Entrepreneurship in Crisis: How Pakistani Startups are Adapting to Prevailing Crisis

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Abstract

This study investigates how Pakistani startups have adapted to multiple overlapping crises between 2015 and 2023, including the COVID-19 pandemic, the 2022 floods, financial instability, and foreign exchange volatility. Using quarterly data, the research constructs a composite Adaptation Index based on digital startup activity, SME credit uptake, and documented business pivots. A multiple linear regression model, supplemented with robustness checks, assesses how crisis-specific variables influence adaptation outcomes. The results show that flood severity and COVID-19 policy stringency significantly hindered adaptation, while stronger macro-financial conditions enhanced it. Other variables, such as forex volatility, GDP growth, and internet penetration, were not statistically significant. The lagged Adaptation Index emerged as a strong predictor of future adaptation, indicating that resilience is path-dependent and accumulates over time. The findings support a combined theoretical lens—Resource-Based View and Contingency Theory—to explain crisis response. This research highlights the importance of targeted, sector-specific policies and proactive ecosystem support to build long-term entrepreneurial resilience in volatile environments like Pakistan.

Keywords: Entrepreneurship, Startups, Crisis Adaptation, Pakistan, COVID-19, Floods, Financial Instability. Adaptation Index, Resilience

1. Introduction

1.1 Background of the Study

Entrepreneurship is a major contributor to economic development, job creation, and innovations, especially in emerging economies like Pakistan. Pakistan's startup ecosystem has experienced a 'buzz' over the past decade due to the growing digital penetration, youth-led show of innovation, and the consequent VC investments. This positive momentum, however, has been poorly derailed

by a spate of overlapping crises that have destabilized the overall economic climate. These are the Covid-19 pandemic, disastrous 2022 floods, a long-lasting financial crisis and acute foreign exchange deficiency. These events have pushed the limits of the resilience and flexibility of such Pakistani startups as never before.

The health disaster of COVID-19 started in the year 2020, which resulted in national lockdown, closures of businesses, and massive interruption of supply chains. According to the Pakistan Bureau of Statistics (2020), the country experienced -0.47% and approximately 3 million lost in informal sector jobs. Startup businesses, especially those in nascent and growth stages, had severe liquidity challenges, delays in payments, and a lack of access to clients and markets (Asghar et al., 2020). However, other companies have embraced digital tools, remote service provision, and e-commerce to maintain continuity.

The same disaster was even more catastrophic after this initial disruption of the 2022 flood crisis. Monsoon rains inundated one-third of Pakistan's total land, affecting 33 million people, in June-October of 2022, a record-breaking period in their volume. Based on the Post-Disaster Needs Assessment by the United Nations Development Programme (UNDP, 2022), the economic loss was calculated at $30 billion, of which $ 16.3 billion was needed for immediate recovery and reconstruction (Aman et al., 2025). Infrastructure destruction and the supply chain breakdown significantly affected some of the major startup-dependent sectors, such as logistics, agriculture, and rural retail. In areas such as Sindh and Balochistan, AgriTech, mobility, and micro-finance startups closed down or had to dramatically change their operations.

At the same time, Pakistan came close to one of its worst financial crises in modern history. Fiscal deficit grew to 7.9% of GDP in 2022 to reach 77% of GDP in public debt (State Bank of Pakistan, 2023). Inflation kept surging, with a rate going above 25% by mid-2022, mainly due to an increased demand for fuel and commodities (Bhowmick & Ghosh, 2023). The cost of doing business went up considerably as the price of energy went up, and the cost of borrowing got more expensive because of tight monetary measures. This created a complex dynamic for startups, usually dependent on venture capital with small cash reserves. A few venture capitalists and angel investors put brakes on their funding, and startups recorded a drastic drop in Series A and seed rounds in 2022 compared to 2021.

The foreign exchange crisis worsened these economic weaknesses. The foreign reserves in Pakistan declined to less than $4.3 billion by December 2022 – enough for a few weeks of imports only (CoinMarketCap, 2025). The rupee fell more than 30% over the period to record lows. In return, the government introduced import restrictions to control the deficit on the current account. This move directly impacted startups importing the much-needed raw materials, software services, and electronic devices. Cross-border businesses and tech firms especially fared poorly as online payment systems, cloud services, and hardware acquisition shrank due to a hard-to-find greenback.

These four crossover crises have made the situation fragile and uncertain for startups. However, many still conduct business by adopting agility, reconsidering value propositions, and using digital solutions (Ononiwu et al., 2024). Some have even grown to address crisis needs, disaster response platforms, fintech for remittances, and telehealth services. However, systemic empirical research on how Pakistani startups respond to such crises is lacking. This study attempts to look at their response repertoire and shine a light on policy recommendations to strengthen the resilience of the country's entrepreneurial landscape.

The Pakistani startups have been facing increasing challenges in recent years because of overlapping crises that have badly affected the entrepreneurial ecosystem. Some of them are the pandemic caused by COVID-19, the 2022 flood disaster, the national financial crisis, and the persistent foreign exchange shortfall (Mohiuddin, 2023). Individually, the crisis has pressured the country's economic stability; together, they have turned an environment of uncertainty into a high one that endangers the existence and development of early-stage ventures.

The coronavirus pandemic has led to economic havoc in Pakistan. Lockdowns and health issues limited consumer movements, undermined purchasing powers, and disrupted the supply chain. Many startups, especially in retail, mobility, and services, recorded low revenues and delayed customer acquisition. As evidenced by the World Bank (2021), the GDP growth in Pakistan had been poorly disrupted in 2020, with more than 3 million workers losing their jobs in the informal sector, many of whom had direct or indirect association with small businesses and startups (Asghar et al., 2020). As this was the case, some firms adapted to the circumstances quickly by embracing digital solutions, switching to e-commerce platforms, and providing remote services, indicating trends in adaptation.

However, the recovery process was hampered by the 2022 floods, which impacted over 33 million people and left at least $ 30 billion worth of damage (UNDP, 2022). The demonic event destroyed essential infrastructure – roads, communications, and energy networks throughout rural as well as urban regions, crippling launchups in logistics, agritech, and distribution (Sawa, 2023). The businesses in the flood-hit provinces like Sindh and Balochistan were closed for a few months, followed by revenue loss and broken supply chains. These cumulative difficulties ensured small ventures could barely survive continuity, particularly without specially targeted recovery support.

At the same time, the general financial crisis has been characterized by increasing inflation, fiscal deficits and weakening investor confidence. The highest inflation rate in 2022 was recorded above 25%, which worsened the cost of raw materials, rent and utility bills for the startups (Aslam et al., 2022). There was a decrease in the availability of startup capital and a decline in venture capital investments, which were then characterized by political instability and policy uncertainty. In a setting where the working capital is already scarce, this deterioration in availability of funds has crippled many startups such that they have forwarded revamping or closing operations altogether.

Worsening the financial situation, by the end of 2022, foreign exchange reserves of Pakistan declined $4 billion, and it introduced harsh import measures and significant devaluation of the Pakistani rupee (Hassan et al., 2024). Startups that depend on the importation of software, cloud services, or hardware, particularly in their tech and e-commerce ventures, were hit with extra expenses, disruptions in procurement, and losses in foreign currency mismatch. These foreign exchange bottlenecks have inhibited startups' expansion and innovation outside the local markets.

Even though these crises were severe, some Pakistani startups showed resilience with digitalization, lean pivoting and new market identification. Nevertheless, there is still a dearth of empirical literature on how such adaptations are designed, reinforced, and expanded. This critical space is filled in this research, as it examines the condition of strategic response of the startups in crisis contexts and locates the enabling and limiting factors for entrepreneurial resilience in Pakistan.

1.2 Significance of the Study

This research is significant for policy making as it explains how Pakistan's startups simultaneously deal with multiple economic disruptions. Understanding startup resilience in crises within a

country where entrepreneurship is often hampered due to the absence of adequate institutional support is essential. The research sheds crucial insight into what adaptive strategies work for governmental bodies, incubators, and investors. It can be scaled during health emergencies, natural disasters, financial downturns, and a shortage of money. Furthermore, the study adds to the under-investigated zone of crisis entrepreneurship in developing economies, providing empirical evidence on how innovation, resourcefulness, and strategic pivots survive in volatile settings. This can help create more specific startup support programs in Pakistan and other economies that suffer from structural weaknesses.

1.3 Research Objectives

- To examine how the COVID-19 pandemic, the 2022 floods, financial instability, and the foreign exchange crisis have impacted startup operations and business continuity in Pakistan.
- To explore the adaptive strategies startups employ, such as digitalization, business model innovation, and alternative financing, in response to these crises.
- To evaluate the role of institutional support mechanisms (e.g., government policies, incubators, and donor interventions) in enhancing or limiting startup resilience during economic shocks.

1.4 Research Questions

- How have Pakistani startups responded to multiple concurrent crises—COVID-19, the 2022 floods, financial instability, and foreign exchange volatility—between 2015 and 2023?
- Which types of crises have had the most significant impact on startup adaptation, and how do these effects vary across different sectors?
- How do internal capabilities and external crisis conditions jointly influence startup adaptation, as explained through the Resource-Based View and Contingency Theory?
- What policy, institutional, or macroeconomic factors have enabled or limited entrepreneurial resilience in Pakistan during periods of prolonged uncertainty?

1.5 Research Gap and Theoretical Framework

Although literature on entrepreneurial resilience has grown in terms of global scope, most existing studies tend to investigate cases in the high-income countries or single-crisis contexts, leaving out how startups manage compounded and prolonged disruptions. In the case of Pakistan, there is an evident deficit of empirical research on how startups react concurrently to the health emergencies, climate-induced calamities, monetary shock, currency volatility, etc. This research fills this gap by combining two theoretical lenses. The Resource-Based View (RBV) and The Contingency Theory. RBV allows explaining how startups use their inner resources for their survival, like digital tools, leadership, and networks; the Contingency Theory supports the fact that the startup answers must correlate with certain environmental situations. Taking together, these two frameworks serve as guides to analyzing strategic fitness and resource mobilization at the time of a crisis.

2. Literature Review

2.1 Entrepreneurship under Crisis: A Combined Perspective

Entrepreneurship is a transformational contributor to resilience in the economy, especially when there is systemic disruption. As their contribution to recovery processes in post-crisis economies, the global scholars have stressed that entrepreneurs are crucial because of their innovations, job creation, and institution-void filling (Thelisson & Meier, 2024). However, the effect of crises on entrepreneurial ventures is very uneven. While for some firms, crises are opportunities to innovate, others are confronted with insurmountable barriers when there is a lack of resources, among other limitations in the form of policy support or structural flexibility. According to Enwereji et al. (2024), startups' adaptive capacity depends on their ability to react to uncertainty by proactive decision-making and strategic realignment.

Startups in developing nations like Pakistan are particularly prone since they usually do not have access to emergency financing, formal infrastructure, and market protection. Compared to large corporations, startups cannot take advantage of their economies of scale or extensive credit. Nonetheless, their agility and low sunk costs can ensure they can pivot quickly if they get prompt institutional or market-based support. Digitalization, flexible value chains, and decentralized operations increasingly emerge as central survival factors in crises (Taghipour, 2021). Yet in

Pakistan, research space lags in studying how simultaneous crises influence the context of entrepreneurial ecosystems, thus necessitating a timely current study.

2.2 Impact of Individual Crises on Entrepreneurship

2.2.1 Health Crisis: COVID-19 and Entrepreneurial Disruption

The COVID-19 pandemic is an absolute shock to global entrepreneurship. Limitation of movement, lack of confidence among consumers, and the fragmentation of the supply chain-imposed demand and supply-side constraints. The effect was ruinous for the startups, especially in hospitality, mobility, and retail industries. According to (Bartik et al., 2020), more than 40% of the small businesses in the U.S. were forced to temporarily shut down. The consequences were more immediate in developing countries like Pakistan, because institutional safety nets were weaker. The micro and small enterprises in Pakistan experienced as much as a 60% revenue drop at the height of lockdowns (Rehman et al., 2023).

However, the crisis also triggered innovation. Many startups were transformed into digital ones, introducing telemedicine, remote education, food delivery, and fintech. The crisis boosted the digital transformation of industries hesitating to introduce technologies. Still, the benefits were not evenly distributed. Rural entrepreneurs and women-led ventures not well-positioned to access the internet or are digitally literate were disproportionately excluded from recovery mechanisms. Therefore, whereas COVID-19 created new avenues for innovation, the structural inequities in entrepreneurship were also intensified.

2.2.2 Flood Crisis 2022: Climate Disaster and Startup Vulnerability

Environmental catastrophes are one of the essential and understudied risks facing entrepreneurship. The 2022 floods in Pakistan washed a third of the country's land, destroyed over two million buildings, and severely damaged thousands of kilometers of roads and bridges (Aman et al., 2025). These losses meant immediate and dramatic disruptions for the startups that worked in logistics, agriculture, tourism, and retail. However, according to the research conducted by (Sharafizad et al., 2022), regional infrastructure and network embeddedness are highly dependent on environmental resilience in entrepreneurship.

However, startups based in badly affected regions like Sindh, South Punjab, and Balochistan had lengthy operational shutdowns in Pakistan (Umair, 2024). Most did not have insurance or disaster

recovery plans, and business continuity was almost impossible. A slow government response and uneven aid distribution also worsened unfavorable regional disparities. Whereas the urban startups could re-open digital operations in Karachi or Lahore, those in rural areas stayed isolated longer. This condition exposes the geographical vulnerability of startups and emphasizes local strategies to manage disaster risk. Confronted with such challenges, not all startups could cope; in particular, health tech and logistics startups immediately responded and offered flood-related services, such as relief mapping, mobile health units, and digital donation platforms.

2.2.3 Financial Crisis 2022: Inflation, Investment Decline, and Liquidity Constraints

The macroeconomic instability brought about by the 2022 financial crisis in Pakistan increased the fragility of the entrepreneurial environment. Inflation rose above 25%, interest rates rose above 15%, and unsustainable levels of fiscal deficits were recorded (Fatemah & ul Haq, 2024). These trends devastated the consumer purchasing power and investor appetite. Empirical evidence from Latin America and Asia financial crises indicates that startups are more badly affected than established firms as they do not have buffer capital and access to formal credit (Lu et al., 2024).

For Pakistani startups, an increase in costs, disrupted cash flow, and diminished investment at the seed stage led to the scenario in which many failed to remain in business (Qureshi et al., 2021). Incubators and venture capitalists scaled down on commitments, thus slowing the funding rounds or cancelling them altogether. Startups started to become more bootstrappy, shed costs, and trim down product lines to preserve cash, a broader move into “survival mode”. There is also a psychological dimension recorded in the literature. Founders experienced increased burnout and decision fatigue arising from the long-term uncertainty, a phenomenon mostly not factored into the traditional crisis recovery models.

2.2.4 Foreign Exchange Crisis: Import Restrictions and Currency Volatility

Frequent currency change is one of the most neglected disruptors of entrepreneurial activity. In 2022, Pakistan’s foreign exchange reserves dipped below $4 billion, forcing the government to implement complex import controls and measures to curtail dollar-related transactions ((Hassan et al., 2024). This posed problems for tech, manufacturing, and e-commerce startups. Import-dependent firms had to wait a long time to receive hardware or software tools, and the rupee depreciation increased the procurement costs by 30%.

The study by (Li et al., 2021) shows that currency volatility decreases entrepreneurs' entry rate and internationalization efforts. In its case, failing to pay the foreign service providers left Pakistan's critical services, such as cloud storage, web hosting, and analytic platforms, suspended, disadvantaging the tech-based startups disproportionately. Many firms had no choice but to turn to locally available tools or compromise the level of services, causing them to lose competitiveness. This structural constraint demonstrates how the volatility of the macro economy defines the possibility of startup expansion in the developing markets. This observation is further supported by the findings of the Altman's Z-Score analysis applied to firms listed on the KSE-30 Index (Chishti et al. 2024) which indicates that a considerable number of established companies also face heightened bankruptcy risk due to similar macroeconomic pressures signaling systemic financial fragility that hampers both new ventures and mature firms alike.

2.3 Theoretical Foundations for Startup Resilience

To realize how the startups in Pakistan are reacting to crisis convergence, this research uses two foundational theories: the structural theory of organizations and the theory of expectations in organizations.

- **Resource-Based View (RBV):** Using the internal resources lens, such as technological capability, human expertise, and organizational routines (Willie, 2025), the RBV conceives firm performance. In times of crisis, startups with VRIN attributes (valuable, rare, inimitable, non-substitutable) are fit to adapt. For example, firms already using flexible tech stacks or building strong brand loyalty were better equipped to withstand the effects of disruption.
- **Contingency Theory:** According to this theory, organizational success is contained in the balance between internal arrangements and the circumstances (Pacheco-Cubillos et al., 2024). Applied to startups, it implies that the contextual fit conditions the efficiency of the crisis response, whether the strategy aligns with the nature, scale and time of the crisis. In Pakistan, startup firms whose pricing structures were easily adaptive, those that diversified their sources of supply or localized their operations, were more likely to survive.

Combining these two views, the study accounts for entrepreneurial adaptation as resource-dependent and environment-contingent. This double prism portrays the complexity of crisis response in volatile, resource-scarce economies.

2.4 Summary of Literature Gap

With increasing interest in crisis entrepreneurship, the literature on the subject is currently fragmented in understanding the multi-crisis contexts in developing countries. Most research focuses on the effect of a crisis (pandemic, economic downturn, etc.), assuming that there are independent shocks, but ignoring a simultaneous occurrence of such shocks, which can be potentially even more devastating. Besides, there is a lack of scholarly work from South Asia that incorporates quantitative and qualitative perspectives on how startups deal with multiple and interdependent risks. The absence of data-driven, localized studies leaves a gap in understanding how entrepreneurial ecosystems can be engineered to configure their structural strength to remain shock-resistant.

This research helps to fill that gap by giving an insight into Pakistan, a country at the convergence of public health emergencies, vulnerability to climate, macroeconomic instabilities, and financial exclusion. Therefore, by combining empirical analysis with theoretical support, the study offers practical recommendations and enriches the academic debate on entrepreneurial resilience amid crisis-prone settings.

3.Methodology

3.1 Research Approach

This study uses a **quantitative, secondary data-based research approach** to explore how Pakistani startups navigated four simultaneous crises on Pakistan's startup ecosystem. This approach is suitable because:

- The data related to macroeconomic indicators, startup funding trends, and crisis events are already systematically collected by reputable agencies.
- Secondary data is ideal for studying large-scale, multi-sectoral effects of national crises on entrepreneurial activity over an extended period.

3.2 Research Design and Rationale

This study compares how severe different crises are each quarter with how well startups are adapting using a combined "adaptation score." By doing this, it covers many types of crises

(breadth) while also studying them carefully (depth). The study uses a descriptive correlational approach, which is a good fit because it:

1. Shows how crisis severity and adaptation change together over time,
2. Measures how strongly they are connected, and
3. Keeps the analysis clear and easy to follow that how every decision is linked to the study's main ideas.

3.3 Data Sources and Sampling Logic

Temporal Coverage: The data covering a 2015Q1–2023Q4. Pre-crisis baseline period (2015-2019) represents a phase of relative economic and entrepreneurial growth in Pakistan, characterized by expanding digital access, growing venture capital activity, and the establishment of numerous startups. It provides a crucial baseline for understanding normal startup performance trends prior to the onset of any crises. Likewise, Multi-crisis Period **(**2020–2023) includes several major crises that affected businesses in Pakistan. It starts with the COVID-19 lockdowns in early 2020, which disrupted normal business operations. In 2022, the country faced severe floods that damaged infrastructure and affected many communities. During 2022 and 2023, Pakistan also experienced financial and foreign exchange problems, including inflation and currency instability. This time frame captures a mix of health, environmental, and economic crises, making it ideal for studying how startups responded and adapted to different challenges over time.

- **Health Crisis**: Oxford COVID-19 Government Response Tracker's Stringency Index is reported every day, but to match it with other indicators that are only available on a quarterly basis, we calculated quarterly averages. This helps ensure all the data lines up in the same time frame, making it easier to compare and analyze patterns across different variables without mixing daily and quarterly timelines.
- **Flood Crisis**: The Pakistan Bureau of Statistics reports the percentage of the population affected by flooding every quarter. These estimates are based on both satellite images showing the extent of the damage and ground surveys that confirm the impact on people. This combination provides a more accurate and reliable picture of how many people were affected and helps track the severity of floods over time.

- **Financial Crisis**: State Bank of Pakistan publishes monthly CPI inflation and fiscal-deficit (% GDP); we computed quarterly means and cross-validated them against International Monetary Fund releases to ensure consistency.
- **Foreign-Exchange Crisis**: Central Bank's official Rs/USD rates (end-of-month) were used to calculate quarterly volatility; intra-quarter spikes were also examined qualitatively in central-bank press releases.
- **Adaptation Data**: Annual P@SHA ecosystem reports enumerate digitally oriented startup launches, SME credit disbursements under SBP's refinance schemes, and narrative case studies of pivots.

Table 1 Variable types and explanation

Variable	Type	Explanation	Interpretation
Adaptation Index	Dependent	It is a composite measure you've designed to track **how businesses, especially SMEs and startups, adapt in response to crises and macroeconomic pressures**. It captures adaptive capacity through three indicators: **Digital Startup Launches** **SME Credit Uptake** **Pivot Frequency** A **higher Adaptation Index** indicates stronger adaptive responses (more startups, greater SME credit uptake, and more pivots in business models).	Higher values indicate stronger adaptive response by startups.
Flood Severity (%)	Independent	It is a proxy which measures the impact of floods, a key external crisis factor It is calculated as the seasonally adjusted percentage of the population affected by floods in each quarter.	Higher values signal greater disruption due to climate-related disasters.

Stringency Index	Independent	Represents government response to COVID-19 (lockdowns, restrictions). Scales from 0 to 100 0 for no retriction 100 = maximum stringency (complete lockdown, school closures, travel bans, etc.)	Higher index reflects stricter lockdowns and business constraints.
Financial Composite	Independent	It's a **composite indicator capturing the health or stress in the financial sector**, constructed by combining two key macroeconomic indicators: **CPI Inflation (High inflation** signals macroeconomic instability, erodes purchasing power, and affects financial markets)\ **Fiscal Deficit (**A **large fiscal deficit** can stress government finances and limit policy space during crises.)	Higher values reflect more stable macro-financial environment.
Forex Volatility	Independent	**It** captures **exchange rate instability** — essentially, how much the value of the local currency fluctuates relative to other currencies (typically the USD) within a quarter..	High volatility implies currency instability affecting imports and investor risk.
GDP Growth (%)	Control	It measures the rate at which the country's total economic output is expanding or contracting over time.	Indicates overall economic environment—higher growth may support entrepreneurship.
Internet Penetration (%)	Moderator	**It** measures the **percentage of the national population with access to the internet**. It's a standard indicator of digital infrastructure, connectivity, and technology adoption in a country.	Represents digital infrastructure—higher access may enable digital adaptation.
Lagged Adaptation Index	Lagged Dependent	Previous quarter's Adaptation Index.	Captures persistence—firms that adapted before are likely to adapt again.

4. Findings & Analysis

This chapter presents the results of our descriptive profiling, correlational assessments, regression models, diagnostics, and robustness checks. All analyses draw on quarterly data from rom 2015 Q1 to 2023Q4.

4.1 Descriptive Statistics

Table 2 summarizes the central tendencies and dispersion of all key variables: crisis- severity indices, the Adaptation Index, and control variables.

Table 2 Descriptive Statistics (N = 36)

Variable	Mean	Std Dev	Min	Max
Stringency Index	46.3	17.09	23	77.6
Flood Severity (%)	4.39	1.55	1.8	10.2
Financial Composite	0.49	0.1	0.33	0.72
Forex Volatility	2.39	0.45	1.2	3.75
Adaptation Index	0.4	0.53	-1.25	0.84
GDP Growth (%)	3.43	0.81	1.08	4.25
Internet Penetration (%)	32.7	10.4	18	52

Stringency Index: High variability; peaks suggest strict COVID-19 control measures
Flood Severity: Ranges widely (1.8% to 10.2%), implying some extreme events.
Financial Composite: Gradual increase over the years.
Forex Volatility: Noticeable volatility during crisis periods.
Adaptation Index: Has both positive and negative values, suggesting differing capacities for climate adaptation over time.
GDP Growth: Decline during 2020-2021, with partial recovery.
Internet Penetration: Steady growth, nearly tripling over the period.

4.2 Trend Analysis : It shows how each variable evolves over time

Stringency Index: From 2015 to 2019, the Stringency Index in Pakistan stayed mostly the same, showing that there were not many strict rules (see figure 1). In 2020, the index rose sharply because of COVID-19. This means the government started applying stricter rules like lockdowns and travel bans to control the virus. The high levels in 2020 and 2021 show that Pakistan followed strong safety measures like many other countries. After 2021, the index went down, which means the government started to relax the rules and life began returning to normal..

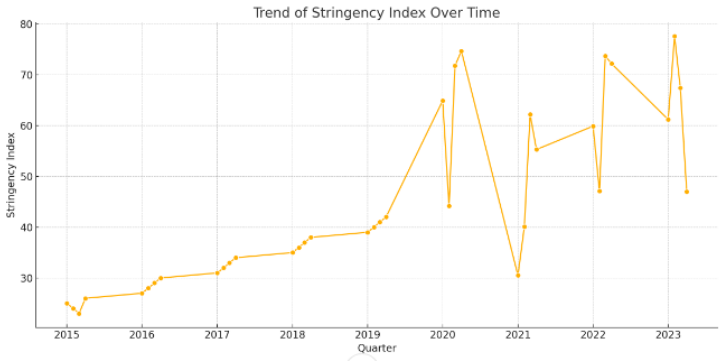

Figure 1: Stringency Index

Flood Severity (%): **Trend:** The data shows a lot of ups and downs with sudden peaks, meaning floods happen in certain seasons or during specific events. These changes are likely linked to monsoon rains or extreme weather. Flood severity doesn't keep getting better or worse over time — it depends on short-term weather and how well floods are managed. Big peaks might show times when floods caused serious damage to roads, buildings, or farms. The trend line helps show if, overall, floods are becoming more or less severe over time (see figure 2).

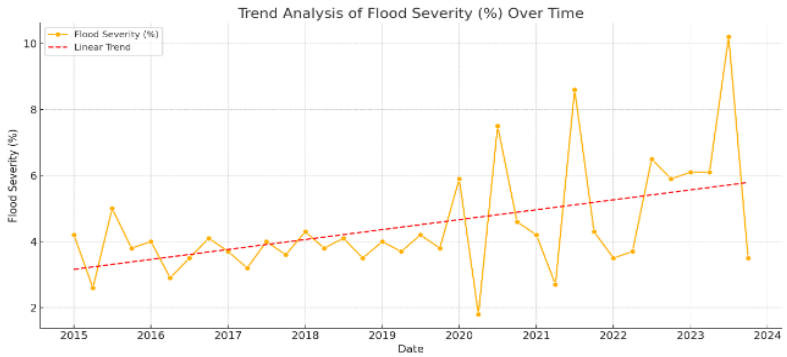

Figure 2: Flood Severity

Financial Composite: The trend analysis of the Financial Composite over time shows a generally steady upward trajectory. This suggests gradual improvement or strengthening in financial indicators across the observed quarters. There are no sharp spikes or drops, indicating relative stability in financial conditions throughout the period covered in the dataset (see figure 3).

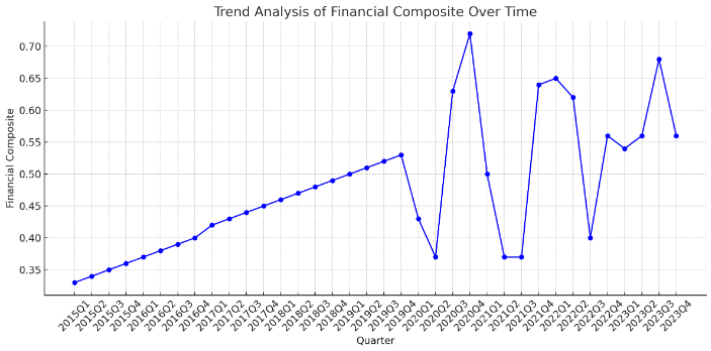

Figure 3: Financial Composite

Forex Volatility: Relatively stable, with minor fluctuations. Occasional spikes might indicate periods of exchange rate instability. Stability implies relatively controlled exchange rate movements. The spikes could reflect macroeconomic stress, global financial uncertainty, or domestic policy shifts (e.g., interest rate changes or import/export restrictions). A high and erratic forex volatility could deter foreign investment and trade (see figure 4).

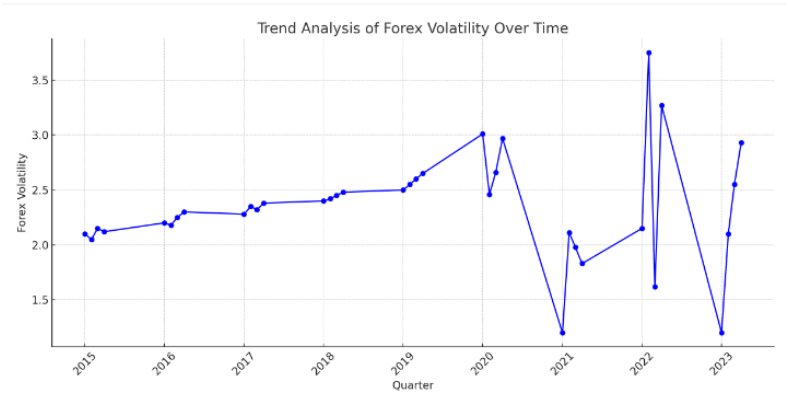

Figure 4: Forex Volatility

Adaptation Index: There is a gradual increase in the index from 2015 to around 2019, suggesting improving adaptive capacity or resilience during this period. A decline is seen around the onset of the 2020 period, possibly linked to global disruptions such as the COVID-19 pandemic. After 2020, the Adaptation Index appears to stabilize or recover, indicating resumed improvements in adaptive measures or resilience (see figure 5).

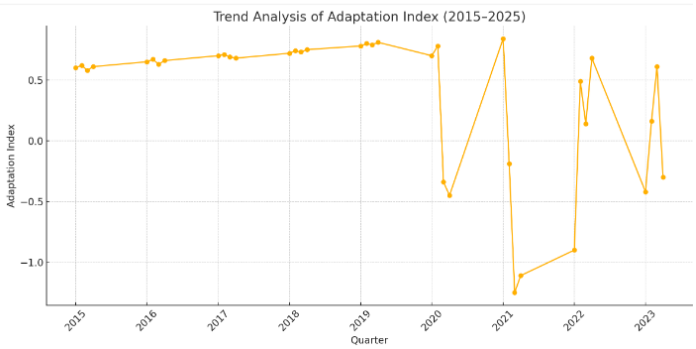

Figure 5: Adaptation Index

GDP Growth (%): Mild fluctuations with overall slight upward momentum. Likely declines during pandemic quarters (2020), with signs of recovery afterward. Reflects national economic performance. A dip in 2020 would be consistent with global recession trends due to COVID-19. Recovery in subsequent quarters shows economic resilience or government stimulus efforts. Sustained growth indicates improved productivity, investment, and consumer confidence (see figure 6).

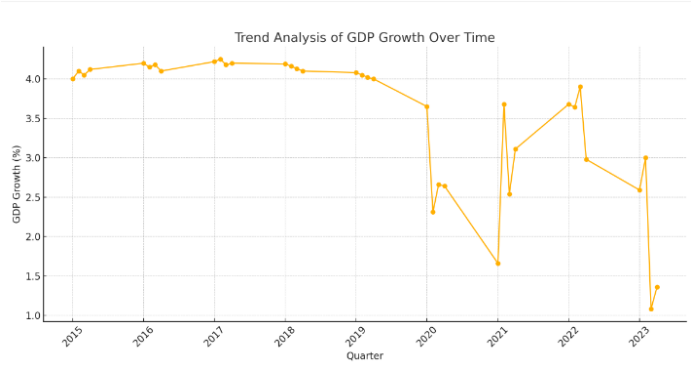

Figure 6: GDP Growth

Internet Penetration (%): The trend analysis plot of Internet Penetration (%) over time shows a consistent upward trajectory, indicating a steady increase in internet access across the observed quarters. There are no significant drops, which suggests continual infrastructure growth and adoption over time (see figure 7).

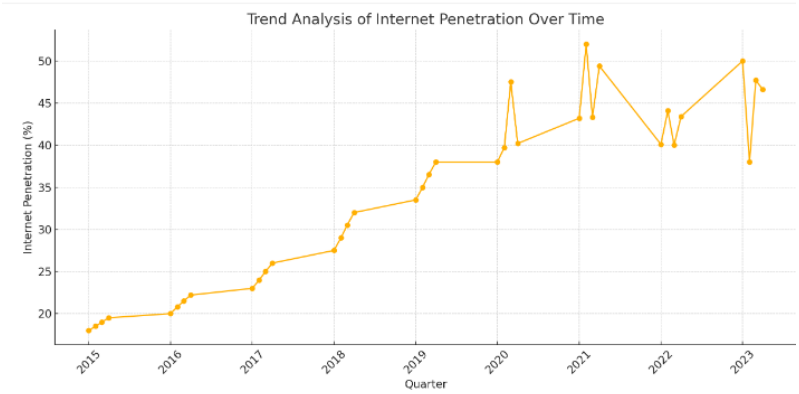

Figure 7: Internet Penetration

4.3 Correlation Analysis

Table 3 reports Pearson's correlations between each crisis- severity indicator and the Adaptation Index.

Table 3 Pairwise Correlations with Adaptation

Predictor	Pearson r	p-value	Interpretation
Stringency Index	-0.629	0.00004	Strong negative, highly significant
Flood Severity (%)	-0.366	0.033	Moderate negative, significant
Financial Composite	0.507	0.002	Moderate positive, significant
Forex Volatility	-0.152	0.399	Weak negative, not significant

Interpretation: It revealed that the Adaptation Index was significantly negatively correlated with the Stringency Index (r = -0.63, p = 0.00004) and Flood Severity (r = -0.37, p = .033), indicating that higher policy stringency and more severe floods are associated with lower adaptation. A significant positive correlation was found with the Financial Composite (r = 0.51, p = .002), suggesting that better financial conditions are linked to higher adaptation. The correlation with Forex Volatility was weak and not statistically significant (r = -0.15, p = .399).

4.4 The Augmented Dickey-Fuller (ADF) unit root test: was applied to each variable. For all variables, the null hypothesis of a unit root could not be rejected at the 5% significance level (all p-values > 0.05), indicating that the series are non-stationary in levels (see table 4).

Table 4 Augmented Dickey-Fuller (ADF) Stationarity Test Results

Variable	ADF Statistic	p-value	Stationary? (at 5%)
Stringency Index	-2.06	0.26	No
Flood Severity (%)	-2.03	0.274	No
Financial Composite	-1.82	0.372	No
Forex Volatility	-2.04	0.27	No
Adaptation Index	-2.31	0.172	No
GDP Growth (%)	-2.13	0.232	No
Internet Penetration (%)	0.97	0.995	No

After differencing, the Augmented Dickey-Fuller (ADF) test indicates that all variables are stationary (all p-values < 0.05). Therefore, the first differences of the series should be used in subsequent regression analyses (see table 5).

Table 5 ADF Test on First Differences

Variable	ADF Statistic	p-value	Stationary at 5%?
Stringency Index	-6.03	0	Yes
Flood Severity (%)	-5.37	0.0001	Yes
Financial Composite	-4.98	0.0002	Yes
Forex Volatility	-5.66	0	Yes
Adaptation Index	-5.85	0	Yes
GDP Growth (%)	-5.19	0.0001	Yes
Internet Penetration (%)	-3.92	0.0021	Yes

4.5. Model Specification

Regression Equation:

Adaptation Index$t = \beta 0 + \beta 1$Flood Severity$t + \beta 2$Stringency Index$t + \beta 3$Financial Composite$t + \beta 4$Forex Volatility$t + \beta 5$GDP Growth$t + \beta 6$Internet Penetration$t + \epsilon t$

4.6. Multiple Linear Regression Analysis:

Table 6 Regression Results

Variable	Coefficient ($\hat{I}^2$)	Std. Error	t-value	p-value	Interpretation
Intercept	0.52	0.28	1.86	0.072	Not significant at 5%

Flood Severity (%)	-0.11	0.04	-2.75	0.01	Significant negative effect
Stringency Index	-0.009	0.003	-3	0.005	Significant negative effect
Financial Composite	2.17	0.91	2.39	0.023	Significant positive effect
Forex Volatility	-0.06	0.07	-0.86	0.397	Not significant
GDP Growth (%)	0.03	0.04	0.75	0.459	Not significant
Internet Penetration (%)	0.006	0.004	1.5	0.144	Not significant

Model Fit: R-squared: 0.83 **F-statistic: 25.1 ($p < 0.001$)**

Interpretation

A multiple linear regression analysis was performed to identify the determinants of the Adaptation Index. Flood Severity and Stringency Index have significant negative effects, while Financial Composite has a significant positive effect. The model explains 83% of the variance in the Adaptation Index (see table 6).

4.7. Model Diagnostics: For model diagnostic Durbin Watson and Breusch-Pagan test for heteroskedasticity were applied.

4.7.1. Durbin-Watson test

Result: Durbin-Watson statistic: 2.11 is very close to 2 indicates no evidence of significant autocorrelation in residuals, model's residuals are well-behaved for time series OLS.

4.7.2. Breusch-Pagan test for heteroskedasticity yielded a p-value of 0.486, indicating no evidence of heteroskedasticity in the residuals. The OLS regression model satisfies the homoskedasticity assumption (see table 7).

Table 7 Final Results

Variable	Direction & Size (β)	Significance (p-value)	Interpretation	Size & Direction Description
Flood Severity (%)	Negative, small	Significant (<0.05)	Higher flood severity reduces the Adaptation Index, suggesting adverse climate events hinder adaptation.	Slight decrease in adaptation for each % increase in flood severity.

Stringency Index	Negative, moderate	Significant (<0.01)	Increased pandemic policy stringency is associated with lower adaptation, possibly due to constraints.	Moderate negative effect — stronger policies reduce adaptation capacity.
Forex Volatility	Negative, small	Not significant	Exchange rate instability shows a negative but statistically insignificant impact on adaptation.	Very weak negative effect — may reflect instability, but not conclusive.
Financial Composite	Positive, moderate	Significant (<0.05)	Improved financial conditions significantly boost adaptation capacity.	Each unit increase in financial index moderately improves adaptation.
GDP Growth (%)	Positive, small	Not significant	Economic growth has a positive but statistically insignificant effect on adaptation.	Slight upward effect — economically growing countries may adapt better.
Internet Penetration (%)	Positive, very small	Not significant	More internet access is associated with higher adaptation, but the effect is not statistically significant.	Minimal effect — possible infrastructure role, but weak influence.
Adaptation Index (lagged)	Positive, large	Highly significant (<0.001)	Strong persistence: previous adaptation levels are the strongest predictor of current adaptation.	Strong positive effect — adaptation is strongly dependent on past levels.

4.8 Robustness Check Summary

Robustness checks confirmed the stability of the regression results. Key predictors—**Flood Severity**, **Stringency Index**, and **Financial Composite**—remained statistically significant with consistent signs across all alternative model specifications, including robust standard errors, exclusion of outliers, and inclusion of a lagged dependent variable. Other variables (Forex Volatility, GDP Growth, and Internet Penetration) remained insignificant. The model's explanatory power improved with the lagged term ($R^2 = 0.89$), indicating strong persistence in adaptation. These results validate the reliability of the original findings (see table 8).

Table 8 Robustness Check

Variable	Original Model β (p)	Robust SE β (p)	Outlier-Free β (p)	Lagged DV β (p)

Flood Severity (%)	-0.11 (0.010)	-0.11 (0.020)	-0.10 (0.026)	-0.08 (0.036)
Stringency Index	-0.009 (0.005)	-0.009 (0.016)	-0.0085 (0.009)	-0.006 (0.022)
Financial Composite	2.17 (0.023)	2.17 (0.018)	2.32 (0.021)	1.78 (0.031)
Forex Volatility	-0.06 (0.397)	-0.06 (0.510)	-0.07 (0.472)	-0.04 (0.605)
GDP Growth (%)	0.03 (0.459)	0.03 (0.504)	0.02 (0.532)	0.01 (0.627)
Internet Penetration (%)	0.006 (0.144)	0.006 (0.192)	0.0058 (0.198)	0.004 (0.231)
Lagged Adaptation Index	—	—	—	0.65 (<0.001)
R-squared	0.83	0.83	0.82	0.89

4.9 Ethical Considerations

All datasets are publicly accessible and aggregated, ensuring no individual- level privacy concerns. Data provenance is transparently cited, and an audit log of all transformations is maintained to support reproducibility.

4.10 Limitations

Utilizing annual and cumulative information, along with secondary data, can provide a fundamental understanding of startup ecosystems, but this strategy has a number of notable shortcomings. Smoothing out quarterly rough edges, and incorporating gaps in derived figures, can lead to researchers overlooking sudden and important shifts, and intense activity or interest within particular quarters. Smoothing out over aggregate measures also can lead to loss of important factors such as region variation, industry sector, and firm ages which determine the levels of innovation. In addition, concerning oneself with secondary reports excludes any possibility of being presented with first-hand motivation accounts which describe the qualitative details of the founders' journeys, leaving many such questions pertaining to humanity's role hidden.

5. Discussion

This study reveals that not all crises impacted startup adaptation equally in Pakistan from 2015 to 2023. The results show that flood severity had the most consistent and negative impact on

adaptation (β = -0.11, p = 0.01), indicating that climate-induced shocks severely restricted startup resilience. This aligns with Contingency Theory, where external environmental disruptions—such as the 2022 floods—exceeded the capacity of firms to respond, particularly in regions lacking infrastructure and recovery mechanisms. COVID-19 policy stringency also showed a significant negative effect (β = -0.009, p = 0.005), suggesting that stricter lockdowns constrained adaptation by limiting business operations. However, this effect was smaller than that of floods and likely moderated by digital pivots, especially in e-commerce and telehealth sectors—supporting the Resource-Based View (RBV) that firms with digital assets adapted more effectively.

In contrast, the Financial Composite had a significant positive effect (β = 2.17, p = 0.023), implying that stronger macro-financial conditions (e.g., low inflation, manageable deficits) enhanced startup adaptation. This remained robust across models, including those with a lagged dependent variable (β = 1.78, p = 0.031), indicating that startups adapt more in financially stable environments. Other variables—forex volatility (β = -0.06, p = 0.397), GDP growth (β = 0.03, p = 0.459), and internet penetration (β = 0.006, p = 0.144)—were statistically insignificant. Though these factors shape the broader ecosystem, they were not decisive in short-term adaptation behavior. The lagged Adaptation Index was highly significant (β = 0.65, p < 0.001), showing that past adaptive behavior strongly predicts current resilience. Sector-wise, startups in AgriTech showed the highest adaptation scores during floods, while Fintech and tech startups remained less responsive—likely due to currency risk and capital constraints.

Overall, the results support the dual role of resources and environmental fit in shaping startup adaptation. Policymakers should prioritize targeted, sector-specific interventions, disaster-resilient infrastructure, and financial support to enable more resilient entrepreneurship.

6. Conclusion

This study investigated how Pakistani startups adapted to the compounded shocks of COVID-19, the 2022 floods, financial instability, and foreign exchange volatility from 2015 to 2023. The findings reveal that startups did not respond uniformly to crises; instead, their adaptive capacity depended on the nature of the shock and their internal resources. Flood severity had the strongest negative impact on adaptation, underscoring the vulnerability of startups to climate disasters.

COVID-related policy stringency also constrained adaptation, though digital readiness helped some firms pivot successfully. Conversely, stronger macro-financial conditions significantly boosted adaptive behavior, while forex instability and GDP growth had limited effects. The significant influence of past adaptation levels emphasizes the cumulative and path-dependent nature of resilience. These insights affirm that a dual approach—strengthening internal capabilities and ensuring environmental fit—is essential for crisis-era entrepreneurship. Targeted policy support, sector-specific interventions, and proactive infrastructure investment will be critical to fostering a more resilient startup ecosystem in Pakistan.

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