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Powerlifting Game Digitalization and Management System

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***Abstract*— This work relies on the fact that organizing powerlifting game is still carried out traditionally in Nepal. We have analyzed various steps throughout the game that are being handled by different fragmented tools and software. It was observed that various fragmented tools delayed the game, decreasing performance efficiency of players and organizers which needed to be solved using a single software platform with all integrated features. By incorporating crucial feature like IPF-GL calculation, leaderboard display, lift submission and validations etc., Powerlifting Game Digitalization and Management System (PGDMS) has been designed on a mobile platform to be used specifically in Nepal by aiming at digitalizing and simplifying the traditional and hectic manual process of organizing and executing powerlifting events.**

Index Terms*—*Powerlifting Game, Digitalization and Management, IPF-GL Point, Lift Submission and Validation, Leaderboard.

I. INTRODUCTION

At first sight, powerlifting competitions may seem simple players come one after another, lift their weights, and the game progresses smoothly. However, the reality behind the scenes is much more complex. Players must submit their lift attempts multiple times, follow strict increment rules, and calculate their IPF GL points after each round. For example, if a player attempts 150 kg in the first round and wants to attempt 160 kg next, they must check whether the increase is valid according to competition rules, while also analyzing other competitors' lifts to decide how much more weight is needed to move ahead in their category. Without proper tracking of all players' scores, it becomes extremely difficult to make strategic decisions during the competition.

Organizers and referees face even greater challenges. They must manage event registration, verify player eligibility, weigh athletes, track lift attempts, calculate scores, approve or reject attempts, and update leaderboards—all in real time. In Nepal, most competitions still depend on paper-based processes or separate tools for scoring, registration, and announcements. As a result, errors occur frequently, delays are common, and officials often struggle to maintain transparency. In large events, the lack of a digital system makes it difficult to update scores quickly, which can lead to confusion among athletes, referees, and spectators.

To overcome these challenges, we introduce the Powerlifting Game Digitalization and Management System—a unified, mobile-based platform that streamlines every step of the competition. Inspired by the operational standards of the International Powerlifting Federation (IPF), the system includes real-time IPF GL point calculation, role-based access (player/referee/admin), QR-code check-in, automated leaderboard updates, and exportable competition results in PDF or Excel format. These features make the event faster, more accurate, and easier to manage while reducing human error and manual work.

Beyond improving efficiency, this system aims to professionalize sports administration in Nepal, making competitions more transparent, data-driven, and engaging for all stakeholders. This document outlines the motivation behind the project, its objectives, system architecture, technological framework, and future development roadmap toward fully digital powerlifting competitions

A. Problem Statement

1) Problem One: Powerlifting competitions in Nepal face growing difficulties due to disconnected technical systems and outdated workflows. Organizers often must use several separate software tools for important tasks like athlete registration, IPF GL point calculation, and scoreboard management. Since these tools aren't connected, data must be entered manually into each one, which increases the chances of mistakes, scoring errors, and scheduling problems. [1]

2) Problem Two: These issues slow down the competition and make it harder to run events smoothly and professionally. On top of that, paper-based processes for collecting lift attempts and tracking results in real time are prone to human error and cause delays that frustrate both athletes and officials. Without a central system to manage everything, staff are forced to switch between multiple platforms, making it difficult to keep rankings, lift records, and schedules updated and accurate. [2]

3) Problem Three: Additionally, there is no single platform designed specifically for powerlifting needs—such as automatic lot number assignment, proper tracking of attempts, and live score updates. This not only affects the

reliability of competitions but also adds extra work for organizers. There is a clear need for a complete and connected solution that can handle all parts of event management, reduce errors, and improve the overall experience for everyone involved. [3]

With the aim to solve the aforementioned problem, the objectives set for this work are (1) to develop a mobile-based, platform for managing powerlifting competitions by digitalizing athlete registration, lift submissions, referee approvals, (2) real-time result tracking, while also incorporating historical data and performance charts to enable long-term athlete monitoring, (3) improve planning and decision-making, (4) enhance transparency, consistency, and overall event efficiency for coaches, referees, and organizers.

II. RELATED WORK

A systematic review by Ferland and Comtois examined classic (raw) powerlifting performance by analyzing recent literature on athlete characteristics, training methodologies, biomechanics, tapering strategies, and injury profiles.[4] Findings highlighted the physiological traits of elite lifters, such as muscle fiber composition and respiratory strength, and supported training strategies like daily undulating periodization and RPE-based autoregulation. Biomechanical advantages in specific squat and bench press techniques were noted, along with tapering practices and a high incidence of injuries, emphasizing the need for individualized, evidence-based coaching practices.

Austin and Mann (2021) provide a comprehensive resource on the technical, physiological, and strategic dimensions of powerlifting. [5] Their work emphasizes the importance of precise technique across the squat, bench press, and deadlift, and outlines the nuanced rules and regulations governing competitive powerlifting. Additionally, the book addresses training periodization, athlete readiness, and psychological preparation, making it a valuable reference for developers aiming to incorporate biomechanical feedback or training optimization features in powerlifting-focused applications.

Van den Hoek et al. investigated the competition-related factors contributing to success at the International Powerlifting Federation World Championships between 2013 and 2019, analyzing data from 1,312 competitors. [6] The study found that successfully completing 8 or 9 of 9 lift attempts increased the odds of winning by 5.9 times for men and 1.5 times for women. The research highlighted that successful squat (SQ), bench press (BP), and deadlift (DL) attempts, along with a high total score, were critical factors distinguishing gold medalists (GMs) and silver or bronze medalists (SBMs) from nonwinners. These findings provide valuable insights for athletes and coaches to optimize competition strategies, with potential relevance for national competitions and other strength-based sports.

Ferland et al. examined the efficiency of the Wilks and IPF formulas in comparing maximal strength across weight classes, regardless of bodyweight, using data from 26,472 open-class powerlifters in the Open Powerlifting database. [7] Their analysis revealed that the Wilks formula slightly outperformed the IPF formula (54.1% vs. 52%) in facilitating fair comparisons across weight classes. The study further found that the Wilks formula was more effective for men, while the IPF formula performed better for women. These results challenge the IPF's decision to replace the Wilks formula and suggest a need for updated or hybrid scoring systems. The findings contribute to ongoing discussions about fairness and standardization in competitive powerlifting and may guide future revisions to scoring methodologies used in both national and international competitions.

Travis et al. provided the first empirical analysis of weight selection strategies among elite classic powerlifters competing at the IPF Classic World Championships between 2012 and 2019. [8] The study examined attempt selection patterns across squat, bench press, and deadlift for 66 male and 43 female athletes who completed all nine lifts. Findings revealed that male lifters tended to select heavier first attempts (A1) relative to their third attempts (A3) in the bench press and deadlift, while female lifters exhibited larger percentage increases between attempts—particularly from A1 to A2 and A2 to A3—in the same lifts.

Within-lift comparisons showed strategic preferences such as heavier openers for males in the bench press and for females in the squat. On average, lifters opened with approximately 91% of their intended third attempt, followed by a ~5% increase to A2 and ~3% to A3. These insights offer valuable guidance for competition planning and individualized strategy development, particularly in optimizing performance under standardized meet conditions.

The literature review indicates that effective management of weightlifting competitions requires an integrated digital approach to streamline administrative processes while enhancing accuracy and transparency. Traditional paper-based systems and standalone tools offer basic functionality but lack real-time synchronization, data integrity, and analytical depth. Emerging research supports the need for mobile-first platforms that unify event operations with automated workflows and performance analytics, enabling organizers, referees, and coaches to make informed decisions and improve event efficiency.

III. METHODOLOGY

This section describes the technical and managerial features offered by PGDMS and the important aspects covered in the due process.

A. IPF GL Point

The International Powerlifting Federation (IPF) Good Lift (GL) system, introduced in 2020, is a scaling method based on a Von Bertalanffy function. Powerlifting is a strength sport consisting of three movements: the squat, the bench press, and the deadlift. In a powerlifting competition, an athlete must perform three attempts in each movement. Only the best attempt in each movement is kept, and the total of these three attempts determines the winner of the competition. This paper is using the Open Powerlifting dataset [9]. This is a continually updated dataset that compiles competition results from multiple powerlifting federations since as early as 1964.

The present analysis focuses on the relationship between body weight and total lifted (thus, we only consider athletes who performed at least one valid attempt per movement). In competitions, the heavier athletes are expected to lift heavier weights, so federations have established weight classes to ensure fair competitions. For example, Table 1 shows the weight classes on World Games and International Powerlifting Federation (IPF) open division.

TABLE I. WORLD GAMES AND IPF OPEN WEIGHT CLASSES FOR FEMALES

Category	World Games Females (kg)	IPF Open Females (kg)	World Games Males (kg)	IPF Open Males (kg)
Lightweight	Up to 57.0	47.0, 52.0, 57.0	Up to 74.0	59.0, 66.0, 74.0
Middleweight	57.01 - 63.0	63.0	74.01 - 93.0	83.0, 93.0
Heavyweight	63.01 - 72.0	69.0, 76.0	93.01 - 120.0	105.0, 120.0
Super Heavyweight	Over 72.0	Over 84.0	Over 120.0	Over 120.0

To compare the athletes from different weight classes, performances can be scaled according to the athletes' body weight. An ideal scoring formula should take the form of Eq. 1.

$$\text{Score} \propto \frac{y}{f(x)} \tag{1}$$

where x and y are respectively the body weight and the total of the scored athletes, f(x) = E(y|x) is the expected total for a random athlete of the same body weight. Implementing a scoring system can have multiple benefits aside from determining the strongest athlete "pound for pound". Federations may consider using a scoring system for international qualification events to allow athletes to transition smoothly between weight classes instead of undergoing unhealthy diets. This could also help comparing overall performances of different teams.

In practice, f is a nonlinear function, and various models have been proposed to estimate it. These models can be based on a sufficiently flexible family, such as an ad hoc polynomial family, which fits the data well but has limited explanatory power and discards any notion of parsimony. This is what is done with the Wilks score, which rescales the total by a 5-th order polynomial as shown in Eq. 2.

$$\text{Wilks Score} = \frac{C \cdot y}{a + bx + cx^2 + dx^3 + ex^4 + fx^5} \tag{2}$$

where x is the athlete's body weight (in kg), y is the athlete's total (in kg) and *f*wilks(x) = a+ bx+ cx2 +dx3 + ex4 + fx5. The coefficients a, b ,c ,d ,e and f are specific to the sex of the lifter. The constant C is set to 500 in the original version of the Wilks formula and to 600 in the 2020 version known as Wilks-2. The coefficients can be found, for instance, in the IPF models evaluation report. Alternatively, f can be chosen from a family of functions that conforms to some postulates, providing a more interpretable and theoretically grounded model. In 2020, the International Powerlifting Federation (IPF) has implemented the Good Lift (GL) score to replace the Wilks score. The IPF GL score is defined by International Powerlifting Association [10] as shown in Eq. 3.

$$\text{IPF Score} = \frac{100 \cdot y}{A - B \cdot \exp(-Cx)} \tag{3}$$

where the coefficients A, B and C are all positive and IPF GL(x) = A−B·exp (−Cx). [13]

B. Overall Design of the System

The Powerlifting Game Digitalization and Management System operates through a role-driven interaction framework consisting of three primary operational modules: Player Operation Mode, Official Management Mode, and Administrative Control Mode. These modules coordinate the complete workflow of a powerlifting competition, including event creation, registration, lift submission, attempt validation, and leaderboard computation. The overall architecture integrates a React Native mobile application, a Node.js/Express backend, and a MongoDB database for persistent storage.

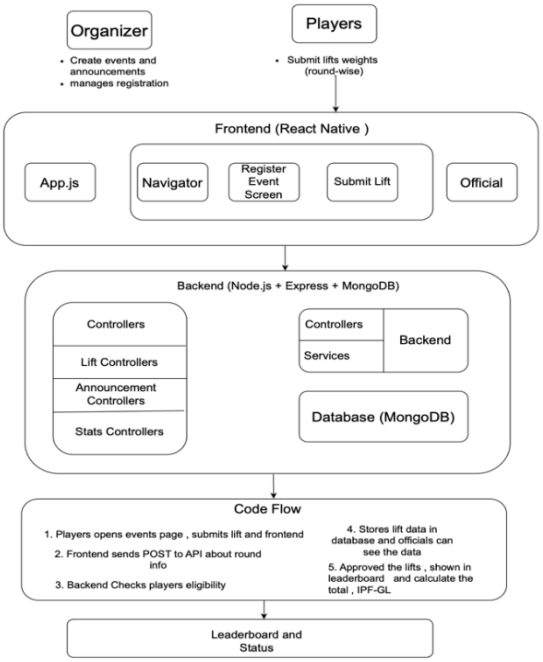

Fig. 1. The overall system architectre

1) Player Operation Mode

In the Player Operation Mode, athletes interact with the system through a mobile application interface that enables them to participate in competitions digitally. Players begin by completing authentication, after which they can browse scheduled events, review event details, and submit registration requests. Once approved, players proceed to enter their lift attempts for each competitive round, with the system enforcing rule-based constraints such as permitted weight changes and number of attempts. Submitted lifts are transmitted to the backend and stored in the database, where they remain pending until reviewed by officials. Players also receive real-time announcements from event officials, view the dynamically updated leaderboard, and access performance analytics such as total lifts, attempt history, and IPF-GL scores. This mode supports continuous interaction throughout the competition, providing athletes with an organized and transparent digital environment.

2) Official Management Mode

The Official Management Mode provides referees and event organizers with a dedicated operational interface for controlling and validating all aspects of the competition. After authentication, officials can create, edit, and delete events; configure registration criteria; and define the structure of competitive rounds. When players submit registration forms, officials review them and approve or reject each entry based on eligibility. During the competition, officials record weigh-ins, verify submitted lift attempts, and update approval statuses, ensuring accurate and fair scoring. Approved attempts automatically trigger leaderboard recalculation,

incorporating totals, rankings, and IPF-GL point computations. Officials also broadcast event announcements, monitor user activity, and review real-time statistics to maintain transparent and well-regulated event flow. This module functions as the authoritative layer that enforces competition rules and ensures data integrity.

3) Administrative Control Mode

Administrators operate within the Administrative Control Mode, which provides high-level management and system oversight capabilities. Admins configure system settings, manage user roles, and ensure overall platform security. They are responsible for monitoring system performance, maintaining database health, and generating regular backups to preserve critical event data. Administrators can also export competition results in PDF or Excel formats, review system audit logs, and handle exceptional cases such as data restoration or correction. This mode upholds the long-term operational stability, reliability, and maintainability of the platform.

4) Unified Processing and Data Synchronization Layer

All user interactions across the three operational modes are processed through a unified backend implemented with Node.js and Express. The backend coordinates authentication, event management, lift validation workflows, QR-based check-ins, announcement handling, and leaderboard computations. A modular controller–service architecture ensures that each request is routed to its corresponding processing component, where business logic—such as scoring rules, eligibility checks, or attempt constraints—is applied. Data persistence is handled through MongoDB, which maintains structured collections for users, events, registrations, lift attempts, approvals, announcements, and computed results. Continuous communication between the React Native frontend and backend APIs ensures real-time synchronization, consistent data propagation, and immediate reflection of leaderboard updates across all user interfaces.

5) Reliability, Integrity, and Competition-Specific Enhancements

To maintain fairness and competition integrity, the system integrates multiple reliability mechanisms. Role-based access control ensures that sensitive operations—such as event editing, lift approval, and system configuration—are limited to authorized officials or administrators. All lift attempts undergo mandatory validation before inclusion in the leaderboard, and detailed audit trails capture each approval or rejection. The scoring engine automatically computes IPF-GL points using stored body-weight data and standardized constants, ensuring accurate representation of athlete performance. Automatic data backups protect the system against loss, while internal validation checks prevent inconsistent or rule-violating entries. These enhancements collectively ensure that the competition environment remains transparent, secure, and professionally managed.

6) System Backup and Maintenance

The Administrative Maintenance subsystem ensures system reliability and long-term data integrity. Admins periodically generate backups of all major databases, including user data, event records, lift histories, and scoring summaries. They also oversee system audits, correct inconsistencies if needed, and monitor platform performance. This subsystem provides essential support functions that safeguard the system from data loss and operational disruptions.

C. Roles of Officials and Players

This Diagram provides a detailed decomposition of the internal processes within the Powerlifting Game Digitalization and Management System. It expands the major subsystems—user management, event control, lift submission, validation, scoring, and leaderboard generation—into fine-grained operational flows. This level of detail illustrates how data moves among Players, Officials, and Admins, and how the system's backend and databases coordinate to maintain a real-time, rule-compliant competition environment.

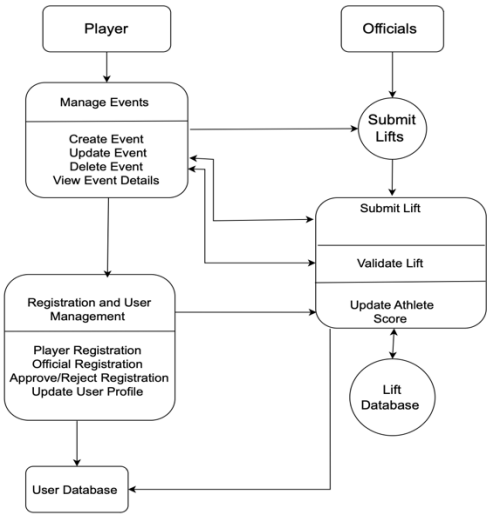

Fig. 2. Decomposition of internal processes within the PGDMS

1) Registration and User Management

The Registration and User Management subsystem begins when a user—whether a Player, Official, or Admin logs into the system. Authentication requests are processed by the backend, which validates the credentials against stored user records. New users registering for the first time submit personal information that is stored as structured user profiles in the database. Players may subsequently update their details or register for specific events, and all profile changes are synchronized with the User Database. Officials access the registration queue to review pending player requests; their decisions to approve or reject are recorded and reflected back into the system. This ensures accurate maintenance of user identity, eligibility, and role-based permissions throughout the platform.

2) Event Management

The Event Management subsystem handles all actions related to creating and controlling competitions. Officials initiate event creation by entering event details such as date, location, and competition structure, which are verified and stored in the Event Database. Players accessing the event list retrieve this information to explore schedules and event attributes. When modifications are made by officials—such as updating rules or editing event parameters—the system updates the stored event data accordingly. Event Management also interacts with user registration information to ensure that only approved players can participate in lifts and competitive rounds.

3) Lift Submission

The Lift Submission subsystem is triggered once a player's event registration has been approved. Players enter lift attempts for each round through the mobile application, providing details such as lift type, weight, and attempt number. These submissions are transmitted to the backend, which checks for compliance with competition rules, including permissible weight changes and attempt order. Valid attempts are stored in the Lift Database as pending submissions. Any subsequent modifications by the player before official validation are also recorded. This subsystem ensures consistent and rule-governed collection of all lifting activity.

4) Lift Validation and Approval

Officials access a dedicated interface to review all pending lift submissions stored in the system. Each lift is examined for correctness, legitimacy, and adherence to event rules. Approved attempts are updated in the database with "validated" status, while rejected attempts include notes explaining the rejection. The outcome of each validation action is communicated back to the player interface. Approved lifts are immediately forwarded to the scoring subsystem, making this module a critical checkpoint for fairness and competition integrity.

5) Athlete Score Updating

Once a lift has been approved, the Score Updating subsystem calculates the athlete's revised totals and IPF-GL points. The system retrieves the athlete's body weight, validated lift values, and competition category to compute the standardized score. Updated totals and points replace earlier values in the database, ensuring that rankings remain accurate and reflective of the athlete's latest performance. These updated results serve as inputs for leaderboard construction and final competition reports.

6) Leaderboard and Announcement Handling

The Leaderboard subsystem compiles approved lift data and updated scores to generate real-time rankings for all athletes. Rankings are recalculated automatically whenever a new lift is validated or a score is adjusted. These rankings are transmitted to both players and officials for monitoring competition progress. In parallel, announcements issued by officials—such as schedule changes, round openings, or administrative notifications—are stored and delivered across all user interfaces. Together, these components maintain transparent communication and provide continuous visibility into competition status.

The sequence diagram show in Fig. 3 illustrates the interaction between system components during player usage of the application. It begins with user login or registration, where credentials are validated and stored via the backend and database. Authenticated users can browse available events, submit event registrations, and record lift attempts, all of which are verified and saved in the database. The system also retrieves announcements, personal performance statistics, and leaderboard data for display. Additionally, players may update their profiles, with changes securely processed and confirmed through the backend.

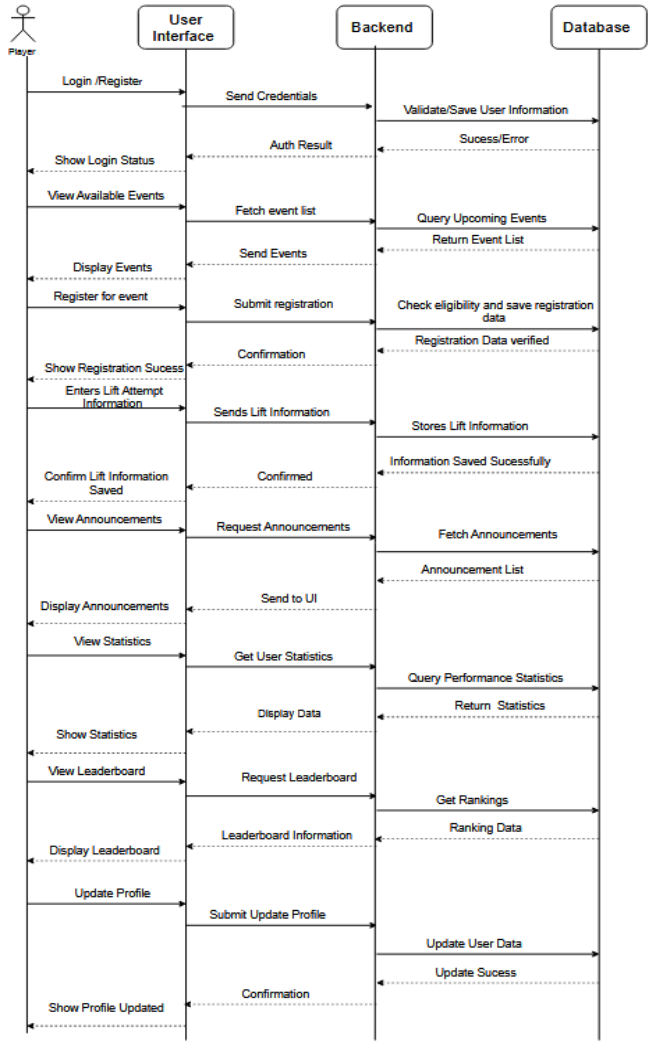

Fig. 3. Sequence Diagram for Player Interaction

Fig. 4 represents the operational workflow of an Official within the system. The interaction begins with login and authentication, where official credentials are validated by the backend using stored database records.

Following authentication, officials can create and manage events by submitting event details such as schedules and competition settings. The backend validates this information and stores it in the database, confirming successful event creation.

Officials can then review player registrations for each event. The system retrieves pending registration data from the database, allowing officials to approve or reject participants. These decisions update player status records in real time.

After the competition, officials upload and validate performance results. The backend stores the results, updates athlete records, and recalculates rankings and standings. Officials may also post announcements and generate event reports, with the system aggregating relevant data and

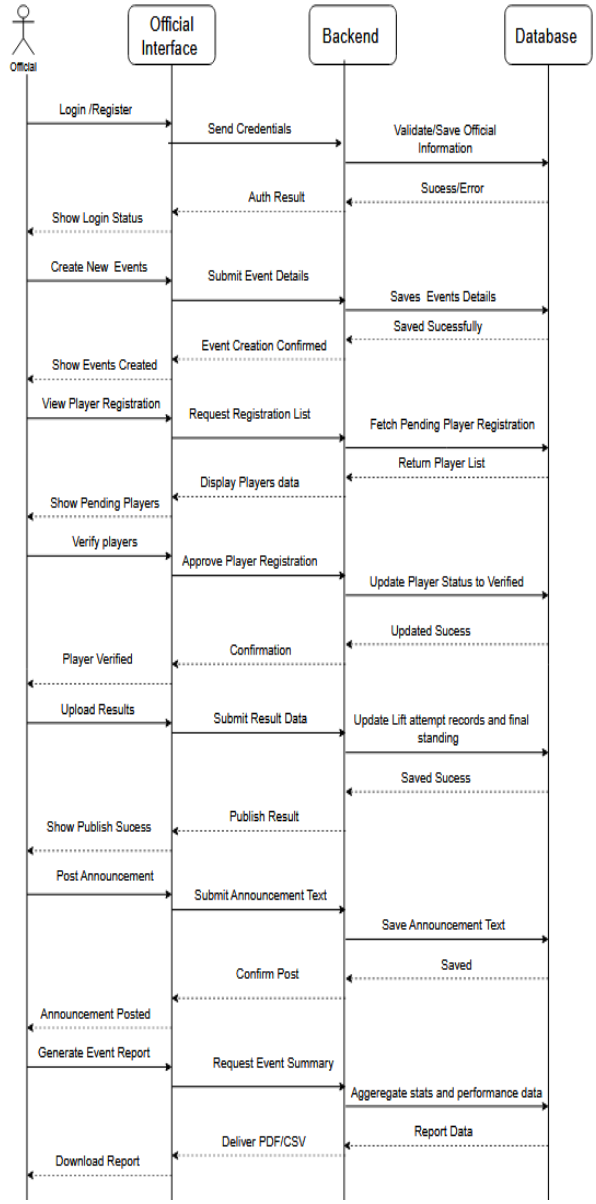

Fig. 4. Sequence Diagram for Official Interaction

IV. Ethical Consideration

Ethical considerations related to athlete data privacy are essential in digital sports management systems. The proposed Powerlifting Game Digitalization and Management System collects sensitive athlete information, including personal details and performance records, requiring responsible data handling to protect athlete rights and ensure fairness. Athletes are informed about the data collected and its purpose, and consent is obtained during registration. Secure authentication and role-based access control restrict sensitive data access to authorized officials and administrators only. Performance data and IPF-GL score calculations are processed consistently and transparently, and athletes may review their data and request corrections in case of inaccuracies.

producing downloadable summaries for transparency and record-keeping.

V. Conclusion and Further Work

This work presented the Powerlifting Game Digitalization and Management System, a mobile-based platform designed to streamline powerlifting competitions in Nepal. By integrating athlete registration, lift submission, referee approvals, real-time leaderboard updates, and performance analytics, the system addresses inefficiencies and errors associated with traditional manual and fragmented workflows. The platform enhances transparency, reduces human error, and improves event management efficiency, enabling organizers, referees, and athletes to focus on competition rather than administrative tasks. Experimental deployment has shown accurate IPF GL point calculations, real-time score updates, and effective data management, making it practical and reliable for competitions of various scales.

The following tangible outputs were successfully produced and validated during the project:

- *User Roles & Access Management:* Separate and secure interfaces for players (lift submissions, profile), officials (event creation, validations), and admins (backup/restore, system settings).
- *Real-Time Leaderboard and IPF GL Point Calculation:* A dynamic leaderboard auto-updating based on verified lifts, with IPF GL scores computed using official formulas.
- *Performance Charts and Athlete Profiles:* Graphical insights and historical lift data available per player, improving user experience and tracking.

Future work will focus on developing a web-based admin dashboard for more efficient event management and adding offline mode support to allow the system to function without internet connectivity, syncing data automatically when the connection is restored.

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