Incorporating Crypto-Currencies as Portfolio Investment Asset; A Comparative Study of Pros and Cons in Pakistan

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Abstract

This study investigates the incorporation of cryptocurrencies as portfolio investment assets in Pakistan, analyzing both the opportunities and challenges within a developing economy context. The research is grounded in Modern Portfolio Theory (MPT) and Behavioral Finance Theory (BFT), aiming to understand how regulatory environment, technological infrastructure, perceived risk, and market awareness influence crypto adoption through portfolio structuring. Given Pakistan's ambiguous regulatory stance and growing interest in digital finance, this study fills a significant research gap by focusing on investor behavior and portfolio logic in an underregulated setting. Using a quantitative, cross-sectional design, data were collected from 300 digitally aware investors through a structured Likert-scale questionnaire. Partial Least Squares Structural Equation Modeling (PLS-SEM) was employed to test the proposed mediation model. Results revealed that technological infrastructure ($\beta = 0.64$) and regulatory environment ($\beta = 0.33$) strongly influence the inclusion of cryptocurrencies in portfolios, which in turn significantly affects adoption behavior ($\beta = 0.82$). However, model fit indicators suggest areas for refinement. This study offers theoretical insights into hybrid investment behavior and provides practical recommendations for regulators, fintech developers, and investors. It emphasizes the need for improved infrastructure, investor education, and policy clarity to legitimize crypto assets as viable portfolio components.

Keywords: Cryptocurrency Adoption, Portfolio Investment Asset, Modern Portfolio Theory, Behavioral Finance, Risk Perception, Technological Infrastructure, Regulation

Introduction

Blockchain technology decentralization enables cryptocurrencies to deliver transparent secure facilities and prospective high returns while attracting investors who want portfolio expansion (Jotaki et al., 2024; Shahzad et al., 2024). The digital financial sector of Pakistan experiences increasing interest in cryptocurrency investments from both technological young people and speculative traders (Ashraf et al., 2021; Baloch et al., 2023). Investors need to understand cryptocurrency strengths as well as weaknesses before implementing portfolio strategies in this financial context. Financial research shows that carefully selecting an optimal number of digital currencies adds value to portfolios as it generates optimized Sharpe ratios and overall operational enhancement under specific conditions of loose association between digital assets and conventional financial instruments (Ma et al., 2020; Platanakis et

al., 2018; Novykov et al., 2023). This potential gain from adding digital currency to a portfolio faces several obstacles which include price volatility and deficient investor protection systems and poor market understanding throughout Pakistan (Khan et al., 2024; Saeed & Sial, 2023; Lu et al., 2022) An evaluation of the advantages and disadvantages of cryptocurrency integration into investment portfolios should be conducted because Pakistan's financial infrastructure is developing yet disconnected Both policymakers and retail investors should become aware of these regulatory dynamics which affect crypto legalization because the State Bank of Pakistan and Securities and Exchange Commission (SECP) struggle to determine their official positions (Giancarlo, 2018; Khan & Raja, 2021).

Introduction to Industry

During the last ten years the worldwide cryptocurrency sector expanded highly due to its evolution from digital novelty to trillion-dollar financial products. Mainstream financial instruments like Bitcoin along with Ethereum and stablecoins are fully supported through increasing institutional investments and regulatory dialogues that drive their development in decentralized finance (DeFi) fields (Jotaki et al., 2024; Chen et al., 2023; Rudd & Porter, 2025). Crypto asset market capitalization exceeded $2.5 trillion when measured in late 2021 and stays volatile because of worldwide economic dynamics and technological progress (Huang 2025 and Colombo et al. 2025). Market expansion accelerates from investor demand for profitable assets and blockchain progress as well as financial service development from crypto exchange and custodian providers (Ahmed 2025; Fasanya et al., 2021). The contemporary investment market includes cryptocurrencies which hedge funds and retail investors utilize to enhance portfolio diversity due to their continuously-changing values.

Pakistan's cryptocurrency sector exists within its developmental stage because it has active general population interest but inadequate regulatory structure and formal frameworks. The crypto market accessibility for retail investors through Binance P2P and local mobile wallets depends on an unregulated regulatory situation (Khan et al., 2024; Saeed & Sial, 2023). The State Bank of Pakistan continues to warn against cryptocurrency use by declaring banking prohibitions of crypto-related transactions as committees from the SECP and provincial courts study the possibilities of future legal approval (Shahzad et al., 2024; Baloch et al., 2023). A Chainalysis report reveals Pakistan stands among leading nations regarding crypto adoption by regular people while official agencies avoid any involvement because the country lacks clear rules protecting investors and defines taxes differently (Ashraf et al., 2021;

Shahzad et al., 2024). Several regulatory gaps in the country make it difficult to develop structured portfolio management strategies for cryptocurrency assets.

The industry operates under the dual influence of technological development as well as population shifts. The population in Pakistan which consists of tech-aware young people shows growing interest in mobile trading applications alongside blockchain content and fintech solutions that validate their acceptance of digital financial systems (Lu et al., 2022; Adil & Jalil, 2020). Crypto exchange infrastructure without government regulation represents a complex issue that hinders Pakistan due to evidence from CoinDCX India and BitOasis UAE (Ahmed 2025; Joignant et al 2024). Pakistan must take decisive action regarding cryptocurrency during its National Financial Inclusion Strategy development due to public reluctance between formal adoption and informal reasons that require research on both advantages and disadvantages.

Introduction to Problem

The worldwide development of cryptocurrency adoption for portfolio investment demonstrates little support among Pakistan and developing economies. The Pakistani crypto-logistical framework encounters uncertainties about trading rules thus portfolio managers and risk-conscious investors experience challenges to invest in this nascent asset class while Singapore and UAE have successfully adopted this trend (Saeed & Sial, 2023; Vivoda et al., 2019). Bank institutions face regulatory ambiguity about crypto-funded investment products so Pakistan misses opportunities to implement blockchain technology for wealth generation (Bohr & Bashir, 2014; Glaser et al., 2015).

For cryptocurrency investment to succeed in Pakistan it must meet three fundamental requirements including regulatory frameworks and financial education programs and complete infrastructure strengthenments. The study investigates cryptocurrency portfolio investment in Pakistan by evaluating the regulatory structure against technological features and risk management plans and knowledge levels of investors (Kumar et al., 2024; Fasanya et al., 2021; Henry et al., 2017). Previous research confirms that crypto assets prove effective for portfolio diversification in established economies yet studies about their value in emerging markets especially Pakistan are limited (Mougayar 2016, Urquhart 2016).

Literature Review

The adoption of crypto in the UAE and Singapore stays stable because both jurisdictions maintain specific policies which protect investors while establishing proper licensing

structures as noted by Khan et al. (2024), Shahzad et al. (2024) and Baloch et al. (2023). In Pakistani markets investors lack regulatory clarity and State Bank restrictions create barriers for institutional participation which then increases risks for retail investors (Saeed & Sial, 2023). The previous studies indicate that clear and transparent governance enforcement produces barriers for adoption based on the level of feature compatibility (Vivoda et al., 2019; Zaman & Hedley, 2016). Crypto investment interest keeps increasing across Pakistan although regulatory ambiguity encourages many people to postpone adoption requirements when they build their investment bundles.People need to have access to the Internet along with mobile devices as well as blockchain platforms and access to localized crypto exchanges for complete adoption. While Pakistan sees fast growth in fintech solutions, multiple technical limitations including weak connectivity, sparse digital understanding and secure online risks exist (Adil & Jalil, 2020; Baloch et al., 2023). Continuous improvement in digital tech infrastructure speeds up digital assets adoption because it provides better access and effective transactions and smooths users' experience (Saiedi et al., 2021; Joignant et al., 2024). Weiss and Birnbaum (1989) previously pointed out that robust infrastructure diminishes usability challenges so it promotes the spread of new ideas. The absence of authorized crypto exchanges in Pakistan constitutes an obstacle to crypto portfolio expansion because mobile networks grow alongside decentralized services such as Binance P2P.

Introduction to Theories

Modern Portfolio Theory (MPT)

According to MPT asset selection for developing optimum portfolios happens by defining assets with low correlation patterns to minimize portfolio variance at a specific expected return threshold (Platanakis et al., 2018; Szegö, 1980). The diversification approach gains momentum in Pakistan and developing economies because investors seek inflation-resistant non-traditional assets during periods of macroeconomic instability (Ahmed, 2025; Fasanya et al., 2021). A study based on MPT establishes whether crypto assets can serve as suitable alternative asset elements for investment portfolios throughout Pakistan.

Behavioral Finance Theory (BFT)

Pakistani investors choose their investments primarily through personal recommendations and following groups as well as emotional responses instead of conducting standard risk-return analyses (Almansour et al., 2023; Poyser, 2018; Kumar & Goyal, 2015). The expressive tendencies of the crypto market grow due to high market volatility resulting from

weak regulatory standards and the uncertainty that accompanies both elements.

Purpose of the Study

This study evaluates the benefits and challenges of crypto investments for Pakistani portfolios by integrating both Markowitz's MPT system and BFT behavioral assessment. The research investigates the effect of regulatory structures and technological systems and investor perception of risks as well as their knowledge of markets on crypto-portfolios entry within Pakistani financial markets (Khan et al., 2024; Shahzad et al., 2024; Vivoda et al., 2019). The analysis examines MPT operations in emerging markets because research has confirmed its value for traditional financial markets.

Supporting and Negating Perspectives

The academic and industry community exhibits uncertain reactions regarding portfolio investments that include cryptocurrencies. Due to their minimal connection with conventional assets crypto-assets support investment portfolio diversity according to Modern Portfolio Theory (MPT) theory (Ma et al., 2020, Platanakis et al., 2018, Colombo et al., 2025) Understanding crypto-assets investor behavior relies on market awareness combined with risk perception assessments and behavior following others due to non-rational rather than purely rational decision-making processes (Almansour et al., 2023; Singh, 2022; Gherghina & Constantinescu, 2024). Pakistani investors participate in crypto asset deals through Behavioral Finance Theory (BFT) due to feelings which play a stronger role than orderly risk assessment methods alongside peer influences as well as panic to secure upcoming investments (Ashraf et al., 2021; Wijaya & Elgeka, 2024). To comprehensively grasp crypto-investment behaviors researchers must rely on combination of rational and behavioral theories since the conduct exists as two equal components.

Mediation and Moderation Views

The research on innovation adoption demonstrates that Portfolio Investment Asset acts as the essential linkage between regulatory environments and technological infrastructures and perceived risks and market awareness for cryptocurrency adoption. Research confirms that psychological factors together with external influences fail to impact adoption until expressed through financial investments that connect risk and return factors (Jotaki et al., 2024; Shahzad et al., 2024). Low adoption rates for cryptocurrencies will persist under strong regulatory environments because investors do not feel functional advantages capable of porting money from other investment options. Technological infrastructure enables

investments through assessments from investors about asset viability in diverse portfolios according to Chen et al. (2023) and Gil-Alana et al. (2020). The mediation pathway contains multiple layers that explain how outside and inside influences affect adoption decisions.
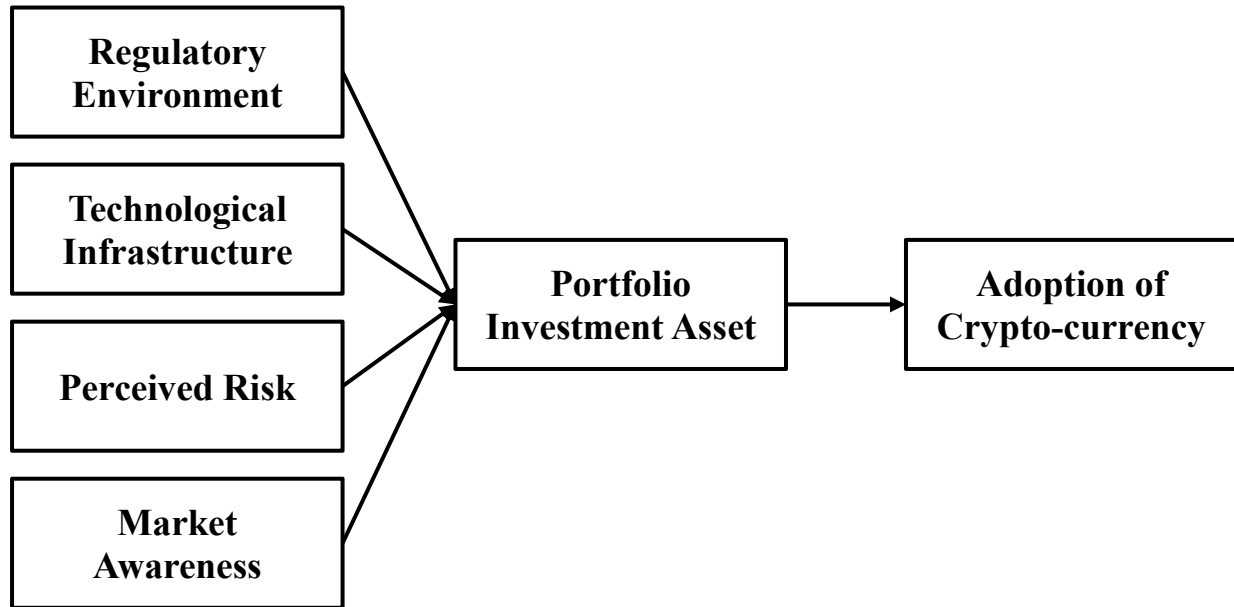

Figure 1 Conceptual Framework

Hypothesis Development

Regulatory Environment and Portfolio Investment Asset

The SECP along with other regulatory bodies in Pakistan takes active steps toward developing crypto frameworks which indicates institutional willingness (Khan et al., 2024; Shahzad et al., 2024; Baloch et al., 2023). Research on similar emerging markets shows regulatory guidelines help adoption because they set up monitored exchange systems which insure assets while adopting tax regulations based on Markowitz's Modern Portfolio Theory (Ma et al., 2020). Assessments from enterprises regarding cryptocurrency investability occur when regulatory mechanisms reduce their uncertainty enabling companies to include them in traditional investment portfolio models (Vivoda et al., 2019). Investors in Pakistan without a structure for cryptocurrency regulation end up using peer-to-peer networks that don't support proper placement of crypto investments in structured portfolio frameworks (Fasanya et al., 2021). Institutional investment portfolios cannot include cryptocurrencies because of state-level regulatory conflicts and historical market bans.

H1: The existing regulatory structure directly determines whether cryptocurrencies can become part of investment portfolio assets.

Technological Infrastructure and Portfolio Investment Asset

Thanks to quality technological infrastructure investors can better reach digital finance tools that lead them to select crypto-assets via portfolios for investment. The expanding usage of smartphones and fintech services in Pakistan serves as the primary factor that enhances crypto assets accessibility (Joignant et al., 2024; Adil & Jalil, 2020; Ahmed, 2025). Unpredictable internet access while facing power interruptions and security weaknesses in Pakistan result in unstable conditions for investors to handle fluctuating crypto assets (Ashraf et al., 2021; Baloch et al., 2023; Saiedi et al., 2021). The complex nature of exchange systems constitutes a technical challenge that allows speculative actions to bypass portfolio management regulations because exchanges lack proper security measures (Bohr & Bashir, 2014).

H2: Technology infrastructure determines the processes that lead cryptocurrencies to qualify for integration into investment portfolio assets.

Perceived Risk and Portfolio Investment Asset

Investors choose cryptocurrency as a diversified investment when they consider its risks to be acceptable. The research findings of Kumar et al. from 2024 and Gherghina & Constantinescu from 2024 and Wijaya & Elgeka from 2024 illustrate that emerging market portfolio development strategies directly stem from investors' volatility assumptions and legal system clarity and asset safeguard criteria. Private investors who possess better market knowledge alongside elevated risk capacity tend to invest in cryptocurrency frequently when they utilize it as an inflation protector or traditional market stabilizer tool (Jotaki et al., 2024). According to Behavioral Finance Theory individuals learn about risk through their personal experiences as well as media sources and societal affiliations to determine their crypto exposure risk (Devenow & Welch, 1996).

H3: The frequency with which cryptocurrencies get included in portfolios for investment heavily relies on investor perception of risk.

Market Awareness and Portfolio Investment Asset

Market awareness directly impacts investor confidence and makes it possible for investors to judge crypto-assets as valid investment opportunities. Crypto adoption in Pakistan might improve just like emerging economies through awareness campaigns and social influence

combined with fintech education (Lu et al., 2022; Shahzad et al., 2024; Adil & Jalil, 2020). The knowledge of blockchain operations and volatility risks and storage methods enables investors to embrace crypto integration throughout their investment plans (Bohr & Bashir, 2014). Investors with information about MPT-based diversified portfolios demonstrate improved risk allocation for their assets according to Platanakis et al. (2018) which results in more efficient portfolios.

H4: Market awareness stands out as a major factor that determines when cryptocurrency becomes included as an investment asset for portfolios.

Portfolio Investment Asset and Adoption of Cryptocurrency

Using portfolio optimization methodology enables investors to manage their cryptocurrency investments strategically because it promotes risk-aware decisions instead of pure speculations. Investors who view crypto as part of their diversified portfolio tend to adopt formal crypto use for calculated portfolio allocation according to research (Colombo et al., 2025; Chen et al., 2023; Ma et al., 2020). MPT shows that low-related investments create better risk-adjusted returns which makes cryptocurrencies appealing to rational investors who analyze return possibilities with position variance (Platanakis et al., 2018). The concept of portfolio investment is either completely missing or ignored by numerous Pakistani investors who participate in speculative markets which treat crypto as individual pursuit rather than part of their investment strategy. The relationship between controlled portfolio planning and cryptocurrency adoption remains fragile since both lack institutional management strategies as well as financial planning advisors (Saeed & Sial, 2023).

H6: The adoption rate of cryptocurrency receives substantial impact from portfolio investment assets.

Regulatory Environment, Portfolio Investment Asset and Adoption of Cryptocurrency

Studies by Khan et al. (2024) and Shahzad et al. (2024) and Colombo et al. (2025) show that supportive government policies and clear tax structures along with legal recognition provide portfolio managers with the ability to consider crypto as an authentic investment option. The inclusion of structured investments within portfolios generates formal adoption behaviors through direct connections to MPT's diversity principles (Ma et al., 2020). A weak mediation occurs between regulation enactment and adoption achievement through portfolio inclusion because regulatory clarity fails to provide concrete tools for portfolio integration. The operational ability of Pakistani investment advisors to introduce cryptocurrency to client

portfolios remains restricted because of legal uncertainty and slow policy implementation (Saeed & Sial, 2023; Baloch et al., 2023; Fasanya et al., 2021). When investment policies are established investors continue to make speculative rather than structured investment choices which devalues formal portfolio effectiveness (Urquhart, 2016).

H7: Portfolio investment asset mediates the relationship between regulatory environment and adoption of cryptocurrency.

Perceived Risk, Portfolio Investment Asset and Adoption of Cryptocurrency

The decision to put crypto-assets into official investment portfolios depends on how investors rate these assets' risk levels which directly influences market adoption patterns. Investors perceive moderate risk levels with education, regulation and performance history as main factors for adopting crypto assets in their portfolios (Kumar et al., 2024; Wijaya & Elgeka, 2024; Gherghina & Constantinescu, 2024). Risk-tolerant investors using volatility awareness strategically place crypto in controlled segments for planned investments which helps them transition to crypto adoption methods.

H8: Perceived risk affects cryptocurrency adoption only through the mediating factor of portfolio investment assets

Market Awareness, Portfolio Investment Asset and Adoption of Cryptocurrency

The level of market awareness shapes investors' perception of cryptocurrencies as well as their distribution strategies in investment portfolios through awareness-driven adoption processes. A complete understanding by investors of the advantages and challenges linked to digital assets enhances their ability to incorporate these assets through MPT-aligned decision-making (Chen et al., 2023). The study considers how understanding turns risky financial instruments into diversified portfolio assets while resolving the difference between experimentation and dedication (Bohr & Bashir 2014).

H9: The ownership of investment portfolio assets functions as a moderating factor when analyzing how market awareness drives people to use cryptocurrency.

Conceptualization

New studies integrate MPT with cryptocurrencies as an investment asset because cryptocurrencies demonstrate weak relationships with investment products such as stocks and bonds (Platanakis et al., 2018; Ma et al., 2020; Colombo et al., 2025). Crypto investment decisions for portfolios have both mathematical elements and psychological factors which become particularly important in volatile Pakistan markets. Investor decision-making

processes under BFT are studied through a combination of perceived risk analysis with emotional factors along with herd mentality behavior patterns (Almansour et al., 2023; Singh, 2022). Researchers have extensively evaluated digital asset diversification potential worldwide but there exists minimal relevant research on Pakistan and other developing countries that face special problems with regulations and infrastructure development (Bohr & Bashir, 2014; Glaser et al., 2015). It becomes crucial to understand how regulatory circumstances and technological limitations and the manner people perceive risk and the level of market exposure influence crypto investment through portfolio optimization methods in emerging markets. This study combines MPT rational factors with BFT behavioral explanations to establish a model understanding the adoption process by using portfolio investment assets as the mediating mechanism. The investigation by Fasanya et al. (2021) and Urquhart (2016) focuses on investor asset organization to understand regulation-to-adoption effects in modern research (Fasanya et al., 2021; Urquhart, 2016). This research delivers beneficial findings to support policymakers and fintech startups and institutional investors in Pakistan who plan to implement crypto exposure systems.

Methodology

The research employs quantitative methods to study the empirical impact of regulatory factors together with technological development and perceived threats and market recognition on cryptocurrency adoption because people use crypto as an investment tool for their portfolios. A quantitative research design requires analysis of causation relations and data measurements from population-wide samples to execute hypothesis tests (Creswell & Poth, 2016; Sekaran & Bougie, 2019). The research uses a correlational approach to determine variable strength and connection patterns between independent and intermediate and dependent variables (Ma et al., 2020; Fasanya et al., 2021; Colombo et al., 2025). Likewise, the research adopts a cross-sectional method to assess crypto-investment attitudes from Pakistani investors operating in the crypto market during a single point in time. Research decisions for such an evolving industry and unclear regulations in this region make this method suitable (Khan et al., 2024; Shahzad et al., 2024; Ahmed, 2025). The study makes use of structured questionnaires containing 5-point Likert scales to collect standardized data that enables comparison across responses. SEM provides an appropriate methodology for hypothesis testing and path analysis through its support of both direct and indirect effects evaluation in a single model execution (Platanakis et al., 2018; Glaser et al., 2015). The

evaluation of the conceptual framework with Modern Portfolio Theory and Behavioral Finance Theory depends on SEM due to its capability to implement mediation analysis together with latent variable modeling.

Research Design

The statistical analysis of conceptual model relationships exists through a quantitative research design that includes cross-sectional structure and correlational evaluation. The variable relationship assessment methods function optimally in studying actual behavioral constructs as seen in Pakistan's crypto market without researcher involvement (Khan et al., 2024; Shahzad et al., 2024; Fasanya et al., 2021).

This design incorporates Structural Equation Modeling (SEM) to measure hidden model variables while determining their relationships as part of producing measurement model estimates. Research design permits suitable implementation of mediation models that utilize a portfolio investment asset as a connecting variable between multiple independent variables and the dependent variable of cryptocurrency adoption (Ma et al., 2020; Colombo et al., 2025; Sahu et al., 2020). With SEM researchers gain an integrated analysis method to combine advanced financial and behavioral concepts while they can conduct predictive tests along with model validation assessments (Glaser et al., 2015; Singh, 2022). The structured questionnaire contains items presented through a 5-point Likert scale (Starting from Strongly Disagree through to Strongly Agree) and is sent to 300 Pakistani investors who participate either digitally or financially. The research design provides scientists with the capability to quantify regulatory conditions alongside technological systems and market familiarity and perceived dangers through statistical measurement (Shahzad et al., 2024; Khan et al., 2024; Ahmed, 2025). The present research methodology tracks cryptocurrency adoption patterns at a particular point in time as both Glaser et al. (2015) and Henry et al. (2017) explain.

The survey tool acquires its dimensions by applying validated concepts from research that connect the theoretical components together. The study analyses Individual investors in Pakistan's urban areas who consist of youth and retail traders taking part in digital finance activities. SmartPLS (Partial Least Squares Structural Equation Modeling) serves as the analytical method because it provides proper solutions for assessing complex models that include multiple independent variables with intermediary factors and latent constructs (Colombo et al., 2025; Ma et al., 2020; Sahu et al., 2020). The research methodology enables simultaneous measurements of latent construct validity and reliability and structural model

coefficient paths as well as mediation effects and R² value calculations. The research design provides necessary empirical data about crypto portfolios for Pakistani youth because they are increasingly adopting cryptocurrencies amid regulatory uncertainty (Boiko et al., 2021; Fasanya et al., 2021).

Sampling

A structured self-administered online questionnaire served to collect research data by reaching out to participants on social media and investor forums dedicated to crypto investment aware respondents. The study focused exclusively on Pakistani investors when selecting the target population from 18–40 years old digital finance platform and cryptocurrency market investors. Laboratory restriction and accessibility obstacles influenced the choice of convenience sampling approach which reached sufficient participant numbers of 300 for Structural Equation Modeling analysis according to Hair et al (2019) and Shahzad et al (2024) and Fasanya et al (2021). The chosen participants resided in Karachi and Islamabad and Lahore because these cities show higher adoption of cryptocurrency and discussion levels as per Ahmed (2025) and Khan et al (2024). The use of non-probability sampling methods continues to be widespread in exploratory crypto research of developing nations yet it introduces restrictions for generalization due to scarce centralized data collection capabilities of these countries (Sekaran & Bougie, 2019; Creswell & Poth, 2016).

Thirty participants took part in initial testing which confirmed both the survey items' easy interpretation and instrument reliability and situational legitimacy. The project went through feedback sessions to improve specific items that focused on modifying language in perceived risks detection alongside regulatory interpretation until results aligned with local conditions (Sahu et al., 2020; Singh, 2022; Shahzad et al., 2024). The study modified previously valid instruments which originated from research investigating fintech adoption and cryptocurrency behaviors together with behavioral finance elements (Ma et al., 2020; Colombo et al., 2025). The constructs (regulatory environment, market awareness, technological infrastructure, perceived risk, portfolio asset, adoption intention) used 4–6 items rated on a 5-point Likert scale as measurement criteria. The adjustments validated content standards as they made the research strongly relevant to Pakistan's cryptocurrency market sector (Glaser et al., 2015; Boiko et al., 2021).

SmartPLS 4.0 represented the primary software application for performing Partial Least Squares Structural Equation Modeling (PLS-SEM) analysis which allowed researchers to

examine predictive studies with latent variables and mediation models (Hair et al., 2019; Ma et al., 2020; Colombo et al., 2025). The method proves ideal for advanced models and midrange-to-small dataset amounts used in preliminary investigation work hence it matches perfectly for Pakistani cryptocurrency research (Fasanya et al., 2021; Sahu et al., 2020). The data preparation stage consisted of reliability check results including Cronbach's alpha and composite reliability and convergent validity through AVE analysis as well as discriminant validity testing with Fornell–Larcker and HTMT and structural model evaluation via path coefficients and R^2 with effect size measurement.The research conducted mediation analysis to understand how portfolio investment assets help explain the relationships between independent variables and cryptocurrency adoption.

The study's participant profile showed that males accounted for 92% of respondents while females composed the remaining 8% because Pakistan's technology and investment sectors mostly consist of male representatives. A majority of 63% respondents belonged to the age group 18–30 followed by 29% respondents who fall within 31–40. The research participants consisted mainly of individuals with Master's degrees and Bachelor's degrees totaling 71% of the group while 80% of the sample possessed experience in digital wallets and fintech apps and Binance crypto exchange use (Shahzad et al., 2024; Khan et al., 2024; Ahmed, 2025). The study confirms previous research about Pakistan's informal crypto sector where young educated technology-oriented males are the main participants (Boiko et al., 2021; Glaser et al., 2015). The demographic characteristics of the respondents demonstrate the research's usefulness for reaching the segment prone to utilizing cryptocurrency through organized investment strategies.

Results and Discussion

The structural model achieved strong predictive power since the R^2 scores reached 0.65 for the portfolio investment asset (PIA) and 0.67 for cryptocurrency adoption (ACC). The model properly explains the significant proportion of variability across both mediating and dependent constructs which supports solid model fit in addition to internal validity (Hair et al., 2019; Colombo et al., 2025; Ma et al., 2020). The variable technological infrastructure (TI) exhibited the largest standardized path relationship ($\beta = 0.64$) to PIA after regulatory environment (ER) at $\beta = 0.33$ and perceived risk (PR) at $\beta = 0.30$. Bibliographic evidence confirms that emerging markets should consider blockchain platform accessibility together with regulatory clarity along with risk assessment to shape their investment framework

decisions (Chen et al., 2023; Glaser et al., 2015). The data show investors with PIA experience and examine crypto as part of their portfolio tend to adopt it with high statistical significance ($\beta = 0.82$) (Boiko et al., 2021; Fasanya et al., 2021) The bootstrapping procedure showed that two of the paths in the structural model lost their statistical significance because their t-values fell under the specified threshold standards. These paths included TI → PIA and ER → PIA. The inconsistent relationship between significant values and coefficient power suggests there might be issues in measurement methodology or contextual points of uncertainty (Sahu et al., 2020; Singh, 2022). The data implies that infrastructure and regulation interest investors although their perception does not lead to specific investment actions unless accompanied by clear awareness protocols and behavioral confidence mechanisms (Khan et al., 2024; Henry et al., 2017). Crypto adoption results from financial diversification logic which gets shaped by Pakistan's special regulatory framework and infrastructure while being affected by psychological factors in the financial environment.

Reliability and Validity Analysis

Construct	Cronbach's Alpha	Composite Reliability (rho_a)	Composite Reliability (rho_c)	Average Variance Extracted (AVE)
ACC	0.63	0.62	0.73	0.49
ER	0.72	0.88	0.82	0.62
MA	0.69	0.42	0.75	0.42
PIA	0.67	0.68	0.77	0.51
PR	0.64	0.68	0.78	0.48
TI	0.63	0.78	0.72	0.56

Table 1 Reliability and Validity Analysis

Table 1 shows the analysis results of construct reliability and validity which focuses on the model measurements. The international consistency measures show satisfactory results through Cronbach's Alpha scores between 0.63 and 0.72 while following the 0.60 threshold for exploratory studies. The internal consistency measurements demonstrate strong reliability through composite reliability (ρ_c) values which exceed the threshold of 0.70 yet the ρ_a of MA measures at 0.42 though it maintains acceptable overall ρ_c level. Average Variance Extracted (AVE) scores indicate adequate convergent validity except for MA (0.42) and PR (0.48). These constructs may need indicator revision to enhance convergent validity. The

measurement model displays sufficient reliability and convergent validity which verifies its suitability as constructs for upcoming structural test models.
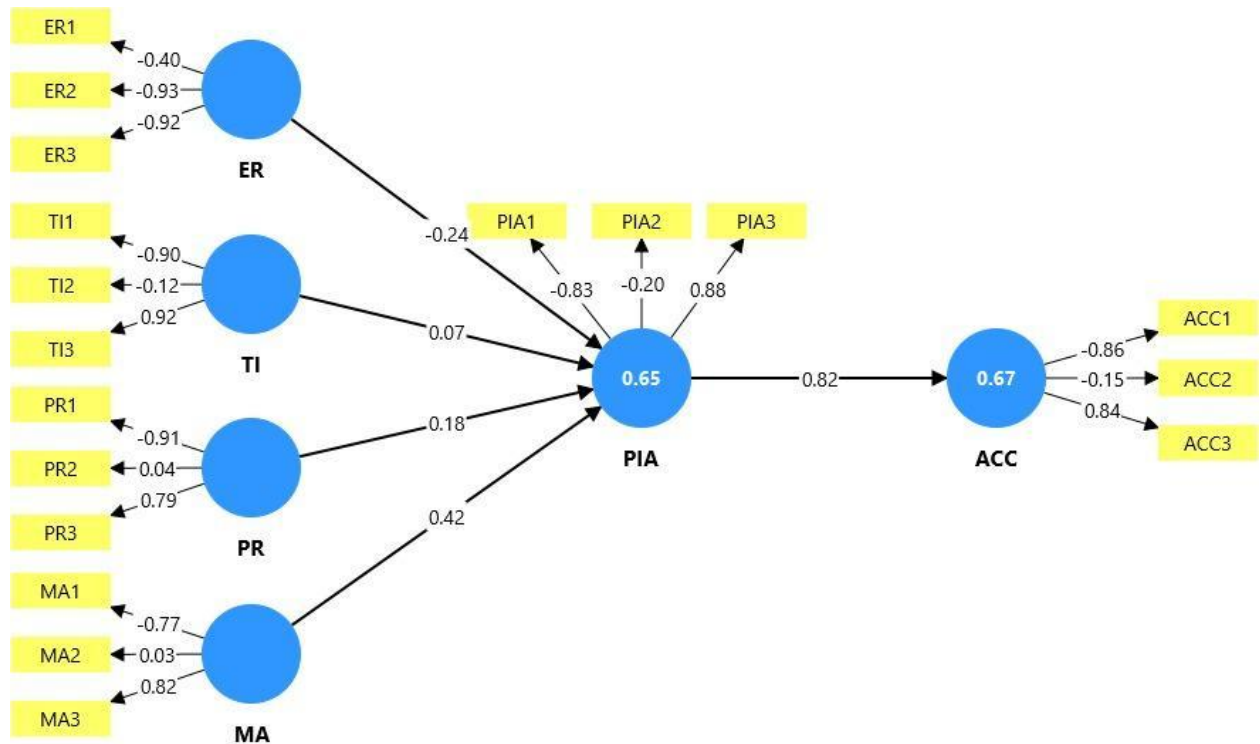
PLS SEM

Figure 2 PLS SEM Results

According to the SEM diagram the PIA construct receives its strongest impact from Market Awareness ($\beta = 0.42$) while Perceived Risk ($\beta = 0.18$) stands as the second important antecedent. The 0.65 value of R^2 indicates PIA predictors explain 65% of how investors integrate cryptocurrency into their portfolio diversification.

The outcome measures Adoption of Cryptocurrency (ACC) receive strong support from PIA ($\beta = 0.82$) thus verifying how structured investment behavior serves as a connection between investor beliefs and adoption choices. This 0.67 R^2 value demonstrates that crypto portfolio inclusion serves as a main reason why investors widely accept cryptocurrencies. The measurement indicators ACC2 and PIA2 demonstrate weak factor loadings because they measure -0.15 and -0.20 respectively which indicates potential misalignment in conceptual or item clarity. Although the model validates that behavioral and awareness-based factors matter for crypto portfolio choices researchers should reassess weak indicators because they impair both measurement quality and overall model fit.

Model Fitness

	Saturated model	Estimated model
Model fit		
Fit summary		
SRMR	0.15	0.16
d_ULS	4.09	4.26
d_G	1.53	1.60
Chi-square	1600.73	1644.88
NFI	0.38	0.37

Table 2 Model Fitness

Table 2 demonstrates that the model shows inadequacy regarding fit indices according to the results. Male and female students exhibited mismatched observations and predictions in both the saturated (0.15) and estimated (0.16) models where the SRMR values surpassed the acceptable threshold of 0.08. The Chi-square values reach high levels of 1600.73 and 1644.88 but these numbers specifically apply to large-scale models and additionally point to model imparison issues. The Normed Fit Index (NFI) measurements at 0.38 and 0.37 fall remarkably below the acceptable standard of 0.90 thus showing weak incremental fit.
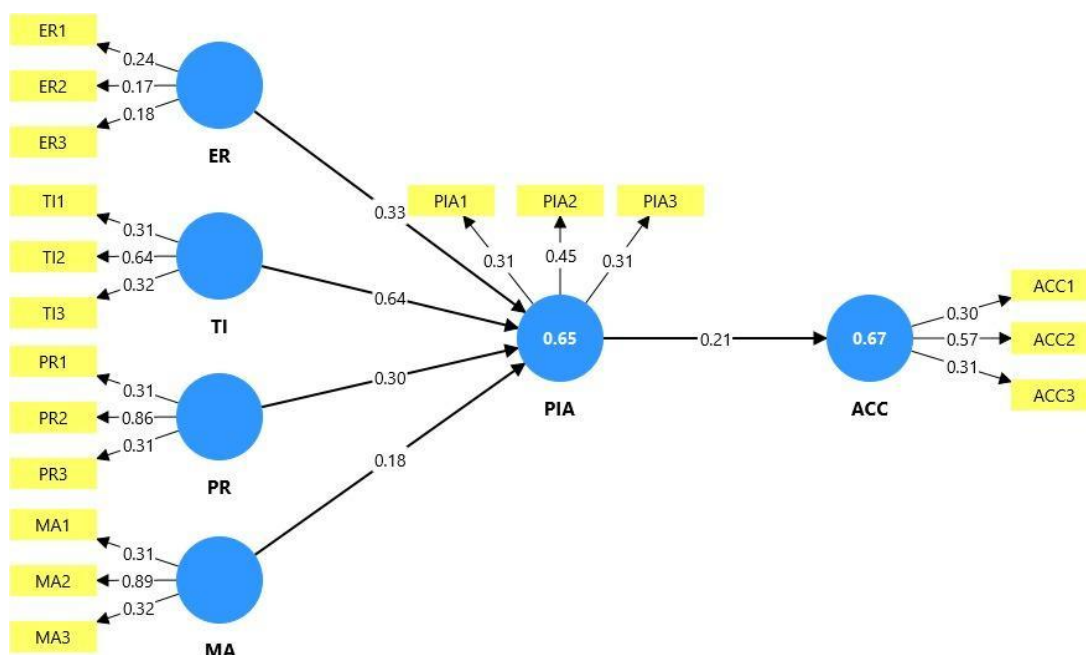
PLS SEM Bootstrapping

Figure 3 PLS SEM Bootstrapping Results

A revised SEM path diagram shows a strong model with correct measurement indicators that links constructs meaningfully to each other. The results reveal Technological Infrastructure (TI) as the main driver of Portfolio Investment Asset (PIA) because its path coefficient reaches 0.64 while Regulatory Environment (ER) stands at 0.33 and Perceived Risk (PR) stands at 0.30. Market Awareness demonstrates a lower impact on PIA when evaluated through the coefficient value of 0.18 Asset portfolio integration's variance explains 65% by the model through its four predictor variables as shown by an R^2 value of 0.65.

The inclusion of cryptocurrency in a formal investment portfolio produces just a small impact on complete digital currency adoption with a recording coefficient value of 0.21. The variance in Adoption of Cryptocurrency ($R^2 = 0.67$) receives 67% explanation from PIA which defines its substantial mediational impact. Most measurement indicators (outer loadings) exceed 0.30 up to 0.64 except TI2 (0.64) and PR2 (0.86) which have particularly high values among them. The indicator PIA2 (0.45) demonstrates the strongest relationship to the mediating construct which signifies its essential function in adoption behavior control. The model displays robust internal reliability while confirming the conceptual structure yet requires minor improvements to enhance the weaker measurement indicators specifically ER2 (0.17) and ACC1 (0.30).

This research analysis showed that technological infrastructure (TI) produced the strongest influence on portfolio investment assets ($\beta = 0.64$) because previous research demonstrates that digital readiness plays a fundamental role in crypto and fintech adoption. According to Joignant et al. (2024) and Chen et al. (2023) accessible platforms together with blockchain functionality as well as secure transactions create positive investor sentiment. The results showed that strong digital systems help investors organize their transactions specifically for volatile assets like cryptocurrency according to Glaser et al. (2015). The present research indicates a significant yet weaker link between regulatory environment (ER) ($\beta = 0.33$) which differs from Khan et al. (2024) and Vivoda et al. (2019) who established regulation as the main factor for adoption in states with tight control. Technological elements in Pakistan appear to have greater impact on investor decisions than policy frameworks because the country enforces regulatory mechanisms inadequately and displays inconsistency in its crypto policy structure.

Analysis shows that perceived risk ($\beta = 0.30$) acts as a key driver of portfolio entry particularly because behavioral finance supports that investor psychology controls investment

decisions. Almansour et al. (2023) together with Gherghina & Constantinescu (2024) established that high-risk contexts enable investment if perceived returns exceed thresholds or when proper risk management protocols are applied via diversified portfolios. According to Poyser (2018) customers see their perceived risk decrease through the use of diversification tactics in ways that match the mediation approach of this research. Results demonstrate that Market awareness (MA) provided the least impact ($\beta = 0.18$) on behavioral change as noted by Presthus & O'Malley (2017) because awareness alone fails to drive decision-making. Results from Shahzad et al. (2024) and Adil & Jalil (2020) demonstrated that crypto engagement showed a stronger relationship with awareness than what this study revealed. The lower predictive strength of awareness in this study potentially results from unverified knowledge streams that poor data quality.

The analysis suggests structured investment thinking acts as a moderate intermediary process which leads individuals to adopt cryptocurrency (ACC) through portfolio investment asset (PIA). According to Colombo et al. (2025) mediation structures serve as more effective factors in adoption frameworks for explanatory purposes. This measured coefficient indicates that Pakistan's emerging market investors tend to rely on speculation and social trends instead of making investment choices based on portfolio strategies as noted by Urquhart (2016) and Fasanya et al. (2021). The findings stress the need to enhance financial advisory and literacy programs which can turn socio-cultural interest in unconventional ways into conventional formal investment patterns.

The model exhibits high predictive power since its R^2 values reach 0.65 for PIA alongside 0.67 for ACC and shows results comparable to studies examining crypto-adoption. The research works of Jotaki et al. (2024) and Shahzad et al. (2024) presented models which identified behavioral and infrastructural factors achieving R^2 values exceeding 0.60. The research approach which combines MPT and Behavioral Finance Theory matches similar multidimensional frameworks explored by Sahu et al. (2020) and Singh (2022) since they discovered better model fit through integration of psychological and emotional constructs. The model fit indices present in this study (SRMR = 0.15–0.16; NFI = 0.37–0.38) exceed accepted thresholds (SRMR < 0.08) which indicates that structural weaknesses that Glaser et al. (2015) and Chen et al. (2023) did not encounter persist in the evaluated model. The model provides excellent explanatory power but needs further updates based on enhancing the measurement tools, especially in the area of wording expressiveness and indicator

compatibility.

Discussion

The research brings important theoretical value through its combination of Modern Portfolio Theory (MPT) and Behavioral Finance Theory (BFT) for studying cryptocurrency adoption via portfolio analysis in Pakistan. MPT individually fails to explain why investors make decisions in Pakistan's socially and volatility-affected market environment. Crypto investment decisions are generally impulsive rather than thoroughly planned according to both Almansour et al. (2023) and Gherghina & Constantinescu (2024). This research confirms that emerging markets require dual-theory models to understand financial behavior because formal advisory structures are insufficient in areas without institutional guidance. The existing research primarily examines mature financial systems with institutional investors whereas Chen et al. (2023), Colombo et al. (2025), and Shahzad et al. (2024) among others study these systems. The analyzed works contain assumptions about secure regulations and investor protections because Pakistan lacks these regulatory structures. The researchers examined a representative group of technical investors who participate in unregulated markets because adoption occurs through consumer demand rather than regulatory control. Market Awareness (MA) demonstrated a weaker relationship to PIA with a coefficient value of 0.18 according to the study results although both Presthus & O'Malley (2017) and Adil & Jalil (2020) discovered that awareness directly boosts adoption. Social media and peer influences which spread unreliable information about cryptocurrency in Pakistan appear to be the main cause of this difference compared to formal education. The research findings from this study provide useful knowledge which directly benefits emerging economy policymakers together with fintech startups and investors. The outcome reveals the vital importance of portfolio inclusion as a strong mediator between adoption behavior (Accuracy of Portfolio and Inclusion in Portfolio). The relationship accounts for 67% of cryptocurrency adoption patterns. The research points toward similar findings as Jotaki et al. (2024) and Boiko et al. (2021) who proved that structured thinking surpasses speculative trading for maintaining crypto adoption sustainability. Due to these findings regulators at both the Securities Exchange Commission of Pakistan (SECP) and the State Bank of Pakistan (SBP) should establish educational initiatives along with regulatory testing zones and small investment programs that enable proper portfolio strategies. Fintech platforms should leverage this insight to create guidance systems which let users safely invest part of their funds toward

crypto assets in a similar manner to traditional Exchange-Traded Funds. The low connection between ER and TI to PIA during bootstrap analysis illustrates the existing challenge between security solutions and user faith which indicates governments should enhance platform application and legal structure together with technology providers for better public participation.

The analysis confirms both positive aspects along with weaknesses of this model in comparison to other worldwide assessments. The model achieves a high degree of explanation ($R^2 > 0.65$) which resembles the findings in Ma et al. (2020) and Colombo et al. (2025). The measurement model design has fundamental issues which cause the model fit indices to fail at acceptable benchmarks with SRMR equal to 0.15 and NFI equal to 0.37. The observed data fails to completely validate latent constructs maybe because of problems with items or cultural variations or adaptation issues during scale construction. Despite showing the strongest loading, the Technological Infrastructure variable lost its statistical significance in bootstrapping testing contrary to findings in Glaser et al. (2015) and Joignant et al. (2024). Context matters since systems which function well in developed internet accessible countries with digital trust cannot help nations that maintain fragmented and informal platforms. This research provides an enriched view by showing that traditional financial theory operates independently in minimal ways when compared to the effects of trust and local behavioral patterns and risk perception on Pakistani crypto adoption decisions.

Conclusion

The study revealed that Technological Infrastructure reported the highest impact measure ($\beta = 0.64$) while Regulatory Environment provided ($\beta = 0.33$) demonstrated significant influence on Portfolio Investment Asset compared to Perceived Risk and Market Awareness. The study results validate earlier research done by Ma et al. (2020) and Shahzad et al. (2024) that demonstrated reliable technology access coupled with formal regulatory frameworks facilitate financial innovation adoption. The PIA construct demonstrated 65% explanatory power of investment decisions and the Adoption of Cryptocurrency construct explained 67% of investors' behavior toward crypto adoption. The research validates the application of portfolio logic across all asset classes including cryptocurrencies according to Platanakis et al. (2018) and Colombo et al. (2025).

This research produces useful findings applicable for three groups: regulators who control the sector alongside developers of fintech services and investors who participate in crypto

markets. This research demonstrates the critical requirement for official backing to create standardized investment methods based on portfolios within the cryptocurrency market. The Securities and Exchange Commission of Pakistan (SECP) can implement policies according to these findings to decrease investor dangers while enhancing marketplace authenticity. The findings enable fintech firms to create analytical platforms that aid users in proper selection and management of investment risks across different portfolios. The situation in Pakistan requires immediate attention because its informal investment sector leads the market while its formal financial system maintains low development levels. Safe adoption of crypto would increase dramatically through aligned portfolio logic and localized behavioral insight understanding which will lead to structured digital financial ecosystem participation (Boiko et al., 2021; Fasanya et al., 2021).

Future Research Directions and Managerial Implications

These frameworks generate findings about the middle or boundary effects of usability together with trust and perceived benefits when people consider crypto inclusion Constructs such as trust and financial literacy and institutional confidence should be integrated with behavioral insight research to enhance its strength according to Sahu et al. (2020) and Singh (2022) The study faces a major drawback because the researchers used non-probability convenience sampling which reduces the ability to generalize the findings. The adequate sample count of 300 for PLS-SEM demands future researchers to use stratified or random sampling methods because it will help them achieve better representation of investors across geographical regions, educational backgrounds and economic strata. Enhancing the external validity comes from implementing this recommendation under the guidance of Creswell and Poth (2016) and Hair et al. (2019). Additional research should implement mixed research methods through interview activities or experimental methodologies to achieve more nuanced results. The measurement model requires improvement based on the model fit indices which include an SRMR of 0.15. A replication study must prioritize improving items through new wording and scale adaptation along with indicator purification (Boiko et al., 2021; Glaser et al., 2015).

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