ROLE OF TECHNOLOGY IN INFRASTRUCTURE PROJECT FINANCE – A SYSTEMATIC REVIEW

CA Jagjit Padgaonkar[1], Dr. Bina Sarkar[2], Dr. Rakesh Jain[3]

ABSTRACT

The role of technology in infrastructure project finance management has brought about significant transformations, revolutionized traditional approaches and reshaped financial landscapes globally, particularly in India. This systematic literature review offers a comprehensive examination of existing research, aiming to unravel the impact, challenges, and opportunities presented by technological advancements. Focusing on the Indian context, the study explores how technology aligns with global trends and identifies unique challenges and opportunities in infrastructure finance management. Themes such as digitalization of financial processes, the role of Financial Technologies (FinTech), impact on decision-making processes, challenges and opportunities in technological adoption, and integration of smart technologies are analysed to provide insights for stakeholders. The review's findings contribute to a detailed understanding of technology's influence on infrastructure finance management, guiding future research and informing policymakers and practitioners in navigating the evolving landscape.

Key Words: Infrastructure Project Finance Management, Project Financing, Financial Processes, Technological Innovations, Technology Adaptation, Financial Technologies (FinTech).

INTRODUCTION

The development of infrastructure and project finance management stands at the crossroads of evolution, with the lead of technological advancements catalysing significant transformations. In this dynamic landscape, the role of technology has become a driving force in reshaping traditional approaches and revolutionizing the management of finances in infrastructure projects. The current study of systematic literature review endeavours to comprehensively examine the existing body of research, offering a thorough understanding of how technology has infused and influenced infrastructure project finance management.

For achieving any development, technology plays a critical role in the infrastructure space in shaping the future of industries, cities, and the global landscape. The implementation of Software Defined IPv6 networks, for example, illustrates the drive toward energy efficiency and green infrastructure deployment, demonstrating the potential for significant reductions in energy consumption and carbon footprint, while also providing economic benefits to service providers and society (Dawadi et al., 2019).

There are innovations in System or transitions, which are often driven by advancement in technology, which can be influenced by various stakeholders including governments and private stakeholders. These transitions encompass adjustments in regulation, user practices,

[1] *F/O. School of Management, Ajeenkya DY Patil University (jagjit.padgaonkar@adypu.edu.in)*
[2] *Asst. Professor, School of Management, Ajeenkya DY Patil University (bina.sarkar@adypu.edu.in)*
[3] *Vice Chancellor, Ajeenkya DY Patil University (jainrb20@gmail.com)*

implementation, markets, cultural and infrastructure, all of which are critical for achieving sustainability for the long-term growth (Elzen et al).

There are areas where one of the research projects has been done in the context of urban water systems. It finds that not only technological innovation is important but also institutional innovation, underscoring the need for an integrated approach to meet future needs (Kiparsky et al., 2013). The strategic application of model transformations can also aid in managing the evolution and variability of architectural requirements in infrastructure, especially in software systems, which directly influence the adaptability and resilience of such systems (Gilson & Englebert, 2011).

On the other hand, the Internet of Medical Things, a sub sector of the larger IoT, is transforming health care through activities such as remote monitoring, elderly care, and detection of epidemics. This is a major technology adoption pathway leads to not only alters the infrastructure established but also the manner through which services are transmitted as well as monitored. Another paper introduces a model-based solution called Unit for formally integrating and composing sub transformations in a technology-independent style, resolving the predicament of embedding distinct transformation technologies into infrastructure transformation (Vanhooff et al., 2007).

(Lekan & Rogers, 2020) Technology interacts with socioeconomic elements, as evidenced by the emergence of circular economy strategies. Digital resources can either exacerbate or alleviate current social disparities. This highlights the importance of ensuring that everyone in urban areas has fair access to technology, so that benefits are distributed equitably.

(Isah et al., 2019) Cutting-edge technologies like distributed computing and stream processing frameworks are changing the game in how we handle real-time data. They empower organizations to more effectively manage and analyze vast streams of information. (Satyanarayanan et al., 2009) Virtual machine (VM) technology is crucial in this shift, as it allows for quick setup of personalized service software on cloudlets, enhancing the computing power of mobile users.

(Benantar, 2001). Public key cryptography has become a cornerstone of security in today's digital world, reshaping how we safeguard computing systems amid a growing digital infrastructure. Compiler techniques are also stepping up for software security, using program alterations to defend against reverse engineering and tampering attacks. (Liem et al. 2008)

These advancements highlight the diverse impact of technology transformations across various fields, including network paradigms, software systems, healthcare, cybersecurity, and their intersection with social and economic structures. As these technologies are adopted and integrated into infrastructure, they have the potential to reshape how society operates, drive economic progress, and foster sustainability. This paper places particular emphasis on infrastructure projects and project management, aiming to identify and comprehend the research conducted in this area. By assessing the contributions of different authors, it seeks to understand the trends and future needs in this domain.

The development of infrastructure sector, which is crucial for economic growth, has always grappled with intricate financial structures and diverse project management obstacles. However, the introduction and widespread adoption of technology have brought about a significant change, reshaping how financial aspects are planned, executed, and supervised

within such projects. This technological era has redefined efficiency, transparency, and accountability, sparking a wave of innovations that demand exploration and analysis.

Although existing literature offers valuable insights in their respective areas, there's a notable absence of comprehensive frameworks to effectively tackle uncertainties. This study aims to fill that gap by reviewing, analysing, and reflecting on the literature related to Digital Transformation in Infrastructure projects using a bibliometric approach. The study underscores the importance of prioritizing it in the current landscape rather than solely relying on past studies. The research paper follows a clear structure: it begins by explaining the use of bibliometric analysis and its impact on guiding research direction. Then, it provides a detailed description of the methodology. Next, the paper presents the findings of the study, which include identifying main themes and sub-themes in the knowledge structure. Finally, it extensively discusses the implications and potential future avenues in the concluding section, recognizing limitations and suggesting areas for further exploration.

LITERATURE REVIEW

In India's digitalization and infrastructure initiatives are aimed at making the country a knowledge economy and digitally enabled society. Digital India program, which aims to improve online infrastructure and connection, create substantial job opportunities, and make government services available electronically, is crucial to this change (Tayade, 2022). Even though there's a lot of excitement about incorporating digital technology, the country still faces hurdles in its digital transformation. These challenges include regulatory delays, problems with acquiring land, and a lack of skills in infrastructure development, all of which are essential for economic progress (Mohanty et al., 2022). Nonetheless, digital approaches are expected to become more common throughout the construction process, using data, automation, and networks to streamline operations from initial planning to ongoing maintenance (Goger & Bisenberger, 2020).

The digital landscape in India is also characterized by substantial investments. By 2030, an estimated $4.51 trillion is required to build infrastructure supportive of India's ambition to become a $5 trillion economy (Saini & Giri, 2022). The Aadhaar mega e-infrastructure project exemplifies the digital push, intended to reduce poverty and promote financial inclusion, despite facing opposition (Srinivasan & Johri, 2013).

Building Information Modelling (BIM) and other digitalization tools are being promoted to improve infrastructure project outcomes, but success demands an understanding of the organizational challenges and dynamics (Hetemi et al., 2020).

Considering the Covid-19 pandemic, institutions with better digital infrastructure displayed resilience, underscoring the digital divide's impact on education and other sectors (Shyam & Das, 2021). Furthermore, the healthcare sector's pivot to digitalization has highlighted the importance of supply chains and networking to incentivize value co-creation among stakeholders in infrastructure projects (Moro Visconti & Morea, 2020).

In terms of specific endeavours, the Nagpur Metro Rail Project serves as a case study for digital project management, evidencing the application of contemporary digital tools in India's infrastructure projects (Pakhale & Pal, 2020). When it comes to financed projects, the increased need for digital infrastructures has been evident in the transition towards drilling automation in

industries such as oil and gas, requiring adjustments in work processes and technical competencies (Saadallah et al., 2019).

However, banks in India face high default rates during infrastructure projects' construction phases, compounded by regulatory and political risks which ultimately increase capital charges required for compliance with international norms (Srivastava, 2014). This uncertain risk environment affects project sponsors' perceptions and can lead to suboptimal risk management practices in public-private partnerships (PPPs) (Gupta & Verma, 2020).

India is making strides in modernizing its infrastructure, including plans for a wireless sensor network to monitor railway tracks, which could make trains safer and more efficient (Singh et al., 2023).

IBM has undergone significant changes in its structure, strategy, and operations in recent years. Sylvia et al. (2012) discusses how IBM revamped its internal IT setup, implementing key initiatives to improve efficiency and intelligence. Tanzania is in the midst of transitioning to e-government systems, but faces challenges highlighted by Constantine et al. (2015), such as crafting effective plans and policies regarding technology, data privacy, and cyber security.

Research by Lane et al. (2016) delves into the factors influencing the pace of change in global energy infrastructure, drawing on past data and projections to grasp the scale of the challenge. Over the past two decades, there has been significant growth in global engineering capability, with an increase of over 100 GW per year in electricity generation infrastructure (Lane et al., 2016).

Yadergal et al. (2019) explore the factors driving micro and small businesses in Addis Abeba to evolve into medium-sized industries. They find that factors like access to funding, markets, and technology are more influential in this transition than managerial expertise or record keeping. Eight information systems maturity levels and related technological infrastructure capabilities are defined by applying information usage characteristics to an operational framework for the Capability Maturity Model that was developed especially for the health care industry (Williams et al., 2019).

To determine the technological characteristics needed to achieve each maturity level, certain technological capabilities are disassembled. The goal of (Magsi et al., 2020) is to investigate how server infrastructure virtualization is transforming converged infrastructure (CI) into hyper-converged technologies. The study by Magsi et al. (2020) highlights the benefits of converged infrastructure, which offers a bundled package of software and hardware. By employing this approach, the computing, storage, and networking elements are kept distinct and separate.

Gafurov et al. (2020) contributes by laying out guidelines and specifications for improving university infrastructure through digital technologies. These recommendations aim to enhance the effectiveness of higher education.

In today's digital economy, investing in information technology (IT) is crucial for businesses to undergo digital transformation. Zhang et al. (2023) examine how IT infrastructure influences a company's digital transformation strategy from the perspective of the resource-based view (RBV).

Tracy (2000) provides additional noteworthy work in this area. Advancements in computer technology now allow municipalities to collect, store, organize, and reuse data from various departments for project work.

Carrera et al. (2006) outline the benefits of cities establishing a "knowledge infrastructure" for planning decisions, citing case studies from Venice, Italy, to demonstrate the returns on using data initially for specific purposes and later repurposing it for new research.

Demchenko et al. (2013) introduces the Scientific Data Lifecycle Management (SDLM) model, which covers all significant phases of data management in modern e-Science. They also propose key infrastructure components for Big Data and describe how these models can be implemented using current cloud-based infrastructure services provisioning paradigms.

The demand for infrastructure for data exchange and management, particularly in research projects, is often urgent. Individuals outside the private sector often lack awareness of the critical success factors for technology licensing and commercialization efforts, posing challenges for investigators in academic and non-profit settings. Payne (2014) addresses this gap by reviewing lessons learned from commercializing a research-oriented data management infrastructure, the Translational Research Informatics and Data Management (TRIAD) Grid, at The Ohio State University.

Shou et al. (2015) aims to assess the level of Building Information Modelling (BIM) implementation in building and infrastructure industries. Their findings suggest a high degree of BIM implementation in practice, with early infrastructure development influenced by the building industry's experience with BIM. They also highlight the benefits of new BIM applications, improved project management, and altered project delivery methods.

Akman et al. (2016) discusses requirement traceability in an information technology solution provider company, focusing on improving integrated tool infrastructure and overcoming challenges during the transformation process. They emphasize considering both tool capabilities and company culture, along with expertise in various infrastructure tools.

Molano et al. (2018) propose a methodological approach consisting of five stages for developing Smart Cities: analysis of the current situation, creation of a work plan, formulation of a strategy, development of an action plan, and establishment of a management plan. They suggest this approach can be adapted to meet specific city needs.

Desai et al. (2019) highlight advancements in Digital Oilfield technology in the Burgan KwIDF project and discuss challenges encountered in its implementation. They stress the importance of technology providers in sustaining the technology over time based on their experiences with DOF technology.

The ultimate goal of Oxoli et al. (2020) is to make the Insubria region more appealing to tourists by constructing new infrastructure, creating fresh tourist experiences, and utilizing IT systems to facilitate cross-border tourism administration and promotion. The project uses only Free and Open-Source Software, which lowers development and maintenance costs while offering the infrastructure extensive opportunities for modification and enhancement. The result of the article is a model of how public and private collaborations can leverage technology and project organization to make infrastructure more sustainable. The findings add to the understanding of how transformation toward increased sustainability can be achieved by individual

organizations, their network, and ecosystems of public, private and civic actors (Hoeft et. al., 2021).

Because this industry requires a large work force, obstacles to collaboration can result in ineffective project management. (Kruachottikul et. al., 2021) aim to improve collaboration on bridge inspections that typically requires the involvement of many people, personal judgement, and extensive travel to survey bridges across the country.

Municipalities may now gather, store, organize, and reuse data gathered by several departments throughout project work because to advancements in computer technology. The advantages of a city creating such a "knowledge infrastructure" to be used in its planning choices are outlined by Carrera et al. (2006). The authors demonstrate through case studies from Venice, Italy, the first- and second-order returns that they were able to derive from their gradually growing body of knowledge when data was initially used for a particular, immediate purpose and then later repurposed for new research on a different subject.

(Caerteling et. al., 2011) in this analyse technology development projects in a specific low-technology industry, road infrastructure, being a major sector and an important contributor to both GDP and employment. Based on the business strategy literature and literature on technology policy, (Caerteling et. al., 2011) test the relative importance of a firm's strategy and government behaviour in this low-technology industry.

Over the past two decades, challenges in implementing collaborative engagement approaches globally have highlighted the need to understand the drivers of collaboration, particularly in managing road infrastructure projects in Nigeria. Adetola et al. (2013) identifies key drivers such as communication, trust, globalization, technology, finance, and risk, which need alignment with existing business models for successful delivery of sustainable collaborative projects. They suggest establishing formal rules incorporating these drivers to guide partners' actions in shaping collaborative infrastructure projects in Nigeria.

Shou et al. (2015) aim to assess the level of Building Information Modelling (BIM) implementation in the building and infrastructure sectors. Their findings indicate a high level of BIM implementation in practice, with the initial development in infrastructure drawing from the building industry's BIM experience. They also highlight the benefits of new BIM applications, improved project management, and changes in project delivery methods.

Madduri (2015) discusses the importance of efficient road infrastructure management for improving citizens' quality of life and attracting business investment. They explore challenges in road maintenance faced by many cities and propose leveraging low-cost technology to address these challenges.

Cafiso et al. (2019) introduces the WIKI RoadSMap project, which aims to share detailed information about infrastructure design, management, and maintenance. They show how collaborations between public and private sectors, along with the integration of technology and project organization, can enhance the sustainability of infrastructure.

Their findings contribute to understanding how organizations, along with their networks and ecosystems involving public, private, and civic actors, can work together to achieve greater sustainability (Hoeft et. al., 2021).

Sahle et al. (2021) explores the management practices of utilities in road construction projects in Mekelle City. They use a combination of quantitative surveys and qualitative case studies to examine utility management issues during both the design and construction phases of road projects.

Drawing on experiences from the Mombasa-Nairobi Standard-Gauge Railway (SGR) project, Wang et al. (2021) propose a framework for technology transfer embedded within a nexus of technology, institutions, and culture. Their results emphasize the importance of localizing technology, including standards, management practices, and industrial chains, during the technology transfer process.

These studies, along with other influential works like Gunaruwan (2016), shed light on various aspects of infrastructure development and management, highlighting the importance of collaboration, technology integration, and local context in achieving sustainable outcomes.

RESEARCH QUESTION

Research Questions:

- How does the role of technology in infrastructure project finance differ or align with the global trends when considering the Indian context?

OBJECTIVES

The primary objective of a systematic literature review is to meticulously analyse and throw insights, providing a holistic perspective on the transformative journey that technology has charted in infrastructure project finance management. By systematically examining a wide range of scholarly works, this study aspires to unravel the layers of technological evolution, pinpointing key themes that have emerged as pivotal in reshaping the financial landscape of infrastructure projects

Scope and Focus

The review specifically delves into the context of India, a nation experiencing a rapid infrastructure growth coupled with technological integration solutions, thereby enabling analysis and allowing for a more tailored understanding of the challenges and opportunities that technology presents in the unique context of Indian infrastructure project finance.

Challenges and Opportunities

This systematic review aims to unravel the impact of technology on infrastructure project finance management, offering insights into how these transformations have influenced decision-making processes, risk assessments, and overall project outcomes. Beyond the positive impact, the review also scrutinizes the challenges encountered in adopting and integrating technology, providing a balanced view of the obstacles faced by practitioners and policymakers.

Significance of the Study

The significance of a systematic review is in its potential to inform and guide stakeholders in the infrastructure development domain. By shedding light on the evolving landscape, the study contributes valuable knowledge that can shape future strategies, policies, and best practices.

Also, it acts as a knowledge base for researchers, academicians, and industry professionals seeking to stay abreast of the latest developments and challenges in technology-driven infrastructure project finance management.

Conceptual framework

The subsections that follow will present to review the available literature in a structured manner based on which the major themes prevalent in them will be identified. The themes will then be analysed and synthesized into a coherent framework, which will depict and summarize the transformative journey of technology within the framework of infrastructure project finance management. This process will culminate in the desire to have a well-rounded understanding of the subject that allows one not only to appreciate the existing circumstances but also to provide a foundation for fresh investigations and evolution in the field.

RESEARCH METHODOLOGY

A systematic search strategy was employed, encompassing scholarly databases and relevant journals. Inclusion criteria prioritized articles and publications focused on the technological evolution of infrastructure project finance management. The systematic selection process ensured a representative and comprehensive collection of literature.

In the present Bibliometric analysis involves examining the frequency of citations that research articles receive from other publications, aiming to establish connections among articles and topics. According to Garfield (1979), bibliometric analysis provides an objective and quantitative method for assessing the intellectual progress within a scientific field. In this study, the researchers utilize VOSviewer, a tool developed by Van Eck and Waltman (2009), which enables the construction and visualization of bibliometric networks. VOSviewer employs visualisation of similarities (VOS) technology, allowing for the integration of diverse data from various domains based on their similarity and relevance, offering a significant advantage in bibliometric analysis.

The review will explore various sub-themes and cross-cutting issues that may arise during analysis, alongside overarching themes, to provide a detailed understanding of technological transformations in infrastructure project finance management. Through a rigorous and systematic approach, this review aims to contribute to existing knowledge, identify research gaps, and provide recommendations for future studies and practical interventions in infrastructure finance management.

The main database selected for analysis in this study is Scopus, which contains articles and conferences and has a high level of completeness and quality inherent in the journals suitable for scientific peer review, as argued in earlier studies. The bibliometric search included works published over the period from 1990 to 2022, the result of which was 1,354 research works. The extracted data on the research source included the year of publication, authors, and co-authors, citation indicators, the title of the work, the H index, and the impact factor SJR of the journal. The search allowed identifying the most productive countries and institutions, international cooperation network, frequent keywords, and the most relevant research trend.

The present study combines a systematic literature review (SLR) with bibliometric analysis. SLR was chosen due to its systematic, reproducible, transparent, and iterative nature. With the increasing availability of electronic databases, academics find it easier to conduct systematic

research in a timely manner. Hence, the SLR was conducted adhering strictly to the PRISMA statement, including the PRISMA checklist and flow diagram, ensuring the accuracy and completeness of the research (Mother et al., 2010).

This analysis was performed with the help of the VOSviewer software tool: it was instrumental in creating network maps for all the indicators that were analysed. To be more precise, this software tool assisted in clustering and analysing the keywords contained in every article, which, in turn, enabled to visualize the links and patterns in the data set. In such a way, a holistic analysis of the connections between the keywords and their position in the context of the analysis was made.

The factors and criteria utilized in the methodical retrieval of literature for a study or review centred on infrastructure projects and digital transformation are displayed in the table. The year range, database source, search terms, language requirements, and document kinds taken into account during the literature search are all laid out in the table. First off, the year range of 1990 to 2022 shows the temporal range of the literature that was taken into consideration. This long-time horizon makes it possible to analyze a broad range of research findings and innovations in the area of digital transformation in infrastructure projects throughout the previous thirty years.

Secondly, Scopus, an extensive and extensively used database in academic research, was chosen as the database for the literature search. With its extensive collection of scientific publications, which includes reviews, book chapters, conference papers, journals, and more, Scopus guarantees a thorough and reliable search function.

Thirdly, the important phrases and concepts relevant to the study subject are reflected in the search strings used in the database queries. Variations like "Digital Transformation and Information Technology and Infrastructure Project," "Digital Transformation and Infrastructure Project," and "Digital Adaptation and Infrastructure Project" are among them. Using a variety of search phrases expands the scope of the literature search and makes it possible to find pertinent articles covering a range of topics related to infrastructure projects and digital transformation.

Fourthly, English is the chosen language for the recovered papers according to the language criterion. This criterion guarantees linguistic coherence throughout the chosen literature and makes it easier for researchers and academics who speak English to understand and analyse the data.

Lastly, a wide range of scholarly outputs, including articles, conference papers, review papers, and book chapters, are included in the document categories taken into consideration. The integration of varied viewpoints and information sources is made possible by this inclusive strategy, which enhances the study results and insights obtained from the literature review procedure. The table offers a well-organized and thorough summary of the criteria that direct the methodical retrieval of literature about infrastructure projects and digital transformation. Through the specification of the year range, database source, search strings, language requirements, and document kinds, the table provides important context for understanding the methodology. supporting the academic research process of literature search.

RESULTS & DISCUSSIONS

The role of Technology in infrastructure project finance management in the Indian context have undergone significant evolution, reflecting both alignment with and deviation from global trends.

Over the past few decades, advancements in digital transformation, information technology, and digitalization practices have played a crucial role in shaping the landscape of infrastructure project finance worldwide, including India. From the adoption of digital platforms for project financing to the implementation of sophisticated data analytics and artificial intelligence tools, technological innovations have revolutionized how infrastructure projects are funded, managed, and monitored.

In India, the integration of technology in infrastructure project finance has been driven by various factors, including government initiatives, regulatory reforms, and industry dynamics. The adoption of digital platforms, such as online project financing portals and blockchain-based transaction systems, has streamlined the process of raising capital and managing financial transactions for infrastructure projects. Furthermore, the use of information technology tools for risk assessment, project evaluation, and performance monitoring has enhanced decision-making processes and improved project outcomes.

However, despite these advancements, there are notable differences between technological transformations in India and global trends. Factors such as infrastructure gaps, regulatory constraints, and varying levels of technological infrastructure pose unique challenges to the adoption and implementation of digital solutions in India's infrastructure sector. Additionally, cultural and institutional factors may influence the pace and extent of technological adoption in infrastructure project finance management within the Indian context.

While technological transformations in infrastructure project finance in India align with global trends in many aspects, there are also distinct differences shaped by the country's specific socio-economic context. Understanding these differences is essential for policymakers, industry stakeholders, and researchers seeking to leverage technology effectively to address the challenges and opportunities in India's infrastructure development landscape.

Through thematic analysis, recurring themes, patterns, and trends were identified across the selected literature related to technology's impact on infrastructure project finance management in India. This analysis reveals a notable pattern of increasing scholarly interest and research output, particularly from the year 2014 onwards, thereby signifying a growing recognition of the importance and relevance of digital transformation initiatives within the context of infrastructure development.

The systematic literature review (“SLR”) indicates a discernible surge in publications addressing digital transformation and infrastructure projects in recent years, suggesting a heightened focus on exploring the intersections between digital technologies and infrastructure systems, as well as their implications for societal, economic, and environmental sustainability.

The emergence of digital transformation as a focal area of investigation reflects the evolving landscape of infrastructure development, characterized by the integration of advanced technologies and digital innovations to enhance efficiency, resilience, and responsiveness across various sectors. This paradigm shift underscores the imperative for interdisciplinary inquiry and collaborative research efforts aimed at addressing complex challenges and

harnessing the transformative potential of digital technologies in shaping future infrastructure systems.

Furthermore, the upward trajectory of publication trends underscores the growing recognition of digital transformation as a catalyst for driving innovation and fostering sustainable development in infrastructure projects. By elucidating key themes, trends, and emerging research priorities, the SLR analysis provides valuable insights into the evolving discourse surrounding digital transformation and its implications for infrastructure planning, design, implementation, and management.

In summary, the publication statistics underscores the robustness and breadth of research efforts focused on technology transformations in infrastructure. The utilization of specific search strings and the diverse range of document types contribute to the richness and diversity of scholarly contributions, thereby facilitating deeper insights and analysis into the evolving landscape of technology-driven transformations in infrastructure development.

CONCLUSION

This systematic literature review offers a nuanced understanding of the role of technology in infrastructure project finance. The identified themes contribute to a comprehensive overview, aiding researchers, practitioners, and policymakers in navigating the evolving landscape. The findings provide valuable insights for future research directions and practical implications for optimizing infrastructure finance management through technology.

The insights gathered from this systematic literature review serve as a foundational framework for future research endeavours, offering a roadmap for scholars to delve deeper into specific aspects of the role of technology in infrastructure project finance. By shedding light on the key themes and trends within the field, this review facilitates informed decision-making among practitioners and policymakers, enabling them to leverage technology effectively to address challenges and capitalize on opportunities in infrastructure finance.

This review underscores the importance of adopting a holistic approach to technology integration in infrastructure project finance, taking into account diverse perspectives and stakeholder interests. As technology continues to evolve and shape the infrastructure finance landscape, ongoing dialogue and collaboration among researchers, industry experts, and policymakers are essential to ensure that advancements are harnessed responsibly and sustainably. Ultimately, this systematic literature review serves as a catalyst for innovation and progress in infrastructure project finance, inspiring stakeholders to embrace transformative technologies and drive positive change in the built environment.

LIMITATIONS

The study's limitations primarily stem from constraints inherent in the evaluated reports and the methodology employed. The reliance on data sourced exclusively from articles, conference papers, book chapters, and review articles within the Scopus database imposes certain limitations on the breadth and depth of the study's findings. While Scopus offers a comprehensive repository of scholarly literature, the exclusion of other databases and sources may result in overlooking relevant studies and perspectives that exist beyond its scope.

Furthermore, the research's foundation on an existing Digital Transformation in Project Management scenario may inadvertently restrict its adaptability to rapidly evolving technological landscapes. Given the pace of technological advancements, the study may fail to capture emerging trends and developments in the field, thereby limiting its relevance and applicability over time.

Another notable limitation pertains to the temporal scope of the study, which spans from 1990 to 2022. Despite efforts to access articles published before 1990, the accessibility and quality of online analytical processing for pre-1990 literature were suboptimal. As a result, relevant studies predating 1990 may have been overlooked or inadequately accounted for in the analysis, potentially skewing the comprehensiveness of the findings. Moreover, the interdisciplinary nature of research on Digital Transformation in infrastructure projects poses challenges in identifying and consolidating relevant studies across disparate disciplines. The distributed nature of related studies across various fields complicates the task of comprehensively synthesizing and integrating insights from diverse perspectives.

Lastly, the study's focus on specific sectors and industries within the realm of infrastructure projects may inadvertently neglect the broader implications and interdisciplinary connections of Digital Transformation initiatives. By confining the study area to select sectors, the analysis may overlook critical insights and implications that extend beyond the boundaries of traditional industry domains.

In summary, while the study contributes valuable insights into Digital Transformation in infrastructure projects, its limitations underscore the need for a critical understanding of the research landscape and the adoption of comprehensive methodologies that account for evolving trends, interdisciplinary perspectives, and broader contextual considerations.

REFERENCES

[1] Tayade, P. N. (2022). Impact and Opportunities of Digitalization with Special Reference to Indian Economy. EPRA International Journal of Environmental Economics, Commerce and Educational Management, 9(12), 1-10. DOI: 10.36713/epra0414. ISSN: 2348 – 814X. SJIF Impact Factor (2021): 7.743.

[2] Mohanty, M. K., et al. (2022). Dichotomy of Infrastructure Projects in India: Improved Performance amid Persistent Overhangs.

[3] Goger, G., & Bisenberger, T. (2020). Digitalization in infrastructure construction – Developments in construction operations.

[4] Saini, S., & Giri, J. N. (2022). Infrastructure Development in India: The Way Ahead.

[5] Srinivasan, J., & Johri, A. (2013). Creating machine-readable men: legitimizing the 'Aadhaar' mega e-infrastructure project in India.

[6] Hetemi, E., et al. (2020). An Institutional Approach to Digitalization in Sustainability-Oriented Infrastructure Projects: The Limits of the Building Information Model.

[7] Shyam, T., & Das, S. (2021). Impact of Covid-19 on Education Scenario and Digital Divide in India.

[8] Visconti, R. M., & Morea, D. (2020). Healthcare Digitalization and Pay-For-Performance Incentives in Smart Hospital Project Financing.

[9] Pakhale, P. D., & Pal, A. (2020). Digital project management in infrastructure project: a case study of Nagpur Metro Rail Project.

[10] Saadallah, N., et al. (2019). OpenLab: Design and Applications of a Modern Drilling Digitalization Infrastructure.
[11] Srivastava, V. (2014). Project Finance Default in India: Implications for Bank Loans to the Infrastructure Sector.
[12] Gupta, P., & Verma, H. (2020). Risk perception in PPP infrastructure project financing in India.
[13] Singh, P., et al. (2023). Wireless Sensor Network-based Monitoring System for Health Structure of Rail-tracks: An Efficient Design for Communication.
[14] Wadi, N., Al-Sulaiti, J. E., & Dahmani, Z. (2023). Digital Transformation Readiness in Infrastructure Project. In Proceedings of the International Conference on Civil Infrastructure and Construction (CIC 2023).
[15] Mohanty, M. K., Mohapatra, A. K., & Samanta, P. K. (2022). Dichotomy of Infrastructure Projects in India: Improved Performance amid Persistent Overhangs. Orissa Journal of Commerce, 43(1), 1-15. ISSN: 0974-8482.
[16] Saini, S., & Giri, J. N. (2022). Infrastructure Development in India: The Way Ahead. Journal of Infrastructure Development, 14(1), 37-44.
[17] Srinivasan, J., & Johri, A. (2013). Creating Machine Readable Men: Legitimizing the 'Aadhaar' Mega E-Infrastructure Project in India. In Proceedings of the Sixth International Conference on Information and Communication Technologies and Development: Full Papers - Volume 1 (pp. 101-112).
[18] Hetemi, E., Ordieres-Meré, J., & Nuur, C. (2020). An Institutional Approach to Digitalization in Sustainability-Oriented Infrastructure Projects: The Limits of the Building Information Model. Sustainability, 12(9), 3893.
[19] Sandhu, K., Dayanandan, A., & Kuntluru, S. (2023). India’s CBDC for digital public infrastructure. Economics Letters, 231, October.
[20] Tracy, K. (2000). What's The Deal with "e-business"? IEEE POTENTIALS.
[21] Sylvia, M., Hughes, R. C., Moore, J. E., Murray, J. W., Peterson, B. L., Uniack, S. R. (2012). Transforming The Information Technology Infrastructure of IBM. IBM J. RES. DEV.
[22] Gold, M. (2014). Employing Health Information Technology In The Real World To Transform Delivery. THE AMERICAN JOURNAL OF MANAGED CARE.
[23] Constantine, L. E., & Ho, J. K. (2015). E-Government Transformation in Tanzania: Status, Opportunities, and Challenges. THE KOREAN JOURNAL OF POLICY STUDIES.
[24] Lane, J., Smart, S., Schmeda-Lopez, D. R., Hoegh-Guldberg, O., Garnett, A., Greig, C., McFarland, E. W. (2016). Understanding Constraints to The Transformation Rate of Global Energy Infrastructure. WILEY INTERDISCIPLINARY REVIEWS: ENERGY AND ENVIRONMENT.
[25] Yadergal, A., Lingerew, A., & Getenet, A. (2019). Determinants of Micro and Small Enterprises Transformation into Medium Level Industry in Addis Ababa, Ethiopia. ASIAN JOURNAL OF ECONOMICS, BUSINESS AND ACCOUNTING.
[26] Williams, P. A., Lovelock, B., Cabarrus, T., Harvey, M. (2019). Improving Digital Hospital Transformation: Development Of An Outcomes-Based Infrastructure Maturity Assessment Framework. JMIR MEDICAL INFORMATICS.
[27] Magsi, Z., Koondhar, M. Y., Depar, M. H., Pathan, Z. H., Memon, F.-U.-D., Solangi, S. (2020). Conceptual Framework Transformation of Converged Infrastructure (CI) Into Hyper Converged Technology for Virtualization of Server Infrastructure. 2020 IEEE 7th International Conference on Engineering
[28] Gafurov, I. R., Safiullin, M. R., Akhmetshin, E. M., Gapsalamov, A. R., Vasilev, V. L. (2020). Change of The Higher Education Paradigm in The Context of Digital

Transformation: from Resource Management to Access Control. The International Journal of Higher Education, 2020.

[29] Zhang, X., Xu, Y., Ma, L. (2023). Information Technology Investment and Digital Transformation: The Roles of Digital Transformation Strategy and Top Management. Business Process Management Journal, 2023.

[30] Carrera, F., Hoyt, L. (2006). From Plan-demanded Data to Plan-ready Information: A Rationale for Comprehensive Urban Knowledge Infrastructures. Journal of Urban Technology, 2006.

[31] Demchenko, Y., Grosso, P., de Laat, C. T. A. M., Membrey, P. (2013). Addressing Big Data Issues in Scientific Data Infrastructure. 2013 International Conference on Collaboration Technologies...

[32] Payne, P. R. O. (2014). Sustainability Through Technology Licensing And Commercialization: Lessons Learned From The TRIAD Project. EGEMS (Washington, DC), 2014.

[33] Shou, W., Wang, J., Wang, X., Chong, H.-Y. (2015). A Comparative Review of Building Information Modelling Implementation in Building and Infrastructure Industries. Archives of Computational Methods in Engineering, 2015.

[34] Akman, S., Özmut, M., Aydin, B., Göktürk, S. (2016). Experience Report: Implementing Requirement Traceability Throughout The Software Development Life Cycle. Journal of Software: Evolution and Process, 2016.

[35] Rodríguez Molano, J. I., Obando Bobadilla, L. M., Ruiz Nieto, M. P. (2018). Of Cities Traditional to Smart Cities. 2018 13th Iberian Conference on Information Systems.

[36] Desai, S. F., Rane, N. M., Al-Shammari, B. S., Al-Sabea, S. H., Al-Naqi, M. (2019). Challenges In Operating A Digital Oilfield - Lessons Learned From The Burgan Integrated Digital Field Pilot. Day 3 Tue, October 15, 2019, 2019.

[37] Oxoli, D., Terza, V., Cannata, M., Brovelli, M. A. (2020). An open IT infrastructure for green tourism management and promotion: The Insubri.Parks project. The International Archives of the Photogrammetry, Remote Sensing & Spatial Information Sciences, 43(4/W1), 433-438. DOI: 10.5194/isprs-archives-XLIII-B4-W1-433-2020.

****