizing potential risks and uncertainties.

The findings provide valuable insights for housing developers in Kathmandu to improve their risk management strategies and enhance project outcomes.

These key findings contribute to a better understanding of various aspects of construction projects in Nepal, including time and cost management, operational analysis, sales aids and returns, contract administration, and risk management practices. They provide valuable insights for industry professionals, policymakers, and researchers in the Nepali construction industry to improve project performance and achieve successful project outcomes (Mishra & Aithal, 2023a, b, c, d, e, & f).

The construction industry is characterized by unique challenges that set it apart from other industries, including one-off projects, industry fragmentation, low technology awareness and training, required upfront investment, ongoing maintenance costs, and resistance to change (Gasparik et al., 2018). Despite the numerous benefits of information technology (IT) in construction, the industry appears to be moving slowly toward effective IT implementation. Effective information management and communication throughout the project life cycle are key factors in collaborative working, yet the communication process becomes complex and challenging to organize and control as the number of participants rises. The integration of IT in construction management is crucial for timely and successful completion of construction projects, and the use of specialized software, communication technology, and ICT tools supports the industry's growth and innovation. Therefore, the problem is to identify the barriers to effective IT implementation in the construction industry and explore strategies to overcome these barriers to improve project management, enhance collaboration, streamline workflows, and efficiently manage data. All the problem could be attempted to be managed by IT Application.

Research Objective

The main target of the research was to survey the uses of information technology in the construction industries inside Chitwan and Nawalparasi.

Literature Review

Information technology (IT) is defined as the "use of electronic devices and software for the processing, storing, transferring, and presentation of information" (Bjork, 1999). IT has been an essential component of corporations' internal control systems for a very long time. However, the construction industry is just getting started with the rapid expansion of its usage of information technology. The construction industry appears to be moving slowly toward effective IT implementation due to its unique characteristics that set it apart from other industries. These characteristics include one-off projects, industry fragmentation, low technology awareness and training, required upfront investment, ongoing maintenance costs, and resistance to change (Enstep, 2022). Several methods related to information technology can considerably improve construction industry data management. Effective management of information resources is crucial to the completion of any project (Dikbas & Morten, 1999). Planning, organizing, running, and controlling a project can all benefit greatly from the use of IT.

In contrast to other sectors, the construction industry does not benefit as much from the use of information technology (Feng, 2006). IT tools such as general-purpose applications, building engineering applications, cost estimating, planning, scheduling and site management, safety and compliance, drone technology and site survey software, and mobile apps and field data collection have significantly

transformed the construction industry (Enstep, 2022). General-purpose applications such as word-processing software, email clients, and databases cater to a wide range of functions, serving as valuable assets for businesses in their day-to-day activities. Building engineering applications such as Building Information Modeling (BIM) software, Computer-Aided Design (CAD) software, and Energy Simulation software significantly enhance productivity, reduce errors, and promote innovation in the construction and architectural sectors, contributing to the successful completion of projects and the creation of sustainable and efficient buildings. Communication technology is also a significant aspect of IT in the construction industry. Communication networks are necessary for all parties involved in a building project to exchange data and information. Teamwork and coordination may be improved as information flow improves (Enstep, 2022: Feng, 2006).Overall, the integration of information technology in the construction industry has brought significant changes and improvements. It streamlines operations, improves construction quality and safety measures, maximizes efficiency and reliance on data, and enhances project management and collaboration (Bjork, 1999: Enstep, 2022: Feng, 2006). The use of IT tools and software helps control and disseminate information, making it readily available and useful to project teams (IOPscience, 2021). As a result, the construction industry can benefit from increased productivity, cost savings, and improved project outcomes.

Review of Empirical Literature of Information Technology on Construction Projects

Paudyal and KC (2016) examined the role of ICT in construction in Nepal and emphasized the importance of good project management for timely and successful completion of construction projects. Effective information management and communication throughout the project life cycle were identified as key factors in collaborative working. In an advanced system for the management and sharing of project information, all project-related information is compiled into a centralized database and distributed to relevant participants, facilitating collaboration (Feng, 2006).

The application of information technology in the construction industry encompasses various areas. Computing, including software and hardware, plays a crucial role in construction management. Specialist construction software such as Construction Computer Software (CCS), AutoCAD, Primavera, and Buildsmart serve specific purposes in estimating, planning, design, project management, and accounting functions (Retik & Langford, 2001).

Communication technology, including electronic communication and data exchange systems, the internet, and electronic mails (e-mail), enables improved information flow, teamwork, and coordination among project team members (Feng, 2006).

Feng (2006) conducted a study on the application of information technology in construction management in China and found that IT usage in the construction sector is expanding rapidly. Office applications, computer-aided design (CAD) software, cost evaluation software, and communication networks are among the most common applications of IT in the industry. Internet-based communication is experiencing significant growth (Enstep, 2021).

Premdilip & Uma (2020) analyzed the role of information and communication technology (ICT) in the construction industry in India. They concluded that ICT should support the entire construction process, from planning to maintenance. ICT tools facilitate information and data creation, communication, and exchange among project team members. Key ICT resources and programs in the construction industry include electronic communication and data exchange systems, the internet, and electronic data interchange (EDI) (IOPscience, 2021).

Qammaz and AlMaian (2018) conducted research on the significance of ICT in construction risk management in Kuwait. They proposed that ICT, encompassing hardware and software, facilitates effective management and decision-making throughout the construction process. ICT enables the collection, processing, management, sharing, storage, and retrieval of project-related data. It can be tailored to specific projects or activities within a project, handling information of varying degrees of simplicity and complexity (Mishra & Aithal, 2023c).

Overall, the integration of information technology in the construction industry brings numerous benefits, including improved project management, enhanced collaboration, streamlined workflows, and efficient data management. The use of specialized software, communication technology, and ICT tools supports the successful completion of construction projects and contributes to the industry's growth and innovation (Enstep, 2022; Feng, 2006; & IOPscience, 2021)

Methodology

Research Design

This investigation was conducted using a comprehensive survey questionnaire. The present study employed an action research methodology. In relation to the methodology employed in this study, two distinct methodologies were utilized: a quantitative approach and a qualitative approach. A quantitative methodology was employed to gather empirical data and analyze the relationships between various phenomena, as well as to assess the alignment of these phenomena and links with existing theories and prior research findings. Qualitative methodologies aim to gather insights and investigate the perspectives or perceptions of individuals or groups around the phenomenon of delay.

The research was conducted as a case study encompassing ten distinct construction projects located throughout the regions of Chitwan and Nawalparasi.

The methodology employed in this study involved a combination of quantitative and qualitative analysis, known as a mixed methods approach. A quantitative analysis was employed to ascertain the perspectives of respondents regarding the roles of information technology in construction projects in the regions of Chitwan and Nawalparasi. Furthermore, the inclusion of qualitative data served to provide a comprehensive elucidation of the many roles involved.

The present study was conducted based on the utilization of the stratified random sampling technique. In this context, certain scholarly works have further substantiated the rationale and benefits of employing random sampling. For instance, it has been asserted that simple random sampling is a valuable technique for sampling, as it ensures that each element within the population has an equal opportunity and probability of being chosen for inclusion in the sample.

The data analysis was conducted using Microsoft Excel following the administration of a self-administered questionnaire, which was delivered both in person and electronically.

The approaches employed in this study included the utilization of the Ordinal Scale for the computation of Relative Importance Index (RII) as well as the prioritization of components based on their RII rankings.

Study Area

The study area covers ten different construction projects inside Chitwan and Nawalparasi.

Sampling Techniques and Sample Size

The test was picked using the stratified random sampling procedure. The stratum was the Contractor and Consultant. The respondent was chosen using a simple random selection procedure.

The random sample stratum comprised of ten contractors and ten consultants drawn from a total

sample population of thirty.Ten were identified as no longer in operation, and 20 replies were included in the data analysis. MS Excel was used to collect and evaluate the data.

Data Collection Techniques

Primary Data Collection

A visit was made to the construction projects in Bharatpur Metropolitan City and Nawalparasi to assess the progress and ensure that the construction work was proceeding smoothly.The visit served as an excellent opportunity for the construction projects in both Bharatpur Metropolitan City and Nawalparasi to know about the use of IT tools and resources.

The questionnaire survey was conducted by personally visiting individuals and allowing them to independently fill out the questions. Participants were requested to indicate the various functions of Information Technology in the field of Construction through the use of questionnaire surveys.

Secondary Data Collection

Previous research publications served as a source for the secondary data that was obtained. This includes the applications of information technology in the construction sector. Other published and unpublished literature, reports and papers, online and sites from various published publications, and articles were also included.

Data Analysis

The optimal method for analyzing data was the segmentation of gathered information into coherent subjects, patterns, and trends. The study enumerated the various functions of Information Technology (IT) within the construction sector, followed by the administration of a survey to gather individual responses. These responses were subsequently assigned number codes for analysis. The data was analyzed by calculating the Relative Importance Index (RII) for each element to determine their centrality and frequency of occurrence.

The Relative Importance Index (RII) was utilized to determine the ranking of elements within each category.

The placement of variables within each classification was determined by the Relative Importance Index (RII), which was used to assess the degree of association between the variables and their placement within the groups. The psychometric response scale referred to is a commonly used method in which individuals indicate their degree of agreement with a given statement, often employing a five-point scale. The response options provided are as follows: (1) Never, (2) Rarely, (3) Sometimes, (4) Often, and (5) Always.

In this study, we use a Likert scale to assess respondents' opinions, with each respondent providing a rating between 1 to 5. The variables n_1, n_2, n_3, n_4, and n_5 represent the counts of respondents who chose "never," "rarely," "sometimes," "often," and "always," respectively. The highest weight assigned to the Likert scale is denoted by A, and in this study, A is set to 5.

The Relative Importance Index (RII) was determined in the following way:

$$RII = \frac{1n_1 + 2n_2 + 3n_3 + 4n_4 + 5n_5}{A\,(n_1 + n_2 + n_3 + n_4 + n_5)}$$

Results and Discussion

Frequency of IT use relative to the levels of management

On a 5-point Likert scale, respondents were asked to rate how they utilize information technology (IT) in various levels of management in the construction industry. This allowed for an evaluation of the respondents' uses of information technology in the different levels of construction management.

Table 1: RII of uses of Information Technology

S.N.	Roles of Information Technologies on Progress Construction Industries	Percentage of RII	RII	Ranks
	IT usage by management level			
1	Operational Level	82.00%	0.820	1
2	Design Level	77.00%	0.770	2
3	Official Level	72.00%	0.720	3
	Intranet access to information sources and IT functions			
1	E-mail	60.00%	0.600	5
2	Project programs	71.00%	0.710	3
3	Minutes of site meetings	72.00%	0.720	2
4	Schedules (resource)	75.00%	0.750	1
5	Construction drawings	70.00%	0.700	4
	Site hardware use			
1	Mobile Phone	79.00%	0.790	1
2	Desktop	67.00%	0.670	3
3	Laptop	69.00%	0.690	2
	Site management usage of Microsoft Office.			
1	Excel	81.00%	0.810	1
2	Word	67.00%	0.670	4
3	Project	77.00%	0.770	2
4	PowerPoint	72.00%	0.720	3

Source: (Field survey, Jun 2023)

IT usage by Management Level

To assess about the respondents' uses of Information Technology in construction's level of management, they were asked to rate how they use IT in different level of management in construction on a 5-point Likert scale (where 1=Never, 2=Rarely, 3=Sometimes, 4=Often, 5=Always).

Fig 1 shows that 28% of respondents always, 63% of respondents often, 8% of respondent sometimes and 4% of respondents rarely stated the use of IT in operational level of management. Whereas 43% of respondents always, 28% of respondents often, 18% of respondents sometimes and 13% of respondents rarely stated as the use of IT in design level of management. Similarly, 23% of respondents always, 38% of respondents often, 8% of respondents sometimes, 18% of respondents rarely stated the use of IT in official level of management in construction.

Intranet Access to Information Sources and IT Functions

Fig 2 shows that 15% of respondents always, 20% of respondents often, 30% of respondent sometimes and 20% of respondents rarely stated the email as the access to information sources and IT functions via an internet. Whereas 19% of respondents always, 35% of respondents often, 30% of respondents sometimes and 10% of respondents rarely stated the project programs as the access to information sources and IT functions via an internet. Similarly, 25% of respondents always, 30% of respondents often, 25% of respondents sometimes, 20% of respondents rarely stated the minutes of the site meetings as the access

to information sources and IT functions via an internet. Again, 20% of respondents always, 45% of respondents often, 30% of respondents sometimes, 0% of respondents rarely stated the schedules as the access to information sources and IT functions via an internet. And 15% of respondents always, 45% of respondents often, 20% of respondents sometimes, 15% of respondents rarely stated the construction drawings as the access to information sources and IT functions via an internet.

Site Hardware Use

Table 2 shows that 40% of respondents always, 30% of respondents often, 15% of respondentsometimes and 15% of respondents rarely stated the access to information sources and IT functions via an internet as the mobile phone. Whereas 5% of respondents always, 55% of respondents often, 15% of respondents sometimes and 20% of respondents rarely stated the access to information sources and IT functions via an internet as the desktop. Similarly, 15% of respondents always, 30% of respondents often, 40% of respondents sometimes, 15% of respondents rarely stated the access to information sources and IT functions via an internet as the laptop.

Site Management Usage of Microsoft Office

According to table 3, 45% of respondents reported that they always use Microsoft Office applications such as Excel at the site management level, 30% of respondents often use these applications, 10% of respondents sometimes use these applications, and 15% of respondents seldom use these applications. Whereas 10% of respondents claimed that they always use Microsoft Office applications such as Word at the site management level, 40% of respondents often use these applications, 25% of respondents sometimes use these applications, and 25% of respondents seldom use these applications. Similarly, 35% of respondents claimed that they use Microsoft Office applications for projects at the site management level constantly, 35% of respondents stated that they use Microsoft Office applications often, 10% of respondents stated that they sometimes use Microsoft Office applications, and 20% of respondents stated that they seldom use Microsoft Office applications. In addition, 25% of respondents claimed that they always use Microsoft Office applications such as PowerPoint at the site management level, 30% of respondents often use these applications, 30% of respondents sometimes use these applications, and 10% of respondents seldom use these applications.

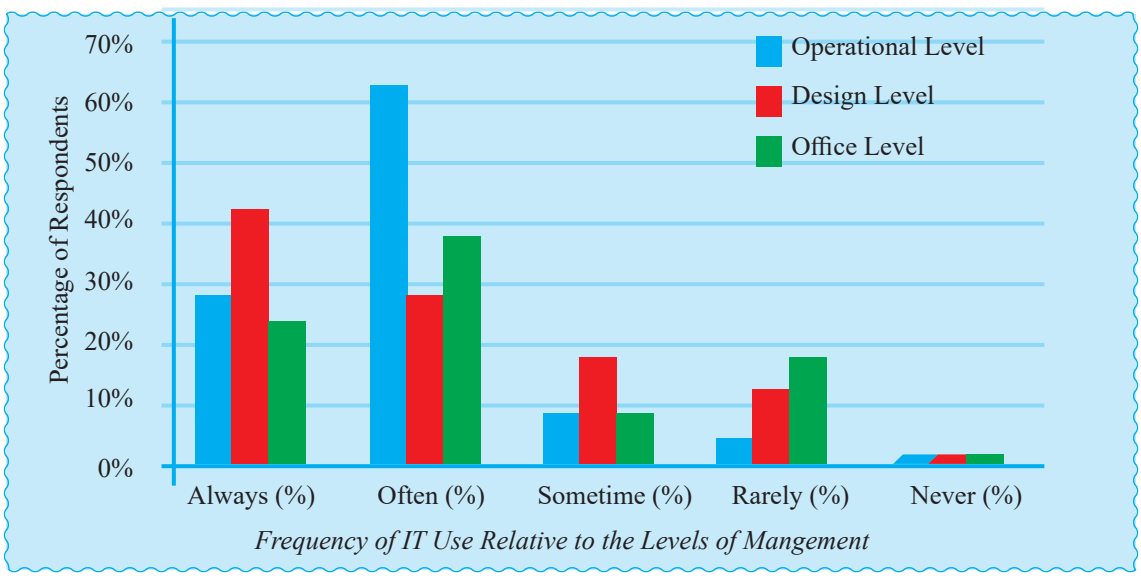

Figure 1: Bar graph for Frequency of IT Use Relative to the Levels of Management

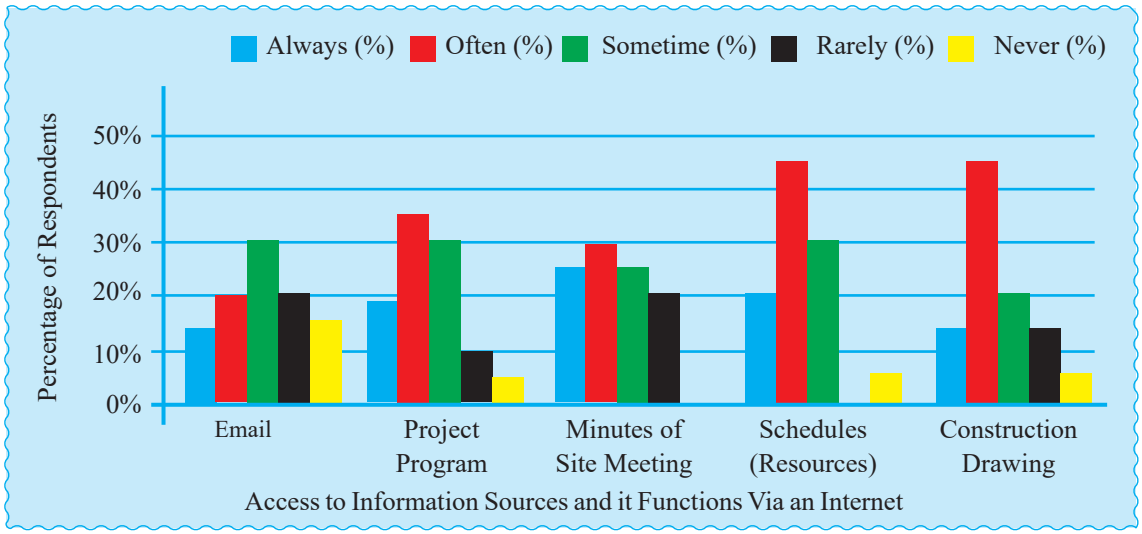

Figure 2: Bar Graph for Access to Information Sources and IT Functions via an Internet

Table 2: Extent to Which Hardware Devices Used on Site Extent to Which Hardware Devise are Used

Particular	Mobile Phone	Desktop	Laptop
Always (%)	40%	5%	15%
Often (%)	30%	55%	30%
Some Times (%)	15%	15%	40%
Rarely (%)	1%	20%	15%
Never (%)	0%	5%	0%

Table 3: Bar graph for Frequency at which Microsoft office applications are Used at Site Management Level

Particular	Always (%)	Often (%)	Sometimes (%)	Rarely (%)	Never (%)
Excel	45%	30%	10%	15%	0%
Word	10%	40%	25%	25%	0%
Project	35%	35%	10%	20%	0%
Powerpoint	25%	30%	30%	10%	0%

Results and Discussion

The findings of the study were analyzed and compared to previous research in a variety of fields. The results of the investigation into the use of information technology in building construction yielded a number of diverse applications.

Premdilip, & Uma. (2020) analyzed the role of Information and Communication Technology (ICT) in India's construction industry and concluded that the use of certain ICT hardware, such as desktop and laptop computers, digital cameras, and smartphones, is pervasive. Tablet PCs and Personal Digital Assistants (PDAs), which are more competent and advanced mobile ICT hardware, were discovered to be in short supply. Again, the firms' general attitude toward ICT is positive, and this may have influenced their confidence in varying degrees to use the technology. However, the current state of ICT usage appears to be more primitive, comprising primarily of simple hardware and software applications. The majority of businesses consider their current ICT usage to be average, despite the apparent paucity of more advanced technical ICT applications.

According to a study conducted by Feng (2006) titled Application of Information Technology in Construction Management in China, the most prevalent use of IT in business and contract administration is for office applications such as spreadsheets and word processing. Building documents are intended for electronic exchange. Utilizing office automation could improve cost management and internal management efficiency. The majority of Chinese architects have access to CAD, which is utilized by the majority of Chinese construction offices.

Koekemoer and Smallwood (2007) conducted a study on Information Technology (IT) in the construction process in South Africa and concluded that the significance of intranet access to information sources and IT capabilities—including construction drawings—indicates the need for IT expertise at all levels of site management. GCs frequently utilize Microsoft Office computer programs. However, general contractors utilize software designed specifically for the construction industry. Through project-specific intranets, IT has enhanced communication by linking the project manager, design team, consulting engineers, general contractors, specialty contractors, and suppliers. Email is a common and efficient method of communication.

The study examined IT's involvement in project management, design and planning, communication, data analysis, and other areas using construction professionals' experiences. The study examined Construction Company IT adoption patterns and trends using survey, interview, and other data.

This investigation, like the last, discovered significant similarities. The construction industry's IT uses matched the prior studies. This result confirmed IT is importance in modern construction.

IT improved construction operations, stakeholder participation, resource management, and project efficiency, according to the report. The results showed that IT's benefits are consistent across varied construction projects and that IT has become an essential part of modern building methods.

The parallels between the two studies showed that IT solutions in the construction industry are not just a trend but a strategic necessity in today's technologically driven market. It also showed how ongoing IT improvements may alter building procedures and help the business expand and succeed.

Conclusion

In conclusion, the construction industry has been slow to adopt information technology (IT), but it has become increasingly clear that IT is a critical tool for the administration and management of construction projects. The adoption of IT in construction has revolutionized the sector, streamlining operations, improving construction quality and safety measures, and maximizing efficiency and reliance on data. Research has contributed to a better understanding of various aspects of construction projects in Nepal, including time and cost management, operational analysis, sales aids and returns, contract administration, and risk management practices. Research shows that the success of individual projects depends heavily on the availability of IT, which is most commonly used in the operational, design, and official levels of management. The most popular information sources are online calendars, meeting minutes, project plans, construction blueprints, and electronic mail, and there is heavy reliance on mobile phones, laptops, and desktops at the construction site. The most popular usage of hardware devices are for Microsoft Excel, Microsoft Project, Microsoft PowerPoint, and Microsoft Word. The findings from Mishra's research contribute to enhancing project management practices, optimizing contract administration processes, and improving risk management strategies in the Nepali construction industry. As the construction industry continues to evolve, the integration of IT will play an increasingly important role in achieving successful project outcomes.

Recommendations

- The observed rise in demand within the construction industry suggests the presence of a notable disparity in information exchange between the operational activities at lower levels and the managerial functions at higher levels.

- From the planning phase through the design and construction phases and finally into the facilities management system, information is used and should be controlled.
- More work needs to be done to investigate the areas where the ICT can assist and improve the construction management process and to assess the expected benefits from implementing the ICT in the managing construction project risks.

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