

The role of UPI (Unified Payments Interface) in Financial Interoperability in India

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Abstract:

Unified Payments Interface (UPI) is a communication protocol interface that connects multiple banks accounts to one mobile payment gateway. Interoperability of this interface –a feature which was enabled recently has made these connection even more flexible, as this interface enabled with interoperability feature can connect to any bank to a mobile payment gateway making payment seamless through a single unified QR code which is unique to each retail merchant. Impacting the payment time and access to payment gateways.

The National Payments Corporation of India (NPCI) introduced UPI as a payment interface for the Indian market during 2016 to enable instant digital fund transfers among customers banking systems and secured payment. A total of 350 million active UPI users have been accounted who have generated payments for a value of 245 billion dollars as per the NPCI report of 2025.

In this study the role of UPI's in financial interoperability and its advantages are explored by explaining the essential capabilities and operational capabilities of UPI in India. NPCI UPI usage data shows that the retail-merchant users and end-users usage rate is at 81.8% of the all modes of payment. This study uses quantitative research approach to study the usage rate of UPI. The study results shows that UPI is one of the popularly used mode of digital payment proving that the digital empowerment alongside trustworthy infrastructure has increased trust in the system.

Studying the NPCI transaction data and transaction data collected from 79 retail merchants shows that insights of merchants getting the advantage of interoperability due which they can have a unified QR code and link of any nationalised or private bank accounts. Factors that influences more merchants to use the UPI mode of payment indicates interoperability as an advantage.

Keywords: UPI, Financial Interoperability, India Digital Payments, Merchant satisfaction.

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I. Introduction:

The Indian financial sector experienced substantial transformations during two decades because of technological progress and regulatory modifications. Indian investments now extend across diverse sectors that range from classic choices such as fixed deposits and gold to embrace mutual funds and stocks and new-age digital assets. Before UPI's 2016 launch, financial inclusion experienced basic obstacles that ended when UPI brought instant affordable digital payment options to the market. The payment processing system operated by UPI exceeded 14 billion transactions during May 2023 (NPCI 2023) which initiated a revolutionary change in safe real-time investment and purchasing methods.

Real-time financial paradigm shifts also have given India unprecedented digital growth surpassing global leaders by delivering 90 billion digital payments in 2022 (BIS). Mobile payment systems enabled India to skip ahead of conventional banking infrastructure by implementing PMJDY and digital wallets alongside RBI Digital Lending Guidelines. Through its UPI system financial accessibility has improved due to bank-fintech-consumer connections that reach rural subscribers. The features UPI Auto Pay, UPI Lite and cross-border transactions serve to increase transparency and manage finances better and decrease dependence on cash thus establishing UPI as the central connector of India's developing financial system.

Transaction volumes of UPI have experienced exponential growth indicating its complete success despite the existing digital literacy and infrastructure barriers. The technology dominates India's digital payment field as it simultaneously increases financial accessibility across the economy. The comprehensive influence UPI has on the interoperability of banks as well as fintechs and service providers demands detailed evaluation. The purpose

of this work is to evaluate UPI's system structure and analyse its effects on financial participants along with investigating the regulatory controls. The analysis explores the achievements of UPI together with its weaknesses and obstructive factors that hinder development of a unified financial system.

The concept of interoperability allows various financial systems and institutions together with technologies to merge their operations into seamless platform-transactions. This crucial requirement developed as India's financial zone became unified to handle increased service needs and decreased fragmented data. Interoperability delivers various advantages that benefit banks and fintech organizations together with merchants and end users through its real-time payment feature and low transaction costs and flexible framework. Users of UPI can send and receive money through dissimilar banks and applications since interoperability ensures cross-platform compatibility which expands both accessibility and user convenience.

Research Hypotheses:

H1: All popular UPI 's are getting the advantage of interoperability.

H2: All factors influencing the usage of UPI among retail merchants is positive.

Research Objectives:

1. Study the UPI usage pattern in India.
2. Study the retail merchant-side UPI usage pattern.
3. Identify the factors that influence use of UPI.
4. Identify the factors that makes merchants use the advantages of interoperability.

II. Literature Review:

UPI popularity:

Rahul Gochhwal (2017) this paper examines UPI as an advanced technological innovation operating within Indian payment systems in a paper by which shows the details about the UPI's significant advancement as compared to extant payment system in terms of cost, ease of use for consumers, settlement times and security and has witnessed good user adoption; Detailed exploration of UPI's architecture, usage process of UPI and it has shown that UPI is the most sought after payment mode than the other traditional means of paying with currency. To support this acceptance of UPI the key driver has been the digital banking technology, its importance in the development of digital payments has been seen in the results of the study by Aarti Sharma (2016).

William Cook & Anand Raman (2019)- This paper has examined the role of NPCI in transforming the way of India manages financial transactions, as well as what lessons can be learnt by India's experience using UPI and also examined the NPCI's activities and effects regarding the evolution of India's payment system while focusing on UPI parameters in the study.

Devadutta Indoria & K. Devi (2021), this research investigates how Indian consumers view and welcome UPI as a single platform that merges various banking accounts and features under one umbrella and a UPI ID and PIN are sufficient to send or receive money which is stated in the study. It is a review which explores that UPI has revolutionized how people make payments in India and it is simple and faster system. The UPI system also provides advantages as Convenience, safety and more and also obstacles as users not knowing enough about the system and security problems, despite of the challenges the UPI became game changing system in the economy and have potential growth in the present day is stated.

Dr.A.Shaji George, A.S.Hovan George, Dr.T.Baskar & A.S.Gabrio Martin (2023); A study evaluates the influence of UPI on Indian financial inclusion as well as national international growth objectives which has details about UPI's success in terms of the economic development by safe and reliable digital payment system stated in paper written by Ankit Karmakar (2024);

An ABCD(Advantages, Benefits, Constraints and Disadvantages) analyses the benefits and drawbacks together with advantages and constraints of UPI and also the paper explains the details about historical evolution, linked platforms of UPI in the study by Mohammad Ansar M, Namreen Asif V A & Dr. Prasad Mahale (2024); The paper examines UPI development while discussing its contribution to inclusive financial services and a regulatory framework is necessary for UPI to develop India towards a truly Cashless and financially inclusive future stated by Bhumi Verma, Mihir Purohit & Jignesh Vidani (2024).

Interoperability of UPI:

The research discusses how UPI enables data system interoperability within its financial network ecosystem written by Elif Cansu Akoguz, Tarik Roukny & Tamas Vadasz (2023) which has details about the interoperability data and its affects in welfare of the financial sector; The paper investigates interoperability services by referencing UPI and allow customers to undertake money transfers across bank accounts, the study aimed to find out factors that are influencing the use of UPI and interoperability services stated in the paper by Ayoub Mswahili (2022); The Research paper investigates the trade-off between competition and financial inclusion and Indian financial inclusion alongside interoperability as demonstrated through UPI's operations done

by Markus K. Brunnermeier, Nicola Limodio & Lorenzo Spadavecchia (2023); The article explores the current developments of UPI together with its social and economic effects detailed with redefining financial transactions and financial inclusion, UPI became popular because of excellent, secure and interoperable service which is facilitating instant money transfers across various bank accounts in the study by Dr. Archana Bhausaheb Hase (2025); The article evaluates digital payment interoperability and it uses UPI as an example to study the impact of COVID-19 by Princee Gupta (2025) the study shows that The COVID-19 period increase the use of digital payment system by exploring the scenarios of use of digital payments system such as UPI in pre and post COVID-19 period in India.

Gaps in Research:

Studies on UPI have traced the effects of UPI on digital payments systems and monitors its transaction patterns, several of the papers have studied the impact and found that UPI has built many convenience and advantage, but the interoperability feature being enabled to the UPI interface has not been enabled studied to identify its impact this study has addressed this gap.

III. Methodology:

The paper uses descriptive research method and the research approach is quantitative. Survey method is used to for the research and the data is collected using data collection tool-structured questionnaire on the subject of UPI and its advantages after the launch of interoperability.

The primary data for the study is collected from the sample unit of retail merchants of Karnataka -who get payments through UPI. The sampling method used is convenient sampling with a sample size of 79.

The collected data is analysed using statistical software SPSS the data is presented in the order of – Descriptive data presenting the profile of the sample , test of reliability and factor reduction test of Factor analysis – to give the identified factors of interoperability that has an impact on the consistent use of UPI.

IV. Data Analysis and Results:

1. UPI users profile data as per NPCI:

UPI transaction information of user's total transaction taken from the NPCL data of year 2024 the following. The data is presented reveals relationships regarding which banks participate in UPI and what affects transaction counts and monetary values. The study draws its analysis from the data of all UPI transaction given under the following items in -

"Number of Banks live on UPI,

Total Volume of transaction through UPI (in Mn),

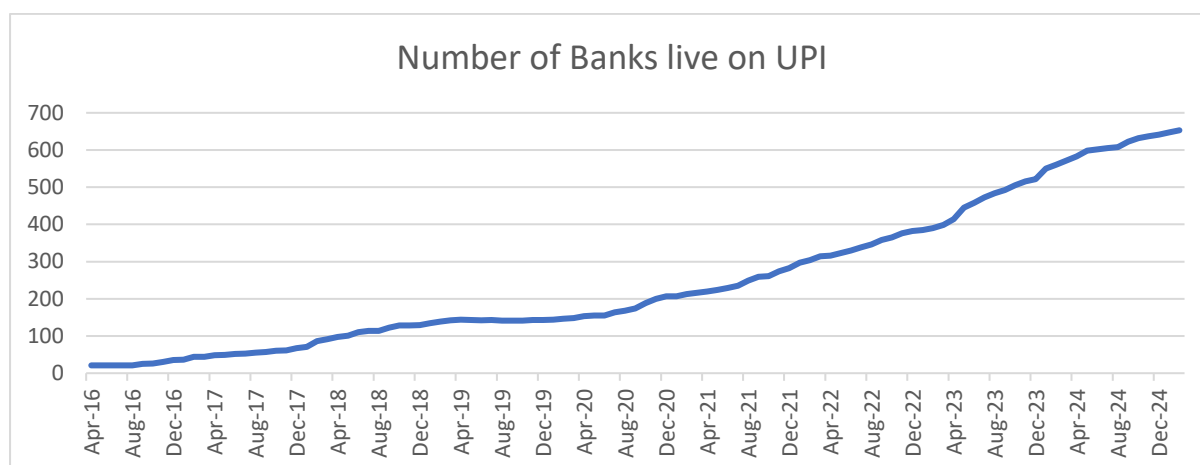
Value (in Cr.)".

The results derived from this response format lack the ability to conduct advanced statistical computations so the exhibited data should be validated through software applications that perform statistical analysis.

Findings:

A detailed statistical breakdown including mean scores and other computed parts was obtained for bank participation data as well as transaction quantity and financial value data including a full analysis span and yearly views. The statistics serve to illustrate both the primary location and range of values that exist in the data which demonstrates total UPI transaction evolution accompanied by its variations across time.

Statistic	No. of Banks	Transaction Volume (Mn)	Transaction Value (Cr.)
Mean	249.9813084	4429.96717	683572.0164
Median	174	1935.88	329027.66
Standard Dev.	190.8699044	5148.433242	745402.6429
Minimum	21	0	0
Maximum	653	16996	2349821.46



Interpretation:

- A continuous upward trend emerges in UPI transaction numbers and amounts while minimum and maximum figures indicate the spreading usage and adoption of UPI.
- The distribution curves show right skew because the average value exceeds the median value during every month.
- The growth data verifies interpersonal UPI capabilities because an increasing number of banking institutions continues to enter the active network ecosystem.

UPI Remitter Members - Top 10 Members (Feb'25)							
Sl. No.	UPI Remitter Members (Feb-2025)	Total Volume (In Mn)	Approved %	BD %	TD%	Total Debit Reversal Count (In Mn)	Debit Reversal Success %
1	State Bank of India	4,400.89	92.13%	7.53%	0.34%	12.56	94.16%
2	HDFC Bank Ltd.	1,335.84	93.74%	6.20%	0.06%	3.56	98.71%
3	Bank of Baroda	1,107.47	90.78%	9.16%	0.06%	2.98	94.41%
4	Union Bank of India	1,035.24	91.72%	8.05%	0.22%	2.9	89.12%
5	Punjab National Bank	925.01	89.74%	10.12%	0.14%	2.77	96.09%
6	Kotak Mahindra Bank	838.1	89.58%	10.23%	0.19%	2.07	2.75%
7	Canara Bank	799.21	90.86%	8.70%	0.44%	2.65	77.52%
8	Axis Bank Ltd.	774.8	93.21%	6.78%	0.02%	1.61	97.96%
9	ICICI Bank Ltd.	646.14	94.86%	5.08%	0.06%	1.29	92.36%
10	Bank Of India	524.43	92.00%	7.17%	0.83%	2.6	63.53%

Interpretation:

- The vast consumer base that trusts State Bank of India results in its leading position for transaction volume.
- The efficient operations become clear from high success rates combined with low technical decline percentages.
- The success rate of debit reversals demonstrates the handling capability of banks' failed operations where HDFC (98.71%) and Axis (97.96%) perform exceptionally well.

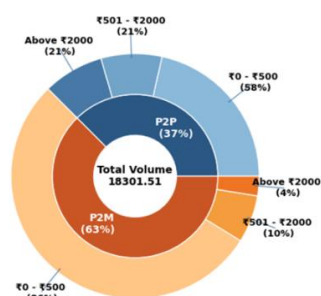
UPI Beneficiary Members - Top 10 Members (Feb'25)						
Sl. No.	UPI Beneficiary Members (Feb-2025)	Total Volume (In Mn)	Approved %	BD%	TD%	Deemed Approved %
1	Yes Bank Ltd.	6,412.99	99.99%	0.01%	0.00%	0.00%
2	Axis Bank Ltd.	1,662.94	99.84%	0.15%	0.01%	0.01%
3	State Bank of India	1,627.18	99.68%	0.10%	0.22%	0.07%
4	HDFC Bank Ltd.	774.5	99.24%	0.72%	0.05%	0.03%
5	ICICI Bank Ltd.	561.55	99.66%	0.27%	0.07%	0.03%
6	Bank of Baroda	434.99	99.91%	0.06%	0.03%	0.04%
7	Canara Bank	423.99	99.33%	0.34%	0.33%	0.12%
8	Union Bank of India	405.83	99.77%	0.11%	0.13%	0.06%
9	Federal Bank Ltd.	374.29	99.82%	0.15%	0.03%	0.00%
10	Punjab National Bank	368.35	99.60%	0.36%	0.04%	0.03%

Interpretation:

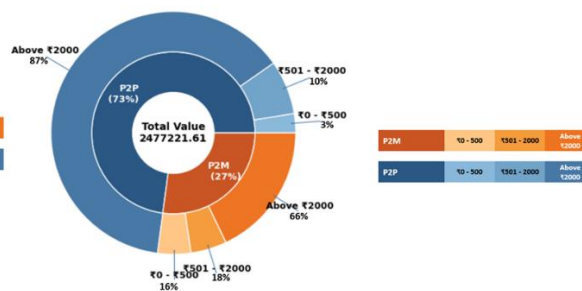
- Yes Bank leads as a UPI beneficiary bank thanks to its business partnerships with PhonePe and other entities.
- The operational reliability of UPI becomes clear through the success rates of nearly every bank exceeding 99 percent.
- The zero or negligible percentage of deemed approval demonstrates that networks operate efficiently to provide quick approval validations.

UPI P2P and P2M Transactions						
Month	Total		P2P		P2M	
	Volume (Mn)	Value (Cr)	Volume (Mn)	Value (Cr)	Volume (Mn)	Value (Cr)
Mar-25	18,301.51	24,77,221.61	6,840.45	18,06,811.06	11,461.06	6,70,410.55

UPI: Transactions (by Volume in Mn) for Mar'25



UPI: Transactions (by Value in Crores) for Mar'25

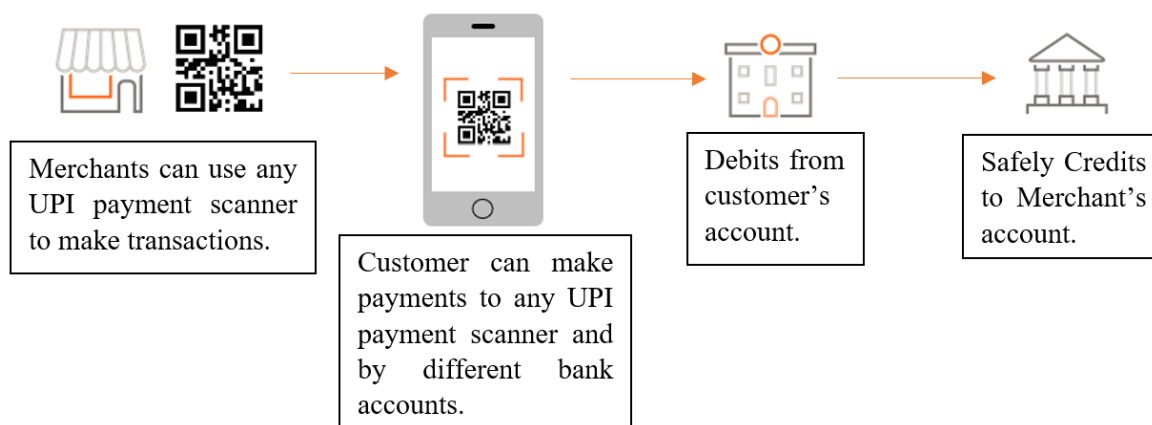


Interpretation:

- P2M volume > P2P, but P2P value > P2M.
- The data shows merchants receive many small-scale retail payments through their store before users conduct higher value P2P transactions.
- UPI operates as a retail payment solution and personal money transfer system because of its ability to support these two functional roles.

2. Data collected by merchants who use UPI scanner:

Merchant-level UPI data analysis through quantitative measures reveals patterns associated with transaction numbers alongside price movements together with customer behaviour trends and scanning activity levels. The analysis gathers information from UPI scanner accepting merchants through direct data collection. The research data processed through the SPSS tool generated descriptive statistics together with cross-tabulation results and measured variable relationships between merchant type and location and transaction volume and peak usage times. SPSS enables superior statistical computations alongside visualization capabilities which produces dependable findings from data interpretations.



First Hypothesis Statement:

H₀: All popular UPI 's are not getting the advantage of interoperability.

H₁: All popular UPI 's are getting the advantage of interoperability.

χ^2 Goodness of Fit

χ^2	df	p
90.1	4	< .001

Interpretation:

The above table shows the goodness of fit test results', at a level of significance of 0.05 the p value from the test is at .001 which is less than the assumed level of significance indicating that the null hypothesis is rejected and alternative hypothesis is accepted that is All popular UPI 's are getting the advantage of interoperability.

Binomial Test: Showing the popular UPI payment modes and the frequency of using UPI.

						95% Confidence Interval	
	Level	Count	Total	Proportion	p	Lower	Upper
B	1	20	79	0.253	< .001	0.16201	0.3636
	2	47	79	0.595	0.115	0.47852	0.7040
	3	7	79	0.089	< .001	0.03637	0.1741
	4	2	79	0.025	< .001	0.00308	0.0885
	5	3	79	0.038	< .001	0.00790	0.1070

Note. H_a is proportion \neq 0.5

Interpretation: From the above table we see that the payment modes and the frequency of using UPI is showing a significance of less than 0.05, So it's shows that all UPI are popular and frequency of use is also high.

Second Hypothesis statement:

H₀: All factors influencing the usage of UPI among retail merchants is not positive.

H₂: All factors influencing the usage of UPI among retail merchants is positive.

The table below shows the factory reduction analysis using KMO test and extracted factors are rotated with Principal Component Analysis and two factors derived is seen here:

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.908
Bartlett's Test of Sphericity	Approx. Chi-Square	580.158
	df	28
	Sig.	.000

Total Variance Explained									
Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	5.189	64.857	64.857	5.189	64.857	64.857	5.170	64.631	64.631
2	1.098	13.730	78.588	1.098	13.730	78.588	1.117	13.957	78.588
3	.870	10.873	89.461						
4	.260	3.244	92.705						
5	.220	2.747	95.451						
6	.176	2.201	97.653						
7	.116	1.448	99.100						
8	.072	.900	100.000						
Extraction Method: Principal Component Analysis.									

Interpretation:

The variables are on the Principal Component Analysis test, From the test result those factors which have an Eigen value of more than 1 in the rotated factors method are considered as fit factors that are leading to using the advantages of interoperability by the UPI using Retail merchants.

Factors that are attained are- Factor 1 that is Extent use of UPI, Factor 2 is Popularity of UPI, are the two factors are driving the interoperability UPI and it's advantages among the merchants who use these UPI for getting payments.

Interoperability as a UPI feature allows merchants to take payment from any payment gateway through an uniform one single QR scanner this advantage to the merchant is supported in this test results by the two factors such as more popular the UPI and longer duration of use of a particular UPI these are two factors that ensures that the merchants get the advantages of interoperability.

Correlation Matrix									
Correlation		Usage Duration of UPI	Type of Popular UPI	Safety of amount credited	Regular use of UPI	UPI Preferred mode of payment	UPI -Fast mode of Payment	Trusted mode -UPI	Ease of Management -UPI
	Usage Duration of UPI	1.000	-.106	.184	.153	.177	.139	.169	.124
	Type of Popular UPI	-.106	1.000	.034	.012	.036	.048	.055	.038
	Safety of amount credited	.184	.034	1.000	.844	.828	.823	.824	.820
	Regular use of UPI	.153	.012	.844	1.000	.859	.785	.808	.886
	UPI Preferred mode of payment	.177	.036	.828	.859	1.000	.836	.769	.913
	UPI -Fast mode of Payment	.139	.048	.823	.785	.836	1.000	.791	.843
	Trusted mode -UPI	.169	.055	.824	.808	.769	.791	1.000	.821
	Ease of Management -UPI	.124	.038	.820	.886	.913	.843	.821	1.000

Interpretation:

The variables related to the safety of amount credited together with ease of management and preference for UPI demonstrate highly positive correlations with values exceeding 0.8 ($r > 0.8$). The relationship between UPI users who manage their accounts routinely and their opinion about management simplicity reaches 0.886 while those who choose UPI also find it simple to manage with a 0.913 correlation.

This test demonstrates that UPI secures high popularity as a payment method when users find it easy to manage and secure. The notion of financial interoperability receives direct backing since ease, trust and preference act as fundamental parameters to enable integrated digital payment transactions between different systems.

V. Results:

The examination of data demonstrates how UPI (Unified Payments Interface) operates in India with exceptional growth and operational success. The extensive expansion of UPI users demonstrates that the platform maintains strong reputation with banking customers. Some months within the dataset demonstrated extreme usage spikes that led to increased average values according to the right-sided distribution pattern. The transaction approval rates along with debit reversal ratios remain high for major remitter banks including SBI and HDFC Bank but beneficiary banks Yes Bank and Axis Bank excel at handling and validating transactions. Users are showing increasing trust in UPI services because they represent a technically advanced stage of development.

An analysis performed using SPSS on the merchant-level data system enables to gain in-depth understanding of user behaviour and system interoperability. The Chi-square (Goodness of fit) analysis indicates that UPI's interoperability functions as an overall positive force for adoption of the various services which supports previous research findings. Results from the binomial test together with factor analysis verify that UPI service popularity and duration of use directly impact merchant ability to benefit from the system. Interoperable UPI payment scanners enable merchants to achieve value owing to two primary elements which include UPI usage penetration and its general popularity as a payment solution.

The variables related to user preference for UPI exhibit a strong relationship because users choose UPI whenever they feel it provides safe transactions coupled with easy management and frequent utilization. Users develop digital financial habits when they perceive UPI to be secure and convenient. Both institutional and merchant evidence indicate that UPI has transformed into a dependable digital payment platform that users endorse because of its interoperability features along with operational reliability and user-friendly characteristics.

VI. Findings:

1. NPCI data shows an exponential increase in UPI transactions from a combination of growing bank participant numbers. As UPI runs on more than 650 active bank platforms its maximum monthly transaction volume has reached 17 billion thus proving massive acceptance within Indian financial structures.
2. Popular mode of digital payment is seen to be UPI among more than 94% of the account holders. Frequency of using is more than once in a day among every UPI user.
3. The retail merchants show that they only use UPI as the most common mode of receiving payment.
4. Safety of amount debited, trust of the mode of payment, ease of payment are all the factors for which the retail merchants are using UPI for receiving payments. Benefit of interoperability of UPI is also perceived by all the retail merchants.

VII. Conclusion:

UPI serves as a fundamental mode of payment in the current as proved in the study and that is made possible by the system that has implemented interoperability as a when there was a need for the market. The study demonstrates the advantages that has been bought to retail merchants with the use of interoperability. Interoperability of UPI is an advantage that is influencing the use of UPI due to the influence of following factor such as - Safety of the amount credited, trusted mode, ease of payment are the major reasons for UPI being considered as a popular mode of payment.

Interoperability of the UPI has created the advantage of use of UPI as a popular mode of payment. Majority of the merchants using UPI are supporting the benefits of interoperability and ease of access and safety.

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