



iJRASET

International Journal For Research in
Applied Science and Engineering Technology



INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 14 **Issue:** X **Month of publication:** October 2026

DOI: <https://doi.org/10.22214/ijraset.2026.85297>

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BidSphere: A Secure Digital Auction and Management System

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Abstract: E-commerce is growing rapidly, and online auctions have become a popular way to trade goods. Unique and rare items that were once auctioned in person can now be bid on remotely, letting buyers and sellers interact through a web platform. This paper presents BidSphere, a web-based online auction system (OAS) and management platform that supports user registration and login, product listing, auction creation, bid validation, automatic auction closing, and winner selection. Live bidding helps buyers respond quickly and improves their chances of winning, while helping sellers reach the best possible price. Participants also save the time and effort of attending an auction in person.

Keywords: E-auction, bidding system, bid validation, winner selection, web application, auction management, security.

I. INTRODUCTION

An auction is a mechanism for allocating goods, services, or other assets according to predefined bidding rules. Traditionally, buyers and sellers had to be physically present. The growth of internet-based e-commerce has changed this model by letting participants communicate and submit bids through digital platforms. Online auction systems allow sellers to publish products and buyers to bid from different locations without travelling, which provides greater accessibility and convenience [1], [2]. Security and trust are central concerns, because participants need confidence that bids and auction outcomes are handled correctly. Blockchain-based mechanisms have been explored to provide transparency, automation, and decentralized operation [1], while other studies address bid protection and reliable auction management [2]. Privacy matters as well, particularly when bid values should not be revealed to other participants. Several studies on sealed-bid auctions have investigated privacy preservation, public verifiability, and zero-knowledge techniques for protecting auction information [3]–[5].

II. LITERATURE SURVEY

Early work on securing electronic auctions focused on cryptographic guarantees rather than decentralized infrastructure. Liaw et al. [6] proposed a secure e-auction protocol that preserves bidder privacy and anonymity, supports auditing, and keeps bids unlinkable to their owners. The scheme relies on a centralized setup, so it offers no decentralized trust model.

As blockchain matured, researchers began applying it to bidding systems. Sarfaraz et al. [2] improved the blockchain structure used for online bidding to strengthen security and transparency, but scalability and privacy challenges remain. Omar et al. [1] built a decentralized auction on Ethereum smart contracts with storage and oracle components; their work mainly demonstrates the open auction model. For sealed-bid auctions, Li and Xue [3] combined zero-knowledge proofs, Pedersen commitments, and smart contracts to keep bids confidential until the reveal stage, at the cost of a more complex architecture.

Fairness has also received attention. SSBAS-FA [5] pairs time-lock encryption with fair arbitration to prevent parties from gaining an advantage by delaying or withholding disclosure, but it also increases architectural complexity. A 2022 study [7] proposed a blockchain-enabled framework to improve auction security, and Kumbhakar et al. [8] built a secure online auction on blockchain and smart contracts; both were evaluated only on a limited scale.

More recent studies use richer, multi-layered designs. Vangujar et al. [9] combined cluster-based consensus, identity-based identification, and zero-knowledge proofs for secure e-auctions, resulting in a complex cryptographic architecture. Swain and Chouhan [10] used a permissioned blockchain with smart contracts to deliver a transparent auction system and note that further work on scalability and practical validation is needed. Table I summarizes the studies reviewed.

Table I. Summary Of Related Work

Author	Main Focus	Main Contribution	Limitations
Liaw et al. (2006) [6]	Secure e-auction protocol	Privacy, anonymity, auditability, unlinkability	Centralized design; no decentralized trust model
Sarfaraz et al. (2021) [2]	Improved blockchain bidding	Security, transparency, improved blockchain structure	Scalability and privacy challenges remain
Omar et al. (2021) [1]	Decentralized auction	Ethereum smart contract, storage, oracle	Mainly demonstrates the open auction model
Li and Xue (2021) [3]	Sealed-bid auction	ZKP + Pedersen commitment + smart contract	More complex architecture
Zhang et al. (SSBAS-FA) (2022) [5]	Fair sealed-bid auction	Time-lock encryption + fair arbitration	More complex architecture
State-of-the-art study (2022) [7]	Auction security	Blockchain-enabled auction framework	Limited large-scale evaluation
Kumbhakar et al. (2023) [8]	Secure online auction	Blockchain + smart contracts	Limited large-scale evaluation
Vangujar et al. (2024) [9]	Secure e-auction	Cluster consensus + identity + ZKP	Complex cryptographic architecture
Swain and Chouhan (2025) [10]	Transparent auction	Permissioned blockchain + smart contracts	Further scalability and practical validation needed

Overall, the surveyed work shows steady progress in privacy, fairness, and transparency. However, three gaps recur: heavy architectural and cryptographic complexity, limited scalability, and a lack of large-scale practical evaluation. These gaps guided the requirements of BidSphere described in the next section.

III. METHODOLOGY

Based on the literature review and the problems identified in existing auction systems, the functional and security requirements of BidSphere were determined.

The major functional requirements are: user registration and login; role-based access for Admin, Seller, and Buyer; product registration and management; online bid submission; bid validation; automatic auction closing; identification of the highest valid bid; winner announcement; and auction and user management by the administrator.

A. System Architecture

BidSphere is proposed as a web-based online auction and management system consisting of different user roles and functional modules. The authentication module provides registration and login, and users must access the system through their registered credentials. Sellers can add and manage product information for items intended for auction. A seller can create an auction by providing the required product and auction details, including the bidding period. Registered buyers can view available auction products and place bids during the active auction period. Before accepting a submitted bid, the system checks whether it satisfies the defined bidding conditions.

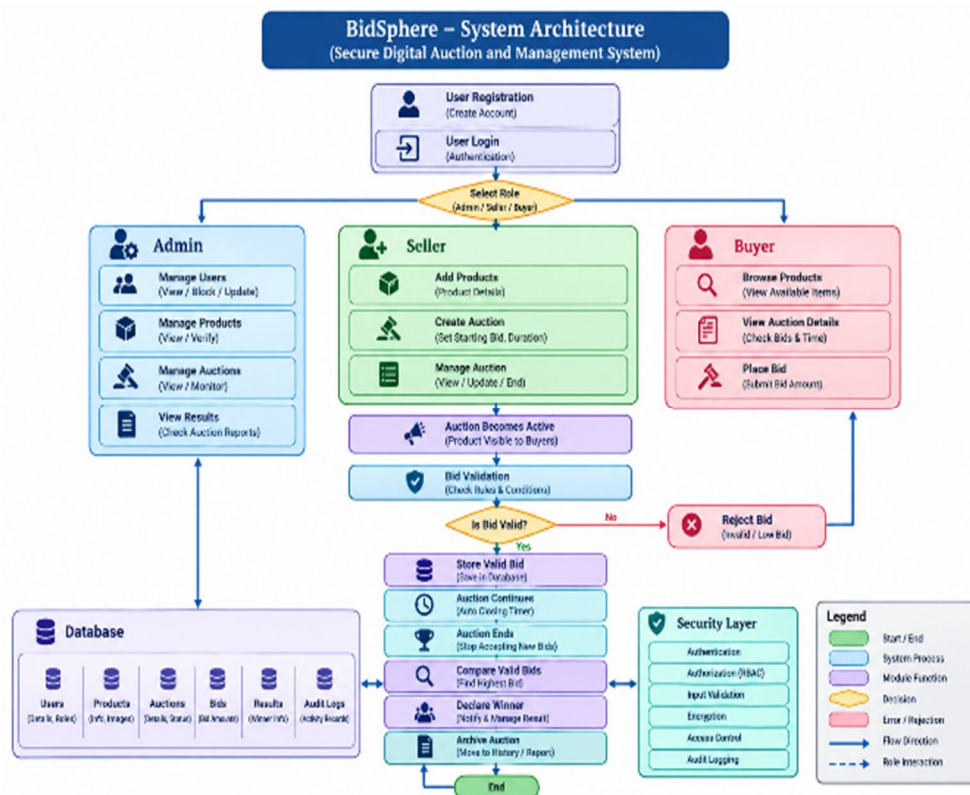


Fig. 1. Workflow of the BidSphere system architecture.

B. Bid Security and Confidentiality Analysis

Bid confidentiality was treated as an important requirement during the design of the methodology, because disclosing one bidder's value to another bidder can affect auction fairness.

Previous research has explored several cryptographic methods for protecting bids, including asymmetric encryption, digital signatures, hash functions, hybrid RSA/AES encryption, and fully homomorphic encryption (FHE) for privacy-preserving bid comparison. For BidSphere, these findings are used as security design principles. The paper claims only those cryptographic or blockchain mechanisms that are implemented in the current system. Advanced mechanisms such as FHE, zero-knowledge proofs, or blockchain commitments are therefore considered future enhancements.

IV. RESULTS AND DISCUSSION

This study shows that privacy, security, fairness, and transparency are essential requirements for an OAS. Several solutions have been proposed to meet them, and blockchain-based auction systems make bidding more secure and transparent. The basic requirements for secure bidding are user registration, authentication, bid validation, and winner selection. Advanced technologies are treated as future improvements rather than as part of the basic system.

A. System Functionality

The system supports three major user roles: Admin, Seller, and Buyer. The Admin manages users, products, auctions, and auction results. The Seller can add products and create and manage auctions by specifying parameters such as the starting bid and auction duration. The Buyer can browse available products, view auction details, and submit bids. Fig. 2 shows the category parameters (starting-price factor, reserve-price factor, and demand score) used by the price recommendation service. The role-based structure provides controlled access to the different system functions. It reduces unauthorized access to administrative and auction-management operations and gives a clear separation of responsibilities among users. Such controlled access is important in secure online auction environments, where the legitimacy of participants and auction operations affects system reliability [2], [3].

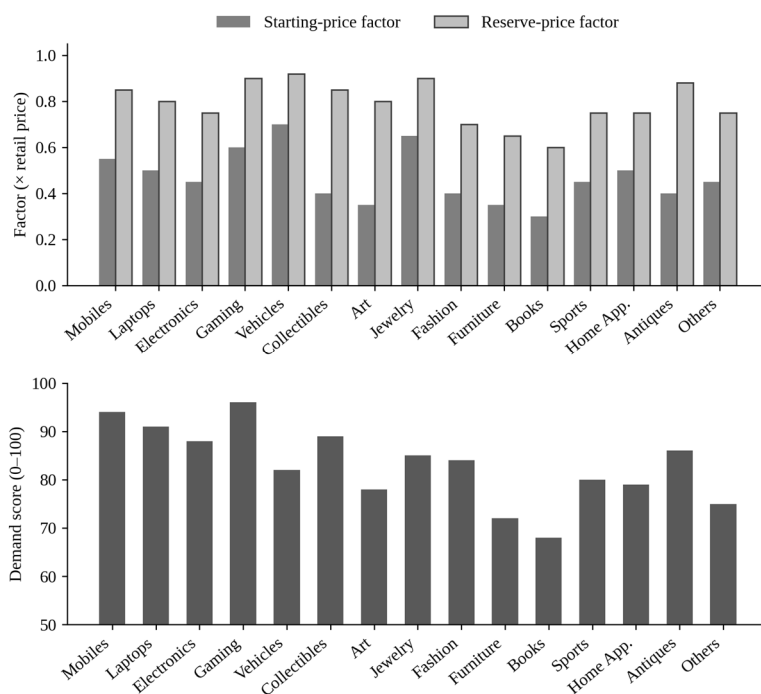


Fig. 2. Category parameters used by the price recommendation service.

B. Security and Access Control

Security is a major part of the proposed architecture. User authentication is performed during login, while authorization determines the functions available to the Admin, Seller, and Buyer roles.

This security-oriented design is consistent with previous research, which identifies security, privacy, data integrity, and verification as major challenges in online auction systems [1]–[3], [6]. However, unlike the blockchain-based solutions proposed in some studies, BidSphere currently uses a conventional web application architecture with application-level security and database management.

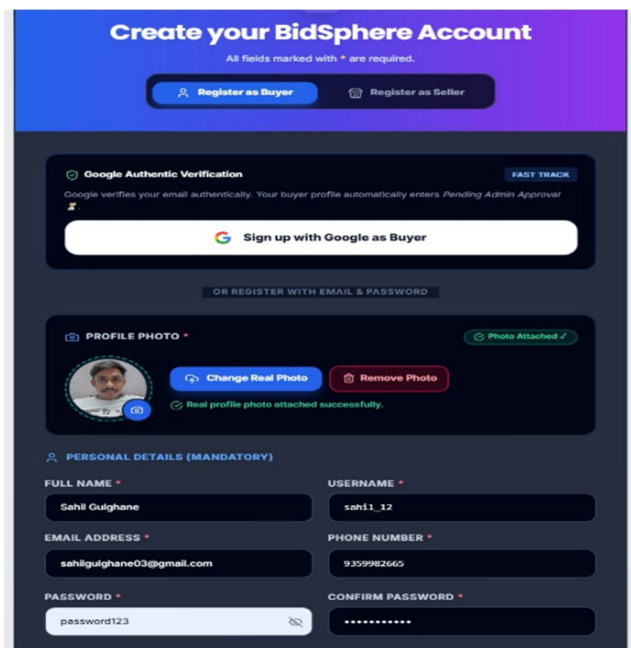


Fig. 3. Security and access control of the OAS.

C. Database Management

The system keeps auction-related information in a structured database. The main data categories are user information, roles, product details, auction information, bid records, and auction results. By storing bid and result records, the database also supports traceability of auction activities. This is relevant to previous research, which highlights the importance of traceability and reliable auction records for building confidence in online auction platforms [1].

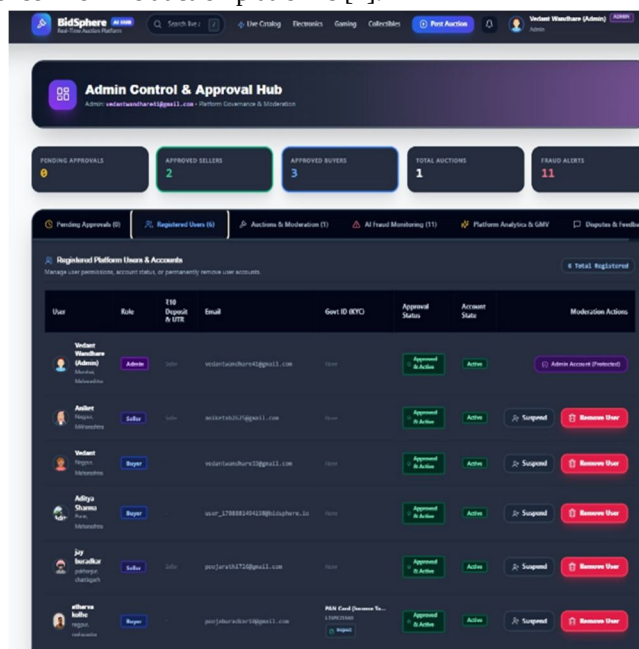


Fig. 4. Database management of the OAS.

D. Discussion

The results indicate that the proposed BidSphere architecture can organize the complete auction lifecycle, from user registration to winner declaration. The platform assigns distinct permissions to administrators, sellers, and buyers according to their respective responsibilities. The literature also indicates that advanced technologies such as blockchain, smart contracts, encryption, and zero-knowledge proofs can provide additional guarantees of transparency, privacy, and tamper resistance. Overall, the proposed system demonstrates that a structured web-based architecture can provide essential online auction functionality through authentication, authorization, bid validation, controlled data management, and automated winner selection. Future evaluation can measure the system using parameters such as response time, bid-processing time, database performance, successful bid validation rate, and system security under different user loads.

V. FUTURE SCOPE

The BidSphere platform can be extended with advanced technologies and security mechanisms investigated in existing research. Blockchain-based auction mechanisms could be considered in a future version to provide additional transparency and decentralized verification.

Sealed-bid mechanisms could be introduced to provide greater privacy for bidding information [3], [5]. Independent verification methods could be explored to allow auction outcomes to be checked without relying solely on the platform. [4].

Privacy-preserving techniques, including zero-knowledge proofs, may be considered for protecting sensitive bidding information. Future versions could also investigate trustworthy auction mechanisms with reduced communication overhead and evaluate the privacy-related costs of blockchain-based auctions.

The platform could incorporate enhanced security features to identify suspicious user activity and fraudulent bidding. These measures may help prevent unauthorized access, bid manipulation, and collusive bidding. Techniques for detecting malicious users, identity-based authentication [9], and automated detection of suspicious bidding patterns could be incorporated to reduce threats such as unauthorized access, bid manipulation, and shill bidding.

Scalability and performance evaluation are also important areas for future work. Large-scale testing and extensive testing can assess response speed, request-handling capacity, database efficiency, and overall system stability under varying workloads. These results can help determine whether BidSphere can support larger-scale auction operations, database performance, and system reliability under different workloads. These measurements would help determine the suitability of BidSphere for larger auction environments. Future versions may also include secure online payment and transaction management, so that completed auctions are followed by secure payment and order-processing workflows. Integration with notification services could alert users to new bids, outbids, auction completion, and winning results.

Finally, BidSphere could be developed into a more comprehensive, privacy-preserving, and decentralized BidSphere could be expanded into a secure and scalable auction platform by integrating stronger authentication, confidential bidding, independent result verification, blockchain-based records, and automated fraud detection. These improvements could enhance trust, protect sensitive information, and support reliable digital auctions, blockchain-based record management, and intelligent fraud detection. Such extensions would move the system beyond basic auction management toward a more trustworthy, scalable, and secure digital auction ecosystem.

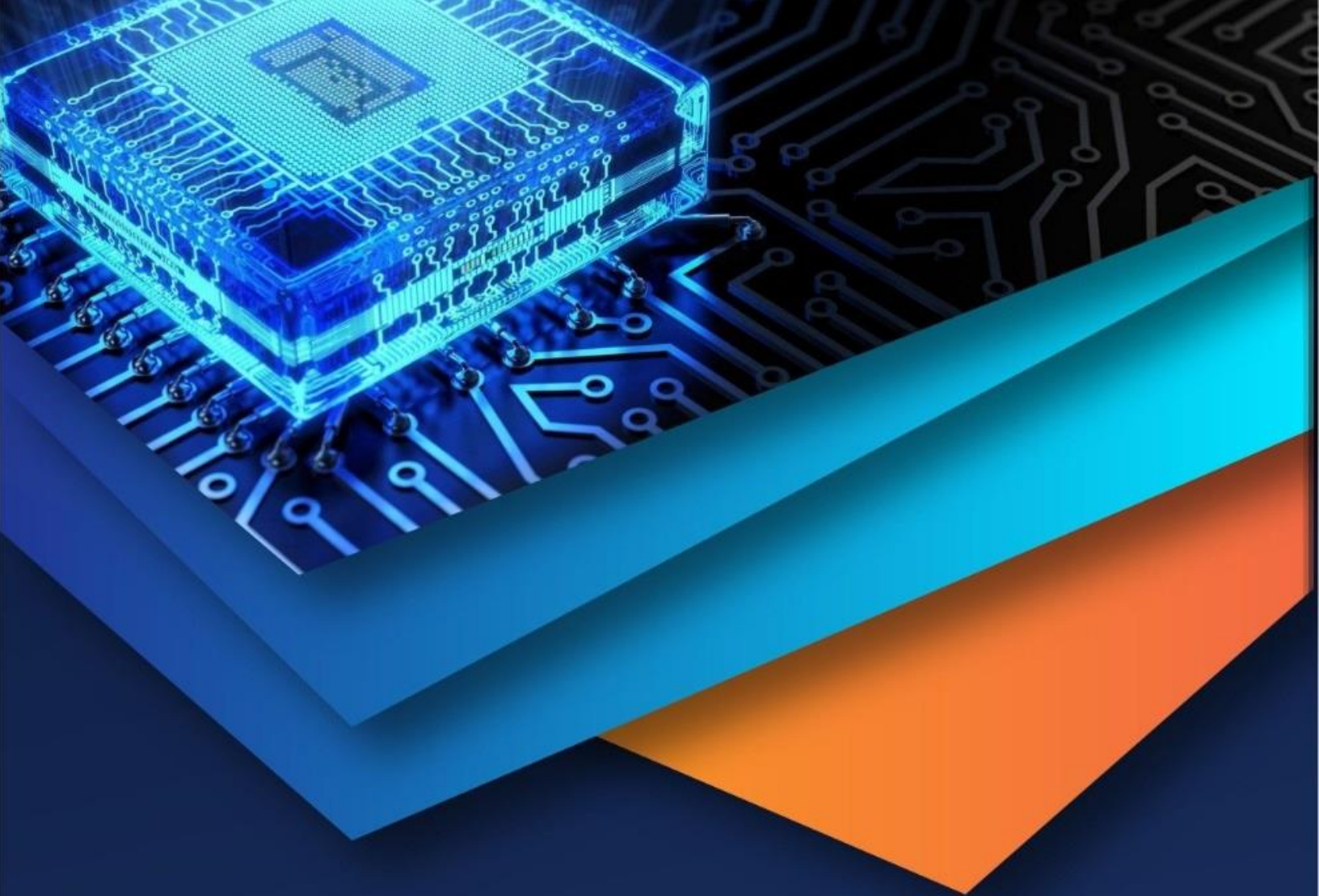
VI. CONCLUSION

This paper presented BidSphere, a secure digital online auction and management system designed to provide an organized platform for online auctions. The proposed system includes user authentication, product management, auction creation, online bidding, bid validation, automatic winner selection, and administrative management. It aims to simplify the online auction process by allowing sellers and buyers to interact with each other directly.

Overall, BidSphere demonstrates how essential online auction operations can be integrated into a centralized web-based management platform. Future integration of blockchain-based verification, privacy-preserving bidding, advanced authentication, fraud detection, secure payment processing, and scalability improvements could turn the current system into a more secure, transparent, trustworthy, and large-scale online auction platform.

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