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Bridging the Digital Divide: Theoritical Perspectives on ICT Integration in Indonesian Education Policy

Fadhilatul Imaduddin[1], Masagus Firdaus[2]
[1,2] *University of PGRI Palembang, Indonesia*

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ABSTRACT

This article examines the integration of Information and Communication Technology (ICT) within Indonesia's education system through multiple theoretical frameworks. Despite national initiatives such as *Merdeka Belajar* and *Digitalisasi Sekolah*, the implementation of ICT continues to face systemic barriers including infrastructure inequality, teacher preparedness, and fragmented policy execution. Utilizing a qualitative, literature-based approach, the study analyzes ICT integration through the lenses of Diffusion of Innovation, TPACK, SAMR, Constructivism, and Connectivism. These frameworks illuminate the sociocultural, pedagogical, and technological factors shaping ICT adoption in Indonesia's diverse educational landscape. The findings underscore the need for locally responsive strategies that prioritize sustainable teacher professional development, inclusive infrastructure expansion, stakeholder collaboration, and context-sensitive policy formulation. Furthermore, the article outlines key benefits of ICT—such as enhanced access to information, personalized learning, and 21st-century skill development—while critically examining barriers rooted in inequities and institutional limitations. Practical strategies are proposed to address these challenges, including digital professional learning communities, culturally relevant content development, and innovation incentives. The study concludes by identifying future research directions, including longitudinal studies, inclusive practices, and policy evaluation. By offering a multidimensional perspective, this article contributes to ongoing discourse on how to bridge the digital divide and foster more equitable, effective ICT integration in Indonesian education.

Keywords
ICT, Indonesian Education, Technology Integration, Digital Divide, Policy Strategy

Corresponding Author :
fadhilatulimaduddin7111@gmail.com

INTRODUCTION

Over the past twenty years, the world has witnessed a profound and accelerated evolution in the field of Information and Communication Technology (ICT), a transformation that has reshaped the foundational structures and modalities of education on a global scale. The integration of ICT

has revolutionized the mechanisms through which knowledge is accessed, disseminated, and co-constructed, allowing both learners and educators to operate beyond traditional spatial and temporal limitations. In numerous countries, particularly those with advanced digital infrastructure, the incorporation of digital technologies into classroom environments has facilitated more flexible, inclusive, and learner-centered pedagogical models. Prominent scholars such as Kozma (2005) and Fullan (2013) have emphasized that technology should not be perceived solely as a supplementary instrument; rather, it functions as a catalyst for pedagogical innovation and systemic educational reform.

In emerging economies like Indonesia, the potential of ICT to serve as a transformative tool in advancing both educational quality and equity is increasingly recognized. National initiatives such as *Merdeka Belajar* (Freedom to Learn) and *Digitalisasi Sekolah* (School Digitalization) exemplify strategic governmental commitments to leveraging digital solutions in modernizing the education system. These initiatives aim to foster learner autonomy, creativity, and equitable access to educational resources across Indonesia's geographically and socioeconomically diverse regions. Nevertheless, despite the presence of forward-thinking policies, the translation of these agendas into practical, school-level implementation remains uneven. A considerable number of educational institutions—especially those located in remote, rural, or economically disadvantaged areas—continue to grapple with substantial barriers. These challenges include limited or unreliable internet connectivity, inadequate digital infrastructure, and insufficient professional development opportunities for teachers to acquire competencies in effective ICT integration.

Recent empirical research has highlighted the extent of these systemic disparities. For example, a report by the World Bank (2023) reveals that over 40% of Indonesian schools lack stable internet access, and more than 60% of teachers, particularly in rural regions, express low confidence and proficiency in utilizing digital tools for instructional purposes. Supporting these findings, Setiawan and Kusumawardani (2022) document that many educators tend to use technology superficially, primarily substituting traditional methods rather than leveraging digital tools to design transformative, student-centered learning experiences. These insights underscore a critical tension: although the availability of technological tools has increased, the ecosystem's readiness—both in terms of infrastructure and pedagogy—remains underdeveloped.

To systematically understand the process and challenges of ICT integration in education, scholars have proposed several theoretical models. Rogers' (2003) Diffusion of Innovation Theory provides a lens to examine how

new technologies and ideas are adopted and diffused within educational systems, revealing patterns of innovation uptake. The Technological Pedagogical Content Knowledge (TPACK) framework (Mishra & Koehler, 2006) highlights the dynamic intersection of technology, pedagogy, and content knowledge, emphasizing the need for teachers to develop integrated competencies. Puentedura's SAMR model (2006) offers a practical taxonomy of technology integration, ranging from basic substitution to complete redefinition of learning tasks. Furthermore, Constructivist Learning Theory and Connectivism serve as foundational pedagogical paradigms, advocating for active, student-driven learning facilitated by digital technologies and connected networks. While these theoretical models are frequently cited in international academic discourse, there is a notable gap in the literature regarding their comprehensive and contextualized application to Indonesia's educational landscape.

This study aims to address this lacuna by applying a multi-theoretical analytical lens to examine the current conditions of ICT integration within Indonesia's education system—both at the policy and school practice levels. Employing a qualitative methodology rooted in literature-based analysis, the research synthesizes insights from diverse theoretical frameworks to critically explore the enabling factors and persistent challenges in the nation's digital education transformation. The study not only seeks to map the present state of affairs but also endeavors to formulate strategic and context-sensitive recommendations that can support more inclusive, effective, and sustainable ICT integration across Indonesian schools.

What distinguishes this research is its commitment to a layered and interdisciplinary theoretical approach that bridges globally recognized educational theories with the specificities of national policy frameworks and local classroom realities. By conducting a critical engagement with academic literature, government documents, and empirical findings, the study contributes to a richer understanding of the complex interplay between innovation, infrastructure, pedagogy, and equity in education. Ultimately, this research aspires to inform and influence both policy development and educational practice, providing actionable insights for educators, decision-makers, and scholars dedicated to promoting digital inclusion and pedagogical advancement in the Indonesian context.

RESEARCH METHOD

This research adopted a qualitative methodology, specifically utilizing a literature-based analytical approach as its primary means of inquiry. The study

was carried out through a structured and methodical process of identifying, selecting, and critically analyzing a wide array of scholarly materials, official government publications, and internationally recognized reports that pertain to the integration of Information and Communication Technology (ICT) in the educational sector. Key sources of primary data included peer-reviewed academic journal articles, policy briefs released by the Indonesian Ministry of Education, Culture, Research, and Technology (Kemendikbudristek), as well as global research outputs from major international organizations such as the World Bank and UNESCO.

The literature selection process was guided by specific inclusion criteria, which prioritized works published within the past decade that directly address themes such as ICT-related educational policy, digital transformation initiatives in schools, teacher preparedness for technological integration, and pedagogical innovations driven by digital tools. The analytical framework employed in this study was informed by five prominent theoretical models: Rogers' Diffusion of Innovation theory, the Technological Pedagogical Content Knowledge (TPACK) framework, the Substitution Augmentation Modification Redefinition (SAMR) model, Constructivist Learning Theory, and the theory of Connectivism. These frameworks served as interpretive lenses to explore the dynamic interactions among policy structures, technological infrastructure, human resource capacity, and sociocultural contexts within the Indonesian educational landscape.

Data analysis was conducted using a thematic synthesis method, which involved identifying recurring patterns and core themes across the literature. Key themes that emerged included issues of equitable access to ICT, the capacity and readiness of teachers, the design and implementation of technology-enhanced instruction, and the degree of coordination across educational policies. These themes were interpreted in light of the theoretical frameworks to facilitate a comprehensive and critical evaluation of the enabling factors and persistent challenges associated with ICT integration. The ultimate objective of this analytical process was to generate evidence-based recommendations that can inform sustainable and contextually relevant implementation strategies.

To enhance the reliability and credibility of the findings, a process of cross-validation was employed, wherein identified themes were compared and corroborated across multiple data sources and theoretical models. Although the qualitative nature of this research limits the generalizability of its findings to broader populations, it provides rich, context-sensitive insights that are highly valuable in the realm of policy-oriented educational research.

RESULT AND DISCUSSION

The incorporation of Information and Communication Technology (ICT) into Indonesia's educational landscape represents a dual reality—an inspiring opportunity for transformative change coupled with persistent structural and contextual challenges. On one hand, national initiatives such as *Merdeka Belajar* (Freedom to Learn) and *Digitalisasi Sekolah* (School Digitalization) underscore a strong governmental will to modernize education through digital means. These policies signify an ambitious vision to promote innovation, improve educational access, and prepare students for a technology-driven future.

However, this study reveals that the translation of these national aspirations into tangible outcomes at the school level remains uneven and fragmented. Implementation is frequently hindered by infrastructural disparities, varying levels of digital literacy among educators, and policies that lack sensitivity to the cultural and socio-economic diversity across Indonesia's archipelagic regions. The findings indicate that while policy frameworks are in place, their actualization on the ground is constrained by a misalignment between national directives and the practical realities faced by schools—especially those in rural and under-resourced areas. By applying multiple theoretical perspectives, this study seeks to unpack these complexities and offer a more nuanced understanding of the barriers to, and enablers of, effective ICT integration.

From the perspective of the Diffusion of Innovation Theory, originally formulated by Rogers (2003), provides a robust framework for understanding how new technologies and practices disseminate across social systems over time. This theory classifies individuals or institutions into five adopter categories: innovators, early adopters, early majority, late majority, and laggards, depending on their willingness and speed in adopting innovations. In the educational context, particularly in Indonesia, this model helps explain the disparities in ICT integration among schools.

Urban schools, typically situated in metropolitan areas such as Jakarta or Surabaya, often fall into the early adopter category due to greater access to infrastructure, financial resources, and administrative support. Conversely, schools in rural and remote areas are more likely to be late adopters or laggards, hindered by limited infrastructure, constrained budgets, and lack of professional development.

For successful adoption, the presence of effective communication channels, leadership, and community engagement is essential. Schools that cultivate collaborative relationships with stakeholders—parents, local authorities, and educational foundations—are more likely to succeed in

implementing digital initiatives (Suryani & Purwanti, 2021). Moreover, the rise of social media, educational forums, and online professional learning networks facilitates the sharing of best practices. This theory highlights that the adoption of technology is not solely a technical matter but is deeply influenced by social dynamics and cultural readiness.

This framework is directly relevant to strategies that promote stakeholder collaboration and capacity building in ICT implementation. Understanding where schools fall along the adopter spectrum can inform tailored interventions that respect local contexts and readiness levels.

The Technological Pedagogical Content Knowledge (TPACK) framework, introduced by Mishra and Koehler (2006), offers a comprehensive model for the effective integration of technology in educational settings. It emphasizes the importance of a dynamic interplay between three domains of teacher knowledge: Content Knowledge (CK), Pedagogical Knowledge (PK), and Technological Knowledge (TK). Mastery of each domain, as well as the ability to interweave them, is essential for designing effective technology-enhanced learning experiences.

In the Indonesian educational landscape, achieving proficiency in TPACK presents significant challenges. A national survey conducted by Setiawan and Kusumawardani (2022) revealed that fewer than 40% of secondary school educators felt confident in integrating all three domains in their instructional practices. This underscores the need for continuous, contextually relevant professional development programs tailored to local realities.

Koh et al. (2020) highlight that in Southeast Asian contexts, TPACK training must consider local pedagogical traditions, socio-cultural norms, and infrastructural limitations. Professional development initiatives should not only enhance technical skills but also promote pedagogical innovation and subject-specific integration.

The relevance of the TPACK framework is clearly reflected in strategic recommendations advocating for sustained teacher capacity building. Initiatives such as peer mentoring, collaborative lesson planning, and digital professional learning communities directly support the development of integrated knowledge among educators. Furthermore, by embedding TPACK principles into teacher training curricula, institutions can foster more confident and competent digital educators, ultimately improving the quality of ICT integration in schools.

Similarly, The SAMR Model, developed by Puentedura (2006), presents a structured framework for evaluating the extent to which technology transforms teaching and learning processes. The model is composed of four progressive

stages: Substitution, Augmentation, Modification, and Redefinition. These stages represent a continuum from basic enhancement of traditional tasks to the complete reimagining of learning experiences.

At the Substitution level, technology serves as a direct replacement for traditional tools, such as using a word processor instead of handwritten notes. Augmentation introduces functional improvements, like incorporating spell-check or digital comments. Modification allows for significant task redesign—such as students collaborating on real-time documents—while Redefinition enables the creation of entirely new tasks that were previously inconceivable, like producing multimedia presentations for global audiences.

In the Indonesian context, practical implementation of the SAMR model remains uneven. Many teachers operate within the substitution or augmentation levels, often using ICT tools for administrative functions or basic content delivery. However, as Alqahtani (2021) noted, SAMR-based professional development can empower educators to design more transformative, student-centered learning experiences.

This model is closely tied to strategies that emphasize pedagogical innovation and inquiry-based learning. Moving from enhancement to transformation requires not only access to digital tools but also sustained institutional support, opportunities for experimentation, and a mindset shift among educators. Embedding the SAMR framework into professional development programs can guide teachers toward designing richer, more interactive learning experiences that foster creativity, collaboration, and deeper understanding.

Insights from Constructivist Learning Theory, rooted in the foundational work of Jean Piaget and Lev Vygotsky, emphasizes that learners construct knowledge through active engagement with their environment and through social interactions (Piaget, 1954; Vygotsky, 1978). Rather than being passive recipients of information, learners are viewed as active participants who make sense of new knowledge by connecting it to prior experiences and collaboratively solving problems.

In digitally enhanced learning environments, constructivist principles are realized through interactive and collaborative platforms. Tools such as Google Docs, Padlet, and educational wikis enable students to co-create content, engage in inquiry-based projects, and reflect on their learning processes. This approach aligns with Vygotsky's concept of the Zone of Proximal Development (ZPD), where students achieve higher levels of understanding through guided interaction with peers or technological scaffolds.

In Indonesia, research conducted by Rizki et al. (2020) in secondary schools found that project-based learning involving ICT significantly improved students' higher-order thinking skills and engagement. This supports the argument that constructivist learning, when combined with appropriate digital tools, leads to deeper conceptual understanding and more meaningful learning experiences.

The application of this theory underscores the importance of strategies that promote active, student-centered learning. Educators must design tasks that encourage collaboration, critical thinking, and reflection—principles that are well-supported through technology-enhanced instruction.

Connectivism, a modern theory of learning advanced by George Siemens and Stephen Downes, addresses the realities of the digital age by conceptualizing learning as a process of building networks of information, people, and resources (Siemens, 2023). Unlike earlier theories focused on individual cognition, connectivism emphasizes the capacity to navigate and learn from vast, distributed information environments.

This theory is particularly pertinent in today's post-pandemic educational landscape, where hybrid learning models, MOOCs, and global digital communities have become commonplace. In Indonesia, connectivism provides a valuable lens for understanding how students can engage in self-directed learning and cultivate global competencies.

For instance, Indonesian students participating in collaborative projects via Edmodo or Facebook groups demonstrate enhanced intercultural communication skills and digital literacy. These experiences help students develop their own Personal Learning Environments (PLEs), allowing them to curate content, interact with diverse perspectives, and adapt to evolving knowledge domains.

From a strategic perspective, connectivism aligns with efforts to develop 21st-century skills such as communication, collaboration, and lifelong learning. Teachers, therefore, transition from being content transmitters to facilitators of networked learning experiences, guiding students in becoming effective digital citizens.

To address these issues, several strategic recommendations emerge. First, teacher capacity building Sustained professional development is crucial to empower teachers with the knowledge and skills necessary for effective ICT integration in their classrooms. Training programs should be designed based on the actual needs of educators and focus not only on technical skills but also on pedagogical strategies and content integration that utilize technology effectively. Peer mentoring systems, where experienced teachers guide and

support their colleagues, can greatly enhance skill development and foster a collaborative culture of learning within schools. Encouraging teachers to share successful practices and challenges creates a supportive environment that promotes ongoing innovation and confidence in using ICT. *Example: Collaborative Learning Communities*. Some schools have established collaborative learning communities, where teachers regularly convene to discuss ICT-related challenges, exchange resources, and co-develop lesson plans. These forums promote continuous professional growth and help build a collective sense of responsibility for advancing technology use in education..

Second, infrastructure investment. Improving digital infrastructure is essential to ensure all students and educators have equitable access to technology. Targeted funding from government budgets, as well as partnerships with private companies and NGOs, can facilitate the provision of devices, internet connectivity, and technical support in underserved areas. Efforts such as distributing tablets or laptops to students in rural locations can open up new learning opportunities that were previously inaccessible. Additionally, community-driven projects to create local internet access points can significantly improve connectivity and engagement in digital education. *Case Study: Community Internet Access*. In a rural district, a community initiative successfully established Wi-Fi hotspots accessible to students and families, enabling them to connect to online educational resources. This not only improved access but also strengthened community ties by encouraging collaborative learning and information sharing beyond the classroom.

Third, responsive policy-making. Formulating ICT policies that are inclusive and involve multiple stakeholders—teachers, students, parents, and school administrators—helps create more effective and relevant strategies. Collaborative policy development ensures that the diverse needs and perspectives of those directly impacted are considered, increasing the likelihood of successful and sustainable ICT adoption. The Ministry of Education, Culture, Research, and Technology (Kemendikbudristek) in 2023 emphasized the importance of participatory digital policy-making to build strong foundations for ICT in schools. Policymakers should create platforms for ongoing dialogue and feedback, fostering transparency and mutual accountability. *Example: Stakeholder Engagement*. A school district in Indonesia regularly organized forums involving teachers, parents, and local community members to discuss ICT integration plans. These consultations helped address concerns, gather practical insights, and build collective ownership, resulting in more responsive and effective ICT policies.

Fourth, localized digital content to maximize student engagement and relevance, it is essential to develop digital educational content that reflects students' cultural, linguistic, and environmental contexts. Localized content makes learning more meaningful and relatable, helping students connect their studies with their lived experiences. Schools can partner with local educators, cultural experts, and community members to create resources that celebrate and preserve local heritage while supporting academic goals. This approach not only enriches the curriculum but also promotes students' pride in their cultural identity. *Example: Culturally Relevant Curriculum*. A school in Bali developed a curriculum integrating local history, cultural practices, and environmental themes into digital lessons. This strategy increased student interest and participation while fostering a stronger sense of identity and community connection.

Fifth, Digital professional learning communities provide teachers with platforms for ongoing collaboration, mentorship, and resource sharing focused on ICT integration. Such communities can be organized through online forums, social media groups, or virtual workshops, allowing educators to access support and innovative ideas beyond their immediate school environment. These communities encourage collective problem-solving and inspire educators to continuously refine their digital teaching practices. Building a culture of lifelong learning around technology is key to sustaining progress in ICT integration. *Case Study: Online Learning Networks*. An online network of Indonesian educators was created to facilitate the sharing of resources, pedagogical strategies, and success stories related to ICT use. This virtual community has become a vital support system, especially for teachers in remote areas, helping them stay connected and motivated.

Finally, Robust monitoring and evaluation systems are fundamental to understanding the effectiveness and impact of ICT initiatives. Regular assessments allow schools and policymakers to identify successes, challenges, and areas needing improvement. Defining clear performance indicators and collecting feedback from all stakeholders—students, teachers, and parents—enables data-driven decision-making to enhance program design and implementation. Continuous evaluation supports accountability and ensures resources are used effectively. *Example: Evaluation Frameworks*. A school district developed a comprehensive evaluation framework incorporating quantitative student achievement data, qualitative teacher feedback, and community input. This holistic approach provided valuable insights that guided iterative improvements to their ICT programs.

As Indonesia continues to navigate its digital transformation, aligning theory, policy, and practice will be essential in creating an education system that is inclusive, innovative, and future-ready. The road ahead will require persistent attention to the socio-economic and cultural diversity of Indonesian learners, while anticipating the ethical and technical challenges brought by rapid digital advancement. Integrating Artificial Intelligence, adaptive learning systems, and data-driven policy-making into classrooms and governance structures will further demand interdisciplinary collaboration and long-term commitment. Ultimately, the success of ICT integration lies not merely in technological adoption, but in nurturing a generation of critical thinkers, ethical digital citizens, and adaptive learners who can thrive in an increasingly interconnected and dynamic world.

CONCLUSION

This study has demonstrated that the integration of Information and Communication Technology (ICT) in Indonesian education is a multidimensional process shaped by the interplay of infrastructure, pedagogical capacity, policy alignment, and socio-cultural factors. Through a multi-theoretical lens encompassing the Diffusion of Innovation Theory, TPACK, SAMR, Constructivist Learning Theory, and Connectivism, this research reveals that successful ICT implementation in education requires more than just the provision of hardware and connectivity—it demands a coherent, systemic transformation that aligns national vision with local realities and needs.

The findings point to a number of persistent challenges. Disparities in infrastructure—particularly in rural and remote regions—remain a major barrier to equitable access. Many schools lack stable internet connections, adequate digital tools, and sufficient technical support. Simultaneously, teacher preparedness remains limited, with the majority of educators reporting low confidence and limited experience in integrating digital technologies meaningfully into instructional design. This leads to a predominance of low-level technology use (i.e., substitution and augmentation stages in the SAMR model), rather than the development of truly transformative, student-centered learning environments.

From a theoretical standpoint, the study demonstrates the relevance of combining multiple frameworks to provide a holistic understanding of the ICT integration process. The Diffusion of Innovation Theory helps explain the variable rates of adoption among schools and educators, highlighting the need for differentiated strategies based on readiness levels. The TPACK framework

emphasizes the critical intersection between technological, pedagogical, and content knowledge in shaping effective teaching practices. The SAMR model offers a practical tool for evaluating the depth of technology integration, while Constructivism and Connectivism provide strong pedagogical foundations for designing active, collaborative, and networked learning experiences.

Importantly, this study contributes to the literature by contextualizing these frameworks within Indonesia's specific educational, cultural, and policy environment. By doing so, it highlights how theoretical models developed in global contexts must be localized and adapted to be effective in practice. For instance, professional development programs must take into account not only teachers' technical competencies but also their pedagogical beliefs, cultural values, and the socio-economic realities of their schools. Similarly, policies should be designed through participatory processes that involve teachers, students, parents, and community members, ensuring that ICT strategies are responsive, inclusive, and grounded in local knowledge.

In light of these findings, several strategic implications emerge. First, there is an urgent need to invest in sustained and scalable teacher capacity building that integrates TPACK and SAMR principles. Such programs should prioritize peer mentoring, collaborative planning, and ongoing digital professional learning communities. Second, infrastructure development must be targeted and equitable, with particular attention to underserved schools. Partnerships with private sector actors, NGOs, and local communities can play a pivotal role in filling resource gaps and ensuring continuity of access. Third, policy-making should adopt a bottom-up approach, incorporating feedback from stakeholders and adapting to diverse local contexts. Finally, the development of localized digital content that reflects Indonesia's cultural and linguistic diversity is essential for fostering engagement and relevance in the classroom.

Furthermore, the study underscores the importance of developing robust monitoring and evaluation systems to assess the long-term impact of ICT initiatives. These systems should include both quantitative and qualitative indicators, enabling policymakers and educators to make informed, data-driven decisions. Transparent feedback loops between schools and policymakers can support iterative improvements and foster greater accountability.

As Indonesia continues to advance its digital transformation agenda in education, a shift from fragmented interventions toward coherent, systemic strategies is essential. Aligning global insights with local innovations, and fostering collaborative ecosystems that link educators, institutions, and communities, will be key to achieving meaningful and sustainable change. Ultimately, this study argues that ICT, when thoughtfully integrated, has the

potential not only to enhance teaching and learning, but also to promote greater equity, innovation, and resilience within Indonesia's education system.

Looking forward, future research should further explore how multi-theoretical frameworks can inform and enhance the implementation of ICT across Indonesia's diverse educational contexts. There is a pressing need for longitudinal studies that systematically examine the sustained effects of teacher training programs, digital infrastructure development, and iterative policy reforms over time. Such studies would offer critical insights into what interventions yield the most durable and equitable outcomes. In addition, research focusing on student experiences—particularly from marginalized or remote communities—can shed light on how learners navigate and benefit from technology-enhanced environments, and how digital tools affect engagement, comprehension, and equity.

Investigating students' voices, learning trajectories, and digital agency will be vital in creating educational ecosystems that are inclusive and learner-centered. Finally, future inquiries should not only build on existing theory but also push its boundaries by integrating perspectives from localized pedagogies, indigenous knowledge systems, and socio-cultural realities. By aligning theoretical advancement with practice-based insights, future scholarship can play a pivotal role in shaping a digital education landscape that is equitable, contextually grounded, and resilient in the face of future disruptions—both within Indonesia and in similar educational systems around the globe.

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