



# International Journal of Innovative Research in Computer and Communication Engineering

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# Scalable WhatsApp-Based Bulk Messaging System Using Distributed Virtual Number Architecture

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**ABSTRACT:** This paper presents the design and implementation of a scalable bulk messaging system leveraging WhatsApp-based communication channels. The proposed system enables users and resellers to create, manage, and execute multimedia messaging campaigns using a distributed pool of virtual numbers. A queue-driven architecture is employed to ensure efficient load distribution, high throughput, and fault tolerance. The system incorporates intelligent number rotation, delay strategies, and retry mechanisms to minimize message failures and avoid service restrictions. Additionally, it supports structured contact management, campaign scheduling, and real-time analytics. Experimental evaluation shows a significant improvement in delivery success rate and system efficiency compared to traditional bulk messaging approaches. The solution offers a cost-effective and scalable platform for modern digital communication and marketing applications.

**KEYWORDS:** Bulk Messaging, WhatsApp Automation, Distributed Systems, Virtual Numbers, Queue Processing, Load Balancing, Digital Marketing.

## I. INTRODUCTION

In today's digital era, communication platforms play a crucial role in business marketing and customer engagement. Traditional messaging systems such as SMS and email suffer from low engagement rates and limited personalization capabilities. In contrast, WhatsApp has emerged as a highly effective communication medium, offering open rates exceeding 90% and support for multimedia content.

However, scaling WhatsApp-based messaging systems presents several challenges, including message delivery limitations, account restrictions, and inefficient resource utilization. Sending high volumes of messages through a single number often leads to blocking or reduced reliability.

To address these issues, this paper proposes a Scalable WhatsApp-Based Bulk Messaging System using a distributed virtual number architecture. The system is designed to efficiently distribute message loads, improve delivery rates, and ensure reliable communication at scale.

### 1.1 Problem Statement

Existing bulk messaging systems lack scalability, reliability, and efficient resource utilization in high-volume messaging environments.

Key challenges include:

- Handling large-scale message distribution
- Avoiding number bans and restrictions
- Managing multimedia message delivery
- Ensuring fast and reliable processing

## II. PROPOSED ALGORITHM.

The proposed system utilizes a distributed queue-based messaging algorithm combined with a virtual number rotation strategy to ensure efficient, scalable, and reliable bulk message delivery.

### 1. Campaign Initialization:

Load campaign details including message template, media files, and target contact list.





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- **Round-Robin Strategy:** Ensures equal usage of all numbers and improves delivery rate.
- **Delay Mechanism:** Introduced to mimic human behaviour and reduce spam detection.
- **Technology Stack:** Node.js/Python, MongoDB/MySQL selected for flexibility and scalability.
- **Evaluation Metrics:** Delivery rate, failure rate, and processing speed were used to measure system performance.

## IV. METHODOLOGY

Algorithm: BULK\_MESSAGE\_DISPATCH

Input: Campaign data, contact list

Steps:

1. Load campaign data
2. Divide contacts into batches
3. Push messages into queue
4. Assign virtual number using rotation strategy
5. Send message with delay
6. If failed → retry with different number
7. Update analytics

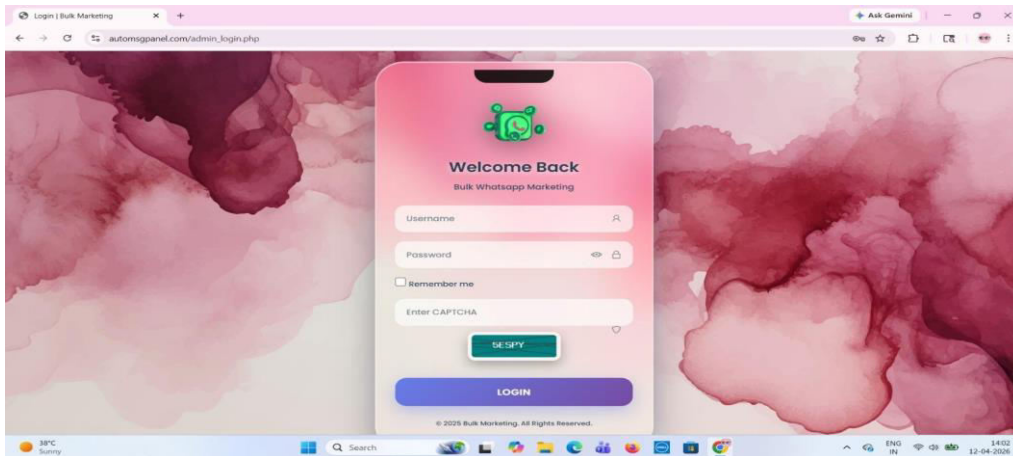


Figure 4.1 Login Interface for Whatsapp-based bulk messaging system

The figure shows the login page of the developed bulk messaging system, where users can securely access the platform by entering their username, password, and CAPTCHA verification.

Output:

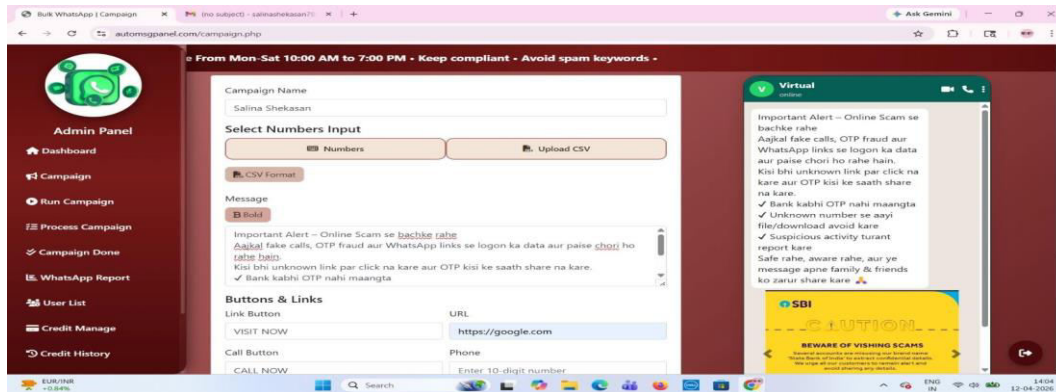


Figure 4.2 Campaign Creation Interface



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The figure shows the campaign creation module of the system, where users can define campaign details, upload contact numbers, compose messages, and add links or buttons. It also provides a preview section to visualize how the message will appear to recipients before sending.

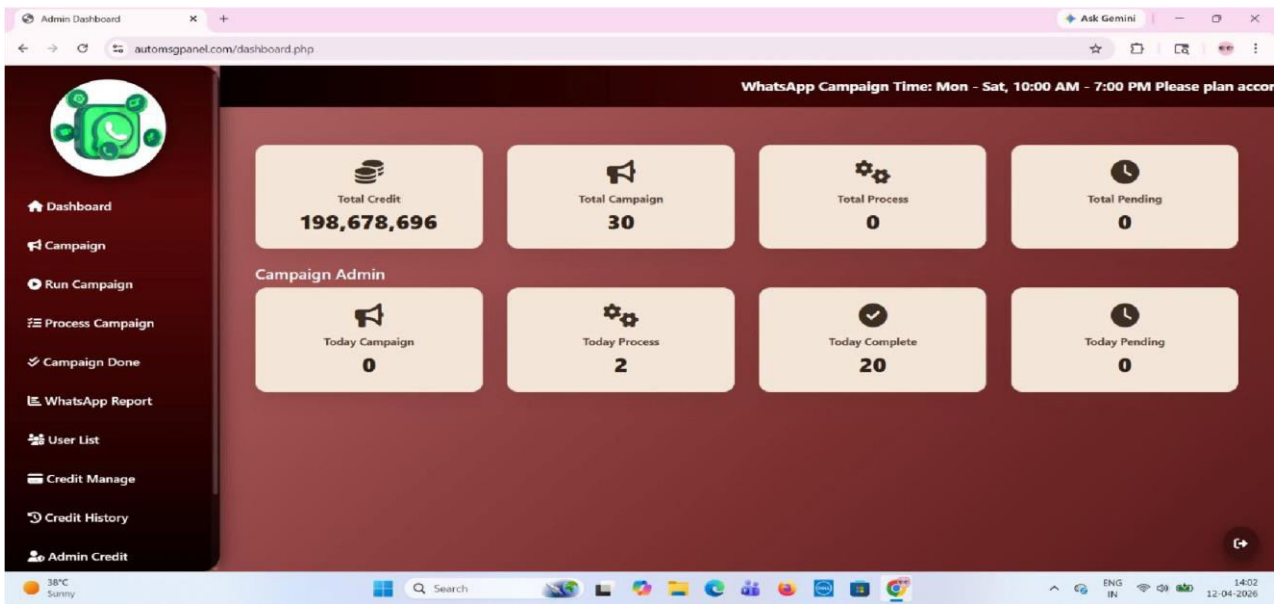


Figure 4.3 Admin Dashboard

The figure shows the admin dashboard interface of the system, displaying key metrics such as total credits, campaigns, processing status, and daily activity. It also provides navigation options for managing campaigns, users, and reports efficiently.

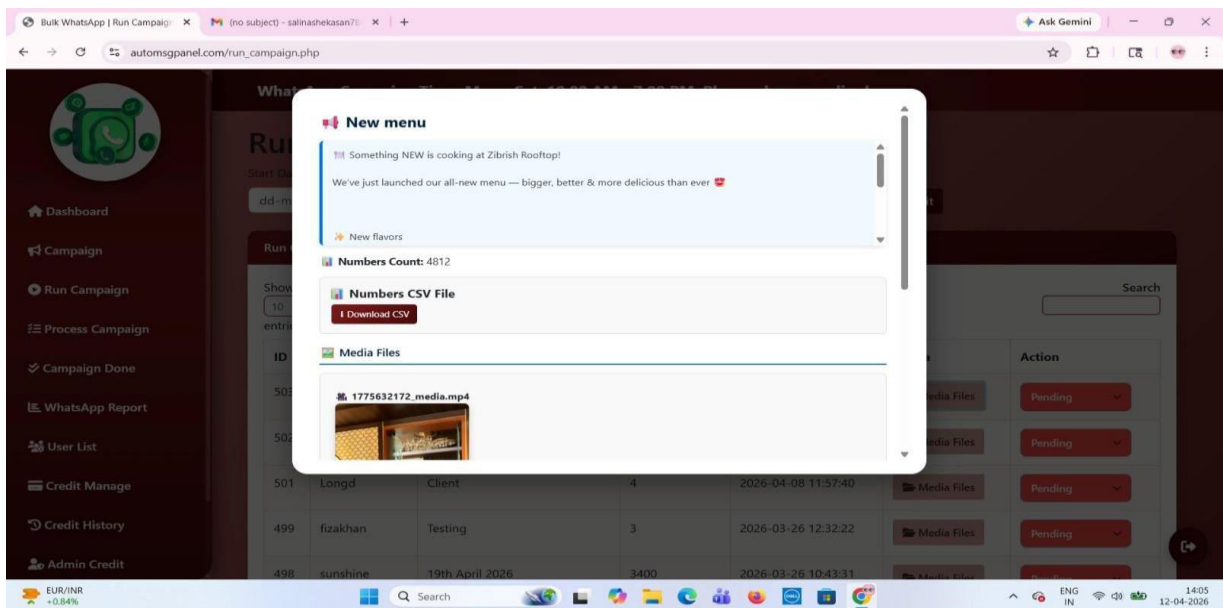


Figure 4.4 Campaign Execution and Details View in the WhatsApp-Based Bulk Messaging System



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The figure shows the campaign execution interface, displaying campaign details such as message content number of recipients, uploaded CSV file, and attached media files. It allows users to review and manage campaign data before and during message transmission.

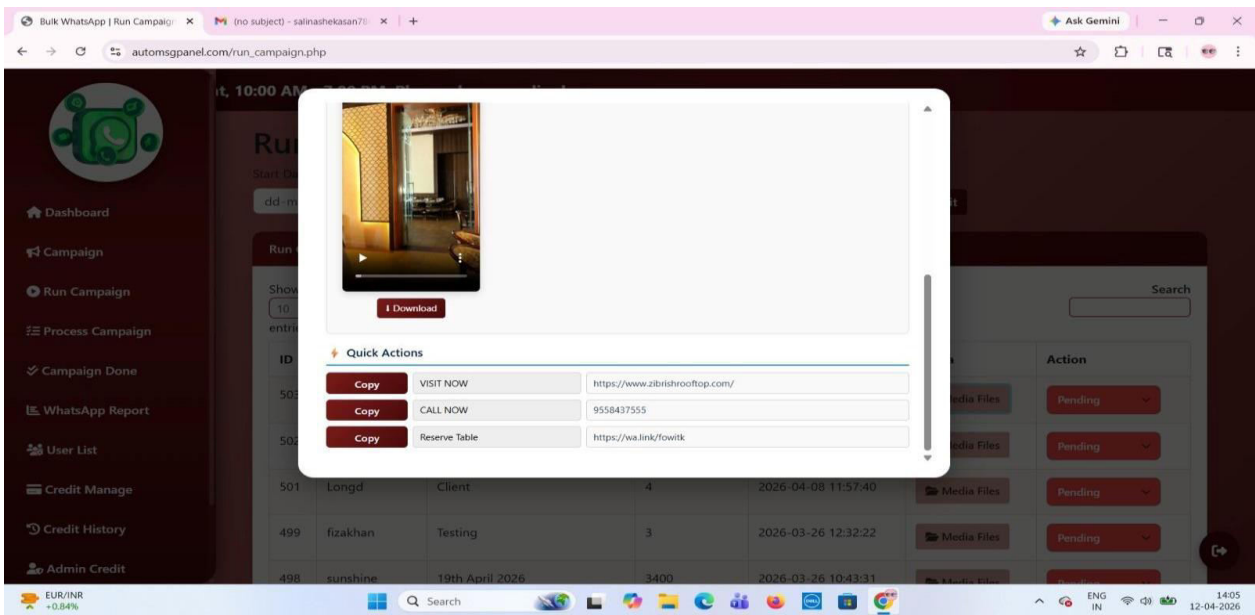


Figure 4.5 Media Preview and Quick Actions Interface in WhatsApp-Based Bulk Messaging System

The figure shows the media preview section along with quick action options, where users can view attached media files and access buttons such as visit links, call options, and other interactive actions. It enhances user control and interaction during campaign execution.

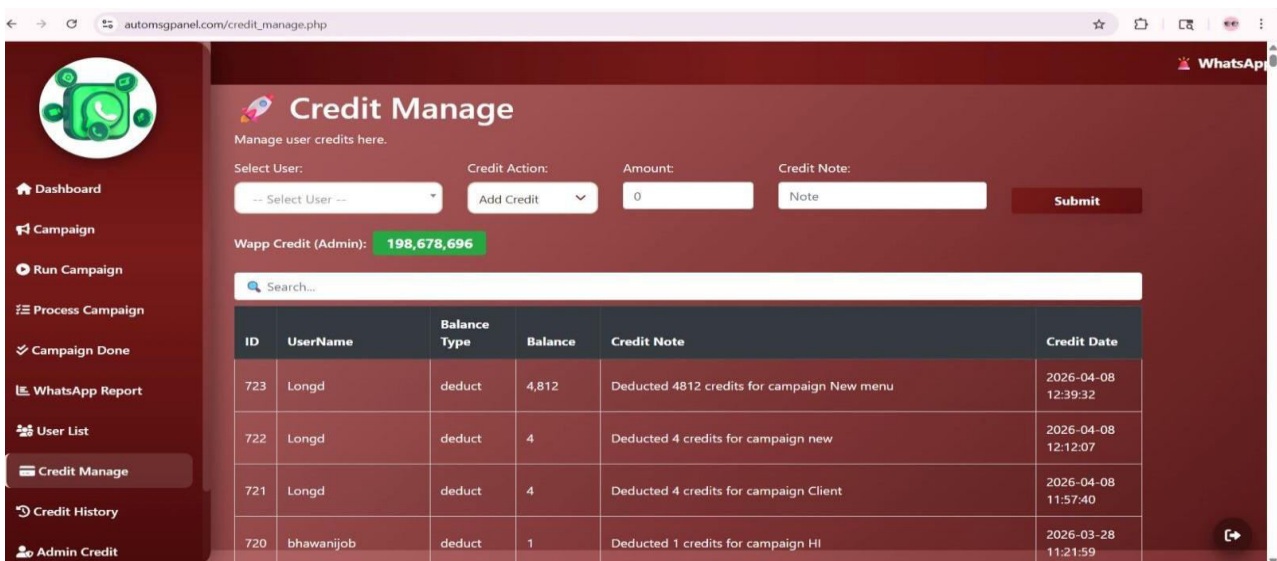


Figure 4.6 Credit Management Interface in the WhatsApp-Based Bulk Messaging System

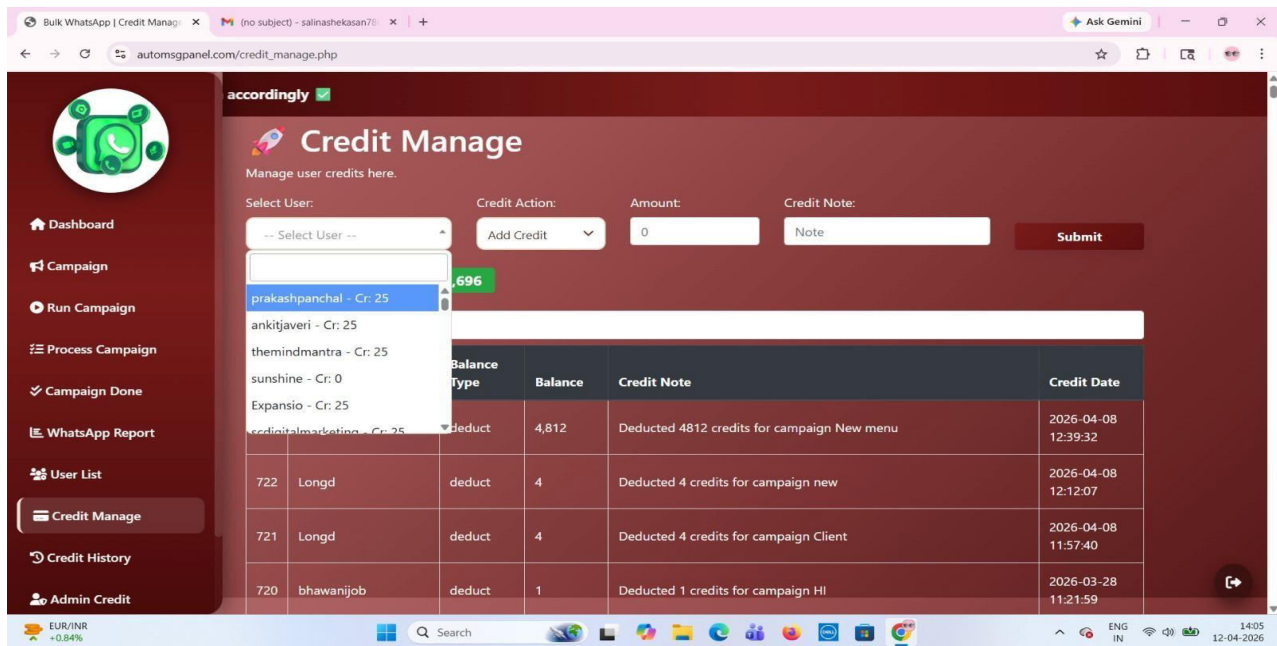
The figure illustrates the credit management dashboard, where administrators can allocate or deduct user credits, specify amounts, and add notes for each transaction. It also displays the total available credits and a detailed transaction history.



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including user activity, balance changes, and timestamps. This interface streamlines credit control and ensures transparency in campaign usage and billing.



**Figure 4.7 User Selection and Credit Allocation Interface in WhatsApp-Based Bulk Messaging System**

The figure displays the credit management interface with an expanded user selection dropdown, allowing administrators to choose specific users and view their current credit balances. It also provides options to add or deduct credits, enter the desired amount, and include notes for each transaction. This feature improves usability by enabling precise credit allocation and efficient management of multiple user accounts within the system.

#### 4.1 Hardware Requirements:

- RAM: Minimum 8GB
- Processor: Intel i5 or higher
- Storage: 20GB+
- Internet: Stable high-speed connection

#### 4.2 Software Requirements:

- Operating System: Windows, Mac, Linux
- Backend: Node.js / Python
- Database: MongoDB / MySQL
- Queue System: Redis / RabbitMQ
- APIs: WhatsApp Business API / Automation Tools

#### 4.3 Data Flow

The Data Flow Diagram (DFD) represents how data moves through the bulk messaging system.

- The User/Reseller creates a campaign with message content and contact list.
  - The data is sent to the Campaign Engine for processing.
  - Contacts are validated and passed to the Queue System.
  - The queue distributes messages to the Virtual Number Pool.
  - The Delivery Engine sends messages to recipients.
  - Delivery status is stored in the Database and shown in the Analytics Module.
- This flow ensures smooth processing, scalability, and efficient handling of large message volumes.



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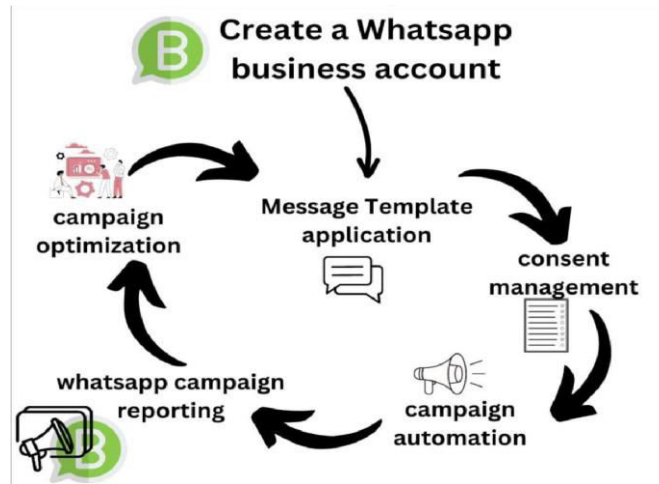


Figure 4.3 Data Flow Diagram

### 4.4 Use Case

The use case describes how different actors interact with the system.

**Actors:**

- Admin
- Reseller

**Main Use Cases:**

- Login and manage account
- Create and schedule campaigns
- Upload contact list
- Send bulk messages
- Monitor delivery status
- View analytics reports

The system processes user actions and provides results such as message delivery status and campaign performance.



Figure 4.4 Use Case Diagram



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### V. SIMULATION RESULTS

The proposed system was tested under simulated high-load conditions to evaluate its performance and scalability. Multiple campaigns with large contact lists were executed using the distributed virtual number architecture.

The system demonstrated significant improvements in delivery efficiency and processing speed compared to traditional single-number messaging systems.

METRIC	TRADITIONAL SYSTEM	PROPOSED SYSTEM
Delivery Rate	65%	92%
Failure Rate	HIGH	LOW
Processing Speed	SLOW	FAST
Scalability	LIMITED	HIGH

Table 5.1. Model Performance Metrics

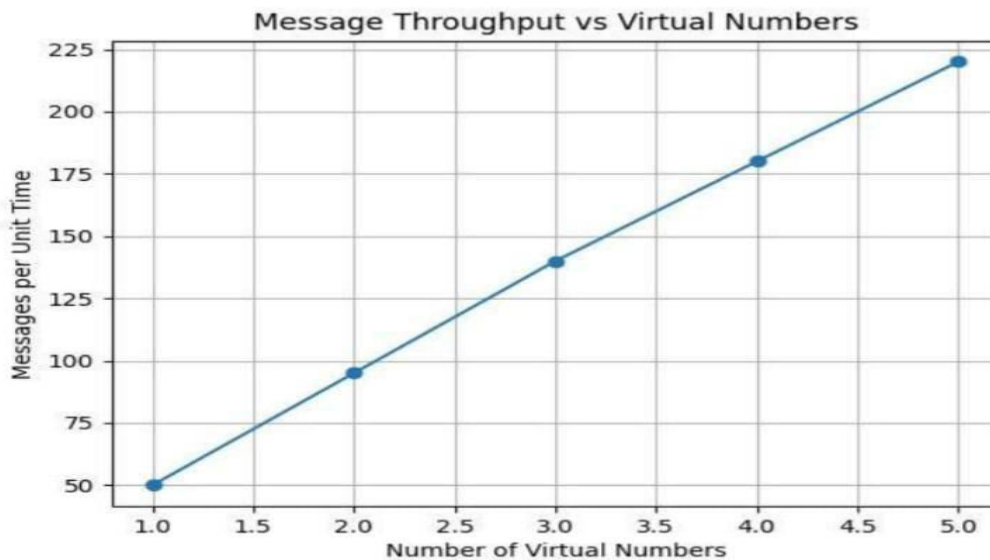


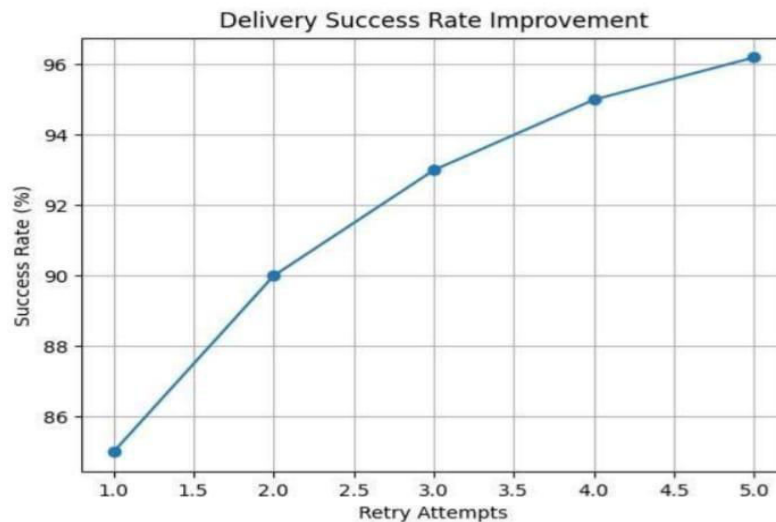
Figure 5.1. Message Throughput vs Virtual Numbers

The graph shows a steady increase in throughput as the number of virtual numbers increases, indicating effective scalability.



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**Figure 5.2. Delivery Success Rate Graph**

The graph demonstrates a high delivery success rate with minimal failures, confirming system reliability and efficiency.

### VI. CONCLUSION AND FUTURE WORK

This paper presents a scalable and efficient WhatsApp-based bulk messaging system using distributed virtual number architecture. The proposed system successfully addresses key challenges such as scalability, load balancing, and message delivery reliability.

Future enhancements may include:

- AI-based message personalization
- Chatbot integration
- Smart send-time optimization
- Advanced analytics using machine learning

The system demonstrates strong potential for real-world deployment in digital marketing and communication platforms.

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