An Automated Approach for Enhancing Efficiency and Transparency in Student Selection Process for Public Sector General Universities

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The admission process in public sector universities in Pakistan faces challenges, including a large volume of applications, complex eligibility criteria, and the need for equitable seat allocation across various quotas. Many public sector universities still rely on manual or semi-automated admission systems, which result in inefficiencies related to time and transparency. Furthermore, these systems are vulnerable to errors in the seat allocation process due to human involvement at certain stages.

To address these issues, this paper proposes a fully automated admission system for public sector general universities. The system is developed and implemented at the University of Sindh, Jamshoro, one of Pakistan's oldest and largest public sector universities. Following the successful implementation of the system, a performance evaluation and comparative analysis are conducted to assess its effectiveness and confirm its feasibility for all public sector general universities in Pakistan.

Additionally, a usability study is carried out to ensure the system's flexibility and ease of use from the user's perspective. The results from the usability study and comparison indicate that the proposed system outperforms existing systems in terms of flexibility**,** reliability**,** efficiency, and transparency**.**

Keywords: Admission Systems, Seat Allocation, Public Sector General Universities.

Introduction:

The rapid advancement of technology has revolutionized various sectors, with automation playing a key role in transforming operations. This automation revolution has significantly impacted the education sector, particularly in admission and seat allocation systems. While automation at the school and college levels is relatively straightforward, it becomes more complex at the university level due to the variety of parameters and criteria involved. At the university level, the goal of admission automation is to streamline the seat allocation process, reduce human error, and optimize both time and cost.

In public sector universities of Pakistan, traditional methods of managing admissions rely on either manual or semi-automated systems. These methods are not only time-consuming but also prone to errors and lack transparency. Public sector general universities in Pakistan face several challenges in the admission and seat allocation process, such as a large volume of applications, complex eligibility criteria, a wide variety of choices for each degree program, a lack of resources, and issues with quota management (e.g., male and female quotas).

Given these challenges, this paper explores the need for an automated system in the admission process of public sector general universities in Pakistan. It proposes a generic, fully automated approach for admission and seat allocation. The system has been implemented and tested at one of Pakistan's largest public sector general universities, where it has been in operation for the past two years. A performance evaluation of the implemented system indicates that it outperforms the previously used Java-based semi-automated admission system.

Aim and Objectives:

In this research, the design of an automated admission framework specifically for public sector general universities in Pakistan is proposed, with a focus on improving the efficiency, transparency, and precision of the student selection process, in response to the limitations of the current manual or semi-manual filtering methods, which are susceptible to human error and lacks students' satisfaction. The main objectives of this research work are given below:

- To propose and design a framework for a fully automated admission system for public sector general universities of Pakistan.
- To propose a choice selection and seat allocation algorithm that ensures fair and efficient allocation of seats.
- To perform system implementation and testing of the proposed system and to evaluate the proposed system for its effectiveness, efficiency, and usability.

The remainder of this paper is structured as follows: Section 2 provides background information and a literature review on student selection and seat allocation systems. Section 3 details the proposed system, while Section 4 discusses the system's implementation and testing. In Section 5, the results are presented and analyzed, and Section 6 concludes the paper, offering future directions to expand and enhance this work.

Background:

The concept of student selection was first introduced by Gale and Shapley in 1962, who proposed two mechanisms: The Student Proposing Deferred Acceptance (SPDA) and the College Proposing Deferred Acceptance (CPDA). These mechanisms aimed to address issues related to college admissions, with the main goal being to ensure the best matches between students and colleges. Gale and Shapley demonstrated the different outcomes of these two mechanisms and their implications for the admission process.

In 1999, Balinski and Sönmez further explored these mechanisms in the context of college admissions, considering seats to be consumed by students while highlighting the importance of college priorities, such as exam scores. Abdulkadiroglu and Sönmez

introduced the quota system, utilizing the SPDA mechanism, and shifted the focus toward minority reserves, as shown by Kojima. These studies primarily focused on school choice mechanisms, which may not be directly applicable to Pakistan's public sector general universities.

Several mathematical models have also been developed for choice selection systems, including models for matching and marriage stability, doctors' distribution, and school and university choice selection. Some notable works include:

- **Marriage stability models**: Roth's model involves matching two groups (e.g., boys and girls) who wish to marry suitable partners from the opposite group, with each group having complete and transitive preferences over the other group.
- **Doctors' distribution models**: Kamada's model addressed the allocation of doctors to urban and rural areas in Japan, focusing on the challenge of assigning doctors to rural areas, where there is often a shortage. Similar work has been proposed to balance the distribution of doctors and ensure healthcare access in rural areas.
- **School choice**: Kojima's study demonstrated that affirmative action policies based on majority quotas might harm minority students. To address this, Hafalir et al. proposed alternative policies based on minority reserves and studied affirmative action policies considering both upper and lower type-specific bounds, with solutions proposed for hard or soft bounds. In another study, Dur et al. discussed a scheme for seat distribution where 50% of seats were assigned to neighborhood schools on priority, and the remaining 50% were based on choice.

The most relevant work in this context is presented in Rajesh et al. (2018), who modeled a choice selection system for a public sector general university in Pakistan. They proposed a semi-automated system for choice selection. In contrast, this paper proposes a fully automated admission system that leverages an optimized model for choice selection in Pakistan's public sector general universities.

Rajesh's work presents several limitations:

1. **Desktop-based system**: The system is limited to desktop usage.
2. **Separate databases**: When a selection involves different types of tests in one session (e.g., general test and law test), it requires creating two separate databases and running them separately. This results in a single student being selected twice, leaving one seat unoccupied and leading to seat wastage.
3. **Scalability**: The system is not scalable, and its algorithm is time-intensive.
4. **Manual tasks**: Many tasks, including data entry, were manual, leading to a high likelihood of human error.

In contrast, the fully automated system proposed in this paper aims to overcome these limitations and improve the efficiency and accuracy of the admission and seat allocation process.

Materials and Methods:

`To propose and develop a comprehensive automated system aimed at enhancing the efficiency and transparency of the student selection process, we focus on the case of the University of Sindh, Jamshoro, one of the oldest and largest public sector general universities in Pakistan. The university has jurisdiction over several divisions, including Hyderabad, Mirpur Khas, Larkana, and Sukkur. The University of Sindh consists of one main campus located at Jamshoro, along with four additional campuses in Thatta, Badin, Dadu, and Neshehroferoz.

Each year, the University's Directorate of Admissions announces admission opportunities for more than seventy academic programs. It receives more than twenty thousand applications, with candidates applying across various categories, such as General Merit, Female, Employee, Sports, Disabled, and Self-Finance.

The admission process at the University of Sindh involves several stages, as shown in Figure 1. Initially, applicants submit their admission forms, which are then verified for eligibility. Once eligibility is confirmed, preliminary merit lists are generated and published for objections. After addressing any objections, final merit lists are published in phases until all seats are allocated and confirmed.

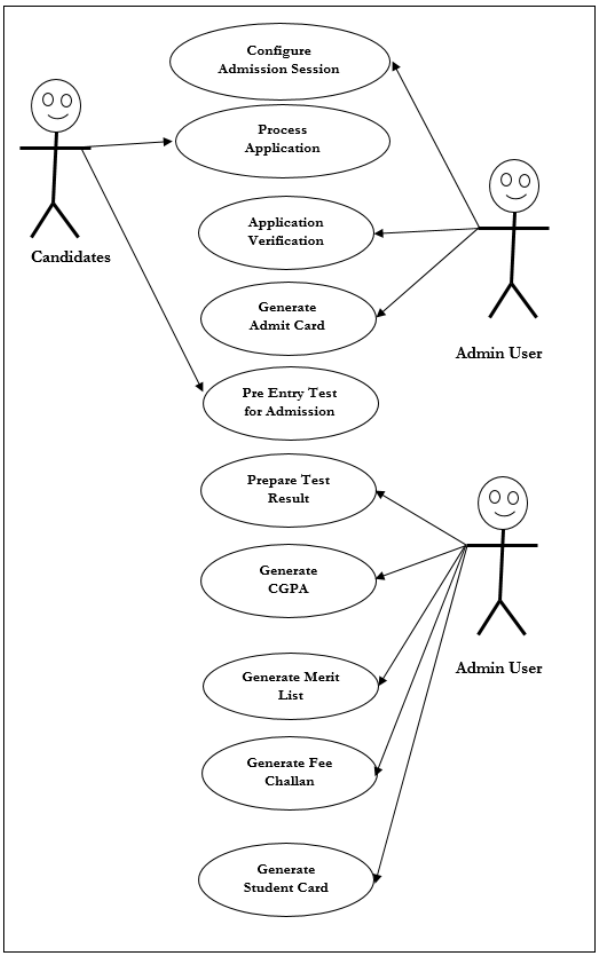


Figure 1. High-Level Admissions Management Use Case

The university distributes seats across various faculties and departments according to different quotas (e.g., male/female quota**,** sports quota**,** disabled quota, etc.). Additionally, district-wise seat allocations add complexity to the process, particularly when distinguishing between seats for areas within and outside the university's jurisdiction. The details of the various quotas are provided in Table 1, while the seat distribution across faculties and departments is illustrated in Tables 2 and 3.

Table 1. List of Quotas

S.No.	Quota	S.No.	Quota
1	Sports Quota	8	FATA Nomination Quota
2	Female Quota	9	Foreign Nationals
3	Disabled Person Quota	10	Northern Areas Quota
4	Employee Quota	11	Self Finance Quota
5	Army Personnel Quota	12	AJK Quota
6	Affiliated College Employees Quota	13	Pharmaceutical Industry Quota
7	Shuhda Waris	14	NCEAC Quota

Table 2. Category-Wise Seats Distribution

Distribution of Allocated Seats For Bachelor Degree Programmes - 2023																
DISCIPLINE	Quota / General Merit (Jurisdiction)	Quota/General Merit (Out of Jurisdiction)	Total Merit Seats	Female Quota	Sindh University Employees Quota	Affiliated College Employees Quota	Wards of Shuhda Quota	Disabled Person Quota	Sports Quota	Commerce Quota	Total Reserved Seats	Self Finance (Sindh Province)	Self Finance (Other Province)	Self Finance (Foreign Nationals)	Total Self-Finance Seats	GRAND TOTAL
Faculty of Arts																
Arabic (BS)	20	15	**35**	12	10	2	1	1	0	0	**26**	15	5	25	**45**	**106**
Art History (BAH)	20	15	**35**	12	10	2	1	1	0	0	**26**	15	5	25	**45**	**106**
Communication Design (BCD)	50	15	**65**	12	10	2	1	1	1	0	**27**	23	5	25	**53**	**145**
English Applied Linguistics (BS)	80	15	**95**	12	10	2	1	1	2	0	**28**	30	5	25	**60**	**183**
English Language and Litrature (BS)	160	15	**175**	12	10	2	1	1	2	0	**28**	30	5	25	**60**	**263**
English Language Teaching (BS)	80	15	**95**	12	10	2	1	1	2	0	**28**	30	5	25	**60**	**183**
Fine Arts (BFA)	50	15	**65**	12	10	2	1	1	1	0	**27**	23	5	25	**53**	**145**
Persian (BS)	20	15	**35**	12	10	2	1	1	0	0	**26**	15	5	25	**45**	**106**
Philosophy (BS)	20	15	**35**	12	10	2	1	1	0	0	**26**	15	5	25	**45**	**106**
Sindhi (BS)	50	15	**65**	12	10	2	1	1	1	0	**27**	23	5	25	**53**	**145**
Textile Design (BTD)	70	15	**85**	12	10	2	1	1	1	0	**27**	28	5	25	**58**	**170**
Urdu (BS)	50	15	**65**	12	10	2	1	1	1	0	**27**	23	5	25	**53**	**145**
TOTAL	**670**	**180**	**850**	**144**	**120**	**24**	**12**	**12**	**11**	**0**	**323**	**270**	**60**	**300**	**630**	**1803**
Faculty of Commerce and Business Administration																
Banking and Finance (BS)	50	15	**65**	12	10	2	1	1	1	0	**27**	23	5	25	**53**	**145**
Business Administration BBA (Hons)	164	42	**206**	12	10	2	1	1	2	10	**38**	61	5	25	**91**	**335**
Commerce (BS)	100	15	**115**	12	10	2	1	1	2	0	**28**	36	5	25	**66**	**209**
Forensic Accounting and Fraud Examination (BS)	50	15	**65**	12	10	2	1	1	1	0	**27**	23	5	25	**53**	**145**
TOTAL	**364**	**87**	**451**	**48**	**40**	**8**	**4**	**4**	**6**	**10**	**120**	**143**	**20**	**100**	**263**	**834**
Faculty of Engineering and Technology																
Electronic Engineering (BE)	25	10	**35**	0	2	0	1	0	0	0	**3**	10	1	1	**12**	**50**
Telecommunication Engineering (BE)	25	10	**35**	0	2	0	1	0	0	0	**3**	10	1	1	**12**	**50**
Data Science (BS)	41	21	**62**	12	10	2	1	1	1	0	**27**	22	5	25	**52**	**141**
Information Technology (BS)	71	21	**92**	12	10	2	1	1	1	0	**27**	30	5	25	**60**	**179**
Software Engineering (BS)	71	21	**92**	12	10	2	1	1	1	0	**27**	30	5	25	**60**	**179**
TOTAL	**233**	**83**	**316**	**36**	**34**	**6**	**5**	**3**	**3**	**0**	**87**	**102**	**17**	**77**	**196**	**599**

Table 3. District-wise Seat Distribution

ALLOCATION OF SEATS (DISTRICT QUOTA ORIENTED BACHELOR DEGREE PROGRAMMES)

S.No.	Name of District	BE (EE)	BE (TE)	PHARM-D	BS (DS)	BS (IT)	BS (SWE)	BS (CS)	LLB (HONS)	BBA (HONS)
1	Hyderabad	3	3	4	4	10	10	10	8	24
2	Tando Allahyar	2	2	2	2	4	4	4	4	10
3	Tando Muhammad Khan	2	2	3	3	6	6	6	6	12
4	Matiari	2	2	3	3	6	6	6	6	12
5	Badin	2	2	2	2	4	4	4	4	8
6	Thatta	2	2	2	2	4	4	4	4	8
7	Sujawal	1	1	1	1	2	2	2	2	4
8	Tharparkar	1	1	3	3	6	6	6	6	12
9	Mirpurkhas	2	2	5	5	6	6	6	10	16
10	Umerkot	1	1	2	2	4	4	4	4	8
11	Sanghar	1	1	2	2	4	4	4	4	10
12	Dadu	2	2	5	5	6	6	6	10	16
13	Jamshoro	2	2	4	4	6	6	6	8	16
14	Shaheed Benazirabad/Nawabshah	2	2	3	3	3	3	3	6	8
15	Sukkur	1	1	4	4	4	4	4	8	8
16	Ghotki	1	1	2	2	2	2	2	4	4
17	Shikarpur	1	1	2	2	2	2	2	4	4
18	Jacobabad	1	1	2	2	2	2	2	4	4
19	Larkana	1	1	2	2	2	2	2	4	4
20	Kambar / Shahdadkot	1	1	2	2	2	2	2	4	4
21	Kashmore / Kandhkot	1	1	2	2	2	2	2	4	4
22	Khairpur	1	1	2	2	2	2	2	4	4
23	Karachi Division	1	1	1	1	1	1	1	2	2
24	Naushahroferoz	1	1	2	2	2	2	2	4	4
	TOTAL	**35**	**35**	**62**	**62**	**92**	**92**	**92**	**124**	**206**

The flow diagram of the overall methodology of the proposed system is shown in Figure 2. The overall methodology of the proposed system consists of 13 steps, starting from configuring the essential parameters or criteria of admission by the admission office to generating enrolled students' roll numbers and ID cards.

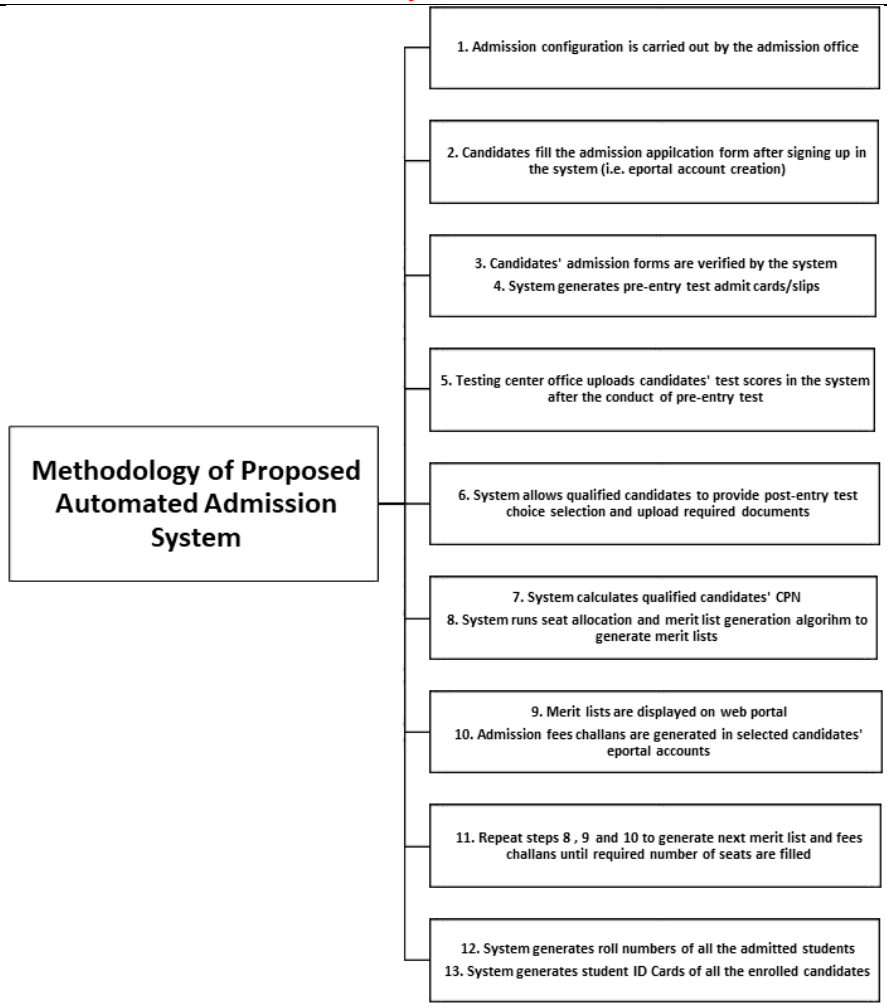


Figure 2. Flow diagram of methodology

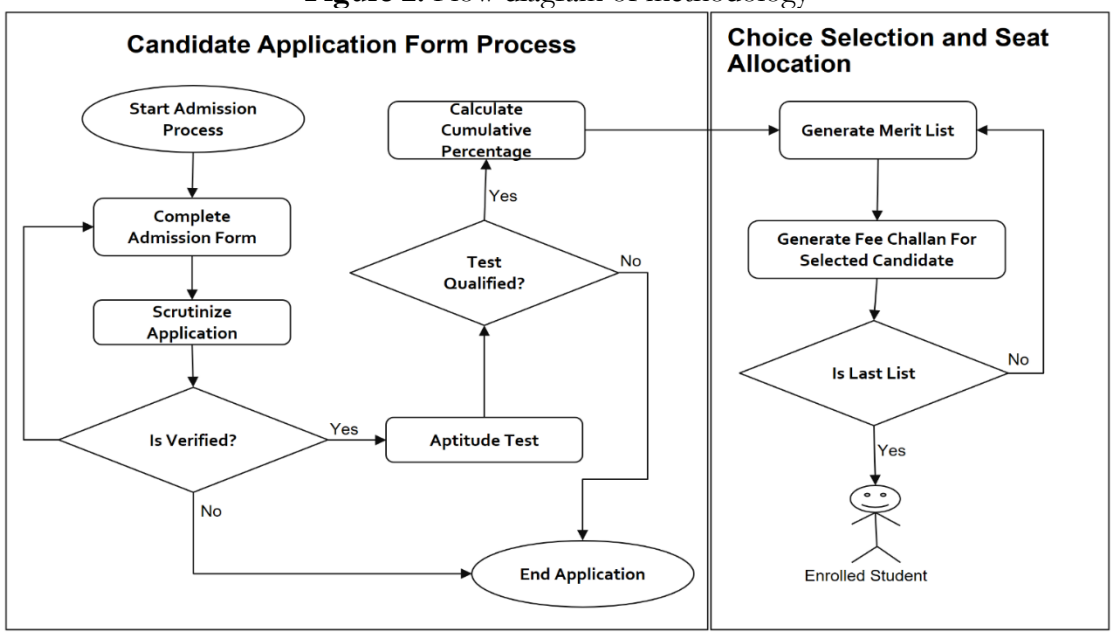


Figure 3. High-level architecture of the proposed framework for the automated admission system

The overall high-level architecture of the proposed framework is shown in Figure 3, while the data flow diagram of the first part of the proposed system (i.e., candidate

application form process) is shown in Figure 4. The key aspects of the proposed system are explained below:

- Application Submission: Thousands of applications are received, each containing the applicant's preferred disciplines and required documentation.
- Eligibility Verification: Each application is reviewed to ensure that the applicant meets the eligibility criteria for their chosen disciplines.
- Aptitude Test Administration: Applicants are required to take an aptitude test, and their scores are recorded in the system.
- Score Calculation: A cumulative score is calculated based on the applicants' aptitude test results and academic records.
- Merit List Generation: Preliminary merit lists are generated (seats allocated) based on the university's set criteria, applicants' cumulative score (i.e., **CPN**), and preferences.
- Resolving Objections: After publishing the preliminary merit lists on the web, any objections raised by applicants are recorded and addressed before finalizing the merit lists.

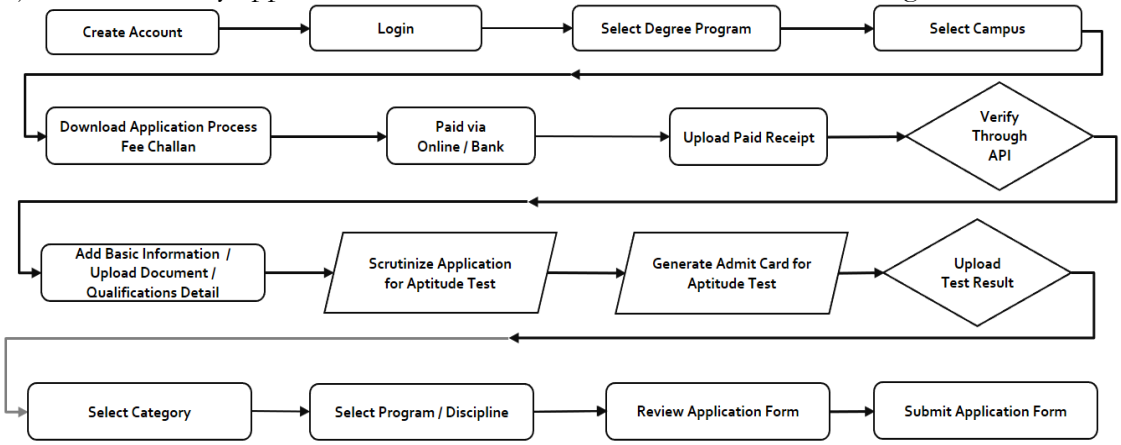


Figure 4. Data flow diagram of the proposed automated admission system

Seat Allocation in the Proposed System:

The seat allocation problem at the University of Sindh involves several key considerations and complex scenarios. Below are some of the key scenarios that illustrate the intricacies of the seat allocation process:

Scenario 1:

A male applicant from one of the four main divisions of Sindh applies for morning shift admission under both general merit and self-finance categories. Depending on his cumulative score, he might be offered a program under either category. If he secures his first-choice program, he will not be considered in future merit lists. However, if offered a lower priority program, both categories (general merit and self-finance) are checked. If he accepts the general merit seat, he will not be considered for self-finance in future lists, and vice versa.

Scenario 2:

A male applicant applies for both morning and evening shifts, including self-finance. He competes for seats in both shifts and under both the general merit and self-finance categories. If he is offered a program in either shift, his choice will affect his eligibility in future merit lists.

Scenario 3:

A female applicant from one of the four main divisions applies for both morning and evening shifts, but not for self-finance. She competes for both general merit and female quota seats. If she is offered a program in either category and accepts it, her eligibility in future merit lists will be affected similarly to the previous scenarios.

Scenario 4:

A male applicant from outside the University's jurisdiction applies for admission. His seat allocation and eligibility are determined by the out-of-jurisdiction seat distribution, making the competition for available seats even more intense.

Scenario 5:

An applicant applies for admission under multiple quotas (e.g., employees quota**,** sports quota**,** disabled quota). The system must ensure that the applicant competes fairly within each quota, and the allocation of seats must reflect the applicant's cumulative score and preferences.

The complexity of the seat allocation process arises from the need to consider multiple quotas, prioritize applicants based on cumulative scores, and manage preferences for different shifts and programs. To optimize seat allocation and maximize utilization across all available disciplines, we implemented a strategy aimed at addressing the common issue of demand imbalance**.**

In many admission systems, candidates submit their program choices before taking the entrance test. This results in highly competitive or popular disciplines quickly attracting a large volume of applicants, many of whom may ultimately be ineligible based on their test performance. As a result, disciplines with lower initial demand often end up with unfilled seats, even though there may be qualified candidates who would benefit from admission to these areas. This imbalance leads to inefficiencies in seat utilization and often disappoints candidates who could have found suitable placements.

To address this issue, the proposed new process flow allows candidates to select their desired disciplines only after receiving their test scores. This change enables candidates to understand their academic standings and eligibility for specific disciplines before making a choice. They can make more informed decisions, targeting disciplines where their test scores meet admission thresholds. For example, a candidate whose score is below the cut-off for a high-demand discipline might realize they have a better chance of admission in a related field with available seats.

This approach benefits both candidates and institutions:

- **Candidates** gain insight into the disciplines realistically attainable for them, minimizing rejections and unmet expectations.
- **Institutions** benefit from a more efficient allocation process, with higher seat occupancy across all departments, reducing the number of vacant seats in less competitive disciplines.

This strategy aligns with the broader goal of optimizing the admission process, ensuring fair access to education, and better meeting the demand and capacity of each discipline.

Optimizing the System for Reduced Processing Time:

To enhance the efficiency of the seat allocation process, a new approach was proposed and developed to reduce the query load on the database by utilizing batch fetching and in-memory storage. This approach focuses on minimizing the number of database queries needed for each candidate by relying on efficient in-memory data management to handle seat allocation. Below are the key components of the proposed approach for time optimization:

Key Components of the Optimized Approach:

1. **Batch Fetching and In-Memory Storage**:
   - The entire set of candidates**,** choices, and categories is retrieved in just three main queries**.**
   - This data is stored in memory, allowing the system to avoid repeated database queries for each candidate, which significantly improves efficiency.
2. **Use of Hash Tables for Quick Access**:

- Once the data is stored in memory, hash tables are created to map each candidate to their respective choices and categories.
- These hash tables (or associative arrays in PHP) provide O(1) time complexity for data access, enabling instant retrieval of each candidate's choices and category availability, thus reducing the time spent on retrieving and checking data.
- A code snippet for creating hash tables is given below.

```
class Admission_Model {
…
…
   function createHashTable ($list_of_data, $key) {
      $hash_table = array ();
      foreach ($list_of_data as $data) {
         $id = $data[$key];
          if (! isset($application_choices_array[$id])) {
             $hash_table[$id] = array ();
          }
         array push($hash_table[$id],$data);
      }
   }
…
…
}
```

Apart from the above code snippet, more detailed code is uploaded on GitHub for those who are interested in code-level technical details. The link to the GitHub account is: https://github.com/ka5hifshaikh/automate_admission.

3. **Simplified Seat Allocation Algorithm**:

- Instead of querying the database for each check, the optimized approach retrieves all necessary data in a few main queries and then uses hash tables to access and update data as needed, minimizing database interactions.
- The proposed algorithm for seat allocation is shown in Figure 5; however, for the sake of simplicity and understanding, the flow diagram of the seat allocation algorithm is described below step-by-step, which is also illustrated in Figure 6.

Seat Allocation Process:

For non-technical readers, here's the step-by-step breakdown of the seat allocation mechanism:

Step 1: Execute Main Queries Once:

- Retrieve all candidates, sorted by CPN (Cumulative Points Number).
- Retrieve all choices related to each candidate.
- Retrieve all categories with their corresponding seat allocations.

Step 2: Create Hash Tables for Efficient Lookup:

- Create a hash table that maps each candidate to their respective choices.
- Create another hash table to store seat allocation details for each category, allowing O (1) lookup when checking seat availability.

Step 3: Process Seat Allocation with Minimal Database Interaction:

- For each candidate in the list, retrieve their choices from the hash table.
- For each choice, check the category's seat availability in the hash table.
- If a seat is available, allocate it to the candidate and update the hash table accordingly.
- Move to the next candidate and repeat the process.

Summary:

This optimized approach reduces the load on the database and minimizes database queries by leveraging in-memory data management and hash tables. By processing seat allocation with fewer database interactions, the system becomes significantly more efficient, ensuring faster processing and better scalability.

```
BEGIN
  // Step 1: Execute main queries
  candidatesList ← fetchAllCandidatesOrderByCPN()
  choicesList ← fetchAllChoices()
  categoriesList ← fetchAllCategories()

  // Step 2: Create hash tables
  candidateToChoicesHash ← createHashTable(choicesList, "candidate_id")
  programToCategoryHash ← createHashTable(categoriesList, "program_id")

  // Step 3: Allocate seats
  FOR each candidate IN candidatesList DO
    candidateChoices ← candidateToChoicesHash[candidate.id]

    FOR each choice IN candidateChoices DO
      program ← choice.program_id
      category ← choice.category_id

      IF programToCategoryHash[program][category].seatsAvailable > 0 THEN
        allocateSeat(candidate, program, category)
        programToCategoryHash[program][category].seatsAvailable -= 1
        BREAK // Move to the next candidate once seat is allocated
      END IF
    END FOR
  END FOR
END
```

Figure 5. The proposed algorithm for seat allocation

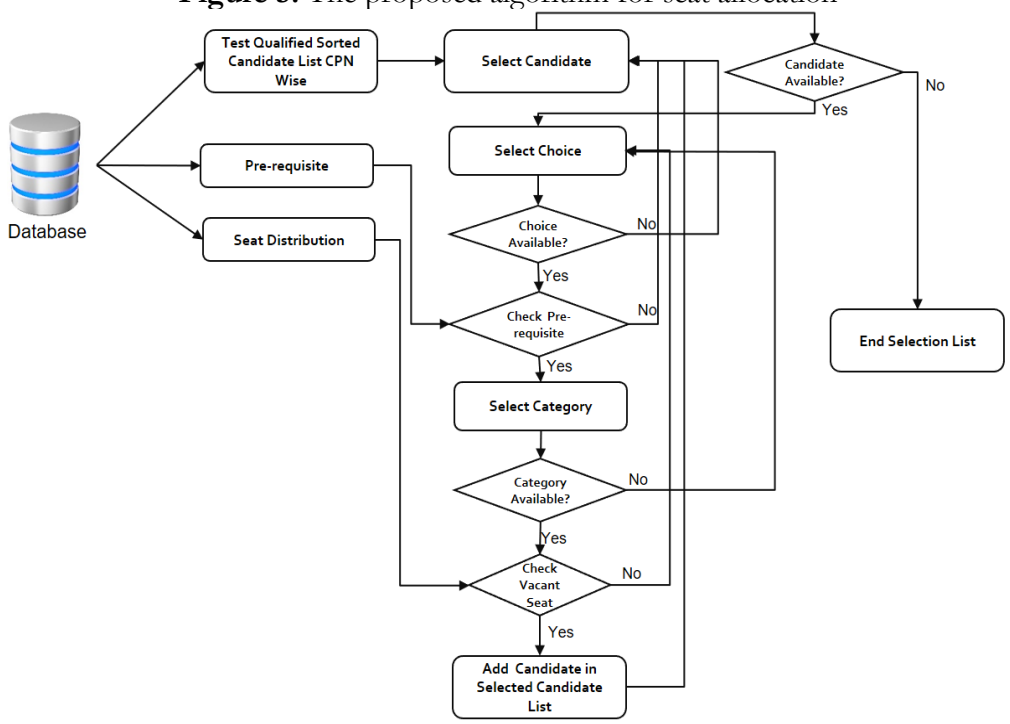


Figure 6. The flow diagram of the proposed algorithm for seat allocation

System Implementation:

The proposed system has been implemented as a fully automated admission and seat allocation system at the University of Sindh. The key tools and technologies used to develop and deploy the system include: XAMPP, MySQL Database, HTML, CSS/Bootstrap, JavaScript, PHP, jQuery, SQLYog, PHPStorm, and FileZilla.

To ensure the system's security, it is hosted as a secure site using the HTTPS protocol. The system is also protected against Distributed Denial of Service (DDoS) attacks through the use of Cloudflare. Additionally, the system has been tested and secured against SQL injection and other common cross-site scripting (XSS) attacks.

Figure 7 shows the login page for the University of Sindh's Admission Portal. Candidates can log in using their CNIC (Computerized National Identity Card) number and password, or they can create a new account (Sign-up) as first-time users by clicking the "New Registration" button. The information required for new registration (Sign-up) is displayed in Figure 8, while the candidate's dashboard on the admission portal is shown in Figure 9.

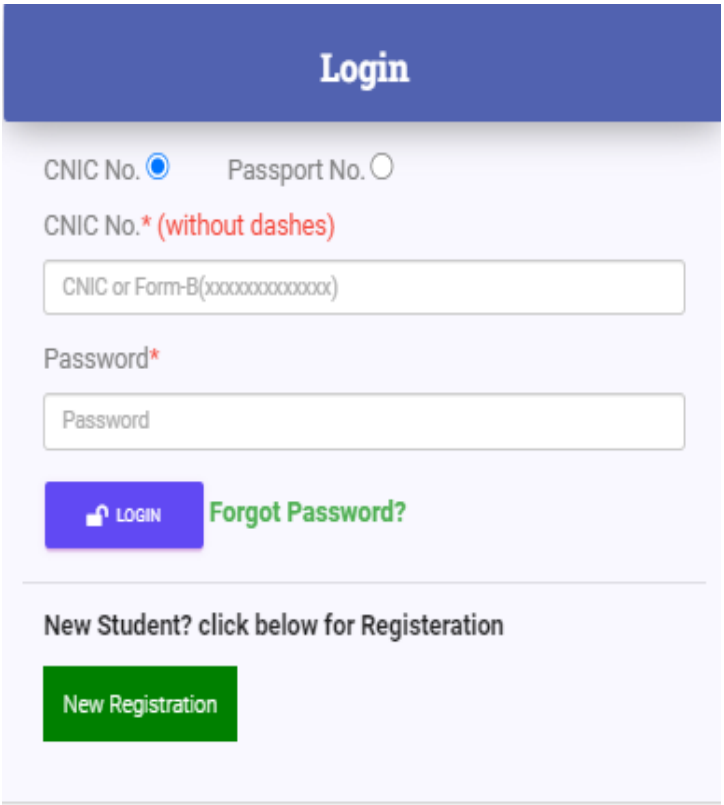


Figure 7. Login Page

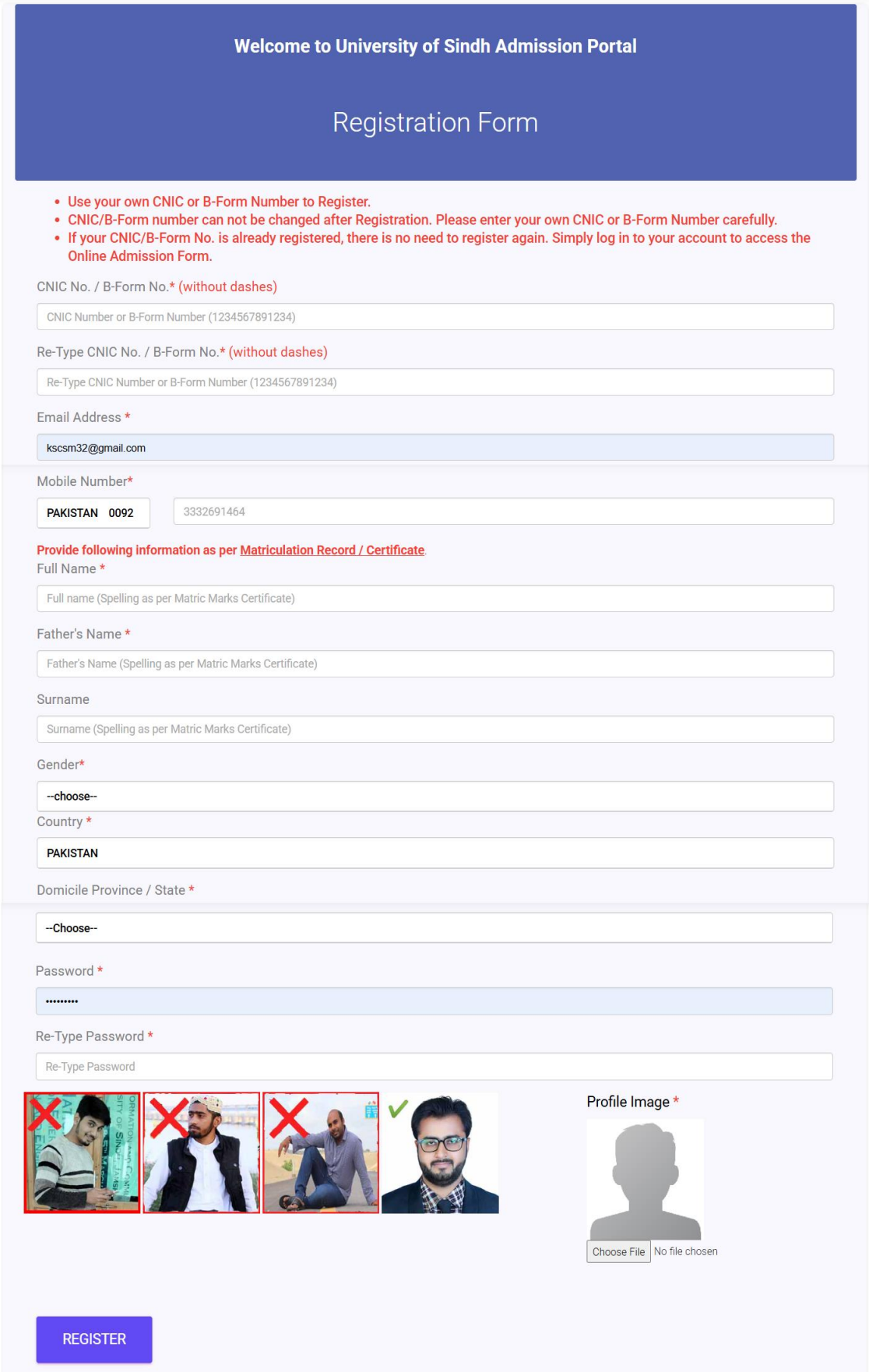


Figure 8. Sign-up (New Registration) Page

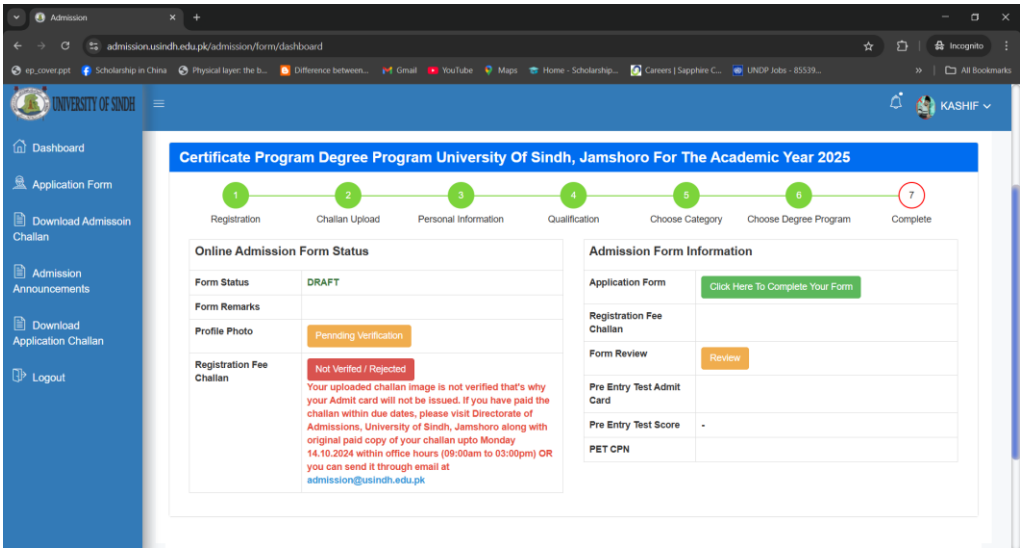
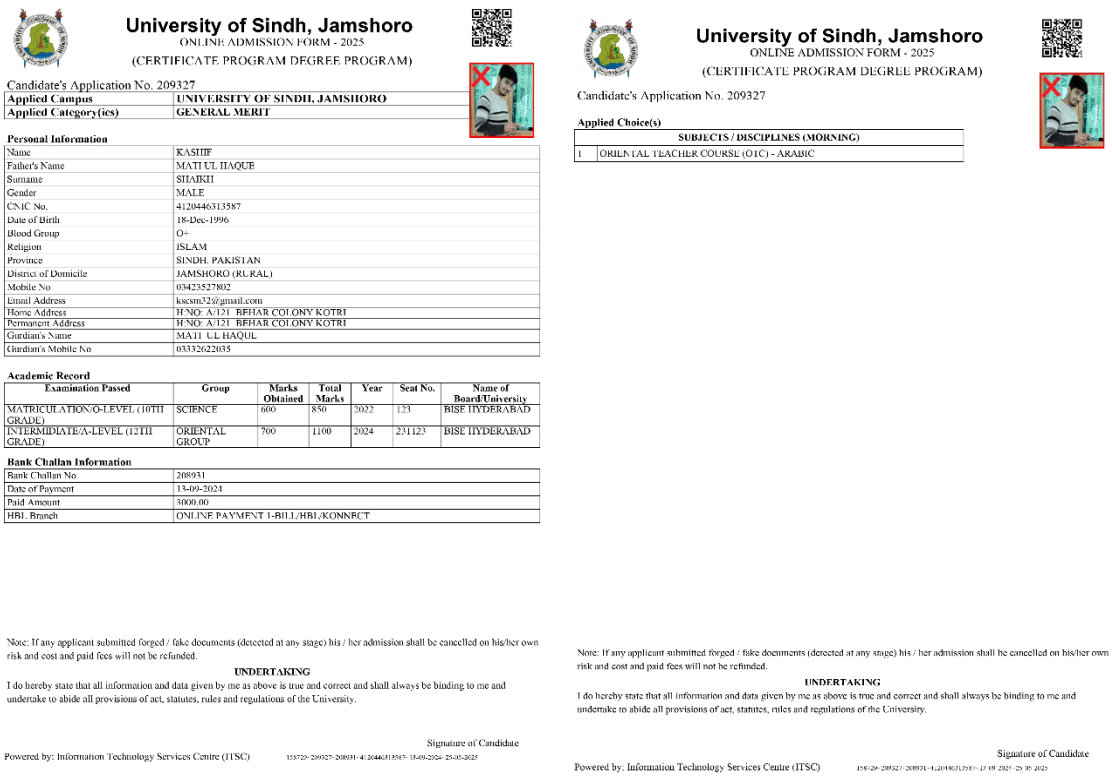


Figure 9. Candidate's dashboard of the developed admission portal

After candidates complete and submit their application forms on the admission portal, they can download a PDF of their filled form (as shown in Figure 10) for their records. This feature ensures that applicants can keep a copy of their submitted information for future reference.

Once the admission forms are submitted and the pre-entry test is conducted, the automated seat allocation system (as discussed in the previous section of this paper) generates the merit lists, which are published on the admission portal (as shown in Figure 11). The portal provides a transparent system for students to view these merit lists. The lists are organized by category and district, allowing applicants to check their status and compare it with others in their respective groups. This system ensures both transparency and fairness in the admission process.



University of Sindh, Jamshoro
ONLINE ADMISSION FORM - 2025
(CERTIFICATE PROGRAM DEGREE PROGRAM)

Candidate's Application No. 209327

Applied Campus	**UNIVERSITY OF SINDH, JAMSHORO**
Applied Category(ies)	**GENERAL MERIT**

Personal Information

Name	KASHIF
Father's Name	MATI UL HAQUE
Surname	SHAIKH
Gender	MALE
CNIC No.	4120446313587
Date of Birth	18-Dec-1996
Blood Group	O+
Religion	ISLAM
Province	SINDH, PAKISTAN
District of Domicile	JAMSHORO (RURAL)
Mobile No	03423527802
Email Address	ksesm32@gmail.com
Home Address	H NO: A/121 BEHAR COLONY KOTRI
Permanent Address	H NO: A/121 BEHAR COLONY KOTRI
Gurdian's Name	MATI UL HAQUL
Gurdian's Mobile No	03332622035

Academic Record

Examination Passed	Group	Marks Obtained	Total Marks	Year	Seat No.	Name of Board/University
MATRICULATION/O-LEVEL (10TH GRADE)	SCIENCE	600	850	2022	123	BISE HYDERABAD
INTERMIDIATE/A-LEVEL (12TH GRADE)	ORIENTAL GROUP	700	1100	2024	231123	BISE HYDERABAD

Bank Challan Information

Bank Challan No.	208931
Date of Payment	13-09-2024
Paid Amount	3000.00
HBL Branch	ONLINE PAYMENT 1-BILL/HBL/KONNECT

Note: If any applicant submitted forged / fake documents (detected at any stage) his / her admission shall be cancelled on his/her own risk and cost and paid fees will not be refunded.

UNDERTAKING

I do hereby state that all information and data given by me as above is true and correct and shall always be binding to me and undertake to abide all provisions of act, statutes, rules and regulations of the University.

Signature of Candidate

Powered by: Information Technology Services Centre (ITSC)

University of Sindh, Jamshoro
ONLINE ADMISSION FORM - 2025
(CERTIFICATE PROGRAM DEGREE PROGRAM)

Candidate's Application No. 209327

Applied Choice(s)

	SUBJECTS / DISCIPLINES (MORNING)
1	ORIENTAL TEACHER COURSE (OTC) - ARABIC

Note: If any applicant submitted forged / fake documents (detected at any stage) his / her admission shall be cancelled on his/her own risk and cost and paid fees will not be refunded.

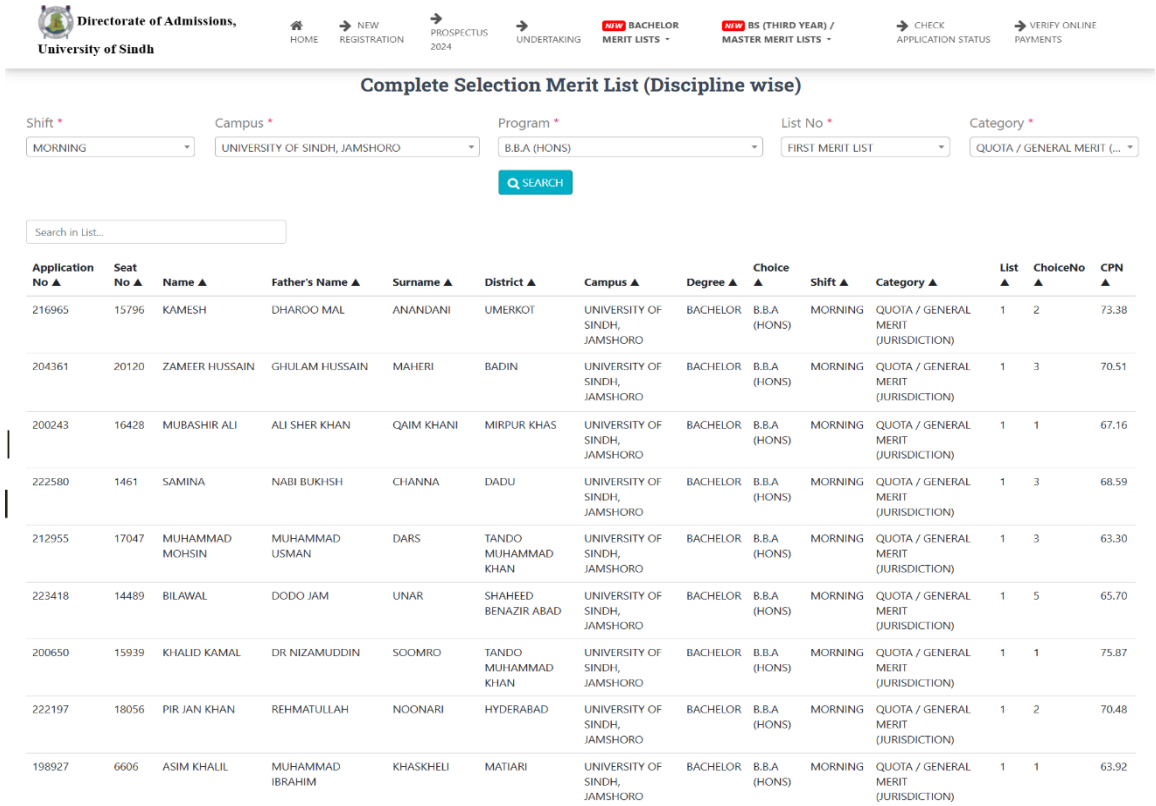
UNDERTAKING

I do hereby state that all information and data given by me as above is true and correct and shall always be binding to me and undertake to abide all provisions of act, statutes, rules and regulations of the University.

Signature of Candidate

Powered by: Information Technology Services Centre (ITSC)

Figure 10. PDF of the candidate's filled and submitted admission form



Application No	Seat No	Name	Father's Name	Surname	District	Campus	Degree	Choice	Shift	Category	List	ChoiceNo	CPN
216965	15796	KAMESH	DHAROO MAL	ANANDANI	UMERKOT	UNIVERSITY OF SINDH, JAMSHORO	BACHELOR	B.B.A (HONS)	MORNING	QUOTA / GENERAL MERIT (JURISDICTION)	1	2	73.38
204361	20120	ZAMEER HUSSAIN	GHULAM HUSSAIN	MAHERI	BADIN	UNIVERSITY OF SINDH, JAMSHORO	BACHELOR	B.B.A (HONS)	MORNING	QUOTA / GENERAL MERIT (JURISDICTION)	1	3	70.51
200243	16428	MUBASHIR ALI	ALI SHER KHAN	QAIM KHANI	MIRPUR KHAS	UNIVERSITY OF SINDH, JAMSHORO	BACHELOR	B.B.A (HONS)	MORNING	QUOTA / GENERAL MERIT (JURISDICTION)	1	1	67.16
222580	1461	SAMINA	NABI BUKHSH	CHANNA	DADU	UNIVERSITY OF SINDH, JAMSHORO	BACHELOR	B.B.A (HONS)	MORNING	QUOTA / GENERAL MERIT (JURISDICTION)	1	3	68.59
212955	17047	MUHAMMAD MOHSIN	MUHAMMAD USMAN	DARS	TANDO MUHAMMAD KHAN	UNIVERSITY OF SINDH, JAMSHORO	BACHELOR	B.B.A (HONS)	MORNING	QUOTA / GENERAL MERIT (JURISDICTION)	1	3	63.30
223418	14489	BILAWAL	DODO JAM	UNAR	SHAHEED BENAZIR ABAD	UNIVERSITY OF SINDH, JAMSHORO	BACHELOR	B.B.A (HONS)	MORNING	QUOTA / GENERAL MERIT (JURISDICTION)	1	5	65.70
200650	15939	KHALID KAMAL	DR NIZAMUDDIN	SOOMRO	TANDO MUHAMMAD KHAN	UNIVERSITY OF SINDH, JAMSHORO	BACHELOR	B.B.A (HONS)	MORNING	QUOTA / GENERAL MERIT (JURISDICTION)	1	1	75.87
222197	18056	PIR JAN KHAN	REHMATULLAH	NOONARI	HYDERABAD	UNIVERSITY OF SINDH, JAMSHORO	BACHELOR	B.B.A (HONS)	MORNING	QUOTA / GENERAL MERIT (JURISDICTION)	1	2	70.48
198927	6606	ASIM KHALIL	MUHAMMAD IBRAHIM	KHASKHELI	MATIARI	UNIVERSITY OF SINDH, JAMSHORO	BACHELOR	B.B.A (HONS)	MORNING	QUOTA / GENERAL MERIT (JURISDICTION)	1	1	63.92

Figure 11. Admission portal displaying merit lists (seat allocation)

The merit lists, as shown in Figure 11, are automatically generated by simply setting a few parameters (e.g., program, shift, batch, test type, campus, merit list number, etc.) on the "Generate Merit List" page of the automated admission system (as shown in Figure 12). Once all the required parameters are selected, the merit list based on the chosen criteria is processed and generated with just a click of the "Generate Merit List" button by the admin. This method of generating merit lists is both simple and efficient.

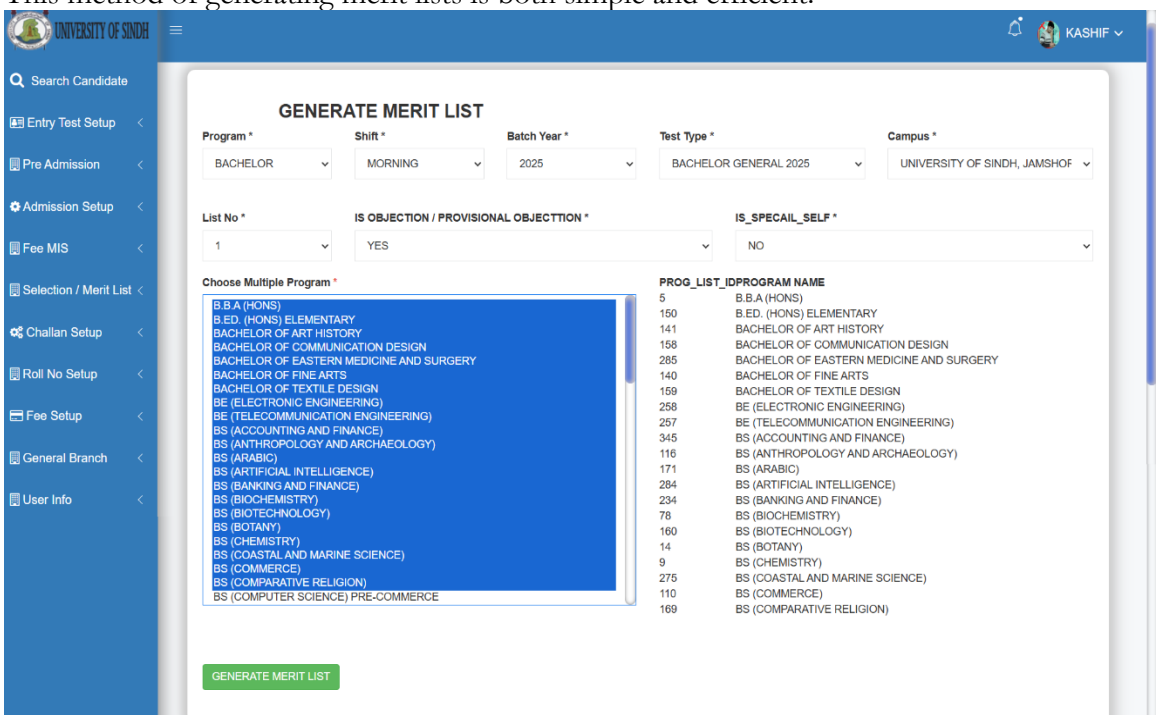


Figure 12. Generate Merit List Page (Admin Panel)

After the seat allocation process, the admission fee challans for the selected candidates are generated through the admin panel, as shown in Figure 13. Once generated, these challans appear in the candidate's online admission portal account. The candidate can then view, download, and pay the challan either at a bank or online.

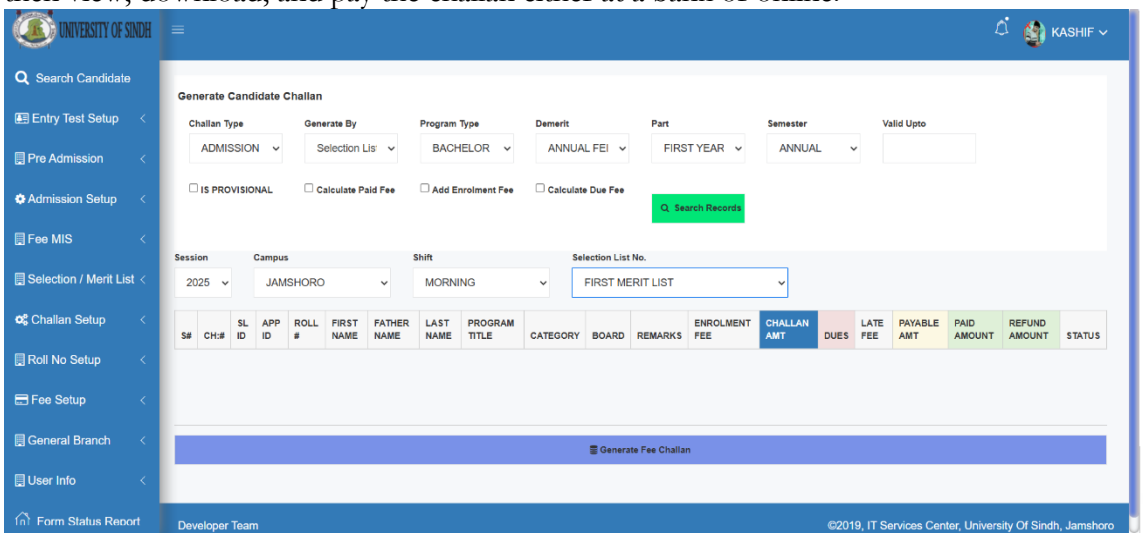


Figure 13. Generating selected candidates' admission fees challans

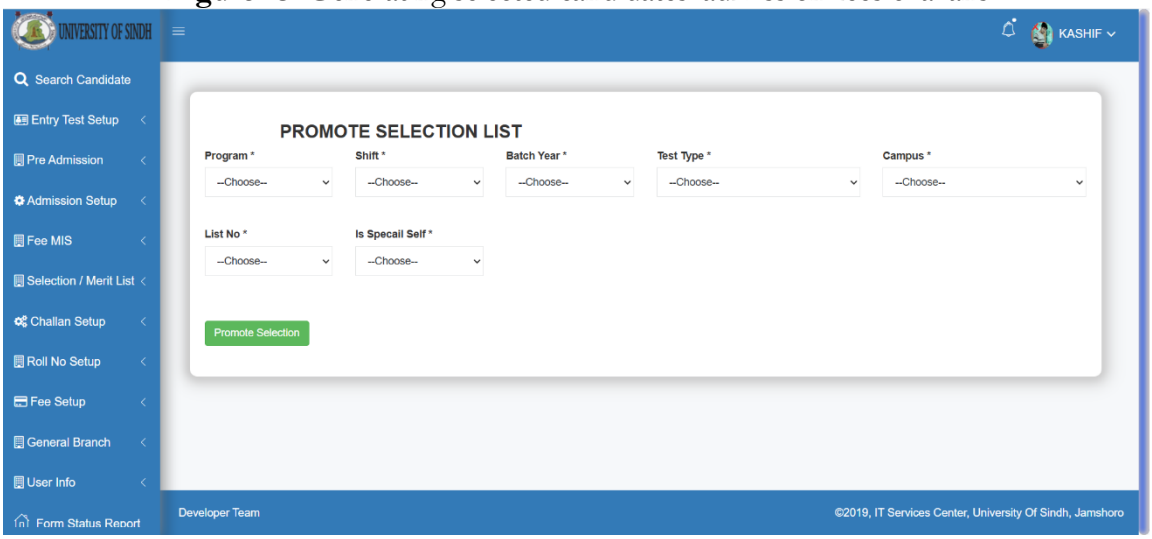


Figure 14. Promoting candidates to the new upcoming merit list

To ensure the correct updating of admission records for all qualifying candidates, the "Promote Selection List" page in the admin panel, shown in Figure 14, allows administrators to move students from their previous seat allocation to their newly assigned program or course.

It is worth noting that, in addition to the features shown in Figures 7 to 14, the fully automated admission and seat allocation system includes many other interesting features. However, due to space limitations, these additional features are not discussed in this paper.

Results:

To evaluate the effectiveness of the proposed automated admission and seat allocation system, a performance and comparative analysis was conducted between the previous system [1] and the proposed system, as summarized in Table 4. The results shown in Table 4 demonstrate that the processing time of the proposed system is significantly shorter compared to the previous system used at the University of Sindh. The previous system [1] required an average of 0.2 seconds per candidate, resulting in a total processing time of 4,000 seconds (approximately 1 hour) for 20,000 candidates. In contrast, the

proposed system reduces the processing time to just 0.02 seconds per candidate, cutting the total processing time down to 400 seconds (less than 7 minutes), representing an improvement of 90%.

Table 4 Comparison analysis of the previous system and the proposed system

Metric	Previous System [18]	The Proposed System
Automation	Semi-automated (only student selection part is automated)	Fully automated admission system
Processing Time per Candidate	0.2 seconds	0.02 seconds
Database Queries	Multiple queries (per candidate query)	Only 3 required for initial fetch operation
Average Time Complexity	O(n*m)	O(n)
Scalability	Limited	High
Accuracy/Reliability	85%	99%

In terms of query processing, the previous system [1] executed approximately 60,000 queries for seat allocation to 20,000 candidates. In contrast, the proposed system reduced the query execution to just three queries for the initial fetch operation, covering all candidates, choices, and categories, achieving a remarkable 99.96% reduction in the number of queries.

The previous system [1], with a complexity of O(n * m), slowed down as the number of candidates (n) and choices (m) increased. In comparison, the proposed system improved efficiency by reducing the time complexity to O(n) through the use of hash tables and pre-fetching techniques, ensuring that the time complexity remained consistent regardless of the number of candidates or choices.

When tested for scalability, the previous system [1], due to its O(n * m) complexity, started to hang or halt as the number of candidates and choices increased. However, the proposed system continued to perform well under the same conditions.

Finally, when it comes to seat allocation, the previous system [1] achieved a reliability and accuracy rate of 85%, while the proposed system improved the allocation accuracy to 99.99%, representing a 15% increase in accuracy for overall seat allocation.

To ensure that the system is both flexible and user-friendly, a usability study was conducted, involving 9,350 real candidates who used the system to apply for admission at the University of Sindh, Jamshoro, Pakistan.

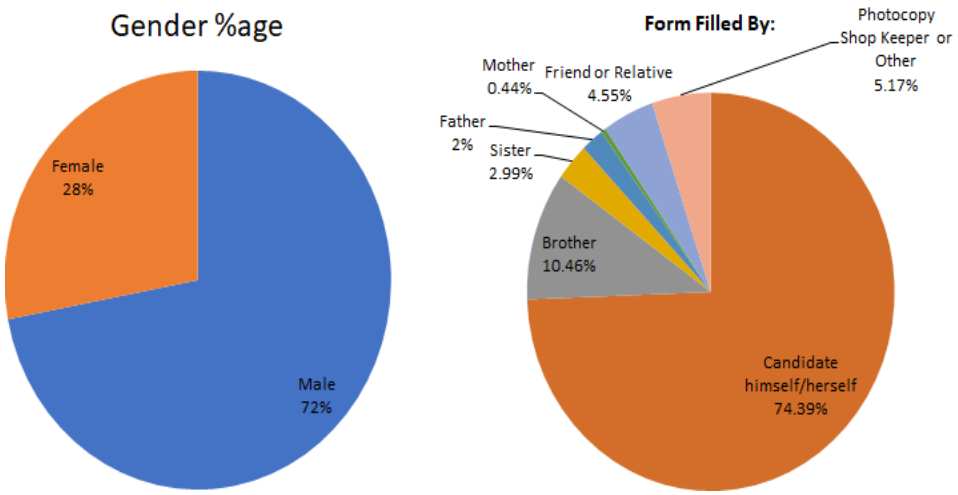


Figure 15. Usability Evaluation Participants' Information

Upon completing the usability evaluation, the post-test questionnaire data from all candidates is imported into Microsoft Excel for analysis, where various charts and graphs are

generated from the data. Figure 15 displays the gender information of the usability study participants along with their responses to the first question of the post-test questionnaire. Meanwhile, Figure 15 presents the overall summarized results of the usability study.

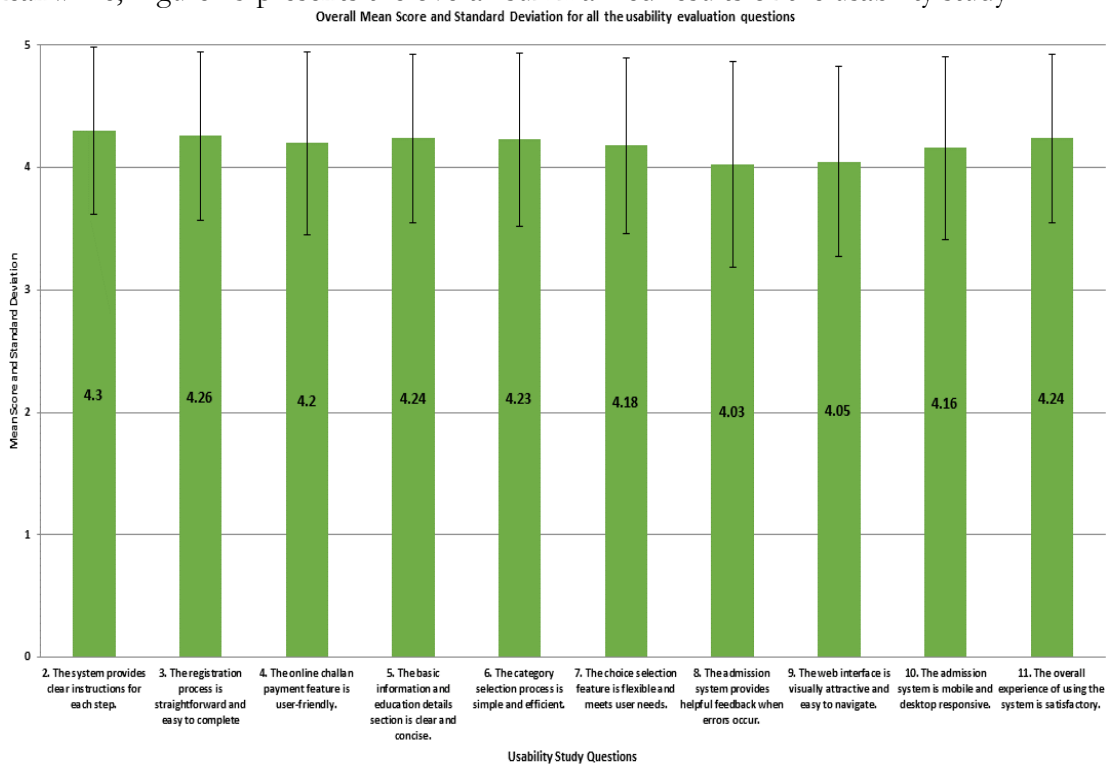


Figure 16. The mean scores and standard deviations for the 10 usability questions asked in the post-test questionnaire

The graph/chart in Figure 16 displays the mean scores and standard deviations for the 10 usability questions. According to existing literature on usability testing and evaluation [2][3], a system or product is considered flexible, user-friendly, and usable if its final mean score is 4.0 or above on a 5-point Likert scale. Since the mean scores for all 10 usability questions exceed 4.0, the proposed automated admission system is deemed a flexible, easy-to-use, and highly usable solution for admission and seat allocation at public sector general universities in Pakistan.

Discussion:

In this section, a comparative analysis of the proposed system with several existing and relevant systems is discussed. First of all, note that many automated admission systems worldwide have been proposed, but they are not designed for Pakistan's quota-based seat distribution. For example, the work presented in [4] exploits neural networks for university admissions in Kenya, but in their work [4], the authors did not consider the quota management, while the proposed system can handle various types of quota systems. In another work [5], a university recommender system for school and college students is proposed, but it lacked a dynamic seat allocation feature, while the proposed system is capable of it. In [6] and [7], the authors have proposed matching algorithms for school and college choices, but they also did not consider the complexity of quota distributions.

In addition to the aforementioned systems, the proposed system also outperforms compared to the previously used semi-automated admission system [1] at the University of Sindh (refer to Table 4 in the previous section). In short, the proposed fully automated admission and choice selection system uniquely integrates quota management (ie, table 1), district-wise allocations (i.e., table 3), and a post-test choice selection mechanism, making it more feasible and adaptable to Pakistani public sector general universities' admission

challenges. Moreover, all the aforementioned existing systems [6][7][1][4][5] did not conduct a usability study, and hence, these were not tested or evaluated for user experience or user satisfaction. In contrast to them, the proposed system was tested and evaluated for user satisfaction. The results of the usability study were very promising and suggested that the proposed system is an acceptable and feasible solution for the admission and seat allocation for public sector general universities of Pakistan.

Table 5 presents a summary of the comparative analysis of the previous (i.e., before) and the proposed (i.e., new) system and highlights the key differences between both of them. This table (i.e., table 5) indicates that the new automated admission system improves accuracy, fairness, transparency, and efficiency by replacing manual and semi-manual tasks with a new fully automated approach that benefits both students and administration.

Table 5. Comparison: Traditional (i.e., before) vs. Proposed (i.e., new automated) Approach

Aspect	Traditional or Previous System	Proposed Automated System
Form Filling & Data Entry	Students fill out paper forms by hand. Staff then enters each one manually into the computer a slow and tiring process that often leads to mistakes.	Students fill their forms online directly. The system captures the data instantly, reducing time and chances of error.
Discipline Selection Timing	Students are asked to choose their preferred programs before taking the entry test, often without knowing for what they actually qualify for.	Students choose their programs after the test, based on their actual scores making their decisions more realistic.
Basis for Seat Allocation	Seats are allocated mostly based on preferences, with little alignment to test scores.	Allocation is based on both student preferences and their merit (CPN), ensuring a fairer outcome.
Seat Distribution Accuracy	Mistakes are common due to manual filtering or transferring data between systems. This can lead to wrong seat assignments and wasted seats.	The system uses rules and algorithms to allocate seats accurately, minimizing chances of error.
Handling Popular Programs	Popular disciplines get too many applicants, while others stay empty. This imbalance is hard to fix manually.	The system balances choices with merit, helping ensure all programs get filled fairly.
Transparency	Because of manual steps and scattered data, students can't easily track how seats were given leading to confusion and complaints.	Everything is processed centrally and published online. Students can clearly see how and why seats were allocated.
Opportunities for Students	Many eligible students miss out on programs they actually qualify for, just because they chose wrongly before the test.	Students can pick programs that match their performance increasing their chances of getting into a suitable discipline.
Scalability & Time	With thousands of forms, the process takes weeks or even months to complete. The more students apply, the harder it becomes.	The system can handle thousands of applications in minutes, making it practical even for large universities.
Error Risk	High due to manual entry, repeated checks, separate systems, and human oversight.	Very low because the process is centralized, automated, and needs minimal manual work.

Conclusion:

This paper addresses the issues of transparency and inefficiency in the admission process of public sector universities in Pakistan. We propose, develop, and implement a fully automated admission system that streamlines seat allocation, minimizes human errors, and enhances both efficiency and transparency. The proposed system features application submission, eligibility verification, entry test administration, cumulative score (CPN) calculation, seat allocation, and merit list generation. Additionally, it includes a post-entry test choice selection mechanism that allows candidates to choose their programs/subjects after receiving their test scores, optimizing seat allocation. The system employs optimization techniques such as batch fetching, in-memory storage, and hash tables to reduce database queries and processing time. A performance and comparative analysis involving over 20,000 candidates shows a 90% reduction in processing time, a 99.96% decrease in database queries, and a 15% improvement in seat allocation accuracy. The system ensures transparency by displaying merit lists online, allowing candidates to check their status and raise objections if discrepancies are found in seat allocation. Usability studies confirm that the system is user-friendly and flexible. As future work, we aim to integrate predictive analytics and machine

learning to offer personalized program recommendations based on candidates' cumulative scores (CPN) and historical data, further optimizing seat allocation.

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Author's Contribution: This project is a result of teamwork in which all the authors have equally contributed, apart from system implementation, testing, and evaluation, which is mainly carried out by the first author.

Conflict of interest: There is no conflict of interest of any type between the authors about publishing this manuscript.

Project details: N/A

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