

Transforming Budgeting Practices in the Digital Economy: A Systematic Review of Technological Advances and Digital Literacy

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Abstract. This study aims to systematically review the transformation of budgeting practices within the digital economy, focusing on the integration of digital technologies and digital literacy. Employing the PRISMA-based Systematic Literature Review (SLR) approach, the research analyzes 156 selected articles from five major databases published between 2015 and 2024. The findings reveal that technologies such as cloud computing, artificial intelligence, and big data analytics significantly enhance the efficiency, transparency, and accountability of budgeting systems across both public and private sectors. However, the success of this transformation is highly dependent on users' digital literacy levels. The study also identifies research gaps, particularly the lack of longitudinal studies and frameworks for digital literacy development in budgeting. These insights offer theoretical contributions to technology adoption models and provide practical implications for policymakers, financial managers, and system developers in designing adaptive and sustainable budgeting strategies in the digital era.

Keywords: Digital Budgeting, Digital Literacy, Financial Transformation, E-Budgeting, Digital Economy

Introduction

In the mindset of the digital revolution sweeping various sectors, organizational financial management practices are undergoing significant transformation. One crucial aspect affected is the budgeting system, which has traditionally been manual, hierarchical, and document-based (Sánchez & Pérez, 2020). Boev (2022) highlights how digitalization drives the shift toward strategic, multi-level budgeting that aligns financial resources with modernization initiatives. The Digital Economy era demands speed, accuracy, integration, and transparency in financial decision-making processes, thereby encouraging the implementation of technology-based budgeting systems such as e-budgeting, cloud-based budgeting, and real-time budget planning systems (Maliarchuk, 2024; Nurfadilah et al., 2021; Hassan & Othman, 2020). Santos (2024) emphasizes the importance of automation and digital forecasting in SMEs' financial planning, while recent findings also suggest that digital transformation significantly enhances budgetary control and overall financial performance (Ebhot, Yao, & Sampene, 2024).

This transformation relates not only to technical and procedural aspects but also touches on the strategic dimensions of organizations, particularly in strengthening competitiveness, efficiency, and public and corporate accountability (Al-Htaybat & von Alberti-Alhtaybat, 2017; Harun et al., 2022). Research shows that implementing digital technology in budgeting systems improves planning quality, cross-departmental collaboration, and real-time budget control (Barth & De Franco, 2021; Margherita & Braccini, 2020), while simultaneously strengthening transparency and accountability, especially in the public sector (Purwanto et al., 2021). Several studies further highlight how digital transformation contributes to enhanced public accountability through scalable platforms, automation, and real-time data access (Ikwanusi et al., 2024; Ramadhani & Aliyah, 2024; Kasmono et al., 2024). The role of leadership and institutional readiness has also been found critical in ensuring that digitalization initiatives yield measurable improvements in transparency and performance management (Shahzad et al., 2024; Steccolini & Agostino, 2021).

However, the success of digital budgeting implementation depends heavily on two main pillars: technology and human capacity. While technological infrastructure provides the necessary

systems, platforms, and automation capabilities, it is human capital – particularly digital literacy – that ensures these tools are adopted and utilized effectively. Without digitally literate personnel, even the most advanced systems risk being underutilized or misapplied. Hoan (2024) emphasizes that low digital proficiency among civil servants – such as in data management, digital transactions, and content creation – becomes a significant barrier to the effective execution of digital transformation initiatives in public administration. Similarly, studies have shown that public officials with limited competencies in digital tools often struggle to implement and sustain digital budgeting systems effectively (Hakim et al., 2022; Yuniarti, 2024). In the context of rural governance, Balo et al. (2024) highlight that training, cloud-based HR systems, and intergovernmental cooperation are essential to overcome resistance and technical limitations. Moreover, capacity building is not limited to skill development alone – it also involves fostering institutional readiness and cultural adaptability. A review by Dzulkifli et al. (2023) revealed that successful digital governance requires synchronized efforts in policy support, leadership commitment, and organizational transformation. In many cases, gaps in infrastructure and human capabilities must be bridged simultaneously (Melentyeva, 2023). On the other hand, continuous digital literacy education for communities and frontline public service workers has also been identified as vital to fostering transparency and participatory governance (Urquizo et al., 2020). In support of this, Yuniarti (2024) underlines that improving digital and financial literacy in SMEs leads to more structured budgeting behavior and stronger decision-making foundations.

Unfortunately, literature on budgeting in the digital economy context remains scattered and has not been systematically integrated. Many studies discuss e-budgeting as part of digital government (Scholl & Scholl, 2014), while others highlight digital transformation in the private sector without explicitly linking it to budgeting systems (Nambisan et al., 2019). Therefore, a systematic review is needed to comprehensively examine relevant literature on budgeting in the digital economy era, with a specific focus on two main dimensions: the role of technology and digital literacy. For the purpose of this study, the term *digital budgeting* is used as an umbrella concept that encompasses various technology-driven budgeting approaches, including e-budgeting (web-based systems for public sector transparency), cloud-based budgeting platforms (for real-time and collaborative financial planning), ERP-integrated systems (which link budgeting to broader enterprise functions), and AI-powered forecasting tools. These terminologies are unified under the concept of digital budgeting to reflect the convergence of tools, processes, and user interactions in modern financial management systems.

Margherita and Braccini (2020) stress the transformative potential of digital tools in shaping strategic financial management, yet rarely contextualize budgeting within broader digital reforms. Similarly, digital governance studies often focus on transparency or participation without addressing how budgeting practices evolve structurally through digital integration (Misuraca & Viscusi, 2015). Meanwhile, the literature on digital literacy tends to concentrate on general education, labor readiness, or e-learning (Spante et al., 2018), but not on how it enables competent interaction with digital financial systems such as e-budgeting or AI-based planning platforms. Moreover, there is limited synthesis on how these two domains – technological innovation and human digital capacity – jointly influence budgeting quality, speed, accuracy, and accountability across both public and private sectors. As highlighted by Wirtz et al. (2022), the fragmentation of digital transformation research creates thematic silos, hindering the development of unified frameworks applicable to integrated financial systems. A systematic literature review would allow researchers and practitioners to map key themes, identify gaps, and formulate models that align budgeting processes with the core demands of the digital economy. This study addresses three main research questions:

RQ1: How has the concept of budgeting evolved in the digital era?

RQ2: What are the roles of technology in budgeting system transformation?

RQ3: How does digital literacy influence the effectiveness of digital budgeting?

Methods

This study follows the strict guidelines of the PRISMA protocol (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) in conducting a systematic literature review (figure 1.). The literature search process was conducted across five major databases: Scopus, Web of Science, Google Scholar, IEEE Xplore, and ScienceDirect, with publication years limited to 2015-2024. The search

strategy employed comprehensive keyword combinations including "Digital Budgeting," "Digital Economy," "Budgeting TransFformation," "E-budgeting," "Cloud-based Budgeting," "Technology Adoption in Budgeting," "Digital Financial Management," "Digital Literacy," and "ICT in Public Financial Management," strategically connected using Boolean operators AND, OR, and NOT to optimize search results. Inclusion criteria specifically covered peer-reviewed articles in English that substantively discussed technology-based budgeting transformation and digital literacy through both empirical and conceptual approaches.

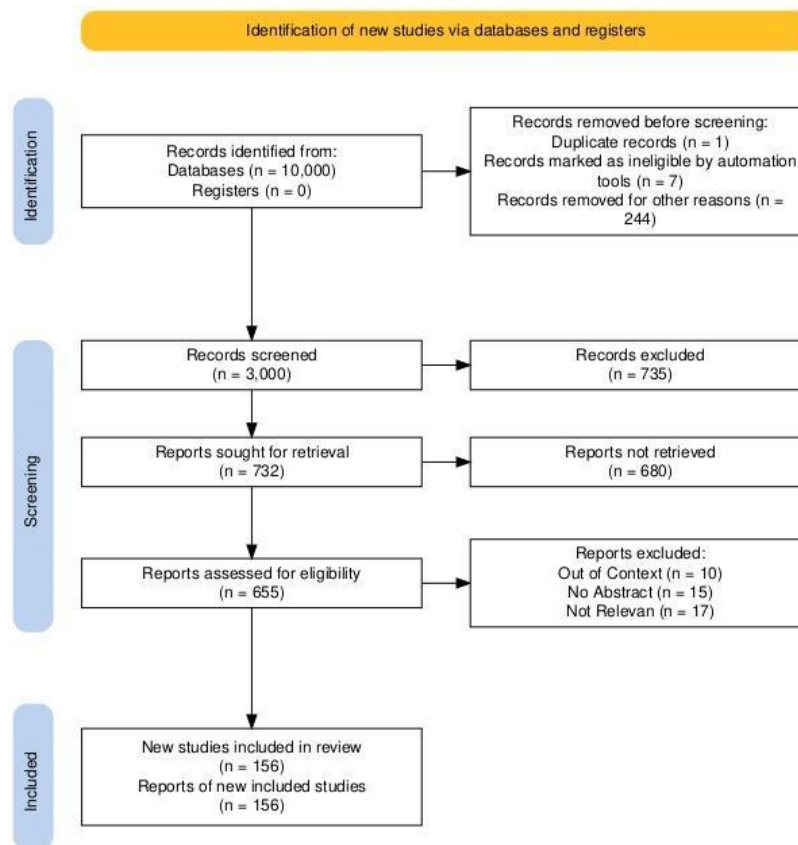


Figure 1. PRISMA protocol

Exclusion criteria filtered out conference proceedings, working papers, and review articles that did not present new empirical or theoretical contributions. The screening process was conducted in stages, beginning with title and abstract analysis, followed by full-text evaluation, all performed by two independent reviewers. Consistency in assessment was demonstrated by high inter-rater reliability of 0.87. From the initial 10,000 articles identified, the systematic screening process resulted in 156 high-quality articles meeting all inclusion criteria for final analysis. The PRISMA flow diagram shows the detailed selection process, with a final inclusion rate of 1.56% from the initial pool, demonstrating the study's high selectivity and focus on relevant, high-quality research.

Results and Discussion

The transformation of budgeting practices in response to digital disruption has garnered increasing academic interest in the past decade. This section presents the key findings of the systematic review in relation to the study's research questions. Specifically, it addresses RQ1 on the evolution of budgeting practices, RQ2 on the role of technology in budgeting transformation, and RQ3 on how digital literacy shapes implementation effectiveness. From an initial pool of over 10,000 scholarly articles retrieved through systematic database searches, a total of **156 studies** were selected based on

Moreover, accountability frameworks in emerging markets are strengthened through blockchain and AI-enhanced audit systems.

The growing academic attention reflects not only technological maturity but also increasing complexity in fiscal environments that demand agile and adaptive budgeting tools (Omori et al., 2023). This distribution of topics also reveals a geographical imbalance, with most empirical studies originating from North America, Europe, and East Asia, while developing economies remain underrepresented. This gap suggests the need for contextualized research that addresses digital budgeting challenges in resource-constrained environments, where infrastructure limitations and digital divides may affect adoption (Paweloszczek & Czarnacka-Chrobot, 2023). Taken together, the trend analysis indicates a maturing research field that is moving from descriptive accounts of digital tools toward critical evaluations of outcomes, user experiences, and strategic alignment. It also affirms the central thesis of this review: that digital budgeting transformation is both a technological and human-centric endeavor, demanding integrated frameworks for policy, practice, and pedagogy. These findings directly respond to RQ1, highlighting how budgeting practices have evolved in the digital era, particularly with the emergence of integrated technologies, governance models, and user-centric systems.

Budgeting System Transformation

The systematic review reveals a clear and consistent shift in budgeting practices, with organizations across sectors transitioning from traditional manual systems to digitally enhanced budgeting frameworks. This transformation reflects not merely a technological upgrade but a redefinition of budgeting as a dynamic, real-time, and integrative process within the broader context of digital governance and strategic management (Agostino et al., 2022). Three primary forms of technological adoption dominate the literature:

1. **Electronic Budgeting (e-Budgeting)**
E-budgeting systems have replaced static spreadsheets and manual inputs with web-based platforms that support collaborative, transparent, and auditable budgeting workflows (Chatwin & Arku, 2021). In the public sector, they enhance citizen engagement and fiscal openness. In corporate settings, these systems facilitate tighter financial control and traceability (Gupta et al., 2020).
2. **Cloud-Based Budgeting Systems.**
Cloud solutions have become the backbone of modern budgeting platforms, enabling centralized access, scalability, and multi-user interaction. For instance, Warren et al. (2015b) underscore that such platforms support version control and unified data sources for improved responsiveness, especially in hybrid or decentralized setups (Warren et al., 2015b). Similarly, Sidorova et al. (2023) emphasize enhanced data visibility and forecasting precision as key advantages.
3. **Real-Time Integrated Financial Management Systems (IFMS) as Part of Digital Budgeting Systems**
Among the most advanced forms of digital budgeting systems, IFMS integrate budgeting with accounting, procurement, and performance management. Built on ERP platforms and often enhanced by AI-driven dashboards, these systems enable predictive modeling, real-time forecasting, and rapid budget adjustments in response to dynamic conditions (Nambisan et al., 2019). Beyond automation, IFMS promote strategic agility by providing integrated data visibility and scenario simulations. However, their effectiveness depends on user adaptability and organizational readiness. As Horlacher and Hess (2016) highlight, optimizing IFMS requires a shift in mindset, supported by digital

One of the most compelling findings across the reviewed literature is the multifaceted benefits that digital transformation brings to budgeting practices. These benefits are not merely incremental improvements but represent qualitative shifts in how financial planning and control are conceptualized and executed within organizations. First, accuracy emerges as a foundational advantage of budget digitalization. Automated systems significantly reduce human errors and data duplication through the use of real-time, rule-based validations. These mechanisms ensure that entries adhere to predefined logic, thresholds, and accounting standards, thereby increasing the reliability of financial information

(Warren et al., 2015a). As a result, budgeting processes become not only faster but also more dependable, allowing decision-makers to work with higher confidence in their data integrity. Second, accountability is markedly strengthened through the use of digital tools. E-budgeting systems typically embed digital footprints and permission-based access controls that record user activities and enforce role-specific visibility. This traceability facilitates internal audits, enhances transparency, and builds trust among stakeholders, particularly in public sector organizations where oversight is crucial (Gupta et al., 2020). In this sense, budgeting transitions from a closed administrative task into an auditable, transparent function aligned with governance best practices. Third, digital budgeting enhances agility – a crucial capability in today’s volatile economic environment. Integrated dashboards and real-time data visualization allow finance teams to monitor budget performance continuously and respond swiftly to emerging issues. Whether adjusting to unexpected policy changes or external market shocks, organizations equipped with digital budgeting tools can rapidly simulate scenarios, revise allocations, and implement corrective actions with minimal delay (Sidorova et al., 2023). This responsiveness repositions budgeting as a strategic and adaptive process rather than a static, annual routine. Collectively, these benefits underscore that the transition to digital budgeting is not only a technical adjustment but a strategic investment in organizational performance, governance quality, and decision-making agility.

Despite these benefits, the effectiveness of digital budgeting is constrained by internal readiness. As Sonjaya (2024) emphasizes, the success of implementation hinges on a combination of IT infrastructure, leadership support, and organizational culture (Sonjaya, 2024). Without adequate training and strategic alignment, organizations risk underutilizing the tools or encountering user resistance (Horlacher & Hess, 2016). Digital budgeting transformation is a multifaceted evolution, merging technological innovation with human adaptability. It repositions budgeting from a static control function to a responsive, forward-looking enabler of strategic governance.

The evolution of budgeting practices in the digital era is inseparable from the integration of advanced technologies that redefine both the speed and quality of financial decision-making. Across the reviewed literature, Enterprise Resource Planning (ERP) systems, blockchain technology, artificial intelligence (AI), and big data analytics are frequently cited as key enablers of budgeting transformation.

Enterprise Resource Planning (ERP). ERP platforms have become the backbone of integrated financial systems, enabling seamless data flow across departments and aligning budgeting processes with real-time operational data. As Nambisan et al. (2019) argue, ERP systems allow financial planning, accounting, procurement, and performance monitoring to function cohesively, reducing data silos and improving efficiency. Recent works further demonstrate how AI-driven ERP platforms enhance predictive analytics for budgeting accuracy and automate routine tasks like invoice processing and compliance checks (Mandavilli, 2025).

1. Artificial Intelligence (AI) and Predictive Analytics.
AI technologies are increasingly embedded within financial systems to support scenario planning, anomaly detection, and dynamic forecasting. Sharma et al. (2024) highlight how machine learning algorithms, particularly PSO-SVM models, significantly improve forecast stability in ERP-based financial planning (Sharma et al., 2024). AI not only increases forecasting precision but also enables rolling budgets and adaptive planning (Marri, 2025).
2. Blockchain Technology.
Blockchain introduces transparency and immutable records into financial systems, making it valuable for budget tracking, audit trails, and automated compliance through smart contracts. As Zhao (2024) notes, blockchain’s decentralized structure supports trust and accountability in budget transactions, especially in sustainability-linked financial governance (Zhao, 2024).
3. Big Data Analytics.
The use of big data in budgeting has enabled real-time decision-making and deeper insight generation. Korapati (2025) observes that AI-enhanced ERP platforms equipped with big data capabilities allow organizations to process massive datasets for predictive modeling, risk analysis, and trend-based resource allocation (Korapati, 2025).

Taken together, these technological advancements underscore a reimagining of budgeting as not only a financial activity but a strategic intelligence process rooted in integrated, adaptive, and transparent systems. This section addresses RQ2, demonstrating the shift from manual budgeting to

digital systems and how this transformation reflects deeper structural and strategic realignments within organizations.

Digital Literacy's Role in Budgeting Effectiveness

While technological infrastructure forms the backbone of digital budgeting systems, digital literacy among users is the critical human enabler that determines whether such systems are adopted, sustained, and effectively utilized. Research shows that digital competency significantly influences the performance and accuracy of Management Information Systems (MIS), particularly in SMEs, where resources are limited but decision-making pressure is high (Zheng, 2024). In this context, digital literacy refers not only to operating digital tools, but also the ability to analyze, evaluate, and apply digital technologies for strategic decision-making. Horlacher and Hess (2016) observed that proficient digital users are more capable of integrating system-generated insights into financial planning, which includes interpreting dashboard data, performing simulations, and managing real-time forecasting. Moreover, digital fluency helps reduce organizational resistance to technological change. As Scholl and Scholl (2014) note, user confidence and familiarity with digital tools play a central role in adoption behavior, especially in public sector contexts where accountability and compliance standards are high. Individuals who are more digitally literate are more inclined to explore new functionalities and contribute to continuous improvement. Organizational support is also key. Providing structured training, mentorship, and opportunities for peer learning fosters a culture of digital readiness. According to Agostino et al. (2022), such environments promote the development of adaptive mindsets, enabling employees to evolve in sync with technological innovations.

Importantly, inadequate digital skills have been identified as a primary reason for underperformance in digital budgeting, especially in SMEs and emerging economies.. This aligns with recent findings by Ifada et al. (2025), who argue that digital literacy directly contributes to the success of accounting digitization, with poor literacy impeding adoption and effective use (Ifada et al., 2025). Finally, studies in financial education reinforce that digital literacy also enhances individual budgeting skills, particularly in mobile app-based contexts. For example, Dwivedi (2025) finds that students who regularly use budgeting apps show stronger financial habits and literacy gains (Dwivedi, 2025). In conclusion, digital literacy is not a peripheral concern but a strategic pillar of budgeting effectiveness in the digital era. It closes the gap between system capability and user behavior, and its development should be prioritized alongside technological investment. These insights answer RQ3, showing how varying levels of digital literacy significantly influence the success or failure of digital budgeting adoption and its practical outcomes.

Research Gaps and Emerging Themes

In reflecting on RQ1 to RQ3, this review also reveals significant gaps in the literature and emerging directions for future research. Despite the growing body of literature on digital budgeting, this review identifies several significant research gaps that warrant deeper scholarly attention. While most studies emphasize the benefits and immediate outcomes of digital budgeting implementation, longitudinal research remains limited, especially regarding sustained use, behavioral adaptation, and learning across multiple budget cycles. This gap is crucial, as budgeting is inherently iterative and its digital transformation requires adaptive capabilities over time (Agostino et al., 2022; Zheng, 2024).

A second major gap lies in the digital capacity of small and medium enterprises (SMEs) and local institutions. Most digital budgeting frameworks are derived from studies in large corporations or well-resourced public organizations, with few addressing the unique constraints of SMEs—limited digital skills, low IT budgets, and dependence on informal systems (Śledziewska & Gabryelczyk, 2015; Purwaningsih & Eitiveni, 2025). This limits generalizability and raises questions about equity and inclusion in digital budgeting reforms. To better map research trends, a bibliometric analysis using VOSviewer revealed four primary research clusters:

- a. **Technology Adoption and Integration:** Dominated by studies on ERP, AI, blockchain, and big data, this cluster shows increasing focus on system interoperability and data-driven decision-making (Nambisan et al., 2019; Pessin et al., 2025).
- b. **Organizational Change and Resistance:** This theme explores how resistance to digital change manifests behaviorally and structurally, with digital readiness playing a moderating role (Horlacher & Hess, 2016).

- c. **Digital Literacy and Human Capital:** As discussed by Ndibalema (2025), insufficient digital literacy, particularly in underdeveloped educational systems, remains a persistent barrier.
- d. **Transparency and Participatory Budgeting:** Most often linked to the public sector, these studies explore how e-budgeting platforms enable fiscal openness and citizen inclusion (Chatwin & Arku, 2021; Gupta et al., 2020).

These clusters demonstrate how technology, human behavior, and governance interact in shaping digital budgeting outcomes. Notably, digital budgeting is now understood not just as a technical exercise but as a strategic lever of organizational agility and digital governance. Emerging themes also suggest that future research should adopt interdisciplinary perspectives, combining insights from finance, information systems, behavioral science, and public administration. Equally, there is a call for contextualized research, especially in resource-constrained regions where digital divides still shape budgeting capacity (Junaedi et al., 2024). To synthesize the findings and address the research gaps identified, this study proposes a conceptual framework that models the interconnection between technology enablers, digital literacy, and the effectiveness of digital budgeting systems. The framework emphasizes that while technologies such as ERP, AI, blockchain, and big data act as direct enablers of digital budgeting systems, the successful realization of budgeting outcomes—accuracy, accountability, and agility—relies heavily on the mediating support of digital literacy across three dimensions: skills, mindset, and organizational readiness. This model is intended to guide future empirical investigations, particularly in testing second-order relationships and structural pathways within digital budgeting adoption.

Tabel 1. Conceptual Framework of Digital Budgeting Transformation: The Role of Technology Enablers and Digital Literacy

Identified Gap	Description	Proposed Future Research
Lack of longitudinal studies	Most studies focus on short-term implementation outcomes	Conduct multi-year studies on digital budgeting sustainability
Limited SME context	Dominated by large public/private organizations	Explore challenges and adoption models in SMEs
Fragmented frameworks	Few models integrate tech and literacy	Develop holistic digital budgeting adoption frameworks

Building upon this framework, Table X presents a summary of identified gaps and recommended directions for future research in the domain of digital budgeting transformation.

Conceptual Framework of Digital Budgeting Transformation

Based on the synthesis of the reviewed literature and identified research gaps, this study proposes a conceptual framework that integrates the roles of technology enablers and digital literacy in shaping the effectiveness of digital budgeting systems. The model illustrates how key digital technologies—ERP, AI, blockchain, and big data—serve as enablers of digital budgeting practices, which in turn produce outcomes such as accuracy, accountability, and agility. Furthermore, digital literacy acts as a foundational support mechanism, ensuring users have the necessary skills, mindset, and organizational readiness to adopt and sustain these systems effectively. The framework (figure 3) aligns with second-order constructs in structural modeling and is expected to guide future empirical testing and policy formulation in budgeting transformation research.

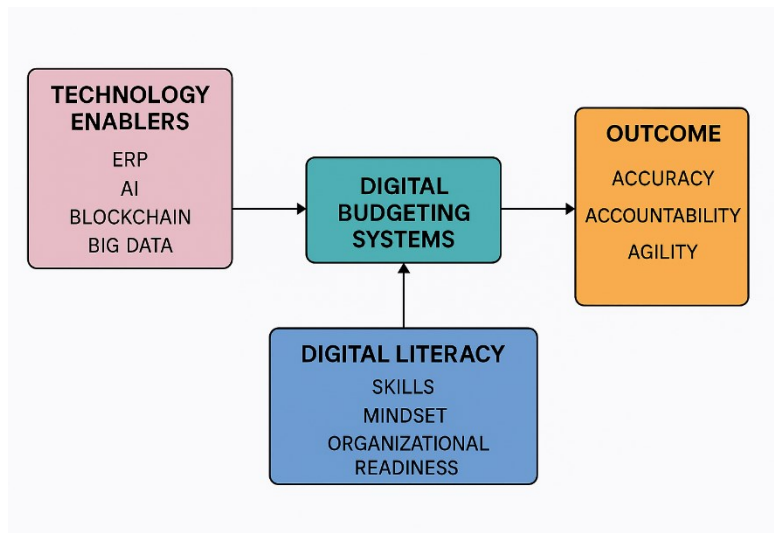


Figure 3. Conceptual Model of Digital Budgeting Effectiveness

Conclusion

This systematic review underscores that the transformation of budgeting practices in the digital era is both significant and accelerating. The reviewed literature consistently demonstrates that the adoption of advanced technologies—such as ERP, AI, blockchain, and big data analytics—has fundamentally reshaped how organizations plan, execute, and control their budgets. Coupled with a growing emphasis on digital literacy, this transformation reflects a broader paradigm shift in financial management, moving from static, paper-based processes toward dynamic, data-driven, and participatory systems. However, the effectiveness of digital budgeting is not determined by technology alone. The success of implementation is closely tied to the readiness of human resources and the presence of proactive institutional policies that foster digital competency at all organizational levels. Without sufficient digital skills and behavioral adaptability, even the most sophisticated systems may fail to deliver their intended benefits.

In light of these findings, several practical recommendations are proposed to guide effective and sustainable digital budgeting implementation; (1) Developing structured digital literacy programs that address diverse user needs, from operational staff to top-level financial managers. (2) Institutionalizing continuous training and mentoring, ensuring that digital budgeting tools are not only adopted but meaningfully integrated into daily decision-making. (3) Strengthening regulatory frameworks related to digital auditing, cybersecurity, and data integrity to ensure trust and compliance in digital financial environments. From a theoretical perspective, this study contributes to the expansion of technology adoption models by contextualizing them within budgeting and public financial management domains. It emphasizes the interplay between technological capability, human adaptability, and institutional context, thus enriching existing frameworks such as the Technology-Organization-Environment (TOE) model and Unified Theory of Acceptance and Use of Technology (UTAUT).

On a practical level, the insights offered in this review are highly relevant for policymakers, financial administrators, and system developers. Policymakers can use these findings to design inclusive digital transformation roadmaps; financial managers are better equipped to anticipate change resistance and training needs; while developers can design budgeting systems that are more user-centered, flexible, and integrated with strategic decision-making processes. Looking forward, future research should prioritize longitudinal and context-sensitive studies to assess the sustained impacts of digital budgeting. There is also a pressing need to build integrative frameworks that combine financial planning logic with digital governance principles, particularly in under-researched contexts such as SMEs and developing regions. In conclusion, budgeting in the digital era is no longer a back-office administrative function—it has become a strategic enabler of agility, transparency, and innovation. Realizing its full potential requires harmonizing technological advancement with human capacity and institutional readiness.

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