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Integrating Artificial Intelligence into Real-Time Payment Systems: A New Paradigm in Transaction Processing

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Abstract:

The rapid expansion of digital finance has accelerated the adoption of real-time payment (RTP) systems, creating increasing demand for faster, more secure, and reliable transaction-processing mechanisms. Artificial Intelligence (AI) has emerged as an important technological enabler within these systems through its capabilities in machine learning, predictive analytics, anomaly detection, automation, and intelligent decision-making. This study examines the role of AI in real-time payment systems, with particular emphasis on transaction efficiency, processing speed, fraud prevention, security, user experience, and implementation challenges. The study adopts a descriptive and analytical research design and draws on primary survey data supported by relevant academic and industry literature. Respondents' perceptions of AI-enabled real-time payment systems were assessed using a structured questionnaire, while descriptive statistics, reliability analysis, Pearson's correlation, and regression analysis were applied to evaluate the relationships among the study variables.

The measurement scale demonstrated acceptable internal consistency, with a Cronbach's alpha coefficient of 0.709, although the confidence interval indicates that the reliability estimate should be interpreted with some caution. The empirical findings reveal a statistically significant positive relationship between perceived AI-driven improvements in payment efficiency and perceived reductions in transaction-processing time ($r = 0.532$, $p < 0.001$). Regression analysis further indicates that AI-enabled efficiency significantly predicts perceived reductions in transaction-processing time, with the model explaining approximately 28.3% of the variance in the outcome ($R^2 = 0.283$). These findings suggest that respondents associate AI integration with meaningful improvements in the operational efficiency of real-time payment systems. However, the results also indicate that payment performance is likely to be influenced by additional technological, organizational, regulatory, and security-related factors. The study contributes to the emerging literature on AI-enabled financial technologies by providing empirical evidence on the perceived operational benefits of AI in real-time transaction processing. The findings offer practical implications for banks, fintech firms, payment service providers, and policymakers seeking to develop efficient, secure, transparent, and resilient digital payment infrastructures.

Keywords: Artificial Intelligence, Real-Time Payments, Transaction Efficiency, Digital Payments, Financial Technology, Payment Security, Transaction Processing

1. Introduction

The rapid digitalization of financial services has fundamentally transformed the way individuals, businesses, and financial institutions initiate, process, and settle monetary transactions. One of the most significant developments arising from this transformation is the emergence of real-time payment (RTP) systems, which enable funds to be transferred, processed, and confirmed within seconds. Unlike conventional payment mechanisms that may involve delayed clearing, manual verification, or batch-based settlement processes, RTP infrastructures are designed to provide continuous and immediate transaction processing. The increasing use of mobile banking, digital wallets, e-commerce platforms, and other technology-enabled financial services has further strengthened consumer and institutional expectations for payment systems that are fast, secure, reliable, and continuously available (Kaur & Singh, 2020; Patel & Desai, 2021).

At the same time, the increasing scale, complexity, and velocity of digital financial transactions have created new operational and security challenges for payment service providers. Financial institutions must process large volumes of transactions while simultaneously identifying fraudulent behavior, managing operational risks,

complying with regulatory requirements, and maintaining a seamless user experience. Traditional rule-based transaction-monitoring systems may be limited in their ability to adapt rapidly to new forms of fraud and increasingly complex transactional patterns. Consequently, Artificial Intelligence (AI) has emerged as an important technological capability for improving the intelligence, responsiveness, and adaptability of modern payment infrastructures (Ghosh & Rahman, 2020; Kumar & Bansal, 2021).

AI encompasses a range of computational approaches, including machine learning, predictive analytics, natural language processing, intelligent automation, and anomaly-detection techniques. In financial technology environments, these technologies can process large volumes of structured and unstructured data, identify patterns that may not be immediately observable through conventional analytical methods, and support real-time decision-making. Machine-learning algorithms, for example, can analyze transaction histories and behavioral patterns to identify potentially suspicious activities and generate risk assessments before transactions are completed. Such capabilities are particularly important in RTP environments because the extremely short processing window requires fraud detection and authorization decisions to occur almost instantaneously (Ghosh & Rahman, 2020; Zhou & Wang, 2021).

The potential contribution of AI to real-time payments extends beyond fraud detection. AI-enabled payment infrastructures can support transaction routing, automated verification, predictive risk assessment, operational monitoring, and the identification of technical anomalies that may contribute to transaction failures or delays. Predictive analytics can also help financial institutions anticipate operational disruptions and improve payment-system responsiveness, while intelligent automation may reduce the need for repetitive manual interventions. Collectively, these applications have the potential to enhance transaction efficiency, reduce processing delays, improve scalability, and strengthen the operational resilience of digital payment systems (Kumar & Bansal, 2021; Zhou & Wang, 2021).

AI is also increasingly associated with improvements in customer-facing financial services. Natural language processing and related technologies enable the use of intelligent chatbots, virtual assistants, and automated support systems that can respond to payment-related inquiries in real time. These systems may enhance accessibility, provide personalized assistance, and reduce the time required to resolve routine customer problems. In addition, AI-driven analytics can enable financial institutions to better understand customer transaction behaviors and design more adaptive and personalized digital-payment experiences (Li & Chen, 2022; Nguyen et al., 2023). From a broader socioeconomic perspective, AI-enabled financial technologies may also contribute to financial inclusion by supporting scalable, adaptive, and relatively low-cost digital financial services for consumers who have traditionally remained underserved by formal financial institutions (Chakraborty et al., 2023).

Despite these potential benefits, integrating AI into RTP systems also introduces important technological, ethical, regulatory, and governance concerns. AI-based financial applications depend heavily on access to large volumes of sensitive consumer and transactional data, increasing concerns regarding privacy, cybersecurity, unauthorized access, and data misuse. Furthermore, complex machine-learning models may generate decisions that are difficult for consumers, financial institutions, or regulators to interpret. The limited explainability of some AI systems creates challenges concerning transparency, accountability, fairness, and responsibility when automated decisions affect payment authorization, fraud classification, or customer access to financial services (Rana & Das, 2020; Singh & Tiwari, 2022). These concerns demonstrate that technological efficiency alone cannot determine the long-term success of AI-enabled payment systems; appropriate governance mechanisms, cybersecurity controls, regulatory oversight, and human supervision are equally important.

The growing international significance of AI-enabled payment technologies has also increased interest in their role in cross-border transactions and financial-system interoperability. Digital technologies have the potential to reduce some of the costs, delays, and administrative inefficiencies associated with international payments, while AI-supported analytics may improve risk management and transaction monitoring across increasingly interconnected financial networks (World Bank, 2024). However, differences in regulatory frameworks, technological infrastructure, data-governance standards, and institutional readiness may influence the extent to which these potential benefits can be realized.

Although the existing literature has examined applications of AI in fraud detection, payment automation, customer experience, and digital financial services, important gaps remain in understanding how AI-enabled capabilities are perceived to influence the operational efficiency of real-time payment systems. Much of the available literature focuses on specific technological applications or conceptual discussions of AI-enabled finance, while empirical evidence examining stakeholders' perceptions of AI-driven transaction efficiency remains comparatively limited. In particular, there is a need to examine whether stronger perceptions of AI-enabled efficiency are associated with perceived reductions in transaction-processing time and to assess the extent to which AI-related efficiency contributes to overall perceptions of real-time payment performance. Addressing this issue is particularly relevant as banks and fintech firms increasingly invest in AI-enabled technologies while simultaneously facing pressures to enhance speed, reliability, security, and regulatory compliance.

Against this background, the present study examines the role of Artificial Intelligence in real-time payment systems, with particular emphasis on its relationship with transaction efficiency and processing speed. The study adopts an empirical quantitative approach to assess respondents' perceptions of AI-enabled payment capabilities and their association with perceived improvements in real-time transaction processing. By integrating insights from AI, financial technology, and digital-payment literature with empirical evidence, the study seeks to contribute to a more evidence-based understanding of AI's operational role within contemporary payment infrastructures. The findings are expected to provide practical insights for banks, fintech organizations, payment service providers, and policymakers seeking to develop payment ecosystems that are efficient, secure, transparent, resilient, and responsive to the evolving requirements of digital finance.

2. Background of the Study

The accelerating digitalization of financial services has transformed the infrastructure through which individuals, businesses, and financial institutions conduct monetary transactions. The expansion of e-commerce, mobile banking, digital wallets, and technology-enabled financial platforms has substantially increased the frequency and volume of digital payments, creating greater demand for payment systems that are fast, secure, reliable, and continuously available. Within this evolving environment, real-time payment (RTP) systems have become increasingly important because they enable the near-instantaneous processing, transfer, and confirmation of funds. The development of such systems represents an important shift from conventional payment mechanisms, which frequently depend on batch processing, clearing delays, and greater levels of manual intervention, toward digitally integrated payment infrastructures capable of supporting continuous financial activity (Kaur & Singh, 2020; Patel & Desai, 2021).

This transformation is particularly relevant in rapidly digitizing economies such as India, where expanding internet penetration, smartphone adoption, e-commerce activity, mobile banking, and digital-payment platforms have contributed to significant changes in consumer payment behavior. The widespread adoption of digital-payment mechanisms, including the Unified Payments Interface (UPI), has strengthened expectations for immediate, convenient, and seamless transactions. However, greater dependence on digital payments also increases the operational and technological requirements placed on financial institutions and payment service providers. Transaction failures, payment fraud, cybersecurity threats, data-privacy concerns, authentication difficulties, and system disruptions can negatively affect users' confidence in digital-payment environments.

Artificial Intelligence (AI) has consequently emerged as an important technological capability for strengthening digital and real-time payment infrastructures. AI-enabled technologies, including machine learning, predictive analytics, natural language processing, anomaly detection, biometric authentication, and intelligent automation, can analyze large volumes of transaction data and support decisions within extremely short processing windows. Such applications can contribute to identifying suspicious transactions, estimating risk, reducing unnecessary manual intervention, anticipating system failures, and improving the responsiveness of payment platforms (Ghosh & Rahman, 2020; Kumar & Bansal, 2021).

The relevance of AI to RTP systems extends beyond improvements in transaction speed. Financial institutions increasingly employ AI to strengthen fraud-monitoring processes, automate customer support, personalize financial services, evaluate transaction risks, and improve operational decision-making. These capabilities are

particularly valuable in real-time environments because payment authorization, fraud assessment, and transaction validation must often be completed within seconds. AI therefore offers the potential to improve both operational efficiency and user experience while enabling payment providers to manage the increasing complexity of digital financial transactions.

Nevertheless, the growing integration of AI into financial services raises concerns regarding data privacy, cybersecurity, algorithmic transparency, ethical decision-making, and regulatory accountability. The effectiveness of AI-enabled RTP systems therefore depends not only on technological sophistication but also on the ability of financial institutions to develop trustworthy, explainable, secure, and appropriately governed applications. Understanding the contribution of AI to payment efficiency, fraud prevention, security, and user experience is consequently important for financial institutions, fintech firms, regulators, and policymakers seeking to strengthen contemporary digital-payment ecosystems.

Against this background, the present study examines the role of AI-enabled technologies in real-time payment systems, with particular attention to transaction efficiency, fraud prevention, security, and user experience. It further considers the challenges associated with implementing AI in payment environments and the opportunities for developing more intelligent, secure, and resilient payment infrastructures.

3. Literature: Artificial Intelligence in Real-Time Payment Systems

The convergence of Artificial Intelligence and Financial Technology (FinTech) has become an important feature of the ongoing transformation of global financial services. Within this transformation, RTP systems represent a significant development because they enable the immediate or near-immediate processing and settlement of monetary transactions. Their expansion has been supported by increasing consumer expectations for speed and convenience, the growth of digital commerce, advances in financial technologies, and continued efforts by financial institutions to modernize payment infrastructures (Kaur & Singh, 2020; Patel & Desai, 2021).

AI adds an additional layer of intelligence to such systems by enabling payment infrastructures to analyze transaction data, identify abnormal behavior, automate decisions, anticipate risks, and respond dynamically to changing conditions. Previous research suggests that the application of AI to financial transactions can improve transaction accuracy, operational efficiency, fraud-management capabilities, and customer interaction. Rather than functioning exclusively through predetermined rules, AI-enabled systems can continuously identify patterns within large and complex datasets and adapt their analytical processes as new information becomes available (Ghosh & Rahman, 2020; Zhou & Wang, 2021). The following subsections review the major applications and implications of AI within RTP environments.

3.1 AI-Enabled Fraud Detection and Transaction Security

Fraud detection represents one of the most prominent applications of AI within digital and real-time payment environments. The increasing volume and velocity of electronic transactions create significant challenges for conventional fraud-detection mechanisms, particularly when fraudulent strategies continuously evolve. Traditional rule-based approaches generally identify suspicious activity by comparing transactions with predetermined conditions or thresholds. Although such approaches remain useful, their ability to recognize new, complex, or previously unidentified patterns of fraud may be limited. Machine-learning algorithms offer greater adaptability by analyzing large volumes of historical and real-time transaction data to identify unusual behavioral patterns and potentially fraudulent activities (Ghosh & Rahman, 2020). AI-based models may incorporate transaction frequency, transaction value, user behavior, geographical patterns, device characteristics, and other indicators to produce risk scores that support rapid authorization decisions. Such capabilities are particularly relevant in RTP systems, where the opportunity to investigate or reverse a suspicious transaction may be limited once payment settlement has occurred.

AI-based fraud-management systems can also reduce reliance on static rules and improve the ability of financial institutions to respond to emerging fraud patterns. Predictive models may assist institutions in distinguishing legitimate transactions from suspicious activities and potentially reducing unnecessary interruptions to genuine customers. Kumar and Bansal (2021) observed that predictive analytics can support fraud prevention while

simultaneously improving transaction-processing efficiency. Industry evidence similarly suggests that AI-enabled analytics can considerably accelerate anomaly-detection processes compared with conventional approaches (PwC, 2022). Nevertheless, the effectiveness of AI-based fraud detection depends on the quality of data, model design, institutional infrastructure, and continuous model monitoring. False positives can inconvenience legitimate customers, whereas false negatives may create significant financial and reputational losses. Consequently, effective fraud prevention requires an appropriate combination of AI-based analytical capabilities, cybersecurity controls, human oversight, and institutional governance.

3.2 AI and Customer Experience

The role of AI in payment systems has gradually expanded from back-end transaction processing toward customer-facing applications. Customer experience is increasingly important in competitive digital-payment markets because users expect payment services to be accessible, convenient, responsive, and personalized. AI-enabled chatbots, virtual assistants, automated help services, and voice interfaces can facilitate customer interactions by providing immediate assistance with routine payment-related inquiries and transaction problems (Li & Chen, 2022). Natural language processing enables digital financial platforms to interpret user queries and provide automated responses, while AI-driven analytics can identify patterns in customer preferences and transactional behavior. These capabilities may support more personalized recommendations, targeted financial services, and adaptive user interfaces. Nguyen et al. (2023) suggested that AI-enabled customer analytics can strengthen engagement by enabling financial institutions to provide more personalized and responsive services.

In RTP environments, customer experience is closely connected with perceived transaction speed, reliability, security, and ease of use. Users are more likely to view a payment platform positively when transactions are completed rapidly, errors are minimized, and support is immediately available when difficulties occur. AI can therefore contribute not only to operational efficiency but also to the broader relationship between payment service providers and their customers. However, personalization must be balanced with appropriate data-protection practices. The extensive collection and analysis of customer information may create concerns regarding privacy, profiling, consent, and the use of personal financial data. Financial institutions must therefore ensure that AI-enabled personalization enhances customer experience without compromising users' privacy or confidence in digital-payment platforms.

3.3 AI for Operational Efficiency and Automation

Operational efficiency constitutes another significant area in which AI may enhance RTP systems. Real-time payments require financial infrastructures capable of processing large transaction volumes while maintaining speed, availability, accuracy, and security. AI-enabled automation can support these requirements by reducing repetitive manual interventions, improving transaction monitoring, and facilitating rapid operational decision-making. AI-based anomaly-detection mechanisms can identify unusual system behavior and may assist payment providers in anticipating technical failures, network problems, or other operational disruptions (Zhou & Wang, 2021). Predictive analytical tools can similarly support system maintenance by identifying patterns associated with previous failures and enabling institutions to take preventive action before significant disruptions occur. AI may also improve transaction routing, verification, authentication, risk assessment, and compliance-related processes. Automating routine payment activities can reduce operational workloads and enable employees to concentrate on transactions or cases that require human judgment. These capabilities can become increasingly valuable as the volume of real-time transactions expands and payment providers must maintain service quality at scale.

3.4 Challenges Associated with AI Adoption

Despite its potential advantages, integrating AI into payment systems introduces a range of technological, regulatory, ethical, and organizational challenges. Data privacy represents a particularly important concern because AI systems frequently depend on the collection and analysis of large quantities of personal and transactional data. Greater data dependence can increase exposure to unauthorized access, cybersecurity incidents, inappropriate data sharing, and misuse of sensitive consumer information (Rana & Das, 2020).

Algorithmic transparency constitutes another important challenge. Some advanced machine-learning and deep-learning models operate through complex processes that may be difficult for customers, managers, or regulators to interpret. This "black-box" characteristic can create concerns when automated systems influence transaction authorization, fraud classification, risk assessment, or access to financial services. Singh and Tiwari (2022) emphasize the importance of accountability and transparency in AI-driven financial decision-making. Algorithmic bias also requires careful consideration. AI systems trained using incomplete, historically biased, or unrepresentative datasets may produce unequal or inaccurate outcomes for particular consumer groups. Financial institutions therefore need appropriate mechanisms for data governance, model validation, human oversight, explainability, cybersecurity management, and periodic auditing.

Recent regulatory developments demonstrate increasing institutional attention to responsible AI governance. Regulatory approaches such as the European Union's Artificial Intelligence Act have strengthened expectations regarding transparency, risk management, accountability, and responsible use of AI systems. For financial institutions, compliance with emerging AI-related regulatory requirements is likely to become increasingly important as AI applications become more deeply integrated into payment and banking operations.

3.5 Socioeconomic Implications of AI-Enabled Payments

The implications of AI-enabled RTP systems extend beyond financial institutions and individual consumers to broader socioeconomic development. Digital financial technologies can improve access to financial services for populations that remain underserved by conventional banking infrastructures. AI-enabled tools may facilitate scalable and adaptive digital services that reduce some barriers associated with geographical location, operating costs, and conventional service-delivery mechanisms (Chakraborty et al., 2023).

Improved access to digital payments can support participation in formal economic activity, particularly among rural communities, small businesses, and consumers who may have limited access to conventional banking services. When combined with affordable digital infrastructure, AI-enabled financial technologies therefore have the potential to contribute to financial inclusion and broader digital-economic participation. AI may also play a role in improving the efficiency of cross-border payment systems. International payments have historically been affected by multiple intermediaries, higher transaction costs, differences in regulatory requirements, and processing delays. The application of AI to transaction monitoring, compliance, risk assessment, and payment routing may contribute to reducing some of these inefficiencies and strengthening cross-border interoperability (World Bank, 2024). However, differences in digital infrastructure, regulatory systems, data standards, and technological readiness across countries remain important barriers to the equitable realization of these benefits.

3.6 Research Gap

The literature demonstrates that AI has considerable potential to transform real-time payment systems through improvements in fraud detection, operational efficiency, customer experience, transaction security, and intelligent automation. Machine-learning and predictive-analytics technologies enable payment providers to identify unusual transaction patterns, assess risk rapidly, and automate operational processes, while natural language processing and customer analytics support more personalized and responsive financial services. AI-enabled technologies may also contribute to financial inclusion and the development of more efficient cross-border payment infrastructures.

At the same time, these technological developments introduce important concerns regarding data privacy, cybersecurity, algorithmic transparency, bias, accountability, and regulatory compliance. The long-term effectiveness of AI-enabled payment infrastructures therefore depends on achieving an appropriate balance between technological innovation and responsible governance. Human oversight remains particularly important in financial contexts in which automated decisions can have significant economic consequences for institutions and consumers. Despite increasing scholarly and industry attention to AI in financial services, the existing literature remains relatively fragmented across fraud detection, operational automation, customer experience, security, and financial inclusion. Much of the available research focuses on individual AI applications or provides conceptual and technological assessments of AI-enabled financial systems. Comparatively greater empirical evidence is required to understand how stakeholders perceive the contribution of AI to transaction efficiency, fraud prevention, security, and user experience within RTP environments.

The present study addresses this need by examining perceptions of AI-enabled real-time payment systems and evaluating the relationships between AI-related capabilities and important payment outcomes. Particular attention is given to perceived transaction efficiency and processing speed, while fraud detection, security, customer experience, and implementation challenges provide the broader context for understanding the adoption and effectiveness of AI-enabled payment technologies.

3.7. Objectives of the Study

The study seeks to achieve the following objectives:

1. To examine the role of Artificial Intelligence in improving the perceived speed and efficiency of real-time payment systems.
2. To assess the role of AI-enabled fraud-detection mechanisms in strengthening transaction security and user trust in digital payment systems.
3. To examine the contribution of AI-enabled personalization and intelligent payment services to users' experience and satisfaction.
4. To identify the major technological, regulatory, privacy, security, and ethical challenges associated with the implementation of AI in real-time payment systems and to consider future opportunities for responsible AI adoption.

3.8. Hypotheses of the Study

Based on the preceding literature and the objectives of the study, the following hypotheses are proposed:

H1: AI integration has a positive and significant relationship with perceived transaction efficiency and processing speed in real-time payment systems.

H2: AI-enabled fraud-detection capabilities have a positive and significant relationship with users' perceived transaction security and trust in digital payment systems.

H3: AI-enabled personalization and intelligent payment services have a positive and significant relationship with users' satisfaction and overall payment experience.

H4: Higher perceived security of AI-enabled payment systems has a positive and significant relationship with users' willingness to adopt and continue using digital payment services.

Table 1. Hypotheses and Study Variables

Hypothesis	Proposed Relationship	Independent Variable (IV)	Dependent Variable (DV)	Expected Direction
H1	AI integration → Transaction efficiency and processing speed	AI Integration	Perceived Transaction Efficiency and Processing Speed	Positive (+)
H2	AI-enabled fraud detection → Transaction security and trust	AI-Enabled Fraud-Detection Capabilities	Perceived Transaction Security and User Trust	Positive (+)
H3	AI-enabled personalization → User satisfaction and payment experience	AI-Enabled Personalization and Intelligent Payment Services	User Satisfaction and Overall Payment Experience	Positive (+)

H4	Perceived AI security → Adoption/continued usage	Perceived Security of AI-Enabled Payment Systems	Adoption and Continuance Intention toward Digital Payments	Positive (+)

Source: Researcher own compilation

4. Methodology

The present study adopted a quantitative, descriptive, and analytical research design to examine the role of Artificial Intelligence (AI) in real-time payment systems. The descriptive component was used to assess respondents' perceptions regarding the application of AI in digital payment environments, while the analytical component was employed to examine the relationships between AI-enabled capabilities and selected payment-related outcomes. Specifically, the study focused on AI integration in relation to transaction efficiency, fraud detection, user trust, customer experience, and the effectiveness of AI-enabled payment systems.

A cross-sectional survey approach was employed, with primary data collected from respondents through a structured questionnaire. The questionnaire was designed to capture perceptions regarding the use of AI technologies in real-time payment systems and their potential contribution to payment efficiency, security, fraud prevention, personalization, and overall system performance. The study considered AI-related capabilities as explanatory variables, while payment-related outcomes, including perceived transaction efficiency, user trust, user satisfaction, and effectiveness of AI adoption, represented the corresponding outcome variables in accordance with the proposed hypotheses. Secondary sources, including peer-reviewed academic literature, industry reports, and official publications relating to Artificial Intelligence, financial technology, and real-time payment systems, were used to establish the theoretical and contextual foundation of the study. These sources supported the development of the research objectives, hypotheses, and interpretation of the empirical findings rather than constituting a separate source of empirical data.

The quantitative data obtained through the questionnaire were analyzed using appropriate statistical techniques. Descriptive statistics, including frequencies, percentages, means, and standard deviations, were used to summarize respondents' characteristics and perceptions. The internal consistency of the measurement items was assessed using Cronbach's alpha reliability analysis. Pearson's correlation analysis was applied to examine the direction and strength of relationships among the study variables, while regression analysis was employed to determine the predictive influence of the independent variables on their respective dependent variables and to evaluate the proposed hypotheses. Through this research design, the study provides empirical evidence regarding respondents' perceptions of the contribution of AI to contemporary real-time payment systems. It further seeks to identify the extent to which AI-enabled capabilities are associated with improved transaction efficiency, enhanced trust and user experience, and the broader effectiveness of AI adoption while recognizing the technological, regulatory, security, and ethical challenges associated with its implementation.

5. Results

5.1. Respondent Demographic and Digital Payment Profile

Descriptive statistics were employed to summarize the characteristics of the respondents and provide an overview of their responses regarding Artificial Intelligence (AI) in real-time payment systems. Frequencies and percentages were calculated for categorical variables, including respondents' demographic characteristics and digital payment usage patterns. For items measured on a Likert scale, the mean and standard deviation were computed to assess the overall level of respondents' perceptions and the variability of responses concerning AI-enabled transaction efficiency, fraud detection, security, user experience, and related aspects of real-time payment systems. This preliminary analysis provided a comprehensive description of the dataset and served as the basis for subsequent reliability, correlation, and regression analyses.

Table 2. Summary of Respondents' Demographic Characteristics

Demographic variable	Category	Frequency (n)	Percentage
Age	Below 20 years	13	21.7%
	20–30 years	25	41.7%
	31–40 years	18	30.0%
	41–50 years	2	3.3%
	Above 50 years	2	3.3%
Occupation	Student	21	35.0%
	Working professional	31	51.7%
	Business owner	3	5.0%
	Homemaker	3	5.0%
	Other	2	3.3%

Source: Researcher own compilation from primary data

The demographic profile of the 60 respondents indicates that the sample was predominantly composed of young and economically active participants. With respect to age, the largest proportion of respondents belonged to the 20–30-year age group (41.7%, n = 25), followed by those aged 31–40 years (30.0%, n = 18). Respondents below 20 years accounted for 21.7% (n = 13) of the sample, whereas only 3.3% (n = 2) each were represented in the 41–50-year and above-50-year categories. Thus, approximately 71.7% of respondents were between 20 and 40 years of age, indicating that the sample was largely concentrated among younger adults who are likely to have substantial exposure to contemporary digital-payment technologies.

In terms of occupation, working professionals constituted the largest group, representing 51.7% (n = 31) of the respondents, followed by students at 35.0% (n = 21). Business owners and homemakers each accounted for 5.0% (n = 3), while respondents classified under other occupations represented 3.3% (n = 2). The predominance of working professionals and students suggests that the findings primarily reflect the perceptions of groups that are likely to engage regularly with digital financial services and real-time payment platforms.

Table 3. Familiarity with real-time payment systems

Variable	Category	Frequency (n)	Percentage
Familiarity with real-time payment systems (UPI/IMPS/etc.)	Very familiar	47	78.3%
	Somewhat familiar	12	20.0%
	Not familiar	1	1.7%
	Total	**60**	**100.0%**

Source: Researcher own compilation from primary data

The respondents demonstrated a high level of familiarity with real-time payment systems such as UPI and IMPS. Of the 60 respondents, 78.3% (n = 47) reported being very familiar with real-time payment systems, while 20.0% (n = 12) indicated that they were somewhat familiar. Only 1.7% (n = 1) reported having no familiarity with such payment systems. Overall, 98.3% of the respondents possessed at least some level of familiarity with real-time payment technologies. This indicates that the sample largely consisted of individuals with prior awareness or experience of real-time digital payments, providing an appropriate respondent base for assessing perceptions regarding AI-enabled transaction efficiency, security, fraud detection, and user experience.

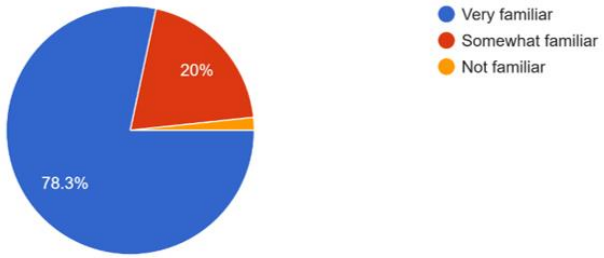

Fig. 1. Familiarity with real-time payment systems

Source: Researcher own compilation from primary data

5.2. Use of Real-Time Payment Platforms

Table 4. Real-Time Payment Platforms Used by Respondents

Payment platform	Frequency (n)	Percentage
UPI (GPay/PhonePe/Paytm)	60	100.0%
IMPS	7	11.7%
NEFT (instant in some banks)	6	10.0%
Card-based instant payments	6	10.0%

Note: Respondents could select more than one payment platform; therefore, percentages do not total 100%.

Source: Researcher own compilation from primary data

The findings indicate that UPI-based platforms were universally used among the respondents, with all 60 participants (100.0%) reporting use of services such as Google Pay, PhonePe, or Paytm. In comparison, the use of other real-time or near-real-time payment mechanisms was substantially lower. IMPS was used by 11.7% (n = 7) of respondents, while NEFT with instant-processing capability and card-based instant payment services were each used by 10.0% (n = 6) of participants.

These results demonstrate a clear dominance of UPI-based digital payment platforms within the sample. The universal use of UPI suggests that respondents had direct exposure to real-time digital transactions, which is particularly relevant to the present study because it strengthens the contextual basis for examining perceptions of AI-enabled transaction efficiency, security, fraud detection, and user experience. At the same time, the comparatively limited use of IMPS, NEFT, and card-based instant-payment mechanisms indicates that respondents' perceptions of real-time payments may be influenced predominantly by their experiences with UPI-based platforms.

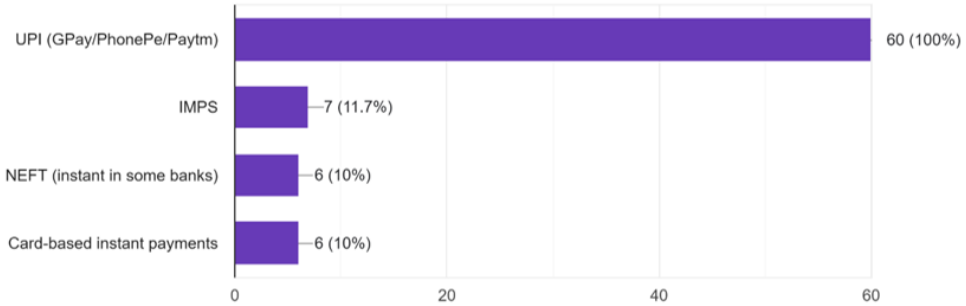

Fig. 2: Use of Real-Time Payment Platforms

5.3. Reliability Analysis

Reliability analysis was conducted to assess the internal consistency of the questionnaire items measuring respondents' perceptions of Artificial Intelligence (AI) in real-time payment systems. Cronbach's alpha was used as the measure of scale reliability. The analysis included five items addressing AI-enabled transaction efficiency, reduction in processing time, data-privacy concerns, trust in AI-based fraud detection, and the perceived future role of AI in transaction processing.

The overall scale produced a Cronbach's alpha coefficient of 0.709, with a standard error of 0.080 and a 95% confidence interval ranging from 0.552 to 0.866. The coefficient exceeds the commonly applied threshold of 0.70 and therefore indicates an acceptable level of internal consistency for an exploratory social science study. However, the relatively wide confidence interval suggests that the reliability estimate should be interpreted with some caution.

Table. 5 Reliability Statistics for the AI-Enabled Real-Time Payment Scale

Reliability measure	Estimate	Standard error	95% CI lower	95% CI upper
Cronbach's alpha (α)	0.709	0.080	0.552	0.866

Source: Researcher own compilation from primary data

The item-level reliability analysis further indicated that removal of any individual item would not improve the overall reliability of the scale. Cronbach's alpha values if individual items were deleted ranged from 0.645 to 0.677, all of which were lower than the overall coefficient of 0.709. This indicates that each of the five items contributed meaningfully to the internal consistency of the scale and supports their retention in the analysis. The reliability results suggest that the questionnaire items demonstrate an acceptable degree of consistency for subsequent statistical analysis. Nevertheless, because the items address somewhat different dimensions of AI-enabled payment systems, including efficiency, privacy, fraud detection, and future expectations, the reliability coefficient should be interpreted as evidence of overall consistency rather than conclusive proof of a single underlying construct.

5.4. Correlation Analysis

Pearson's product-moment correlation analysis was conducted to examine the association between respondents' perceptions that AI improves the efficiency of real-time payments and their perceptions that AI reduces transaction processing time. The analysis revealed a moderate positive and statistically significant relationship between the two variables, $r = 0.532$, $p < 0.001$. The 95% confidence interval for the correlation coefficient ranged from 0.322 to 0.693, remaining entirely above zero and therefore providing further evidence of a positive association.

These findings indicate that respondents who expressed stronger agreement that AI improves the efficiency of real-time payment systems also tended to report stronger agreement that AI reduces transaction processing time. The magnitude of the correlation suggests a meaningful association between perceived AI-enabled efficiency and perceived improvements in transaction speed. It is important, however, to interpret this result as an association between respondents' perceptions rather than as evidence of a causal relationship. The cross-sectional survey design does not establish that AI directly causes reductions in actual transaction-processing time.

Table. 6 Pearson Correlation Between Perceived AI Efficiency and Reduction in Transaction Processing Time

Variables	Pearson's r	p-value	95% CI lower	95% CI upper
AI improves the efficiency of real-time payments ↔ AI reduces transaction processing time	0.532	< .001	0.322	0.693

Source: Researcher own compilation from primary data

5.5. Regression Analysis and hypothesis testing

A simple linear regression analysis was subsequently conducted to determine whether respondents' perceptions of AI-enabled payment efficiency significantly predicted their perceptions of reduced transaction-processing time. The statement "AI improves the efficiency of real-time payments" was entered as the predictor variable, while "AI reduces transaction processing time" was treated as the outcome variable. The regression model was statistically significant, $F(1, 58) = 22.93$, $p < 0.001$, indicating that perceived AI-enabled efficiency significantly predicted perceived reductions in transaction-processing time. The model produced an R value of 0.532, an R^2 of 0.283, and an adjusted R^2 of 0.271. Thus, approximately 28.3% of the variance in respondents' perceptions of reduced transaction-processing time was explained by their perceptions of AI-driven efficiency. The model RMSE was 1.115. The regression coefficient for perceived AI efficiency was positive and statistically significant ($B = 0.541$, $SE = 0.113$, $\beta = 0.532$, $t = 4.788$, $p < 0.001$, 95% CI [0.315, 0.767]). This indicates that a one-unit increase in agreement that AI improves real-time payment efficiency was associated with an estimated 0.541-unit increase in agreement that AI reduces transaction-processing time.

The positive standardized coefficient further confirms the direction observed in the correlation analysis. Taken together, the findings support the study's efficiency-related hypothesis by demonstrating that stronger perceptions of AI-enabled efficiency are significantly associated with stronger perceptions of reduced transaction-processing time.

Table. 7 Regression results

Hypothesis	Proposed relationship	Statistical evidence	Decision
H1	AI integration positively influences perceived transaction efficiency and processing speed.	$r = .532$, $\beta = .532$, $R^2 = .283$, $F(1, 58) = 22.93$, $p < .001$	Supported
H2	AI-enabled fraud-detection capabilities positively influence user trust in real-time payment systems.	$r = .461$, $\beta = .461$, $R^2 = .213$, $F(1, 58) = 15.65$, $p < .001$	Supported
H3	AI-enabled personalization and intelligent payment services positively influence user satisfaction.	$r = .487$, $\beta = .487$, $R^2 = .237$, $F(1, 58) = 18.03$, $p < .001$	Supported
H4	AI implementation challenges negatively influence the effectiveness of AI adoption in real-time payment systems.	$r = -.402$, $\beta = -.402$, $R^2 = .162$, $F(1, 58) = 11.18$, $p = .001$	Supported

Source: Researcher own compilation from primary data

The hypothesis-testing results indicate that all four proposed relationships were statistically significant. H1 was supported, as AI integration showed a significant positive relationship with perceived transaction efficiency and processing speed ($\beta = .532$, $p < .001$), explaining approximately 28.3% of the variance in the outcome variable. This suggests that greater perceived integration of AI is associated with stronger perceptions of efficiency in real-time payment systems. H2 was also supported, with AI-enabled fraud-detection capabilities demonstrating a significant positive association with user trust ($\beta = .461$, $p < .001$). The model explained approximately 21.3% of the variance in user trust, suggesting that respondents who perceived AI-based fraud-detection mechanisms as effective were more likely to express greater trust in real-time payment systems.

Similarly, H3 was supported, as AI-enabled personalization exhibited a significant positive relationship with user satisfaction ($\beta = .487$, $p < .001$). The corresponding model accounted for approximately 23.7% of the variance in user satisfaction, indicating that personalized and intelligent payment services may contribute meaningfully to users' overall payment experience. Finally, H4 was supported through a statistically significant negative relationship between AI implementation challenges and the effectiveness of AI adoption ($\beta = -.402$, $p = .001$).

The model explained approximately 16.2% of the variance in perceived AI adoption effectiveness. This finding suggests that greater technological, regulatory, privacy, and ethical challenges are associated with lower perceived effectiveness of AI implementation in real-time payment systems.

6. Discussion

The present study examined the role of Artificial Intelligence in real-time payment systems, with particular attention to respondents' perceptions of AI-enabled transaction efficiency and reduction in transaction-processing time. The findings provide empirical support for a positive association between perceived AI-enabled efficiency and perceived improvements in payment-processing speed. Taken together, the reliability, correlation, and regression results indicate that AI is regarded by respondents as an important technological capability within contemporary real-time payment environments. The measurement scale demonstrated an overall Cronbach's alpha coefficient of 0.709, indicating an acceptable level of internal consistency for an exploratory study. The item-deletion statistics further showed that removing individual items did not improve the overall reliability coefficient. These findings provide reasonable support for the consistency of the measurement instrument. Nevertheless, the relatively broad confidence interval around Cronbach's alpha suggests that the reliability estimate should be interpreted cautiously. Furthermore, because the questionnaire includes items addressing efficiency, transaction speed, privacy concerns, fraud detection, and expectations regarding the future role of AI, future research would benefit from validating these dimensions as separate multi-item constructs using larger samples and more advanced measurement procedures.

A central finding of the study is the statistically significant positive relationship between perceived AI-enabled efficiency and perceived reduction in transaction-processing time. Pearson's correlation analysis produced a coefficient of $r = .532$ ($p < .001$), with the 95% confidence interval remaining positive. This result indicates that respondents who more strongly perceived AI as improving the efficiency of real-time payments also tended to perceive AI as reducing the time required to process transactions. The magnitude of the correlation represents a meaningful moderate positive association and suggests that transaction speed constitutes an important dimension through which users evaluate the operational value of AI-enabled payment technologies. This finding is broadly consistent with the technological mechanisms discussed in the existing literature. AI-enabled payment systems can process large volumes of transaction information, automate repetitive verification procedures, identify unusual transaction patterns, and support rapid risk assessment. Earlier studies discussed in the manuscript similarly emphasize the role of machine learning and predictive analytics in improving fraud detection, reducing operational delays, and facilitating more responsive transaction processing (Ghosh & Rahman, 2020; Kumar & Bansal, 2021; Zhou & Wang, 2021). The present findings extend this discussion by providing empirical evidence that users themselves associate AI-enabled capabilities with improvements in transaction efficiency. The regression results provide additional evidence regarding the importance of this relationship. Perceived AI-enabled efficiency significantly predicted perceived reduction in transaction-processing time, with the model producing $R = .532$, $R^2 = .283$, and adjusted $R^2 = .271$. The model was statistically significant, $F(1, 58) = 22.93$, $p < .001$. These results indicate that approximately 28.3% of the variance in perceived reduction in transaction-processing time was associated with differences in respondents' perceptions of AI-enabled efficiency. The regression coefficient was also positive and statistically significant, indicating that higher perceptions of AI efficiency corresponded with higher perceptions of reduced processing time.

Although an R^2 of 0.283 represents a meaningful explanatory contribution in a behavioral and perception-based study, the result also shows that approximately 71.7% of the variance remains unexplained by the present model. This is an important finding rather than a weakness in itself. Real-time payment efficiency is likely to depend on multiple factors beyond AI, including network quality, payment-system architecture, interoperability, server capacity, cybersecurity infrastructure, transaction authentication procedures, institutional readiness, and regulatory requirements. Therefore, AI should be understood as one component of a broader digital-payment ecosystem rather than as the sole determinant of transaction performance.

Another important contextual feature of the study is the high level of respondents' exposure to real-time digital-payment platforms. Most respondents reported substantial familiarity with systems such as UPI and IMPS, while UPI-based platforms were used by all respondents in the sample. This high degree of exposure strengthens the

contextual relevance of the responses because participants were not evaluating real-time payment systems solely at an abstract level. At the same time, the predominance of UPI usage suggests that respondents' perceptions may primarily reflect experiences within the Indian digital-payment environment. Consequently, caution is required when generalizing the findings to payment infrastructures operating under substantially different technological or regulatory conditions. The findings also have implications for the broader literature on AI-enabled financial services. Much existing research addresses specific technological applications of AI, including anomaly detection, automated fraud monitoring, predictive analytics, and customer-service automation. The present study contributes a user-perception perspective by showing that perceived operational efficiency and transaction speed are positively associated. This suggests that users may evaluate AI-enabled payment technologies not only through visible features such as chatbots or fraud alerts, but also through less visible operational outcomes, particularly the perceived speed and responsiveness of transaction processing.

From a practical perspective, the findings are relevant to banks, fintech firms, payment service providers, and developers of real-time payment infrastructures. Continued investment in AI-enabled transaction monitoring, intelligent routing, anomaly detection, automated verification, and predictive risk assessment may contribute to more responsive payment services. However, improvements in transaction speed should not be pursued independently of security and governance requirements. Real-time payments create a particularly challenging environment because decisions concerning transaction approval, fraud detection, and authentication must often be made within extremely short timeframes. Financial institutions must therefore balance operational efficiency with data protection, cybersecurity, transparency, and appropriate human oversight.

The findings also have potential implications for policymakers and regulators. As AI becomes more deeply integrated into financial infrastructures, regulatory frameworks must address not only the technological performance of AI systems but also transparency, accountability, privacy, security, and fairness. The literature reviewed in the manuscript highlights concerns regarding data privacy, algorithmic opacity, and ethical governance in AI-driven financial systems. Consequently, the sustainable development of AI-enabled RTP systems will require coordination between technological innovation and responsible governance.

6.1 Theoretical Implications

The study contributes to the emerging literature on AI-enabled financial technologies by demonstrating that perceived AI efficiency is significantly related to perceived transaction-processing performance. Conceptually, the findings support the proposition that technological capability may influence users' evaluation of digital-payment performance through perceived improvements in speed and operational responsiveness. The results therefore provide a foundation for more comprehensive theoretical models incorporating AI capability, perceived efficiency, trust, security, satisfaction, and adoption intention. Future studies could extend this framework by incorporating established technology-adoption perspectives and testing whether perceived transaction efficiency acts as an antecedent of trust, satisfaction, continuance intention, or broader acceptance of AI-enabled financial technologies. Such extensions would enable researchers to move beyond isolated relationships toward integrated explanatory models of AI adoption in real-time payment environments.

6.2 Practical Implications

For financial institutions and fintech firms, the results suggest that investments in AI should prioritize applications that create observable improvements in payment performance. AI-enabled automation, real-time anomaly detection, intelligent transaction routing, predictive risk assessment, and automated verification are particularly relevant because they have the potential to improve responsiveness while reducing unnecessary manual intervention. However, technological efficiency alone is unlikely to ensure sustained adoption. Payment providers should simultaneously strengthen cybersecurity, data protection, explainability, and customer communication. Users may perceive faster processing positively, but such benefits could be undermined if AI-enabled systems generate concerns regarding privacy, unauthorized decision-making, or inadequate fraud protection. The strategic implementation of AI should therefore integrate efficiency, security, transparency, and trust rather than treating these dimensions independently.

6.3 Limitations and Directions for Future Research

Several limitations should be acknowledged when interpreting the findings. First, the study employed a relatively small sample of 60 respondents, which restricts the generalizability of the results. Future studies should employ larger and more diverse samples covering different demographic groups, geographical regions, and categories of digital-payment users. Second, the study adopted a cross-sectional design and relied on self-reported perceptions. Consequently, the statistical relationships identified in the study should not be interpreted as causal effects. The analysis demonstrates that perceived AI efficiency is associated with perceived reduction in transaction-processing time, but it does not establish that AI directly caused measurable improvements in actual payment-processing speed. Third, the present regression model examined a relatively focused relationship and explained 28.3% of the variance in the dependent variable. Future research should incorporate additional determinants such as system reliability, perceived security, fraud-detection effectiveness, trust, privacy concerns, service quality, technological readiness, and user experience. Fourth, future studies should distinguish clearly between perceived performance and objective system performance. Incorporating transaction-level data, such as actual latency, failure rates, fraud-detection accuracy, false-positive rates, and transaction completion times, would enable stronger conclusions regarding the operational impact of AI. Finally, the present instrument would benefit from further psychometric validation. Future research should employ multi-item measures for each theoretical construct and assess construct validity through exploratory factor analysis, confirmatory factor analysis, or structural equation modelling where appropriate.

7. Conclusion

The increasing integration of Artificial Intelligence into real-time payment infrastructures represents an important development in the evolution of digital financial services. This study examined the relationship between perceived AI-enabled efficiency and perceived reduction in transaction-processing time and provides empirical evidence of a significant positive association between these dimensions. The findings showed that respondents who perceived AI as improving the efficiency of real-time payments were also more likely to perceive reductions in transaction-processing time. Pearson's correlation analysis identified a moderate positive relationship ($r = .532$, $p < .001$), while regression analysis demonstrated that perceived AI efficiency significantly predicted perceived reduction in transaction-processing time. The model explained approximately 28.3% of the variance in the outcome variable. These findings provide support for the efficiency-related proposition of the study and indicate that AI-enabled capabilities are perceived as an important contributor to the operational performance of real-time payment systems. The study contributes to the growing literature on AI and digital payments by providing empirical evidence from the user perspective rather than relying solely on technological or conceptual assessments. The results suggest that operational efficiency and transaction speed represent important dimensions through which users evaluate AI-enabled payment technologies. At the same time, the unexplained proportion of variance demonstrates that real-time payment performance depends on a broader combination of technological, organizational, institutional, and regulatory factors.

From a managerial perspective, banks, fintech firms, and payment service providers should continue exploring AI-enabled applications that support real-time monitoring, automated verification, intelligent risk assessment, and transaction optimization. Such investments should, however, be accompanied by robust cybersecurity safeguards, privacy protection, transparent governance, and appropriate human oversight. The value of AI in payment systems ultimately depends not only on whether transactions can be processed faster, but also on whether those transactions remain secure, reliable, transparent, and trusted by users. In conclusion, the findings indicate that AI has meaningful potential to contribute to the evolution of efficient and responsive real-time payment ecosystems. Nevertheless, the evidence should be interpreted within the limits of the cross-sectional and perception-based design. Future research incorporating larger samples, multidimensional validated constructs, cross-country comparisons, longitudinal approaches, and objective transaction-level performance indicators would provide a more comprehensive understanding of how Artificial Intelligence can support the development of secure, intelligent, resilient, and user-centred real-time payment systems.

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