

Evolving Landscape of Digital Technology Adoption: Theoretical Shifts & Future Trajectories

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Abstract:

The swift development of information technologies has revolutionized industries, governance systems, and human conduct to the point where current theoretical underpinnings of technology adoption must be re-examined. This paper critically analyzes the evolving paradigms of digital technology adoption by analyzing major theoretical frameworks—such as the Technology Acceptance Model (TAM), Unified Theory of Acceptance and Use of Technology (UTAUT), and Diffusion of Innovations Theory—while establishing their shortcomings in explaining modern-day digital phenomena such as AI integration, blockchain, IoT, and metaverse ecosystems. From a comparative perspective, the research points out how new technologies negate historical presumptions of user uptake, organizational preparedness, and ICT literacy. In addition, it suggests a conceptual framework for future research that encompasses dynamic user environments, socio-cultural aspects, and environmentally friendly innovation practices. The paper helps to further refine the scholarly work by providing new evidence on how the digital adoption environment is changing and presents actionable recommendations for policymakers, technologists, and research scholars working in the digital transformation age.

Keywords: Digital Technology, Technology Adoption, Digital Communication

1. Introduction

In the context of digital communication technologies, the evolving landscape of technology for individual use has significantly increased with the advent of internet enabled devices; especially with mobile phones making information technology a part of people's daily lives unlike in the 20th century, where it was restricted to organisational use only (Burke, 2002; Nedra et al., 2019 Tamilmani, Rana, Wamba, et al., 2021). Further, this growth has led to rapid technological advancements driving the use to communicate, access information, and engage with services. More recently, this growth of technology has facilitated the creation of environments that are both more automated and more adaptable (FakhrHosseini et al., 2024). Research on the adoption and use of digital technologies, particularly mobile phone-driven applications, represents a well-established and mature area of investigation within the information systems field (Tamilmani et al., 2020). This pervasive influence has led to both opportunities and challenges, prompting the need for a deeper understanding of the factors driving technology adoption and its impact on individuals. With the advancements in the digital technology, primarily consumer facing technologies there is a growing need to consider relevant scenarios and constructs with respect to digital equity, access, individual personality and sociocultural norms in the changing context of technology advancements (Gaikwad, 2024). This research paper conducts a broad historical review of technology adoption theories developed over time vis-a-vis the evolution of digital communication technologies. The review traverses through the journey of technology adoption theories and models with reference to the advancement in technologies highlighting the emerging complex nature of technologies and the multifaceted interplay of factors in user acceptance.

2. Background of Study

The word “digital” comes from Latin—*digitus*, finger—and refers to one of the oldest tools for counting. Digital technology involves the use of systems, tools, and devices to process, store, and transmit data electronically. It includes a broad spectrum of technologies such as computers, smartphones, software applications, the internet, and emerging technologies like artificial intelligence, machine learning, and blockchain (Pullen et al., 2008). In context of theories in the area of technology adoption research, Adoption-diffusion theories have developed over the years

pertaining to the process through which a new technology disseminates over time. The adoption process focuses on an individual's choice to incorporate an innovation into their life, while diffusion describes the collective process of adoption that occurs over time (Straub, 2009). The landscape of digital technology adoption models is diverse, reflecting various theoretical perspectives and practical applications. Research on the adoption and use of digital technologies and applications constitutes a mature stream within the information systems field. This extensive body of work has explored diverse technologies across various countries, employing several theories, settings, units of analysis, and research methods (Goncalves, Oliveira, & Cruz-Jesus, 2018; Tamilmanni et al., 2021; Williams et al., 2009).

Traditional technology acceptance models, such as the Technology Acceptance Model (Davis, 1989) and the Unified Theory of Acceptance and Use of Technology (Venkatesh et al., 2003) have provided valuable insights into this phenomenon (Macedo, 2017). TAM suggests that an individual's perceived usefulness and ease of use of a technology are key determinants of their intention to adopt it. Similarly, UTAUT proposes that performance expectancy, effort expectancy, social influence, and facilitating conditions are key factors. While widely used and accepted, these models primarily focus on cognitive determinants, often overlooking the critical roles of individual differences, psychological factors, and the broader socioeconomic context. This paper addresses these limitations by exploring emerging perspectives and hybrid adoption models to provide a more comprehensive understanding of technology adoption behaviours, particularly in the context of rapidly evolving digital technologies (Gaikwad & Bhattacharya, 2024). By moving beyond the traditional cognitive-dominant perspective and incorporating a more comprehensive and integrated model this research aims to contribute a more refined understanding of the multidimensional nature of technology acceptance.

3. Review of Literature

The 1960s saw the emergence of mainframe computers, which were large, centralized systems primarily used by large organizations (Goncalves, Oliveira, & Cruz-Jesus, 2018). The theories developed during that time were focussed on innovation acceptance and adoption. Among others, two prominent theories that paved way for widely used technology adoption models are the Diffusion of Innovations (Rogers, 1976) and Theory of Reasoned Action (TRA) (Ajzen & Fishbein, 1977) as these models established the basis for further research. Diffusion of Innovations is the most influential theory used in technology adoption (Straub, 2009). It explains *how* innovations spread through society, while TRA explains *why* individuals choose to adopt a particular behaviour. While distinct, they were complementary to help understand the characteristics of an innovation and the social system help predict its diffusion, while understanding individual attitudes and subjective norms to predict individual adoption decisions (Aswani et al., 2018; Dajani & Abu Hegleh, 2019; de Blanes Sebastián et al., 2023a; Mamonov & Benbunan-Fich, 2017).

The introduction of the Theory of Planned Behavior (TPB) and the Technology Acceptance Model (TAM) during the 1980s and 1990s marked significant advancements in understanding individual perceptions regarding behavior and technology adoption. Theory of Planned Behavior (TPB) (Ajzen, 1991) provided a broader framework for understanding behavioral intentions, while TAM offered a more focused approach specifically for technology adoption. These models laid the groundwork for subsequent research and the development of more comprehensive models (Barata & Coelho, 2021). The Technology Acceptance Model (TAM) (Davis, 1989) is the most well-known and extensively used model among the established models related to technology acceptance and use (Dwivedi et al., 2019; Lai, 2017; Y. Lee et al., 2003; Legris et al., 2003). The TAM has been extensively studied and several expansions of the model have been suggested. The model has been applied to various technologies, situations, control and subjects exhibiting its robustness (Venkatesh & Bala, 2008; Williams et al., 2009). The theories evolving during the period from 1990s to 2000s show a growing recognition of the importance of contextual and individual factors in technology acceptance. By integrating additional constructs and acknowledging the influence of external variables, these theories provided more

comprehensive framework for understanding user behavior in technology adoption. Task-Technology Fit (TTF), (Goodhue & Thompson, 1995) highlighted that user involvement in system design enhances task-technology fit, to improve user acceptance and system performance. The Technology Readiness Index (A., 2000) complements the TTF model by focusing on individual readiness to embrace technology. Further, upgraded version of TAM, TAM2 (Venkatesh & Davis, 2000) provides a more robust understanding of user acceptance in various settings by acknowledging the influence of social and contextual factors.

Another theory that emerged earlier in this period by Delone & McLean (Delone & Mclean, 1992) focused on the outcomes of technology adoption rather than the predictors of adoption. It examined the effect of quality of information and quality of the means/system on the motivation of potential users as compared to the Technology Acceptance Model providing interpretation of the user acceptance process. The development of technology adoption models from the 2000s to the 2010s reflect a growing recognition of the complexity of technology acceptance in real-world settings, leading researchers to expand upon the original TAM to better capture the multifaceted influences on user behavior. (Legris et al., 2003; Venkatesh & Bala, 2008; Venkatesh & Davis, 2000) . The integration of TAM with other frameworks alongside the development of dynamic models, enhanced the understanding of the complex nature of technology adoption.

Another successor of TAM, TAM3 (Venkatesh & Bala, 2008) considered factors emphasizing the role of external variables, of user experience and the characteristics of the technology itself, in shaping perceptions of usefulness and ease of use. The model's thorough approach provides a detailed understanding of how personal and environmental elements combine to affect technology adoption. The Unified Theory of Acceptance and Use of Technology 2003, UTAUT model, (Venkatesh et al., 2003) , a more comprehensive and integrated model synthesized elements from eight major technology adoption models, including TAM, TTF, and the TPB and included performance expectancy, effort expectancy, social influence and facilitating conditions as key determinants. (Barata & Coelho, 2021; Patil et al., 2020). The model places emphasis on the utilitarian value, driven by extrinsic motivation, of organizational users, after removing similar or redundant constructs. This comprehensive framework allowed for more nuanced understanding of the factors influencing technology adoption across different contexts, making it a valuable tool for researchers and practitioners alike (Williams et al., 2015). The UTAUT model also considers moderators such as age, gender, experience, and voluntariness of use, further enhancing its applicability in diverse settings (Dwivedi et al., 2019; Lai, 2017).

Over years, with improvement in consumer technologies, an extension of UTAUT model was proposed by Venkatesh et.al. in 2012, highlighting on intrinsic motivation of technology users leading to three new constructs -hedonic motivation, price value, and habit being incorporated in the UTAUT model, referred to as UTAUT2 (Venkatesh et al., 2012). However, the model had limitations in explaining the complex phenomenon of technology adoption as it does not account for social and emotional factors that also influence usage behavior. (Venkatesh et al., 2012) Several upgrades of previous established theories also emerged during this period. Delone & McLean theory upgraded their theory by adding service quality and combining individual impact and organizational impact into net benefits (Delone & McLean, 2003). An upgraded theory, Technology Readiness Index 2.0 (TRI 2.0), developed by Parasuraman and Colby, was introduced in 2015, serving as a psychometric scale designed to measure individuals' propensity to adopt and utilize new technologies in both personal and professional contexts (Parasuraman & Colby, 2015) . This period saw the emergence of various models that integrated social, organizational, and individual factors, reflecting the complexity of technology adoption in real-world settings (Choudhury et al., 2024). The current trend in technology adoption models is characterized by a move towards integrative frameworks that combine elements from multiple theories to address the multifaceted nature of user acceptance. This advancement reflects a deeper understanding that the adoption of technology is influenced by the elaborate relationships among social dynamics, contextual variables, and individual characteristics, necessitating more refined research methodologies and practical applications. Integrating earlier models with considerations

around data privacy, security, trust (Chopdar & Balakrishnan, 2020; Lian & Li, 2021; Thusi & Maduku, 2020; Verkijika, 2018; Vimalkumar et al., 2021) , innovativeness, ethical implications (Balakrishnan & Shuib, 2021; Gansser & Reich, 2021; Qasem, 2021; Shaw & Sergueeva, 2019) and the adoption of specific technologies (Adhiarna et al., 2013; Ben Arfi et al., 2021; Faqih & Jaradat, 2021; Kunz & Santomier, 2019; Lim & Zhang, 2022) . This shift indicates a growing recognition that technology adoption is shaped by a multifaceted combination of social, contextual, and individual elements.

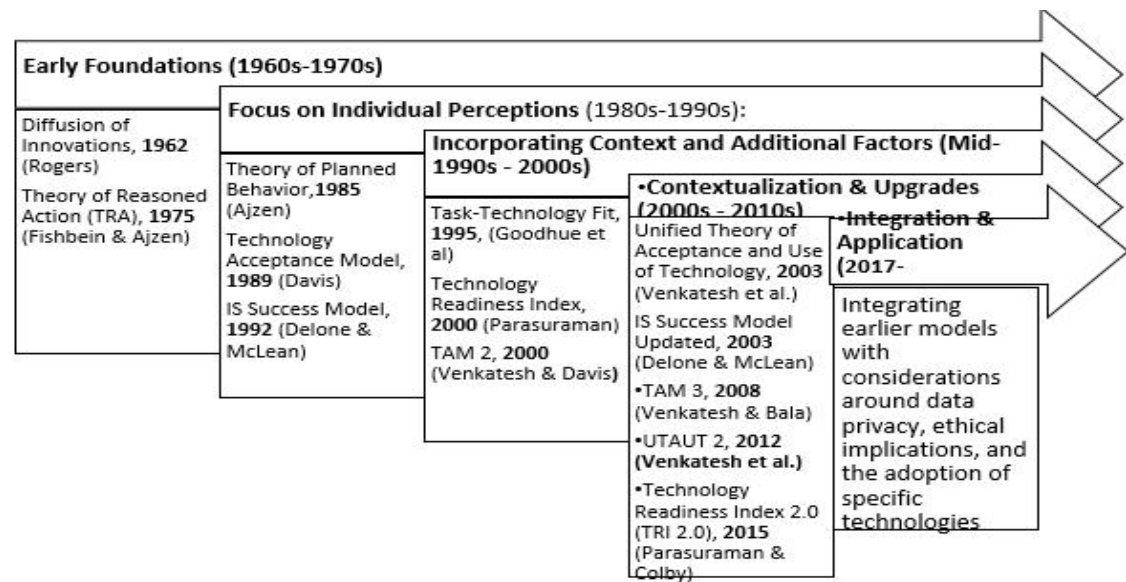


Figure 1. Development of Theories

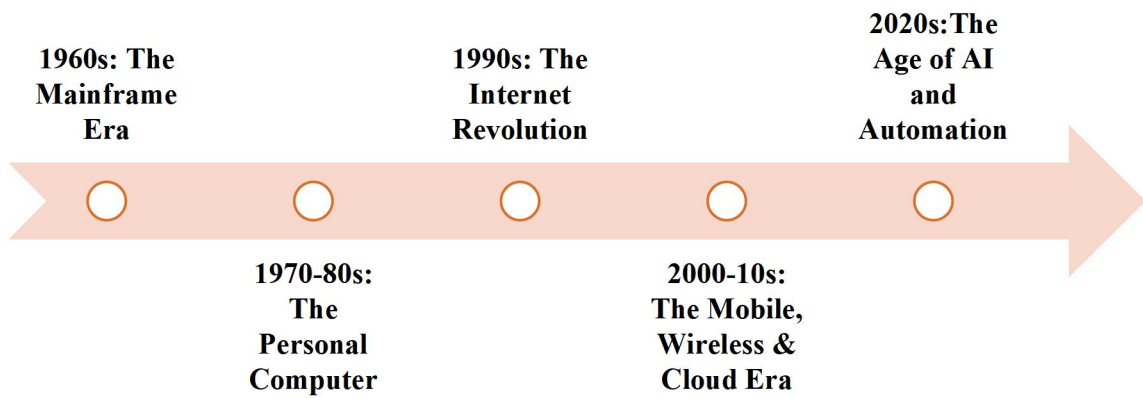


Figure 2. Evolution of Technology

Evolution of Technology

The digital communication technology has undergone remarkable transformations from the 1960s to the 2020s. (Figure 2. Evolution of Technology) The use of computers has progressed from simple calculating tools to powerful and ubiquitous devices that are integral to our lives today (Näsi et al., 2011; Schnaars & Carvalho, 2004). From the introduction and use of computers for industrial use in market in 1970s that led to the era of personal computers in the 1980s, the 1990s and 2000s witnessed the rapid growth of the World Wide Web, mobile phones, and social media, further revolutionizing the way people access and use technology (Hollier & Murray, 2004; J. A. N. Lee, 2004) . The 2010s brought about the widespread adoption of smartphones, tablets, and cloud computing, enabling ubiquitous connectivity and access to a vast array of digital services. The current decade has seen the emergence of transformative technologies such as artificial intelligence, the Internet of Things, and 5G, further blurring the lines between physical and digital realms (Hilbert, 2020; Nickerson, 2008; Wang et al., 2023). Digital technologies are reshaping how we live and conduct business. This ongoing evolution, driven by internet services and modern IT solutions, is transforming our personal and professional landscapes (Baudier et al., 2023; Kshetri, 2021; Melović et al., 2020; R. Sharma & Kshetri, 2020).

Technology Adoption in the Context of Evolving Technologies

Mapping the evolution of technology to the development of technology adoption studies reveals a dynamic interplay. As technology advances, new theories and models emerge to explain how and why people adopt these innovations. During early computers era, adoption research was limited, often focusing on organizational adoption rather than individual consumers. Diffusion of Innovations theory was influential, emphasizing the role of communication channels and social influence. The proliferation of personal computers spurred the development of early adoption models like the Technology Acceptance Model, focussed on perceived usefulness and ease of use. The Theory of Reasoned Action and the Theory of Planned Behavior also contributed to understanding individual adoption decisions. The evolution of technology adoption models reflects a growing understanding of the complex factors influencing user acceptance. From early diffusion theories to contemporary frameworks like UTAUT, researchers continue to refine these models to better capture the dynamics at play in technology adoption across various contexts.

While technology adoption models provide foundational insights into user behavior that remain significantly relevant there is need for ongoing refinement and adaptation to remain effective in understanding how users engage with emerging technologies. The unique characteristics of each emerging technology, along with the specific cultural and demographic factors of user groups (Venkatesh et al., 2012). Some studies suggest that while technology acceptance theories have been extensively tested in developed countries, there is a lack of research on technology usage in less developed countries, leading to conflicting findings about the suitability and predictive power of these theories in such contexts which are likely to attribute to culture factors and type of technology being investigated (Abu-Shanab & Abu-Baker, 2014; Dajani & Abu Hegleh, 2019).

Further, the context in which technology is adopted has become more complex, reflecting industry-specific needs and varying user demographics. The continuous evolution of digital tools and platforms creates a need for models that can adapt more dynamically to new developments. The increasing interconnectedness of technologies and the blurring lines between physical and digital worlds require new theoretical frameworks that can account for these complex interactions (Alesanco-Llorente et al., 2023). Technology adoption models have traditionally focused on user perceptions and behaviors towards new technologies. However, as technology rapidly evolves, these models may need to adapt to account for new factors such as social media influence, rapid innovation cycles, emotional responses of users, changes in user expectations, contextual variables that play significant roles in technology adoption but are not always fully integrated into traditional models (Sahi et al., 2021; P. Sharma et al., 2023). Additionally, digital divide between populations and different demographics and age groups also needs to be considered, particularly explore equitable access to and benefits from AI technologies (Gansser & Reich, 2021)

To address this complexity, in general too there is emphasis on need for more interdisciplinary studies covering concepts from behavioral and social sciences which allows for a comprehensive understanding of human behavior by integrating methodologies and insights from various fields (Hallsworth, 2023). The theories integrated with TAM and its successors or constructs derived come from various disciplines including Psychology and Behavioural Science; Sociology and Cultural Studies; Economics and Management; Communication & Innovation, Education & Learning etc. While some overlap is inevitable, as theories often draw from multiple disciplines. The customer value theory is a widely used framework for understanding the factors that influence user intentions and behavior in the context of emerging technologies, focusing on the value perceived by customers. (Santos-Vijande et al., 2022) UTAUT2 was found to be used with other theories like the Social Cognitive Theory and Technology Readiness Index (Basarir-Ozel et al., 2023; Dhir et al., 2018).

One of the studies from Africa used Information System Success Model (ISSM) and Protection Motivation Theory (PMT) to study factors affecting intention to adopt mobile banking app (Kala Kamdjoug et al., 2021) A notable trend is the move towards value-based assessments in

technology adoption. This approach has since been applied and expanded to various technologies, including augmented reality smart glasses, virtual reality, smart home services, and tablet PCs (García-Monleón et al., 2023; Mohapatra et al., 2020). It was noticed that most of the studies have used modified version of the extended TAM models. This signifies that it not only adds new constructs but potentially adjusts existing relationships within the model to better fit the context in the given geography. It was also found that the research papers covered often depict fragmented elements or specific variables without integrating findings across different contexts or technologies, leading to a lack of comprehensive understanding in the field. However, there is growing need to develop and integrate theoretical frameworks to fully capture the complex dynamics of adoption in this rapidly evolving technological landscape.

4. Research Gaps

TAM and its successors primarily focuses on individual-level factors and may not fully capture the complexity of technology adoption in different contexts (Venkatesh et al., 2012). This statement holds true based on the review conducted. Risk, Trust and Security factors have been extensively explored, further research may categorize potential risks into areas such as social impact, time management (or loss), performance outcomes, and psychological well-being (Bashir et al., 2021). Also, the effect of demographic variables on user's behavioural outcomes and recommendations would provide significant insights. Additionally, societal-level implications of technology adoption covering relevant aspects of digital divide/access etc. need to be considered more in future studies.

Future research should explore additional constructs and relationships relevant to specific domains which have been covered e.g., healthcare ((Duarte & Pinho, 2019), e-commerce (Higuera-Castillo et al., 2023), AI (Kelly et al., 2023) and consider the interplay between individual, social, and organizational factors. While most of the types of technology covered belong to digital commerce, telehealth and further developing on AI driven smart technologies, entertainment and learning can possibly be explored as they increasingly rely on mobile devices. Streaming services, gaming platforms, virtual reality experiences, online learning platforms, interactive simulations can be new technology avenues that can be explored. For example, in context of entertainment, hedonic motivation, social influence, and effort expectancy roles can be explored. Performance expectancy can be examined through content quality, variety, and availability.

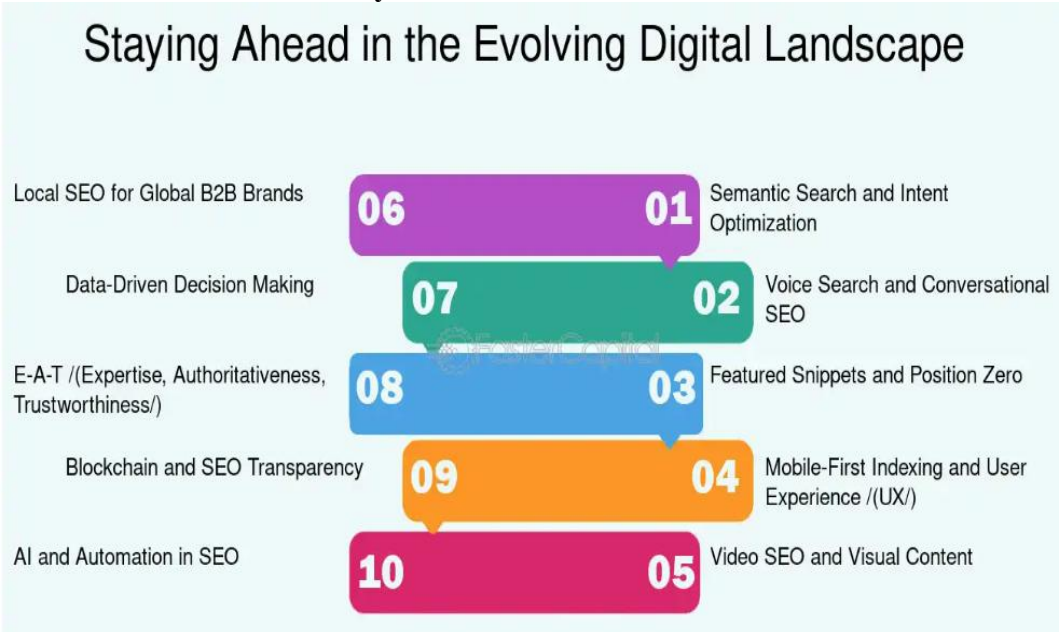
Future research could explore how to better integrate significant contextual shifts (e.g., global crises like pandemic, rapid technological advancements) into the model. Also, future studies could possibly consider how performance expectancy evolves when users are required to adopt a technology, rather than choosing to. Also, if the pandemic-driven changes in technology adoption have become permanent, or are there signs of reversion to pre-pandemic patterns? There also exists bias in technology adoption research towards younger populations and existing users with several studies deploying convenience sampling. This creates a gap in understanding of how other age groups and non-users interact with technology. Among certain economies, developing culturally sensitive and linguistically appropriate data collection instruments is essential for capturing the perspectives of diverse populations. Address the language and education level barrier facilitating broader participation to better understand the dynamics. Tracking technology adoption and use over time can help researchers understand how older adults adapt to new technologies and how their needs and preferences evolve emphasising the need for longitudinal studies. This can inform the development of sustainable and age-friendly technology solutions.

5. Research Methodology

This review provides essential context, tracing the evolution of technology adoption theories alongside the rapid development of digital communication technologies to understand the historical perspective of how earlier models laid the groundwork for contemporary frameworks. A thorough review of the existing theories was carried in a phased manner. Series of extensive search was conducted through aggregator databases like Scopus, EBSCO, JSTOR and Google

Scholar. Theoretical models related to technology adoption were explored using keyword search and mix of Boolean logic to extract theoretical papers etc. The work was focussed on exploratory research to gain understanding of the established and widely adopted theories in the area of adoption of technology related to information systems and information technology acceptance.

6. Discussion and Analysis



(Source: FasterCapital.com)

The image titled presents a visually engaging list of ten key trends shaping the future of digital strategy, particularly in the context of SEO and digital marketing. The list includes: Semantic Search and Intent Optimization, Voice Search and Conversational SEO, Featured Snippets and Position Zero, Mobile-First Indexing and User Experience (UX), Video SEO and Visual Content, Local SEO for Global B2B Brands, Data-Driven Decision Making, E-A-T (Expertise, Authoritativeness, Trustworthiness), Blockchain and SEO Transparency, and AI and Automation in SEO. Each trend is represented as a colorful, numbered block, emphasizing its significance in navigating the increasingly complex digital environment. These components collectively highlight the importance of personalization, automation, trust, and technological integration for maintaining competitiveness and visibility in digital ecosystems.

Conclusion

The rapid adoption of the internet and related technologies led to refinements of existing models and the emergence of new theories to provide a more comprehensive framework. Research also began to explore the social and cultural aspects of digital technology adoption. Technology adoption theories have evolved significantly over time, moving from simpler models focused on individual perceptions to more complex frameworks that incorporate social, cognitive, and contextual factors. The evolving nature of technology, particularly with innovations like artificial intelligence, machine learning, and advanced connectivity, necessitates adaptations to existing models. As technologies become more integrated into daily life and business practices, there is a growing need to incorporate new variables that reflect user experiences and motivations more accurately. Scholars have attempted integrating technology adoption models with newer frameworks to provide a more comprehensive understanding of technology adoption. Also, empirical research on consumer technology adoption has increasingly recognized the evolving context of technology use, although it hasn't fully captured all the nuances. New technologies like artificial intelligence, the Internet of Things, and virtual/augmented reality. Introduce new complexities and user interactions that existing models may not fully capture. Research on technology adoption continues to evolve, seeking to address these emerging challenges and develop more comprehensive models that can explain and predict technology adoption in our ever-changing world.

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