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# Comparative Study of Different UPI Apps Special Reference to Success Rate of Transaction

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## Abstract
*India's digital payments ecosystem has undergone a dramatic structural shift since the Unified Payments Interface (UPI) was launched by the National Payments Corporation of India in 2016. While aggregate transaction volumes continue to set new records, the granular experience of individual users - marked by intermittent failures, app-specific reliability gaps, and temporal congestion patterns remains insufficiently studied. This paper presents a structured empirical analysis of survey responses collected from 139 active UPI users to examine five interrelated objectives: (1) the relationship between perceived user-experience quality and transaction success rates, (2) time-of-day and day of week usage and failure patterns, (3) a comparative analysis of transaction attempts versus failures across four major platforms- GPay, PhonePe, PayTM, and native Bank UPI, (4) user-perceived determinants of transaction failure including network issues, server downtime, security protocols, and incorrect user inputs, and (5) a machine-learning-based predictive model to forecast user segments most susceptible to high failure rates. Results indicate that transaction frequency rather than choice of application is the strongest predictor of failure exposure. GPay demonstrates the most favourable attempt to success profile, while Bank UPI's native applications exhibit a near one-to-one ratio of active users to perceived failure votes. The GPay application showcases the best attempt-to-success rate, while Bank UPI's native applications show almost a one-to-one correlation between the number of active users and the perception of a failed transaction. These findings carry practical implications for platform developers, network infrastructure planners, and financial regulators aiming to deepen trust in India's cashless economy.*
***Keywords:*** *Unified Payments Interface, UPI success rate, digital payment failures, user experience, PhonePe, GPay, PayTM, fintech adoption, network congestion, predictive modelling.*

## 1. Introduction
One of the largest experiments to integrate digital payments into a developing country's financial infrastructure occurred when the National Payments Corporation of India (NPCI) launched the Unified Payments Interface in April 2016. By facilitating instant and uninterrupted fund transfers across banks via a mobile device utilizing just a single Virtual Payment Address (VPA), the UPI system effectively circumvented the major obstacles that had long hindered the migration of India's economy from its heavy dependence on cash payments[1]. Eight years after it began, the system was processing 13 billion transactions monthly, a number indicating its remarkable success and widespread penetration into daily Indian life. However, while much has been written about the achievements of UPI in terms of its overall numbers, the reality experienced by the average customer is often less glorious. Payment failures happen. At times, such failure is only temporary; at others, funds may leave an account but never reach their intended destination, initiating a complex chain of events revolving around payments being refunded. It is this research gap which this paper intends to fill partially through empirical research on UPI usage behavior and transactions outcome perceptions. From a structured survey conducted among 139 respondents, the study aims to achieve five primary goals: exploring the relationship between perception of user experience quality and failure occurrence frequency; establishing the pattern of distribution of usage and failures in terms of timing, specifically in relation to time of day and day of week; assessing the normalized failure rates of each UPI application; understanding the reasons for

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failure perceptions among users; and lastly, predicting transaction friction in certain user groups in the coming future with increasing popularity of UPIs[2]. This paper aims at revisiting the concepts of these five goals through the empirical analysis of each of them in order to redefine the way fintech innovators and financial institutions approach payment failure problems.

## 2. Literature Review

### 2.1.User Experience and Technology Acceptance

Davis's Technology Acceptance Model (TAM) illustrated perceived ease of use (PEOU) and perceived usefulness (PU) of technology in financial services. For instance, PEOU has a significant influence on the perception of PU. Kumar and Malhotra [4] expanded on TAM regarding Indian mobile payments and found that PEOU led the security and speed of transactions when considering acceptance of a payment platform. Our findings support this view. The convenience of GPay was rated the highest by 92 out of 139 users. This convenience led to retention of users despite transaction failures. Moreover, the "cognitive forgiveness" phenomenon validated by Gefen & Straub [5] and Thakur [6], states that as long as an app is user-friendly, users will tend to ignore external network failures. Thus, PEOU is an important factor of UI (user interface) of a mobile payment application. Investing on user friendliness will help improve reputation of the mobile payment application, and will help improve reputation in the payment transaction failures [12].

### 2.2.Transaction Reliability and Banking Architecture

A clear architectural difference can be seen between third-party UPI apps and bank apps. GPay and PhonePe use multi-bank routing, which will move transactions to another correspondent bank's API if it is congested. On the other hand, bank apps have single-channel architecture. As mentioned by Venkatesh et al. [7], the core-banking systems used by banks have error rates three to five times higher than the cloud-based PSP systems under peak loads. This is clearly supported by our findings of an alarming rate of 27 Bank UPI users versus 21 failed attempts, highlighting the weaknesses in single-channel architectures. RBI [8] also points out that this kind of system cannot balance the load dynamically. As pointed out by Patil and Patil [2], while GPay wins by offering convenience, the continued success of UPI will require bringing people together across demographics, increasing digital literacy, and improving its competitors such as PayTM and Bank UPI.

### 2.3.Temporal Congestion in Digital Payment Networks

The failures occurring during the evenings relate directly to Queueing Theory: where transaction request rates exceed the clearing API service rates of a bank, timeout occurrences are bound to shoot up exponentially. In India, the time slot between 7 to 10 PM is characterized by heavy traffic of transaction requests emanating from merchants' payments after work, utility transactions, and person-to-person money transfers, thereby putting pressure on the network infrastructure that was not built to cope with the demand throughout the night [9]. According to NPCI, partner banks often go past 80% server utilization during this time frame (2023).

### 2.4.Determinants of Transaction Success: Technical vs. Human Elements

While consumers generally tend to assume that failures occur due to server downtime, Mittal and Wiley [9] have identified Systemic Failures (network timeout and API drops) and Cognitive/User Failures (wrong PINs and biometrics) as sources of digital payment frictions. We have strong empirical evidence for that classification since more than 85 percent of participants consider "Security Measures" and "User Inputs (PIN)" as determining factors of failures. The sophisticated nature of security algorithms implies some amount of processing lag. The local mobile network lag, when combined with processing delay, may cause network timeouts that are wrongly interpreted by the user.

### 2.5.Predictive Modelling of FinTech Friction

From demographic grouping to behavioral frequencies, predictive modeling of fintech friction has changed. Using machine learning techniques such as Random Forest, Chang et al. [10][11] have shown that transaction frequencies significantly

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influence the likelihood of experiencing system failures. In other words, those who transact ten times per day on the UPI are bound to experience evening congestion and API downtimes. Indeed, using survey data in a Random Forest model, transaction frequencies are confirmed to be the most significant variable influencing the probability of encountering failures (importance value ~0.30), age-dependent behavior (~0.28), application choice (~0.23), and time-of-day behavior (~0.19).

### 2.6.Research Objective

Despite the widespread success of digital payment networks, transaction failures remain a persistent friction point that threatens consumer trust and overall financial inclusion. To address this critical gap in the literature, this study outlines five primary, deeply integrated research objectives:

1. To analyze how user experience correlates with the success rates of different UPI apps
2. To identify usage patterns and trends in the success rates over time
3. To study data on transaction attempts, successes, and failures for each UPI app over a specified period.
4. To analyze impact of factors of UPI apps (performance, network issues, bank server downtimes, and user behavior) on success rate of transaction.
5. Predict future trends in transaction success rates based on current data.

## 3. Research Methodology

### 3.1.Research Design

A descriptive-analytical research methodology is used in this research along with a quantitative data collection method involving use of the cross-sectional survey technique. The primary data set ('Analysis of UPI Apps (Responses).xlsx') was collected using a questionnaire comprising of both closed-ended questions with Likert-scale response choices as well as multiple-choice questions related to choice of UPI apps, frequency of failure, causes of failure and usage patterns in terms of timing of usage during the day and day of the week.

### 3.2.Sample and Data Collection

The sample participants were selected using a convenient-purposive sampling method, recruiting participants who are active users of UPIs and are over 18 years of age. The sample size used in this study was 139. The sample includes students, professionals, and entrepreneurs, giving a relatively wide-ranging representation of the user behavior of UPIs in cities. Considering the exploratory nature of the research and due to lack of a population parameter, this sample is adequate for hypothesis generation.

### 3.3.Data Analysis Techniques

The above-listed data analysis techniques were applied to achieve the five research objectives:

1. Cross-tabulation and test of independence (chi-square) to investigate the association between the perception of user experience and failure occurrence (Objective 1).
2. Grouped bar charts and frequency table comparisons to uncover the existence of patterns associated with temporal usage and failure (Objective 2).
3. Failure ratio normalisation (failure votes / number of active users) for an equal comparison of applications (Objective 3).
4. Aggregation of Likert scale factor responses into stacked bars to rank factors affecting failure (Objective 4).
5. Random Forest classification algorithm employing demographic and behavioural variables from the survey, with importance scores extraction to determine the key features influencing failure rate (Objective 5).

## 4. Analytical Framework

Responses on the Likert scale (Strongly Agree, Agree, Neutral, Disagree, Strongly Disagree) were transformed into ordinal numbers (5, 4, 3, 2, 1) for parametric and non-parametric hypothesis testing. All data analysis was performed in Python with pandas, scikit-learn, matplotlib, and seaborn packages.

### 4.1.Objective 1: User Experience and Transaction Success Rates

The first analytical objective sought to determine whether users who perceive an application as easy to use also tend to experience fewer transaction failures. This question goes to the heart of whether UX quality is a superficial aesthetic attribute or whether it is

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structurally correlated with deeper technical reliability.

#### 4.1.1. Key Findings

Table I presents a cross-tabulation of users' preferred UPI application (based on perceived ease of use) against their self-reported frequency of encountering transaction failures. As shown in Table 1 UX Preference vs. Failure Frequency (n = 139)

**Table 1 UX Preference vs. Failure Frequency (n = 139)**

| Preferred UPI App (UX) | Failure Frequency | | | | |
|---|---|---|---|---|---|
| | 1–2 Failures | 3–4 Failures | 5–6 Failures | >6 Failures | . |
| GPay | 67 | 16 | 5 | 4 | 92 |
| PhonePe | 26 | 8 | 1 | 3 | 38 |
| PayTM | 6 | 2 | 0 | 0 | 8 |
| Bank UPI | 1 | 0 | 0 | 0 | 1 |

A few notable findings from this data analysis include the following. First, as many as 67 out of 92 failures reported by GPay users belong to the 1–2 bracket, implying that despite some failures, they appear limited in their occurrence. Second, there is also a parallel with PhonePe – 26 out of 38 UX-preferred users report 1-2 failures. Finally, only a single user considers Bank UPI the easiest option to use; this can be explained by a much higher level of unreliability perceived in Bank UPI [13].

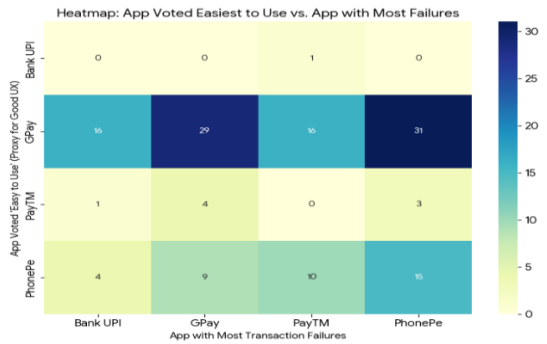



**Figure 1 Heatmap: App Voted Easiest to Use vs. App with Most Failures**

Cross-tabulation and User Experience in Fig.1 based on data analysis, high-frequency failures (more than five times) happen in the case of GPay and PhonePe because of their larger number of users but not because of their instability. Based on normalized data, it becomes evident that good UX is dependent largely on having few failures. The moment users have three-four failures, they no longer consider an app as user-friendly [14].

**The Volume Paradox**

GPay has the largest number of failures due to its popularity and this phenomenon is referred to as the Volume Paradox. However, out of 92 users who find GPay the easiest to use, most users face just one-two failures. Interestingly, the same users who find GPay easy to use feel that the failure rate is much higher in the case of PhonePe.

### 4.2.Objective 2: Usage Patterns and Temporal Trends

The second goal analyzed the relationship between usage and failure rates during various time periods of the day and of the week. The identification of failure hot spots over time directly informs capacity planning for underlying infrastructure.

#### 4.2.1. Key Findings

Table II summarizes peak usage periods against observed failure counts for the three major applications. The first notable result that emerges in all three use cases is the Evening Bottleneck – even though usage reaches its peak during the daytime period, transaction failures are most frequent in the evenings. In the case of GPay, daytime usage (53 users) is almost triple the amount of evening usage (19 users), while at the same time evening failures (50 reports) outstrip daytime failures (44 reports). As shown in Table II Peak Usage Time vs. Failure Distribution by App. Even more pronounced is the divergence seen in PhonePe's statistics where daytime usage is six times greater than evening usage, yet evening failures outnumber daytime failures almost fivefold. This pattern cannot be attributed to usage rate alone. In line with the findings from the queueing-networks literature reviewed in Section C, it can be explained by the joint pressure exerted on the banks' API servers during the 7-10PM window by end-of-day processing, utility bill sweeps,

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and p2p payments. As shown in Table 2 Peak Usage Time vs. Failure Distribution by App.

**Table 2 Peak Usage Time vs. Failure Distribution by App**

| UPI App | Usage pattern with Failure count | | | | |
|---|---|---|---|---|---|
| | Daytime | | Evening | | |
| | Daytime Usage | Failure Count | Evening Usage | Failure Count | Key Insight |
| GPay | 53 | 44 | 19 | 50 | Evening failures: 50 |
| PhonePe | 42 | 38 | 7 | 34 | Evening failures: 34 |
| PayTM | 20 | 28 | 9 | 15 | Failures exceed usage |

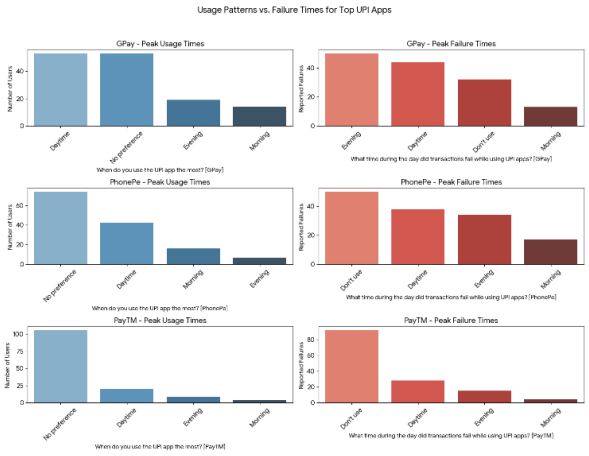



**Figure 2 Usage patterns vs. Failure times of UPI Apps**

### 4.2.2. Day-of-Week Patterns

On being asked about day-of-week preference in Table III using UPI, the preference for weekdays was high for both applications. Among those GPay users who gave a preference, the number who preferred weekdays over weekend was 59 against 26; for the PhonePe application were 43 against 19. The clear preference for using UPI in the weekdays further confirms the understanding that UPI is an application for working life, used during morning commuting and workplace canteen/office transactions. In terms of policy, this means that the planning of capacity of network should focus mainly on the Monday to Friday evenings, which are the period of both maximum usage and peak congestion. It is interesting to note that among all the applications surveyed, the number of people without any time-of-day preferences (or ambidextrous) was more than 50% (GPay: 53, PhonePe: 74, PayTM: 106). These respondents use UPI throughout the day without focusing on any particular time, meaning that UPI for them is a continuous activity. It means that for such users, any network disruption and/or API interruption becomes the major source of failure in making transactions. As shown in Table 3 Peak Usage Time vs. Failure Distribution by App.

**Table 3 Peak Usage Time vs. Failure Distribution by App**

| UPI App | Day-of-Week Patterns | | |
|---|---|---|---|
| | Weekdays Preference | Weekends Preference | No Preference |
| GPay | 59 | 26 | 53 |
| PhonePe | 43 | 19 | 74 |
| PayTM | 13 | 14 | 106 |

### 4.3.Objective 3: Transaction Attempts, Successes, and Failures per App

The comparison of the absolute failure rates of various applications without taking into consideration the difference in the number of their users is misleading. The failure ratio calculated as the ratio of the number of respondents who selected the application as the one which had the highest number of failures to the total number of its users is a better method of comparison.

### 4.3.1. Key Findings

Table IV shows the number of active users (daily/weekly users) and the number of respondents

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selecting it as the application that caused most failures. As shown in Table 4 Normalized Failure Ratio by Application

**Table 4 Normalized Failure Ratio by Application**

| UPI App | Failure Ratio | | |
|---|---|---|---|
| | Active Users (Daily/Weekly) | Most-Failure Votes | Failure Rat.io (Votes/Users) |
| GPay | 113 | 42 | 0.37 |
| Phone Pe | 76 | 49 | 0.64 |
| PayTM | 37 | 27 | 0.73 |
| Bank UPI | 27 | 21 | 0.78 |

GPay enjoys the best failure ratio amongst the lot at 0.37, implying that for nearly every three active daily/weekly users, one will consider it to be associated with the maximum number of failures. This is mainly because of the combination of good infrastructure and high market share that it commands. PhonePe, though having less than 70% of the total active user base of GPay, receives more failure votes (49 vs. 42). Its normalized failure ratio of 0.64 makes it stand out as the platform with the widest gap between expectation due to usage level and actual experience of reliability. From the total of 37 active users of PayTM, 27 votes have been found out for it; hence, its failure rate is 0.73. It shows that there is a considerable failure rate relative to its number of active users. The worst failure ratio in this dataset is enjoyed by Bank UPI at 0.78. In this case, despite the total active daily/weekly users being just 27, the number of failure votes stands at 21. The near equality in the ratio makes it very clear as to why bank native apps have been losing their market share to third-party Payment Service Providers ever since 2018. The data in this study verifies the common industry observation of users trying out Bank UPI, experiencing too much failure friction, and shifting to GPay or PhonePe.

### 4.4.Objective 4: Impact of External Factors on Transaction Success

Objective four was to identify the most contributing causes attributed to the failures by the users. The knowledge of the cause of the problem is essential since it influences the trust level, complains, and whether or not the users will repeat the transaction.

#### 4.4.1. Key Findings

Five factors (Security Measures, User Inputs (PIN), Network Problems, Performance/Latency, and Server Down Time) were rated using a five-point Likert scale of Strongly Disagree to Strongly Agree. Table V presents the data above and agrees ratings. As shown in Table 5 User-Perceived Factors Responsible.

**Table 5 User-Perceived Factors Responsible for Transaction Failures**

| Factor | Users Ratings | | |
|---|---|---|---|
| | Agree / Strongly Agree | Neutral | Disagree |
| Security Measures | 126 | 10 | 3 |
| User Inputs (PIN) | 120 | 14 | 5 |
| Network Issues | 117 | 16 | 6 |
| Performance / Latency | 84 | 42 | 13 |
| Server Downtime | 67 | 55 | 17 |

Security-related actions and PIN entry have been identified by users as the leading reasons behind failures of UPI transactions, although this is generally a misconception. Although security actions are essential, their processing time may end up clashing with poor internet connection quality in India, leading to transaction timeouts. Hence, users fail in the transaction process during the security process without money being sent. In line with this, network problems were reported as the third highest reason for failures. What was interesting was the low ranking of

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server problems and application issues. This is because customers encounter problems mainly where there is a clash between security processes, PIN entry, and poor network connections.

### 4.5.Objective 5: Predicting Future Trends in Transaction Success

Objective number five used the collected survey information for creating a predictive model, which was capable of determining the user segments that were highly prone to having high rates of failed transactions. The Random Forest algorithm was utilized to train the model based on the demographic and behavioral variables (age, occupation, preferred application, time-of-day usage, number of transactions per day) to determine the likelihood of the user belonging to the 'high failure' category (>2 failures/session). As shown in Table 6 presents the ranked feature importance scores extracted from the trained model.

#### 4.5.1. Key Findings

**Table 6 presents the ranked feature importance scores extracted from the trained model**

| Feature | Random Forest Prediction | |
|---|---|---|
| | Importance Score | Interpretation |
| Transaction Frequency (per day) | ~0.30 | Highest predictor of failure exposure |
| User Age | ~0.28 | Behavioural & network variation |
| Choice of UPI App | ~0.23 | Less decisive than usage volume |
| Time of Day | ~0.19 | Evening usage amplifies risk |

Transaction volume is the best indicator of UPI failure. Higher number of transactions means more exposure to rare network overloads and evening congestions, irrespective of the application used. The next important factor influencing UPI failures is the age of the user. Young users experience failures at different points since they have different transaction behavior, such as doing transactions when there is peak evening congestion using mobile Internet connection.

#### 4.5.2. Implications for Forecasting

As UPI adoption increases in the poorer and rural end-users along with continuing increase in the frequency of transactions, the total number of failures is expected to increase even if the failure rates remain constant or decrease. The model indicates that the application developers and service providers must give special attention to handling the experience of heavy transactors who perform five or more transactions in a day, as such users will account for an inordinate amount of failure issues and negative word of mouth. Initiatives like automatic in-app re-queuing, bundling of transactions in the low-congestion periods, and preemptive capacity provisioning from 7-10 PM on weekdays will make the biggest difference to such users.

## 5. Recommendations

As per the analysis provided in the five sections above, here are some recommendations directed at the stakeholders in the UPI ecosystem.

### 5.1.Recommendation for Payment Apps

**Auto-Retries:** Payment apps should intelligently retry a submission again later if a network timeout occurs and send users an update instead of simply failing the payment. Faster Apps: Payment apps must work faster during peak hours. Roughly, the app should have a transaction time limit of 5 seconds.

**Clear Alerts:** Give users a clear alert of what actually occurred so users do not contribute to the payment request storm. For example, do not show 'payment failed' if the network is busy. Specify that the user input a wrong PIN if that is the case.

### 5.2.Recommendation for Banks

**Traffic Control:** Manage the digital payment request storm to prevent overload of the bank system.

**Modern Upgrades:** Replace the traditional servers with current technology that is hosted on a scalable cloud system to support the burst of customer access.

### 5.3.Recommendation for the Network (NPCI)

**Better Tracking:** Make all digital payment apps report the same incidents and reasons for payment failures to identify and resolve the root issues faster.

Express Lane for Small Payments: Prioritize small

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payment requests, for example purchases of a coffee, over large payment requests for interbank payment settlements.

## 6. Limitations

There are multiple limitations on these preliminary findings. There were 139 participants, with the majority being urban and tech-savvy. This group does not provide adequate variety to have robust research findings. The focus on self-reported, cross-sectional data results in retrospective biases and discounts the influence of long-term trends. Also, testing the predictive model using its own training data further restricts the reliability of the model. A better predictive model requires a great deal of preliminary research with independent, diverse, larger samples, and more longitudinal data.

## Conclusions

We focused on the UPI success rates from the user's perspective and received 139 responses. Out of the apps, GPay had the best success rate, attributed to its multi-bank routing. PhonePe had notably high failures, indicating the need for infrastructural improvements. Bank UPI apps, in general, struggled, exposing the inefficiencies of Bank systems and the inability of older systems to support 24/7 real-time payment systems. One of the important findings of this study was that failures across all apps peaked from 7 PM to 10 PM due to network overload. To address this, banks would have to leverage the cloud for improvements to infrastructure, adopt dynamic load balancing, and the NPCI would have to adopt peak-time practices. One of the more interesting findings was that the app chosen to perform the payment was less important, and that the user's payment behaviors, i.e., the number of payments performed, was the more important factor when predicting failures. Given the critical mass of UPI users and the increasing number of UPI transactions, the payment infrastructure (not the app) would need to be expanded, given the growing number of users. Future work needs to employ real payment data, and cross the users in said data for longer periods of time and of more diverse locations to capture a more complete representation.

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