I. Introduction

Health and fitness have taken center stage in today's world, with more and more people emphasizing the importance of physical well-being. As interest in personalized fitness tracking systems rises, a business model known as Fitness as a Service (FaaS) has gained traction. This model offers individuals access to a wide array of fitness services, such as virtual coaching, customized training regimens, and performance tracking, all facilitated through websites and digital platforms. The rise of wearable technology, including fitness bands and smartwatches, has empowered users to monitor their physical activities, evaluate their heart rates, and quantify calories burned in real-time. Nevertheless, it is important to acknowledge the drawbacks associated with these devices. Many users have reported issues related to discomfort, financial costs, and a lack of accuracy, particularly concerning specific sports activities like weightlifting (Huang et al. [1]; Passos et al. [2]).

Even though wearables are widely used for general fitness tracking, they are not always suitable for activities such as weightlifting, which require precise monitoring of movement mechanics. These exercises demand accurate tracking of the lifting technique, the angle of motion, and the force exerted by the lifter. Unfortunately, most existing solutions fail when providing detailed feedback on such activities. Moreover, users do not always prefer wearables, as they may be uncomfortable during intense physical activities like weightlifting, where precision in movement and body alignment is crucial (Jaladara et al. [3]).

This research manages all these gaps by developing a non-wearable IoT-based fitness monitoring system for weightlifting exercises. The proposed system combines MPU6050 sensors to measure the motion of the dumbbells during exercise and RC522 to identify users and store their performance data. The system will transmit this data to a web platform, where users can monitor their exercise metrics, such as the number of repetitions, workout duration, and calories burned, in real time.

This system will use non-wearable technology to provide a more comfortable and accurate alternative to wearables. The goal is to offer real-time feedback to optimize weightlifting routines, ensuring correct form and improving performance. RFID technology allows for personalized data collection and is suitable for personal use and gym settings (Rosadi et al. [4]; Hidayani & Santosa [5]).

Although several fitness tracking tools exist, they are most focused on wearables for general activities, compromising effectiveness in weightlifting (Mohd Sultan et al. [6]). Tracking detailed metrics like lifting technique and burned calories remains challenging for existing systems.

Obviously, there is a gap in providing non-wearable fitness tracking systems specifically tailored for weightlifting activity. Many enthusiast think that, usually, the non-wearable system lacks an accurate and user-friendly method to monitor their workouts effectively. Usually, the effective way to approach the issue more accurately depends on manual tracking or the observations of trainers, which can fall short of providing real-time data and personalized feedback.

This research addresses these gaps by designing a system, non-wearable fitness monitoring system for weightlifting activities that utilize dumbbells. The collaboration of IoT technology and websites offers instant feedback, enabling users to refine their form and enhance their workout efficiency (Erman [7]; Gaikwad [8]).

The main objectives of this study are as follows:

1. To design and develop an IoT-based fitness monitoring system for weightlifting, using inertial sensors (MPU6050) and RFID technology for tracking and personalizing user data.
2. Using the System Usability Scale (SUS), user satisfaction and effectiveness are assessed in real-time feedback to evaluate the system's usability.
3. To assess the system's accuracy in tracking weightlifting movements and estimating calories burned.

The SUS evaluation will help determine usability and identify areas for improvement, ensuring the tool is effective for users to monitor and enhance their weightlifting routines. This research employs a descriptive research methodology, involving the design, development, and testing of an IoT-based fitness monitoring system consisting of MPU6050 inertial sensors to track dumbbell movement.