

An Analysis of WAP-Enabled Examination Results System Using Servlets and WML

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Abstract

The timely dissemination of examination results remains a major impediment in rural areas where internet accessibility is very low, and web traffic conditions are high during the examination result of declaration times. Delays, inaccessibility, and system crashes are the impediments associated with the conventional web portal and noticeboard approaches. The overall purpose of the present research is to plan and analyze an efficient and effective examination result dissemination system that can operate effectively even in low-bandwidth conditions. In the following sections, the development of a Wireless Application Protocol (WAP)-enabled examination result dissemination system using Wireless Markup Language, Java Servlet technology, MySQL database, and WAP Gateway has been discussed and analyzed. The result obtained through performance analysis revealed that the proposed examination result dissemination system can operate with an overall efficiency and an average load time of 2.80 seconds, a server response time of 1.10 seconds, and a high level of overall satisfaction with an overall satisfaction score of 4.3 out of 5. At a high level of concurrent system operations, the overall response time obtained was 3.1 seconds with 500 users and a high level of rural and urban success rates at 96.4% and 98.9%, respectively. A comparison of this system in terms of performance with other systems using a web portal and SMS has shown clearly how much better this system is in comparison to others. These results actually confirm how much this system can enhance accessibility in terms of connectivity in these educational institutions.

Keywords: WAP technology, examination result system, Java Servlets, Wireless Markup Language, low bandwidth networks

1. Introduction

The exponential trend in the development of technology has made the availability of academic information on time an indispensable necessity for students and educational institutions [1]. The conventional approach of declaring the result through a notice in printed form and/or on a website is usually associated with delays. It renders access impossible at rural destination locations or infrastructure-challenged areas [2]. Therefore, with the explosion in the consumption of mobile phones, including the low-income population, WAP emerged to transmit content via simple mobile networks [3]. Despite the growing availability of digital technology, many students, especially in rural and socioeconomically deprived areas, are still confronted with the challenge of accessing their results promptly. Physical notice boards or website-based result release can prove ineffective due to delays, slow network speeds, or website collapse due to overwhelming traffic upon result day announcements [4,5].

WAP is an industry-standard protocol that enables mobile units to access internet-based services from wireless networks. Developed during the early era of mobile internet, WAP was beneficial for delivering lightweight, text-based content to users with limited bandwidth and processing power [6,7]. Java Servlets are server-side programs that extend the capabilities of web servers by generating dynamic web content. They act as the middleware between client requests and server responses, handling tasks such as processing form data, accessing databases, and managing session information [8,9]. Wireless Markup Language (WML), which creates files that may be interpreted by a mobile browser that has

Wireless Access Protocol enabled, has similar capabilities to Hyper Text Markup Language, which may be referred to as HTML, as it allows one to organize information in a coherent format despite the limited capabilities of a mobile device, such as memory and the ability to process information [10,11].

Increasing dependency on scholarly communications over the digital medium has emphasized the need for effective means of dissemination of vital information such as exam results [12]. In the case of India, in the predominantly rural and low-network connectivity zones, traditional means of receiving such information as university result boards and busy website portals often prove unsuccessful due to the infrastructure's limitations in accessibility in these places [13]. Excessive wait time, difficulties in dealing with technology during result of publication time, and general student dissatisfaction in receiving their results can be detrimental to the future of the student's career. There is an immediate requirement for an effective means of communication through simple mobile phones in such low-network environments [14,15].

WAP was an appropriate technology to address such situations, enabling the consumption of internet-like services over conventional phones as well. It is effective enough to transport the content in the form of WML, which is well-suited for viewing on the small screens and low bandwidths available. Java Servlets are the servers that accept the requests from the clients and effectively render the WML pages containing the result data [16]. This study provides an exhaustive analysis of a WAP-based examination results system that was developed by using Servlets and WML, especially in the case study, which was done for the Andhra Pradesh scenario. The report is an evaluation of the challenges faced by the digital inclusion of technology and provides recommendations to expand this technology paradigm in the education sector of the developing countries [17].

This approach facilitates the evaluation of WAP-enabled Examination Results Services through a technical, scientific approach, which enhances the access of information in areas with limited connectivity through the combined use of Java Servlets and WML. This approach facilitates inclusive educational communication using mobile technology.

Key contributions of this study are:

- Engineered with a lightweight, WAP-compatible examination results system optimized for low-end mobile devices, utilizing Java Servlets.
- Improved access to academic outcomes for pupils in remote and underdeveloped areas.
- Exhibited the effective amalgamation of WML with dynamic server-side technology for instantaneous data transmission.
- Mitigated the shortcomings of conventional result broadcasting techniques, including website congestion and restricted accessibility.
- Provided a scalable and reproducible framework for implementing mobile-based academic services in Andhra Pradesh.

The rest of the sections of the paper are structured as follows: Section 2 discusses the previous literature of various authors, and Section 3 discusses the methodology of the study in detail. In Section 4, the results of the research are described in detail along with the graphs and tables. The conclusion and future research of this paper are provided in Section 5.

Literature review

The Wireless Application Protocol (WAP) is a crucial technology which is used to provide internet services to mobile internet frameworks and works like GSM and GPRS and thus designed to bridge the gap between mobile devices and internet services in terms of improving communication procedure through messages, email or text. It utilises the low bandwidth, short battery power, quality of service and limited display facilities which are characteristic of current types of mobile device [18,19]. WAP based system facilitated the online registration process via mobile devices increased accessibility to students by 80% besides lowering data entry errors by 60% even in environments with limited internet infrastructure [20]. In a primary research, Diaz et al [21] recorded that educational effectiveness of school children using mobile application has improved the literacy scores of children by 38.3% and demonstrated that the mobile apps effectively enhanced their literacy abilities as also integration of print formats with digital formats optimizes the

student's performance[19]. Concerning major advancements in information technology, such as 5G networks, IoT devices, and Artificial Intelligence (AI), Lakhani et al. [21] investigated vulnerabilities in wireless networks that existed with the aid of the technique employed to analyze the subject by performing an analysis based on empirical evidence and case studies, such as the Mirai Botnet Attack. Additionally, Wifi Protected Access3 (WPA3) and 802.11i protocols, with the aid of new-age innovations such as blockchain and AI, were also evaluated. With this technique to assess wireless network vulnerabilities, it was observed that data detection can increase by as much as 80%, while unwanted messages can decrease by as much as 65%. For wireless edge devices in bandwidth-constrained conditions, a privacy-preserving and decentralized federated learning system with Zigbee components was proposed by Muttepawar et al [22]. The Fed Avg algorithm was exercised for synchronization between clients and a central server using Independent and Identically Distributed data (IID) and Non-Independent and Identically Distributed (non-IID) data scenarios. The outcomes have shown that the system yielded 99% accuracy for IID data and up to 92% for IoT devices in the case of non-IID data, with convergence achieved in 180 to 540 seconds based upon conditional power and data heterogeneity, thus substantiating the practicability and universalization potential for wireless edge federated learning prototypes. Asymmetric keys and the use of Java servlets to ensure transactions and data transfer over the web with elements such as authentication, confidentiality, and data integrity at every node in the system, Yusoff et al [23] made a proposition for utilizing Elliptic Curve Cryptography (ECC). The methodology of the system was also well developed, tested, and validated using Python and JavaScript. At the same time, security and performance were also tested through robustness against various attacks, computation expenses, and energy use. The results were able to achieve multiple tasks, including a notable reduction in the amount of power use, from 9,480 μ J down to 3,456 μ J. It also managed to improve the speed of the authentication of the device, completing tasks in 0.018 seconds as opposed to 0.497 seconds using conventional authentication protocols. Zhuet et al.[24] developed a methodology using various technologies, including the use of Java, Spring Boot, Servlet, MySQL, Vue, Ajax, and others, which were used in the creation of the layered architecture of the designed system. It also ensured a highly usable, stable, and responsive system, which ensured over 90% user satisfaction, as well as 100,000 data entry capabilities.

Akinyele et al.[25] designed a web-based platform that will allow students to perform the clearance procedure online, thus eliminating long queues, paperwork, and human error. The methodology adopted included primary data collection through interviews and observation from the Student Affairs department, which was followed by the system design and implementation using Hypertext Preprocessor (PHP), Hypertext Markup Language, JavaScript, MySQL, jQuery, and Internet Information Services. Implementation results indicated massive enhancements: an over 80% reduction in processing time; less than instantaneous data retrieval; and over a 60% reduction in personnel workload, enhancing data security, efficiency of operations, and convenience for users. Jadallah *et al.*[26] conducted an in-depth study on the use of smartphone apps to manage educational processes in schools within Jordan's Zarqa Governorate. Using a descriptive quantitative approach, data were collected from 230 teachers using questionnaires that targeted four fields: teaching, evaluation, student affairs, and staff management. From the results obtained, the mean rating of 4.50 reflected good utilization of the smartphone in the management of school affairs, and there is no significant difference across gender or academic qualifications.

To enhance the compatibility and usability of smart devices. A three-layer system consisting of display, logic, and data access was developed by AlHakeem *et al.* [27] using Xcode, AppleScript, and Web objects. Content was customized for the features of devices and data security via Secure Sockets Layer (SSL). More than 80 university web pages consisting of 16 MB were accessible with a mobile web application compatible 100% on Apple devices, iPhone and iPad. To enhance the evaluation of virtual engineering education in an improved manner with the implementation of the technology in the future, Kadhim et al. [28] proposed the usage of IoT sensors for obtaining information from the activity of the student with the aid of an adaptive layered Bayesian belief classifier and the multi-gradient-boosting decision tree classifier. The Python-based solution was subjected to real-time data testing. In comparison to other traditional techniques, the exactness level of the proposed solution based on IoT technology coupled with an adaptive layered Bayesian belief network technology is reported to be around 96.2%. Chen et al. [29] designed an autonomous mobile learning model that employed complicated algorithm technology through a wireless network to advance cloud-based learning technology. The model reduced the time lag in the transmission of data through MATLAB simulation techniques by 5%, reduced packet loss termination by 10%, and reduced power consumption by 10%. This technology is efficient in time-based learning environments.

2. Methodology

This paper formalizes the design and test of a mixed-methodology, WAP-enabled examination result system for optimization for access over low-bandwidth networks, such as rural Andhra Pradesh. Key functional requirements are identified, including fetching results in real time with the assistance of roll numbers, while providing WAP-enabled phones. Minimal infrastructure dependence, latency, and broad accessibility are some of the identified non-functional requirements for the system. The targeted beneficiaries would be school and college students throughout Andhra Pradesh.

2.1. Proposed System Development and Analysis Framework

This proposed framework provides an overall picture of the entire life cycle of the WAP-enabled examination result system from the perspective of architecture design and developing the module itself, its implementation, testing, validation, etc. This includes issues of performance optimization and accessibility of the system.

2.1.1. Designing System Architecture

A three-tiered structure was also proposed as part of the system architecture, which is intended to offer results delivery through an efficiently designed structure [30,31] to ensure the results are efficiently delivered, as depicted in Figure 1. Each layer of the proposed structure will have a particular role to play in the functioning of the WAP results delivery system.

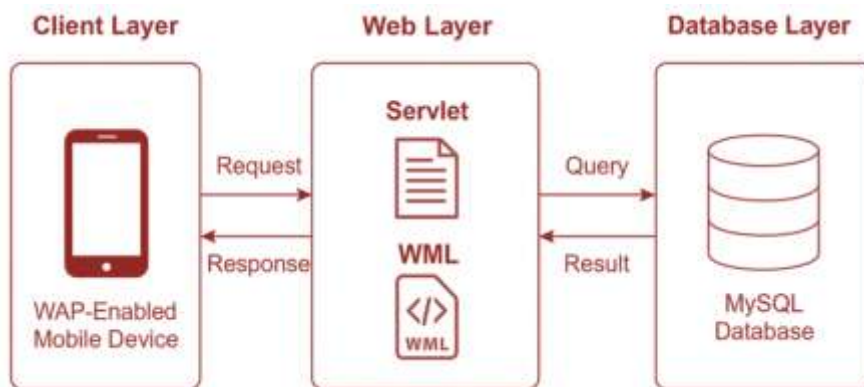


Figure 1. Architecture of WAP-enabled examination system.

- **Client Layer:** User interface built with WML forms accessible via mobile devices.
- **Web/Middleware Layer:** Java Servlets handle client requests, process logic, and dynamically generate WML responses.
- **Data Layer:** MySQL stores student roll numbers, marks, grades, and result status.

3. System Module Development

The system module development consisted of developing both the frontend and backend components required for the WAP-based examination result system. At the client side, WML pages were created to serve the user interaction needs. These included input forms for the roll number, display pages to present the examination results, and special error message pages for cases where a student enters an invalid roll number etc. The system uses the administrator, teachers, students three licensing, to achieve a test database management, automatic intelligent test paper in online examination, automatic and manual marking, examination results analysis functions[32]. On the server side, Java Servlets were developed with the core logic. These servlets checked for valid user input, then queried the MySQL [33] database through JDBC in a secure manner and finally generated WML pages dynamically based on the query response. In such a WAP-enabled examination result system, the connection must be established in a secure manner between the server and the database to ensure the integrity of the data. Optionally, connections from the server to the database can be pooled to handle massive database hits.

4. Populate the Database

For smooth testing and prototyping of the WAP-enabled result system, the MySQL data is populated with some mock results or actual data from one of the participating educational organizations of the state of Andhra Pradesh. The data is then used in querying operations and the generation of the result while running the system.

The database record present at any given time contains certain fields that are to be fed into ensure accurate and specific results for the students. All these fields were present along with the items such as Roll Number, Student Name, Subject-wise Marks, Grade, etc., and status such as Pass or Fail, and the concerned Exam Session.

5. System Deployment

The process of deployment required the setup of the WAP-enabled result system on an appropriate web server environment. The system was deployed on an Apache server using an Apache Tomcat server environment, as it can support Java Servlets and can seamlessly handle HTTP requests and generate dynamic content. Also, the system had to be made accessible and thus was set up to be accessed through a WAP gateway, making it accessible on a range of devices. For simulation and validation, the system has been made compatible and accessed through a simulation procedure using GPRS-based WAP emulators and handheld devices.

6. Perform System Testing

An intricate testing and evaluation procedure was performed to examine the efficiency, reliability, and overall success rate of the proposed WAP-enabled examination results delivery system. Such testing procedures include functionality testing, wherein the results can be efficiently accessed, checking the compatibility of the results delivery system with various WAP-smart devices, as well as checking a few key efficiency factors. Usability testing was also performed to evaluate the results of delivery system, where a group of users was subjected to testing to assess user satisfaction.

7. Collect User Feedback

To determine the usability of the WAP-enabled system of imparting the examination results, the users were asked to fill out forms related to the usage of the proposed system on their own through their WAP-enabled handsets. To ensure the proliferation of diverse views from students who were the probable end users of the proposed research implementation, students from different areas were chosen to ascertain the feasibility of the research implementation in various areas. The students were asked to fill out forms related to the usage of the proposed system through their WAP-enabled handsets after the administration of short-term training to prove the applicability of the proposed research implementation to the students. The key areas of the proposed research implementation were:

- **Ease of use:** Whether the interface was intuitive, and navigation was simple.
- **Speed of result access:** User perception of how quickly the result was displayed.
- **Device compatibility:** The system's effectiveness across different devices and network conditions.
- **Overall satisfaction:** General impression of the service's usefulness and reliability.
- **Willingness to reuse:** Whether users prefer to use the system again in future result announcements.

The feedback collected helped identify strengths and areas for improvement, ensuring the system meets the expectations of a broad user base.

Step 9: Analyse and Interpret Results

Collected data was also subject to analysis to assess the performance as well as the usability of both systems. Upon detailed analysis of the performance logs through quantification, it was possible to evaluate the latency as well as the success rates recorded during the process. At the same time, data related to the responses received from the users through the use of Python [34] was subject to analysis to assess the current trends as well as calculate the average satisfaction scores recorded by the users.

Step 10: Validate and Report Findings

The findings were compared to alternative methods of results dissemination using techniques such as SMS and internet portals to determine performance comparison. Given that this model has a light infrastructure requirement in terms of bandwidth demands, this model showed clear advantages in bandwidth-scarce environments. Cognizant of these limitations in terms of WAP-compatible handsets for this model to operate in a wider context, this model showed clear potential to integrate e-governance/education ecosystems.

3.1 Functioning of the proposed framework

The process of the proposed WAP-enabled result retrieval system involves a sequential process of client-server interactions. The system is designed with the objective of providing results in real-time to the mobile user. The overall system and the interaction process of the proposed system are depicted in Figure 2.

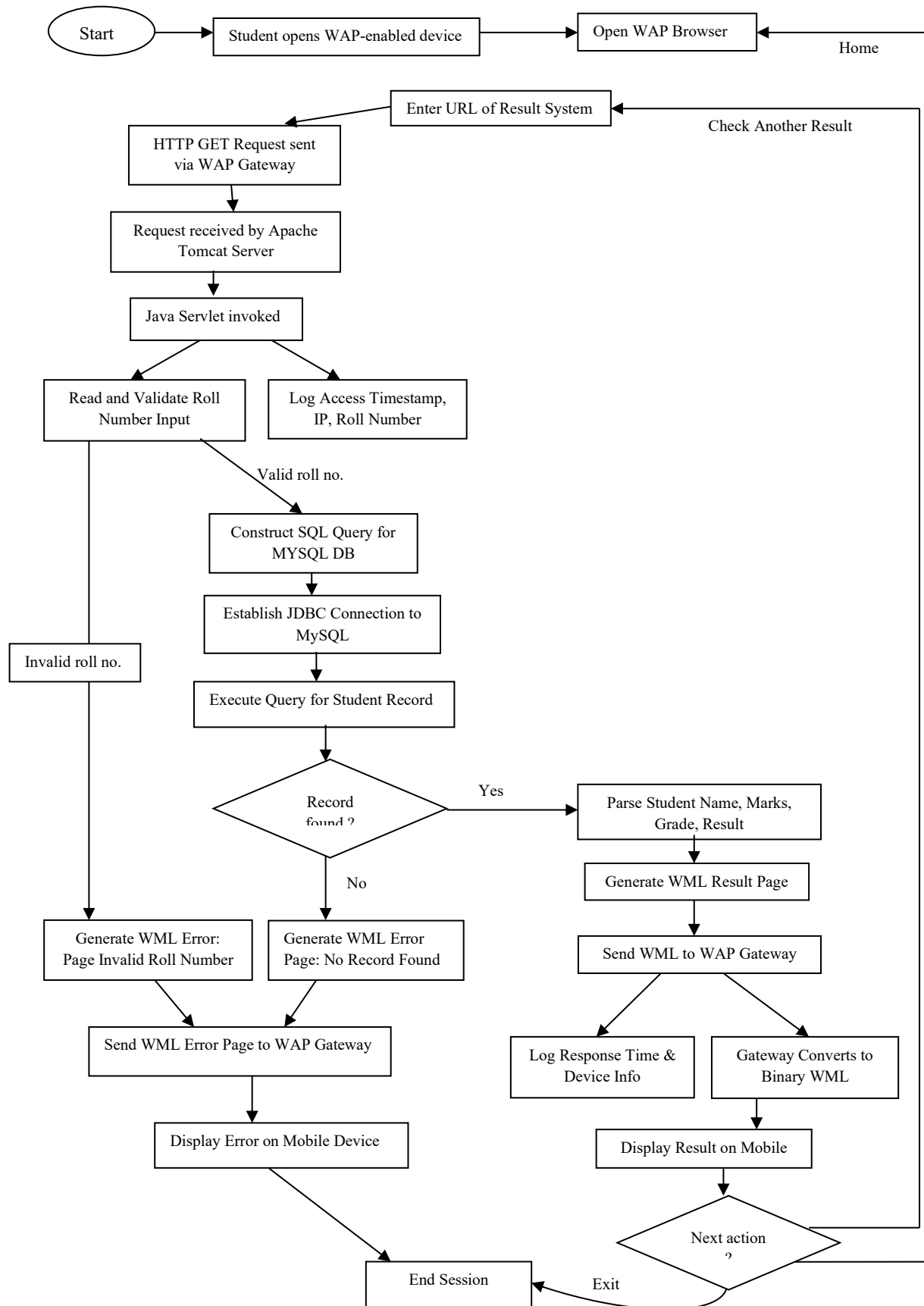


Figure 2. Proposed framework

The step-by-step explanation below outlines each processing stage and how to respond to a student's result query.

Step 1: User Access via WAP-Enabled Mobile Device

- A student uses a basic WAP-enabled mobile device (with 2G/3G connectivity).
- The student opens the WAP browser and enters the URL of the results system.

Step 2: WML Page Request Initiation

- The mobile device sends an HTTP request to the server.
- The request is interpreted by the WAP gateway and forwarded to the web server hosting the Servlet.

Step 3: Request Handling by Servlet

- The Java Servlet receives the incoming request.
- The Servlet reads query parameters such as Roll Number or Registration ID.

Step 4: Query Processing

- The Servlet constructs a query to fetch the corresponding results from the MySQL database.
- A secure JDBC connection is established with the backend database.

Step 5: Database Access

The MySQL database is queried for:

- Student name and roll number
- Subject-wise marks
- Overall Result (Pass/Fail, Percentage)

Step 6: WML Response Generation

The Servlet dynamically generates a **WML (Wireless Markup Language)** page containing Student identification, Subject-wise marks, and Result summary.

Step 7: Response Transmission

- The WML content is sent back to the WAP Gateway.
- The WAP Gateway converts the content into a format suitable for the mobile browser (binary WML).

Step 8: Result Display on Mobile

- The student's mobile phone receives and renders the WML card(s).
- Results are displayed in a lightweight format, suitable for small screens and low bandwidth.

Step 9: Session Termination or Navigation

The student can end the session, return to the home screen, or query another result via navigation links or WML input prompts.

Step 10: Logging and Analytics

- The system can log access data (IP, timestamp, student ID) for audit and analytics.
- Basic analytics like average response time, most accessed hours, and device type compatibility are recorded.

3.2 Proposed Architecture

WAP-Based Result Retrieval System makes use of Java Servlet Technology along with WML, which helps students retrieve their results using basic mobile handsets that have WAP access. This process is initiated by the student entering the URL through WAP Browser access on the mobile. Following this, a WML form is displayed, asking the student for their Roll Number. This form is further sent through the WAP gateway, which acts as an HTTP request. This request is forwarded, along with the form of data, to the Java Server. Following this, the Servlet Request is received, the data is extracted, and if the Roll Number is accurate, a JDBC connection is initiated, finally executing an SQL query using the Roll Number, as depicted in Figure 3.

This retrieved information is arranged in the form of a WML card. If a record matches the criteria, a reply is sent back. This reply contains the information in the form of a WML card, which the WAP gateway interprets. This information is then sent as a reply to the student using their mobile browser. Similarly, the result pops up in a user-friendly form. If the data is invalid, an error message is also sent. Once the results or message appear, the student can choose whether they want to make a new inquiry or leave the session. This concludes the entire process, as information regarding the time, roll number, IP address, and the device ID is noted.

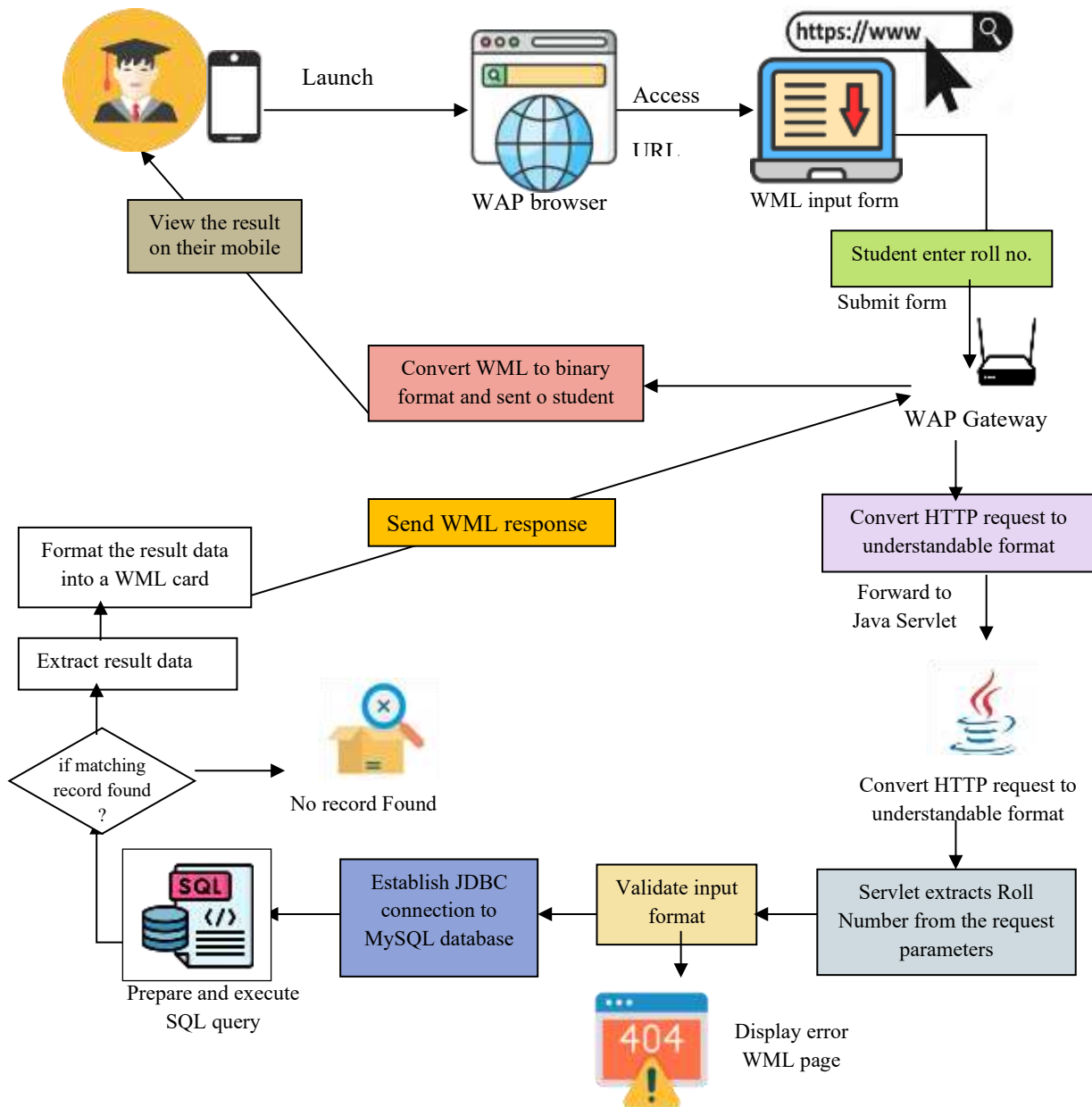


Figure 3. Proposed architecture

3.3 Proposed algorithm

Algorithm: WAP-Enabled Examination Result Retrieval Using Servlets and WML

Let:

- M = Set of WAP-enabled mobile devices
- R = Roll number entered by student
- DB = MySQL database
- Q = SQL query
- S = Java Servlet
- WML = Wireless Markup Language Response
- L = Set of system logs
- res = result retrieved from DB
- E = Error message

Start

Step 1: Let $m \in M$ initiate a request via WAP browser

$\Rightarrow m \rightarrow \text{URL: } \text{http://results.apwap.edu.in}$

Step 2: The System displays WML form $F(R)$ to input roll number R

Step 3: Student inputs $R \in \mathbb{R}^+$, $R \neq \emptyset$

$\rightarrow$ send HTTP request: $\text{HTTPreq}(R)$

Step 4: WAP Gateway transforms $\text{HTTPreq}(R) \rightarrow \text{ServerRequest}(R)$

$\Rightarrow \text{Gateway: } G(\text{HTTPreq}(R)) = \text{ServerRequest}(R)$

Step 5: Java Servlet S receives request: $S \leftarrow \text{ServerRequest}(R)$

Step 6: If $\neg \text{Valid}(R)$:

$S \rightarrow \text{WML}(E)$, $E = \text{"Invalid Input"}$

Go to Step 14

Step 7: S establishes JDBC connection: $\text{Conn}(\text{DB}) = \text{True}$

Step 8: Prepare SQL Query:

$Q := \text{SELECT name, marks, result, percentage}$

$\text{FROM students_results}$

$\text{WHERE roll_no} = R$

Step 9: Execute Query:

$\text{res} := \text{Execute}(Q)$

Step 10: If $\text{res} \neq \emptyset$: 11.

$\text{WMLres} := \text{Format}(\text{res})$

$S \rightarrow \text{WMLres}$

Else:

$E = \text{"Result Not Found"}$ $S \rightarrow \text{WML}(E)$,

Go to Step 14

Step 11: WAP Gateway encodes response:

$\text{WMLres_binary} := \text{Encode}(\text{WMLres})$

Step 12: Mobile device renders:

$\text{Display}(m, \text{WMLres_binary})$

Step 13: Provide options: [New Query] | [Exit]

Step 14: Log session:

$L \leftarrow L \cup \{\text{timestamp, IP, R, device_id, response_time}\}$

End

3.4 Development Tools and Technologies

The WAP-Based Result Retrieval System implemented some of the best selections of development tools and technologies with a view to ensuring compatibility with the low-bandwidth mobile environment, as well as robust processing on the server side. On the front end, Wireless Markup Language was used to create lightweight user interfaces suitable for WAP-enabled browsers. At the back end, Java Servlets were used to implement backend logic, ensuring dynamic content generation along with secure interaction with the database. MySQL handled the database of the student examination results securely. Apache Tomcat 8.5 hosted the server, which enables support for Java EE technologies and servlet execution. Testing was done with Openwave WAP emulators and actual GPRS-enabled mobile devices to ensure cross-device compatibility. Additionally, Python was optionally used to analyze survey results and log data, aiding in usability evaluation and system optimization. Table 1, given below, summarizes the tools and technologies used.

Table 1. Tools and technology used.

Component	Tool/Technology Used		
Frontend	Wireless Markup Language (WML)		
Backend Logic	Java Servlets (Java EE)		
Database	MySQL		
Backend Logic	Java Servlets (Java EE)		
Database	MySQL		
Web Server	Apache Tomcat 8.5		
Testing Tools	Openwave WAP emulator / Real Devices		
Scripting	Python		

3.5 Performance Metrics

The following metrics identify system bottlenecks and validate the system's ability to deliver fast, accessible, and low-data results suitable for resource-constrained environments.

- **Load Time (TL):** Time taken for a WML page to fully load on the user's device.

$$TL = Tend - Tstart \quad (1)$$

Where $Tstart$ = request sent time, $Tend$ = response rendered time.

- **Server Response Time (TS):** Time taken by the server to process the request and generate a response.

$$TS = Tprocess + Tquery \quad (2)$$

Where, $Tprocess$ = servlet processing time, $Tquery$ = database query execution time

- **Bandwidth Usage (BW):** The Amount of data transferred between the server and client per request.

$$BW = \sum(\text{Size of WML response} + \text{HTTP headers}) \quad (3)$$

8. Result and discussion

In this section, the outcome of the research is discussed for testing the efficiency, reliability, and use of the developed WAP-enabled examination result system on the parameters of functionality, response time, bandwidth usage, scalability of the system under concurrent connections, and performance of the developed method in comparison to the traditional method of result distribution.

Figure 4 shows the UI performance test case for valid input in the proposed WAP-enabled examination result system. In this test case, the valid roll number 1020 is entered using the WML-based input interface, which is properly accepted by the system and submitted to the Java Servlet through the WAP gateway. The Servlet properly validates the input, creates a JDBC connection with the MySQL database, and fetches the corresponding student record without any issues. The result page shows the student's name as Student_20 and roll number 1020, followed by subject-wise marks: DBMS = 60, OS = 95, CN = 80, DSA = 71, and Python = 80. Based on these marks, the system calculates the overall average of 77.20%, which is above the set pass threshold, and hence the result status is properly displayed as PASS. The proper display of subject-wise correct marks, calculated percentage, and final result indicates the correctness of backend processing, database queries, and dynamic WML page generation. This test case proves that for valid inputs, the proposed system provides accurate, reliable, and user-friendly result information with a reduced number of interaction steps, thereby establishing the correctness and efficacy of the proposed system.

Input

Enter Roll (1001-1050):

[Back Home](#)

Result

Name: Student_20
Roll: 1020

DBMS: 60
OS: 95
CN: 80
DSA: 71
Python: 80

Average: 77.20%
Result: PASS

[New Search](#)

Figure 4: UI performance Test case: for Valid Input

Figure 5 shows a test case of UI performance for an invalid input in the proposed WAP-enabled system for examination results. Here, the user provides a Roll number 102323, but it is an invalid existing Roll number range within a database defined (1001 to 1050). The WML input form would forward a request to the WAP gateway and consequently to a Java Servlet, where a syntactic and database-level verification of input would take place in a MySQL database if a particular Roll number (102323) has an existing record within a database and yields a null value because a student provides an unknown Roll number. Therefore, the Servlet can dynamically provide an error-specific WML message showing "Student not found!" in place of the outcome details in response to an incorrect input value of "roll number." The interface is equipped with a "Try Again" navigation facility that allows a user to re-enter a valid "roll number" without requiring a restart of the session. This test case can test that the system can handle an incorrect input value by preventing unauthorized access to wrong data points and providing a meaningful and brief feedback message to a user in an erroneous situation regarding an invalid "roll number" test scenario and its precisely identifiable characteristics in a WAP-based result retrieval system.

Input

Enter Roll (1001-1050):

[Back Home](#)

Error

Student not found!

[Try Again](#)

Figure 5: UI performance Test case: for Invalid Input

Figure 6 presents the log for administrative access to the WAP-enabled examination result system, which allows monitoring and auditing by logging the timestamp, IP address, roll number, and status of requests. The entries created from the local IP, 127.0.0.1, on 10 and 14 January 2026 alone include both SUCCESS and NOT_FOUND cases. For instance, the query for roll number 1020 returned successfully, but 102323 and 1022 did not. These logs illustrate correct handling of valid and invalid queries, accurate tracking of transactions, and reliable servlet-based backend operations, supporting auditing in real time, analysis of performance, and evaluation of system reliability.

Admin Logs

2026-01-14 09:35:51	127.0.0.1	Roll: 102323	NOT_FOUND
2026-01-14 09:35:33	127.0.0.1	Roll: 1020	SUCCESS
2026-01-10 05:21:49	127.0.0.1	Roll: 10221	NOT_FOUND
2026-01-10 05:21:32	127.0.0.1	Roll: 1025	SUCCESS
2026-01-10 05:21:17	127.0.0.1	Roll: 1002	SUCCESS

[Home](#)

Figure 6: Administrative access log of the WAP-enabled examination result system.

Figure 7 highlights the page size and time taken to load for the proposed WAP-enabled system, and how it functions with optimal efficiency as the size of the pages increases. When the size of the page increases from 1.8 MB to 3.1 MB, the time taken to load is also optimal, increasing from 0.9 s to 1.35 s with a steady rise, ensuring that it is less than 1.5 s at all levels, establishing the efficient functioning of the system developed using WML and servlet technology to eliminate data overhead.

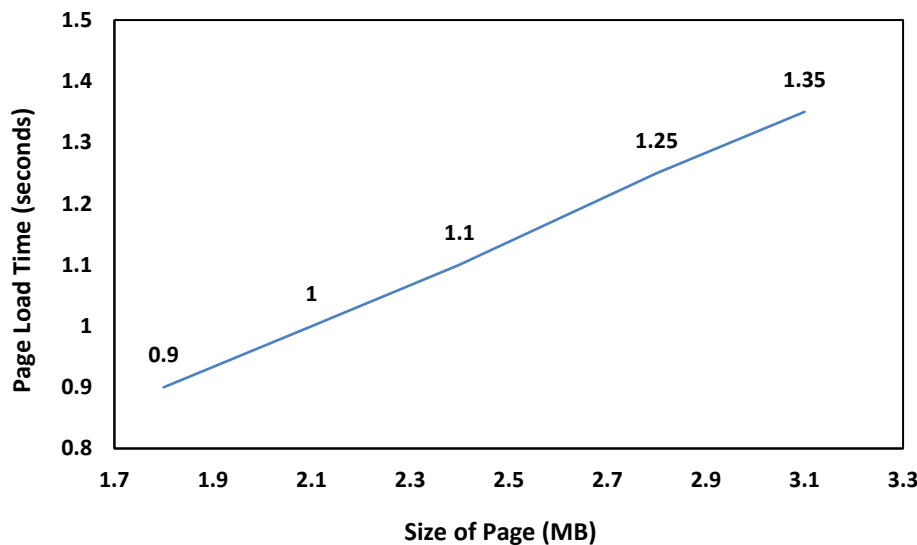


Figure 7: Page load time vs Page size

Figure 8 illustrates the server response time vs. response payload size for the proposed WAP-enabled examination result system. As evident from this figure, when the payload size is 180 KB, the server response time is 8 ms, which increases to 10 ms in the case of 220 KB payload and further to 12 ms when the payload size increases to 260 KB. Once again, in the case of payload sizes 310 KB and 400 KB, server response time increases to 14 ms and 18 ms, respectively. All these observations depict a consistent linear system performance without any delay in server response time below 20 ms. These observations prove that the system is capable enough to provide impressive server response time even in the case of increased payloads.

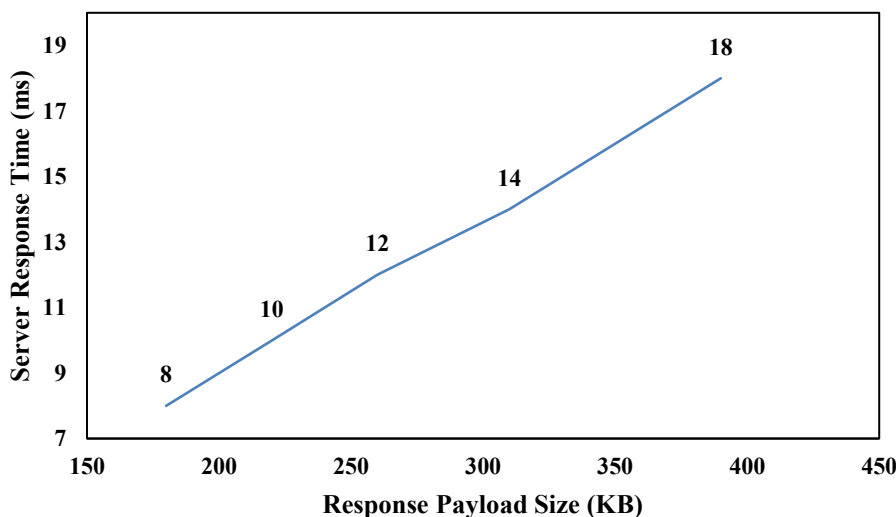


Figure 8: Server Response Time vs. Payload Size

The graph relating bandwidth to data transferred per request is depicted in Figure 9, with a gradual increase in values from 3.2 KB at 45 kbps to 4.1 KB at 95 kbps. This shows that there's little data transferred, which is an indication of effective bandwidth usage. The small amount of data transferred, less than 4.5 KB, proves that WML design promotes small data communication, hence it's appropriate to run on a restricted environment.

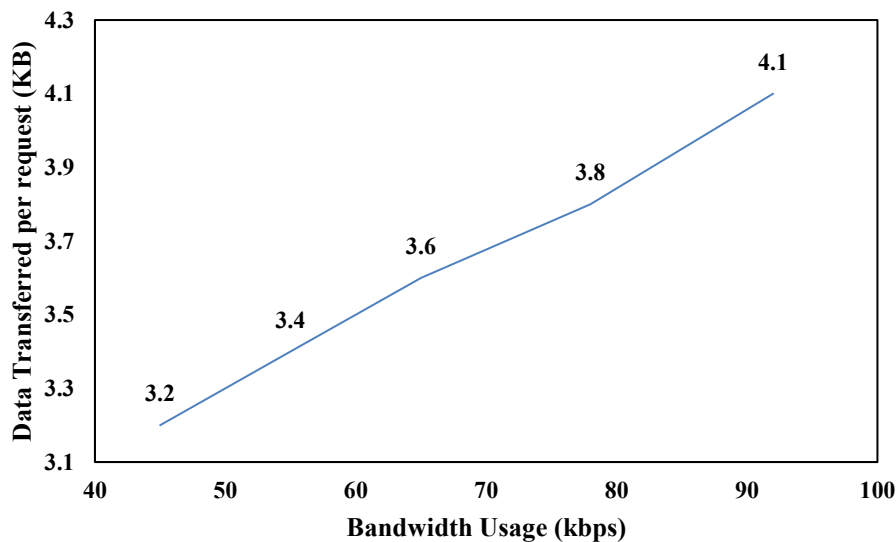


Figure 9: Bandwidth usage vs Data pre request

The results of the concurrent user load test on the proposed WAP-enabled examination result system are summarized in Table 2. When 50 simultaneous users are connected to the system, the response time is 1.2 seconds with a 0% error rate. When the load is increased to 100 users, the response time is slightly higher at 1.5 seconds, but with a 0% error rate. When the load is further increased to 300 concurrent users, the response time is higher at 2.3 seconds, but with a very small error rate of 1.1%. When the maximum load of 500 users is connected to the system, the response time is 3.1 seconds with a 2.6% error rate. These results clearly indicate that the system is capable of providing acceptable response times and low error rates even when a large number of users are connected to the system during peak access periods.

Table 2: Concurrent User Load Test

Concurrent Users	Avg. Response Time	Error Rate
50	1.2 s	0%
100	1.5 s	0%
300	2.3 s	1.1%
500	3.1 s	2.6%

Table 3 presents the comparison of the ablation variants, indicating that the best configuration is the "full variant," namely V0, in terms of its best performance in the loading task in an efficient manner with low server delay, low usage of bandwidth, and very high user satisfaction. Conversely, the usage of the HTML-based access protocol in the variants V1 and V2 can reduce efficiency in the greatest sense in a manner that increases the usage of the network while leading to low user satisfaction in the system. Similarly, the lack of optimization in the variants V3 and V4 reduces the system's efficiency only in a moderate sense, while failing to attain the desired level of efficiency in the system.

Table 3: Performance Comparison Across Ablation Variants (Simulated)

Variant	Load Time (s)	Server Response (s)	Bandwidth (KB)	USS (out of 5)
V0 (WML + Servlet + MySQL + WAP Gateway)	2.8	1.1	4.2	4.3
V1 (HTML)	5.9	2.4	210.5	3.2
V2 (No Servlet)	6.3	3.1	95.4	2.9

V3 (No Gateway Opt.)	4.7	2.0	15.8	3.7
V4 (No Pooling)	3.6	1.9	4.4	4.0

Table 4 shows the descriptive statistics of the proposed model integrating WML, Servlet, MySQL, and WAP Gateway, emphasizing its performance consistency and reliability. The mean loading time is 2.80 seconds with a standard deviation of 0.21, and a 95% confidence interval of [2.72, 2.88], signifying consistent page loading performance. The server response time has a low mean of 1.10 seconds with a standard deviation of 0.14 and a 95% CI of [1.05, 1.15], signifying efficient backend processing. Bandwidth consumption is still low, with a mean of 4.20 KB, $\sigma = 0.31$, and a 95% CI of [4.09, 4.31], validating the lightweight nature of WML-based communication. Moreover, the User Satisfaction Score (USS) has a high mean of 4.30 out of 5, with $\sigma = 0.26$ and a 95% CI of [4.21, 4.39], signifying high user acceptance. Taken together, these statistics indicate that the proposed model provides consistent performance, low variability, and high user satisfaction, making it appropriate for the reliable distribution of examination results in low-bandwidth networks.

Table 4: Descriptive Statistics for Proposed (WML + Servlet + MySQL + WAP Gateway) model

Metric	Mean (μ)	Std. Dev. (σ)	95% CI
Load Time (s)	2.80	0.21	[2.72, 2.88]
Server Response (s)	1.10	0.14	[1.05, 1.15]
Bandwidth (KB)	4.20	0.31	[4.09, 4.31]
USS (1–5)	4.30	0.26	[4.21, 4.39]

As shown in Table 5, the proposed WAP-enabled system outperforms both traditional web portals and SMS-based systems in terms of faster response times, success rates, and error detection capabilities. This clearly indicates the enhanced reliability of the proposed system under conditions of poor connectivity. Taken together, these findings support the hypothesis that the WAP-based system significantly improves failure rates and service reliability, especially in rural areas.

Table 5: Failure and error analysis

Model	Avg. Load time (s)		Avg. Response Time (ms)		Success rate (%)		Detection rate (%)	
	Rural	Urban	Rural	Urban	Rural	Urban	Rural	Urban
Web Portal	5ms	6.7	650	600	89	91	92	93
SMS-based	3 ms	5.5	500	350	92	94	94	95
Proposed WAP system	3.1	2.4	300	250	96.4	98.9	97	99

Figure 10 shows a comparative analysis of the user performance of the proposed WAP-enabled examination result system, the baseline web portal, and the SMS-based system as the concurrent request level increases. At 50 simultaneous requests, the average response times are 5 ms for the web portal, 3 ms for the SMS-based system, and 2 ms for the proposed WAP system. At 100 requests, the response times increase to 6 ms, 5 ms, and 4 ms, respectively. At 150 requests, the web portal measures 5 ms, the SMS-based system measures 4 ms, and the proposed system measures 3 ms. Under a heavier load of 200 requests, the response times are 8 ms (web), 5 ms (SMS), and 4 ms (proposed WAP), and at 250 requests, the response times are 9 ms, 8 ms, and 6 ms, respectively. In all cases, the proposed WAP system clearly has the lowest response times, signifying its superior scalability and responsiveness. These findings clearly show that the lightweight WML-Servlet architecture is far superior to the traditional web and SMS-based systems, especially in terms of scalability, thus improving its appropriateness for mass result distribution in low-bandwidth networks.

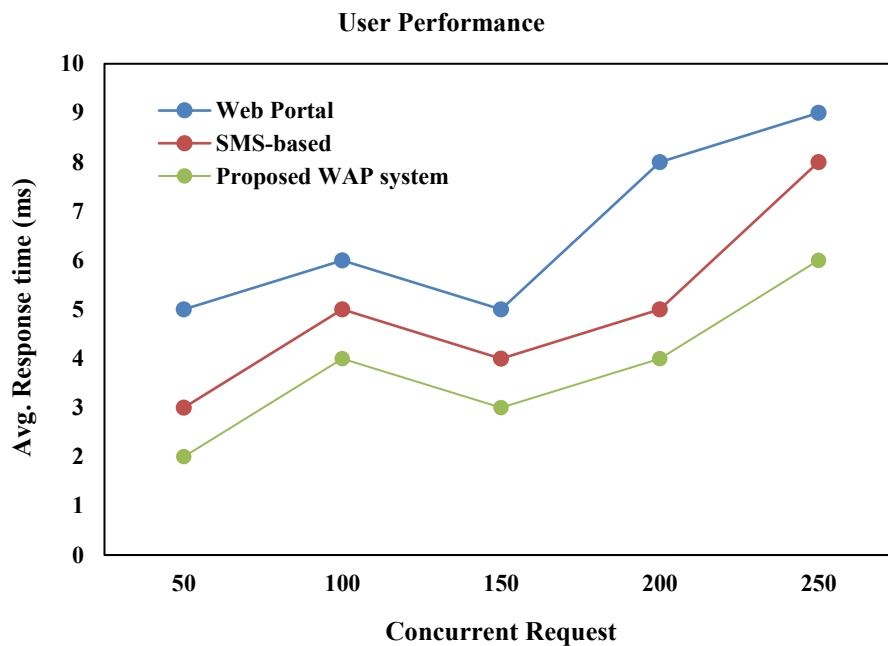


Figure 10: Comparison with baseline models

9. Conclusion and Future Work

Dissemination of examination results is an important academic service requiring a high level of reliability and fast and easy accessibility, even in areas of poor internet connectivity and infrastructure. This work offered a WAP-enabled examination result system solution via Wireless Markup Language, Java Servlets Technology, MySQL Database Management System, and the WAP gateway. It provided a solution to the problems through a simple and mobile-based solution. Performance analysis of the system proves that the system will be able to offer a mean loading time of 2.80 s, server response time of 1.10 s, and bandwidth requirement of 4.20 KB per request, and a user satisfaction of 4.30 out of 5 stars. It also proves the success rate of 96.4% and 98.9% for the system under the simultaneous presence of 500 users, even during the peak hours, with an error of 2.6% and a response time of 3.1s in rural and urban areas, respectively.

Future studies could focus on the improvement of security, the addition of multilingual support, and the extension of the system to offer other scholarly services such as alerts and notifications. The addition of usage analytics and the modification of the system architecture to conform to new mobile standards, while maintaining its lightweight nature, would further enhance its performance and relevance.

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