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E-TRASH+: DIGITAL PLATFORM FOR E-WASTE PICKUP & RECYCLING AWARENESS

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ABSTRACT

Electronic waste (e-waste) has emerged as one of the fastest-growing environmental concerns due to rapid advancements in technology, increased usage of electronic devices, and reduced product life cycles. Improper disposal of electronic products such as mobile phones, laptops, computers, batteries, and household appliances leads to severe environmental pollution and health hazards because these devices contain toxic substances including lead, mercury, and cadmium. Traditional waste management systems mainly depend on manual collection methods and informal recycling sectors, which lack transparency, efficiency, and safety standards. To address these issues, the proposed system "E-TRASH+: Digital Platform for E-Waste Pickup & Recycling Awareness" introduces a centralized web-based platform that facilitates secure and efficient e-waste management. The system enables users to register online, request doorstep pickup services, track recycling activities, and access awareness content related to eco-friendly disposal practices. Authorized recyclers and administrators are integrated into the platform to ensure proper coordination and transparency throughout the recycling process. The application is developed using Java technologies such as Servlets, JSP, JDBC, HTML, CSS, JavaScript, Apache Tomcat, and MySQL database management system. Additionally, the system includes a reward-based mechanism that motivates users to participate actively in responsible recycling activities. The proposed platform minimizes manual effort, improves accessibility to recycling services, enhances environmental awareness, and promotes sustainable development. By integrating digital technology with environmental protection initiatives, the system provides an effective, scalable, reliable, and user-friendly solution for modern e-waste management challenges.

Keywords: E-Waste Management, Recycling Awareness, Digital Platform, Java Web Application, Sustainable Development, Pickup Management, Environmental Protection, MySQL, Servlets, JSP.

I. INTRODUCTION

Electronic waste, commonly known as e-waste, has become a major global environmental challenge due to the rapid growth of electronic and electrical equipment usage [1]. The continuous advancement of technology and the increasing demand for modern electronic devices have significantly reduced the life span of products such as smartphones, laptops, computers, televisions, and household appliances [2]. As a result, discarded electronic products are accumulating at an alarming rate across the world [3]. Improper disposal of e-waste causes serious environmental pollution because electronic devices contain hazardous substances including lead, cadmium, mercury, and brominated flame retardants [4]. These toxic

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materials contaminate soil, water, and air when e-waste is dumped in landfills or processed using unsafe recycling methods [5]. Existing waste management systems mainly focus on biodegradable and non-biodegradable waste while neglecting electronic waste management [6]. In many developing countries, e-waste recycling is carried out by informal sectors that use unsafe techniques such as open burning and acid extraction [7]. These methods expose workers and nearby communities to harmful chemicals and severe health risks [8]. Lack of awareness among the public regarding proper e-waste disposal practices further worsens the situation [9]. Many users are unaware of authorized recycling centers and safe disposal procedures [10]. Additionally, the absence of digital systems for monitoring and managing e-waste collection creates inefficiency, poor transparency, and lack of accountability in recycling activities [11]. Governments and environmental organizations are increasingly emphasizing sustainable waste management practices to reduce pollution and conserve natural resources [12]. Therefore, there is a growing need for intelligent and technology-driven systems that can simplify e-waste management while encouraging public participation [13].

The proposed system "E-TRASH+: Digital Platform for E-Waste Pickup & Recycling Awareness" is designed to address these challenges by providing a centralized and user-friendly web application for effective e-waste management [14]. The system integrates users, recyclers, and administrators into a single digital platform that enables efficient communication and coordination [15]. Users can register online, submit e-waste pickup requests, track recycling activities, and access awareness content regarding eco-friendly disposal practices [16]. The system provides doorstep pickup facilities that improve user convenience and increase participation in recycling programs [17]. Authorized recyclers are assigned pickup requests to ensure safe handling and disposal of electronic waste [18]. The platform also includes reward-based mechanisms to motivate users toward responsible recycling behavior [19]. The application is developed using Java technologies such as Servlets, JSP, JDBC, HTML, CSS, JavaScript, Apache Tomcat, and MySQL database [20]. Secure authentication and role-based access control mechanisms are implemented to ensure data privacy and system security [21]. Database management techniques are used to maintain records of users, recyclers, pickup requests, rewards, and awareness content efficiently [22]. The proposed system improves transparency by enabling real-time tracking of e-waste collection and recycling activities [23]. It also reduces manual effort and enhances operational efficiency through automation [24]. Awareness modules integrated into the platform educate users about environmental protection and sustainable recycling practices [25]. The project supports green computing concepts and contributes toward sustainable development goals [26]. Furthermore, the system demonstrates the practical implementation of web technologies for solving real-world environmental problems [27]. The proposed platform is scalable, cost-effective, and suitable for deployment in educational institutions, households, corporate offices, and municipal waste management systems [28]. By combining digital technology with environmental awareness initiatives, the system aims to promote responsible e-waste disposal and create a cleaner, healthier, and more sustainable society [29][30].

II. LITERATURE SURVEY

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Electronic waste management has become an important research area because of the rapid increase in discarded electronic devices worldwide [1]. Researchers have identified e-waste as one of the fastest-growing waste streams that significantly affects environmental sustainability [2]. Studies indicate that improper disposal of electronic products causes severe pollution due to the presence of hazardous substances such as mercury, lead, cadmium, and arsenic [3]. Landfilling and open burning of e-waste release toxic chemicals into the environment, affecting soil fertility, water quality, and air purity [4]. Several researchers emphasized that informal recycling sectors are major contributors to unsafe e-waste processing activities [5]. Manual dismantling and acid extraction methods used by unregulated recyclers expose workers to serious health risks [6]. Existing waste management systems are often unable to manage electronic waste separately from general waste streams [7]. Researchers highlighted that lack of awareness among citizens regarding safe disposal methods remains one of the major barriers to effective e-waste management [8]. Public awareness campaigns and environmental education programs were found to improve recycling participation significantly [9]. Various studies proposed the implementation of centralized recycling frameworks to improve collection efficiency and waste tracking mechanisms [10]. Digital platforms for waste management have gained importance because they simplify communication between users and recycling agencies [11]. Web-based applications were identified as effective solutions for automating waste collection, monitoring recycling activities, and maintaining transparency [12]. Researchers also focused on integrating reward-based systems to motivate users toward responsible disposal practices [13]. Incentive-driven recycling systems were found to increase public engagement and improve collection rates [14]. Several studies emphasized the role of government regulations and environmental policies in controlling improper e-waste disposal [15]. Sustainable recycling approaches were recommended to recover valuable materials such as gold, copper, aluminum, and silver from discarded electronics [16]. The concept of circular economy has also been widely discussed to minimize waste generation and maximize resource utilization [17]. Researchers suggested the integration of Internet-based technologies for improving waste management operations and service accessibility [18]. Cloud-based monitoring systems and centralized databases were found useful for maintaining recycling records and operational data [19]. Many existing systems still suffer from poor scalability, limited accessibility, lack of transparency, and insufficient user participation [20]. Therefore, modern e-waste management requires technology-driven solutions that combine automation, awareness, and secure data handling [21].

Several research works have focused on the development of web-based applications using Java technologies for efficient waste management systems [22]. Java Servlets, JSP, JDBC, and MySQL databases are widely used for developing secure, scalable, and reliable enterprise applications [23]. Researchers highlighted that Java-based systems provide platform independence, strong database connectivity, and efficient request handling capabilities [24]. Apache Tomcat servers have been extensively used for deploying web applications because of their lightweight and reliable architecture [25]. Studies also emphasized the importance of role-based authentication systems in maintaining secure access control for

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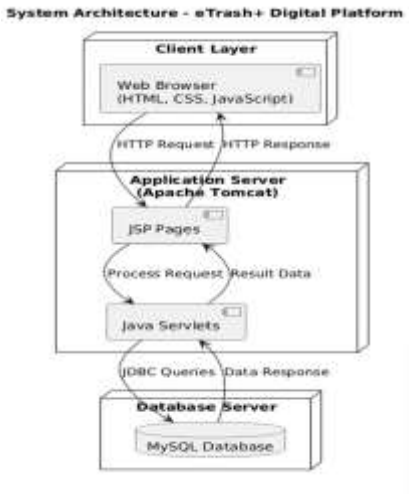
users, administrators, and recyclers [26]. Database-driven systems were found effective for storing and retrieving user information, pickup requests, reward points, and recycling records [27]. Several projects implemented tracking modules that enable users to monitor the status of waste collection and recycling activities in real time [28]. User-friendly interfaces designed using HTML, CSS, and JavaScript improved accessibility and system usability [29]. Researchers also proposed integrating educational modules within digital platforms to spread awareness regarding sustainable recycling practices [30].

III. PROPOSED SYSTEM

The proposed system "E-TRASH+: Digital Platform for E-Waste Pickup & Recycling Awareness" is a centralized web-based application developed to improve the efficiency, transparency, and accessibility of e-waste management processes. The system integrates users, administrators, and authorized recyclers into a single digital platform to streamline e-waste collection and recycling activities. Users can create accounts, securely log in, and submit electronic waste pickup requests through a user-friendly interface. The application enables users to provide details such as item type, quantity, and pickup location for scheduling doorstep collection services. The platform also provides awareness content regarding the environmental impact of improper e-waste disposal and promotes eco-friendly recycling practices. Secure authentication and role-based access control mechanisms are implemented to ensure data privacy and prevent unauthorized access. The system is developed using Java technologies such as Servlets, JSP, JDBC, HTML, CSS, JavaScript, Apache Tomcat, and MySQL database management system. Database connectivity is established using JDBC to manage user data, pickup requests, recycler information, and reward records efficiently.



The proposed system also includes recycler and administrator modules for effective monitoring and management of recycling operations. Authorized recyclers can log in to the system, view assigned pickup requests, update collection status, and confirm recycling activities. Administrators can monitor all platform activities, manage recycler accounts, maintain awareness content, and generate reports related to e-waste collection and recycling statistics. The system provides real-time tracking of pickup requests to improve transparency and accountability throughout the recycling process. Additionally, a reward-based incentive mechanism is integrated into the platform to encourage users to participate actively in responsible e-waste disposal practices. Users receive reward points after successful completion of recycling activities, which motivates long-term participation. The proposed platform minimizes manual effort, reduces environmental pollution, and improves recycling efficiency through automation and centralized management. By integrating digital technologies with environmental sustainability initiatives, the system provides a scalable, cost-effective, secure,

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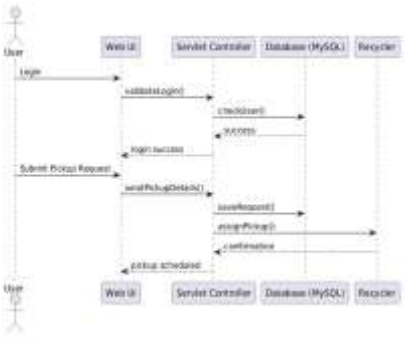
and practical solution for modern e-waste management challenges.

IV. SYSTEM DESIGN

The system design of the proposed "E-TRASH+: Digital Platform for E-Waste Pickup & Recycling Awareness" focuses on creating a scalable, modular, and secure architecture for efficient e-waste management. The system follows a three-tier architecture consisting of presentation layer, application layer, and database layer. The presentation layer is developed using HTML, CSS, JavaScript, JSP, and Bootstrap technologies to provide an interactive and user-friendly interface for users, recyclers, and administrators. The application layer is implemented using Java Servlets and JSP technologies deployed on Apache Tomcat server. This layer handles business logic, request processing, authentication, pickup scheduling, reward management, and awareness content delivery. The database layer uses MySQL for storing and managing system information such as user records, recycler details, pickup requests, reward points, and recycling reports. JDBC connectivity is used for establishing communication between the application server and database server. The system supports multiple modules including User Module, Admin Module, Recycler Module, Pickup Management Module, Reward Management Module, Awareness Module, Authentication Module, and Database Management Module. Each module performs specific operations independently, improving maintainability, scalability, and system performance.



The workflow of the system begins when users register and log in to the platform using secure authentication credentials. After successful login, users can submit e-waste pickup requests by entering item details and pickup location information. The request is stored in the database and assigned to authorized recyclers by the administrator module. Recyclers can access assigned requests, collect e-waste from users, and update pickup status in real time. Once recycling is completed, the system automatically updates reward points to user accounts. The awareness module continuously provides educational content related to environmental protection, safe recycling methods, and sustainable waste management practices. UML diagrams such as use case diagrams, activity diagrams, sequence diagrams,

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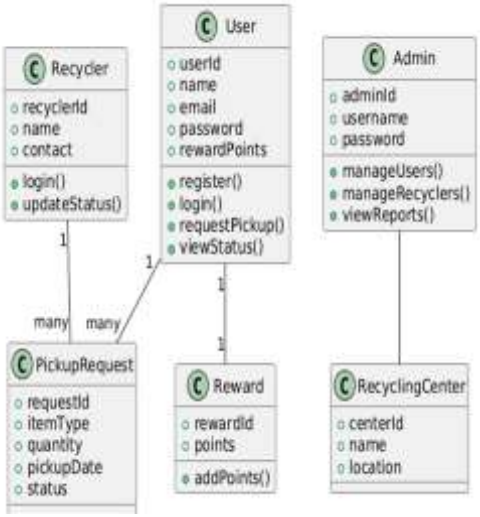
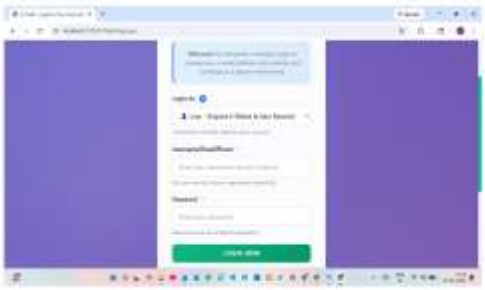
and class diagrams are used to represent system behavior and interactions among system components. Role-based access control ensures that users can access only authorized functionalities, thereby improving security and protecting sensitive information. The modular design and centralized database structure improve transparency, simplify management operations, and enhance overall system reliability and efficiency.



V. RESULTS



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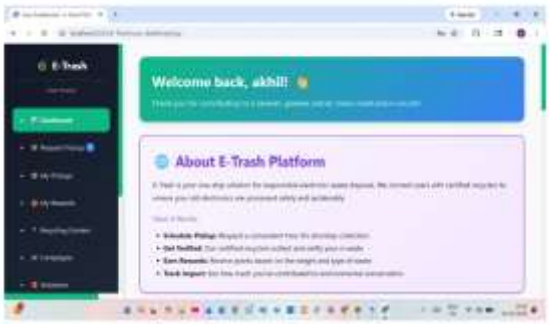

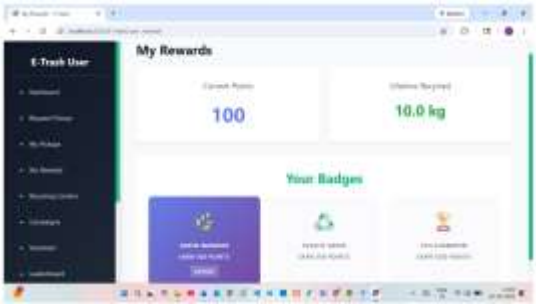

VI. CONCLUSION

The "E-TRASH+: Digital Platform for E-Waste Pickup & Recycling Awareness" project provides an effective and technology-driven solution for addressing the growing problem of electronic waste management. Rapid technological advancements and increasing dependence on electronic devices have resulted in a significant rise in e-waste generation, creating serious environmental and health concerns. Traditional waste management systems lack proper mechanisms for handling electronic waste separately and efficiently. The proposed system overcomes these limitations by introducing a centralized web-based platform that connects users, recyclers, and administrators within a secure and organized environment. The application simplifies the process of e-waste disposal by enabling users to request doorstep pickup services, track recycling activities, and access awareness content regarding eco-friendly disposal practices. The use of Java technologies such as Servlets, JSP, JDBC, Apache Tomcat, HTML, CSS, JavaScript, and MySQL ensures system reliability, scalability, and efficient database management. The implementation of secure authentication and role-based access control improves data protection and system security. Additionally, the integration of reward-based incentives encourages users to participate actively in responsible recycling activities. The platform enhances transparency and accountability by providing real-time monitoring and tracking of recycling operations. The modular architecture improves maintainability and allows future enhancements such as mobile application integration, GPS-based pickup tracking, cloud storage, and AI-driven waste analysis. Overall, the proposed system contributes toward environmental sustainability, public awareness, and responsible waste management practices. By integrating digital technologies with environmental protection initiatives, the project demonstrates how modern web applications can effectively solve real-world

environmental challenges and support sustainable development goals.

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