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Development of an Integrated Commodity Auction System Based on the English Auction Model for Transaction Transparency and Efficiency

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Abstract

Commodity Auction Markets (PLK) serve as a platform for interactions between sellers and buyers to conduct transactions through a price-bidding system. Traditionally, these auctions are held offline to facilitate transactions between farmers, farmer groups, traders, businesses, and other commodity buyers. However, conventional auctions face multiple challenges, including inefficiencies in execution time, limited access to information for buyers, and high operational costs. This study aims to design and develop an Integrated e-Auction Market System (PLT) based on the English Auction model. The system supports the entire auction process from preparation, announcement, and bidding, to winner determination and transaction finalization. System development was conducted using the Rapid Application Development (RAD) approach for planning, analysis, design, and implementation phases. Unified Modeling Language (UML) tools were utilized to model system design components.The web-based PLT system successfully integrates all auction processes efficiently and transparently. It provides stakeholders with access to commodity catalogs, session schedules, and detailed transaction information, while enabling real-time online auctions. The implementation of this system is expected to broaden commodity marketing networks, increase local government revenues, and significantly reduce auction operational costs particularly venue rental expenses.

Keywords: *Integrated Commodity Auction, English Auction Model, Transaction Transparency, Auction Efficiency*.

1. Introduction

An auction is a process of selling goods or services to the highest bidder [1]. It typically involves three main parties: sellers, buyers, and auctioneers. Buyers compete by progressively offering higher prices to acquire the goods or services on offer [2]. Bidding is one of the primary mechanisms in auctions, where participants submit their price offers to win the item being auctioned [3]. Auction markets serve as platforms that facilitate commodity trade through competitive price mechanisms, allowing producers and buyers to interact efficiently.

The English auction model is the most commonly used auction mechanism, in which participants openly compete by continuously increasing their bids until no higher offer is made [4]. The process begins with a registration of items for sale and allows participants to competitively bid in a publicly visible and transparent environment.

Traditional auctions pose several challenges for both sellers and buyers. Sellers must physically prepare and transport items to the auction site, incurring logistical and storage costs. Buyers are required to travel to auction venues, resulting in additional time and expenses. Moreover, there is often a lack of standardized product certification, limited participant reach, and insufficient transparency in the bidding process.

An integrated electronic auction system offers a promising solution to these issues by enhancing transparency and accountability in the procurement process. It allows broader and more efficient participation from multiple stakeholders [5]. Such systems can streamline operations, reduce transaction costs, and minimize fraud by automating and standardizing auction procedures. This becomes increasingly crucial in electronic transactions that typically span multiple jurisdictions without requiring physical presence [6].

This study focuses on the development of a commodity auction system that supports the entire auction lifecycle including preparation, announcement, bidding, winner selection, and transaction finalization. It does not address payment methods, return policies, or delivery mechanisms. The system was developed using the Rapid Application Development (RAD) methodology, which includes four phases: planning, analysis, design, and implementation [7].

In the planning phase, system requirements were aligned with organizational business values. During the analysis phase, user needs were identified and examined using the PIECES framework [8], which also defined system functionality and user roles. In the design phase, outputs, database structure, and user interfaces were

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modeled using Unified Modeling Language (UML). Finally, the implementation was carried out using PHP as the programming language and PostgreSQL for database management. The system was tested using black-box testing techniques [9].
The resulting integrated e-auction system provides accurate information on item catalogs, auction sessions, and transaction details through a web-based platform. It simplifies the initiation of auction sessions and ensures broader accessibility for all stakeholders involved.

2. Research Methods

This study adopts a qualitative research approach. Data collection was carried out through interviews, observations, and literature review. Meanwhile, system design and development were conducted using the Rapid Application Development (RAD) methodology. The details of each method are described as follows:

2.1. Data Collection

Data collection involved three techniques: interviews, observations, and document analysis.
Interviews were conducted with stakeholders involved in the auction system, including government officials responsible for auction management, prospective bidders, sellers, and system operators. Additionally, stakeholders from the integrated farming system (e-KPB) platform (https://e-kpb.lampungprov.go.id) such as agricultural extension workers, farmer group leaders, and system administrators were also interviewed to gather comparative insights.These interviews were used to gather insights on user requirements, expectations, and the challenges faced in implementing the integrated e-auction system.
Observations were carried out to directly monitor the execution of electronic auction processes, from preparation and announcement to bidding, winner determination, and transaction finalization. This approach enabled the researchers to gain a deeper understanding of actual auction practices and to identify potential issues and challenges in system implementation [10].
Document analysis was used to collect data from various written sources, such as legal regulations related to auctions, auction documentation, auction result reports, and relevant scientific literature.

2.2. System Development

The system was developed using the Rapid Application Development (RAD) methodology, which comprises four main phases: Planning, Analysis, Design, and Implementation [9][35].
Planning Phase: In this phase, the researchers identified the business values and organizational needs that underpinned system development [9]. The system requirements were formulated based on business priorities, operational needs, and the expected value of the proposed system.
Analysis Phase: User needs were gathered and analyzed using the PIECES framework (Performance, Information, Economic, Control, Efficiency, Services) to define both functional and non-functional requirements [9][11][35]. Business process modeling produced use case diagrams to capture system behavior.
Design Phase: The researchers designed system forms, outputs, database structures, and user interfaces using Unified Modeling Language (UML) [12]. The database design included class diagrams, schema definitions, and data specifications [9]. The interface design involved menu structures and visual layouts for the system's user interface.
Implementation Phase: The system was implemented using PHP as the programming language and PostgreSQL as the database management system. To ensure the system's functionality met user requirements, black-box testing was conducted [13][14][15].

3. Results and Discussion

This section elaborates on the system development process based on the Rapid Application Development (RAD) methodology, which comprises four key phases: Planning, Analysis, Design, and Implementation. The details of each phase are described below.

3.1. Planning Phase

Based on the researchers' observations, the provincial government requires an auction market system to support domestic trade processes, increase monetary circulation, and contribute to regional revenue. The system is expected to meet business needs by providing accurate, real-time information that can be monitored and controlled by auction operators.
The business value offered by the system includes enhanced transparency of item conditions, prevention of winner fraud, generation of accurate reports, and equal opportunity for all stakeholders to participate in the auction process [9].

3.2. Analysis Phase

Based on the researchers' analysis, several issues were identified due to the manual nature of the auction sessions. The following is the PIECES analysis of the existing system and the proposed improvements:

Performance: Registration of potential buyers and distribution of catalog information by sellers are still carried out manually via SMS, email, and messaging applications. This manual process is time-consuming and may delay auction execution. The proposed system aims to improve operational performance by automating registration and information dissemination through an integrated digital platform.
Information: The current system lacks the ability to deliver accurate and timely information to auction participants due to its manual nature. The proposed system offers centralized, real-time access to data, which ensures better accuracy and availability of auction information [13].
Economy: Each auction session incurs significant operational costs, including venue rental, staffing, and time, as it is conducted offline. The proposed system reduces these operational expenses and time requirements by enabling fully online auction processes.
Control: Auction operators currently face difficulties in monitoring item catalogs, product quality, and transaction records. The proposed system will enhance control by enabling operators to manage, supervise, and evaluate auction performance effectively.
Efficiency: Manual auction sessions take a long time to complete, resulting in suboptimal handling of multiple auctioned items. The computerized system is expected to significantly improve the efficiency of the overall auction process [16].
Services: Sellers face challenges in participating due to the limitations of manual procedures. The proposed system will offer improved services by providing wider and easier access for sellers to list and sell their items [17].

3.3. Design Phase

During the study, the researchers designed the business processes, database structure, and user interface of the system.
Business process design. In this study, the researchers utilized Unified Modeling Language (UML) as a tool to model both the use case diagram [18]. The use case diagram representing the business process of the proposed system is illustrated in Figure 1.

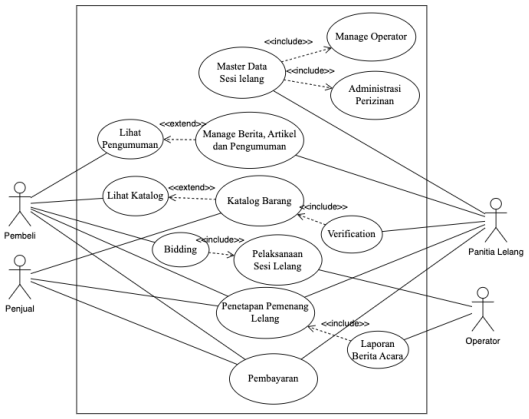

Figure 1. Business Process e-Market Auction

Figure 1 illustrates the business process flow of the auction system, which consists of the following stages: preparation, announcement, execution, winner determination, and transaction. The detailed explanation of each stage is as follows:

1. Preparation Stage. This stage involves the readiness of all necessary resources for auction implementation, including the setup of the electronic auction system, preparation of auction documents, and allocation of human resources who will be involved in the process [19].
2. Announcement Stage, This stage includes the dissemination of auction-related information to the public, such as the date and time of the auction, the types of goods or services to be auctioned, and the eligibility requirements for participants [16].
3. Execution Stage, This is the core activity of the auction, where participants submit their bids for the items or services being auctioned [13]
4. Winner Determination Stage, In this stage, the winning participant is determined based on the highest bid submitted, provided the bidder meets all the specified requirements [15][20]..
5. Transaction Stage, This stage consists of a series of post-auction activities, including payment by the winning bidder, delivery of the auctioned goods or services, and finalization of administrative tasks [21].

Database Design. In this study, the researchers designed a database to store and manage data in a way that enhances both efficiency and transparency within the auction system [21]. The following is a list of tables included in the designed database schema:

1. m_kontrak - {kontrak_id, kontrak_kode, simbol, minimum_transaksi, maksimum_transaksi, fluktuasi, diskon, tanggal_aktif, tanggal_akhir, mutu_id, komoditas_id, jenis_perdagangan_id}
2. m_gudang - {gudang_id, penyelenggara_pasar_lelang_id, gudang_kode, nama_gudang, contact_person, contact_number, nama_pengelola}
3. m_kontrak_keuangan - {kontrak_keuangan_id, jaminan_lelang, denda, fee_penjual, fee_pembeli}
4. m_event_lelang - {event_lelang_id, event_kode, nama_lelang, tanggal_lelang, lokasi, ketua lelang, waktu_sinkronisasi, keterangan}
5. d_lelang - {lelang_id, nomor_lelang, spesifikasi_produk, kuantitas, kemasan, harga_awal, harga_kelipatan, kontrak_id}
6. d_peserta_lelang - {peserta_lelang_id, harga_ajuan, kode_peserta, lelang_id}
7. d_approval_lelang - {approval_lelang_id, harga_pemenang}
8. d_pembayaran_lelang - {pembayaran_lelang_id, tanggal_pembayaran_lelang, tanggal_jatuh_tempo, status_penyelesaian}
9. d_status_proses_penyelesaian - {status_proses_penyelesaian_id, nomor_instruksi, nomor_faktur, tanggal_instruksi, rekening_pembayaran}
10. d_opsi_pembayaran_lelang - {opsi_pembayaran_lelang_id, jenis_member, jenis_opsi, tagihan, biaya_lain, penyelesaian}

Interface design. In the interface design stage, the system consists of five main components: Preparation, Announcement, Execution, Winner Determination, and Transaction. The details of each interface component are described as follows:

Preparation interface - This initial stage allows the auction committee to schedule auction sessions, assign human resources, and manage required administrative licensing documents. The committee inputs master data, including auction operators and session details. This interface also enables users to view key session-related information such as status, available resources, required documents, and session details [22][23]. The implication of this feature is to provide detailed information regarding the operational needs of each auction session, offering a comprehensive overview to ensure readiness. Session preparation details are shown in Figure 2.

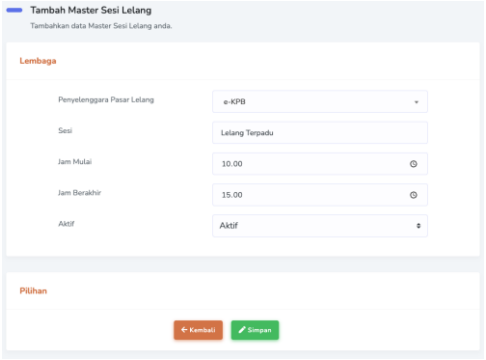

Figure 2. Auction Session Master Data

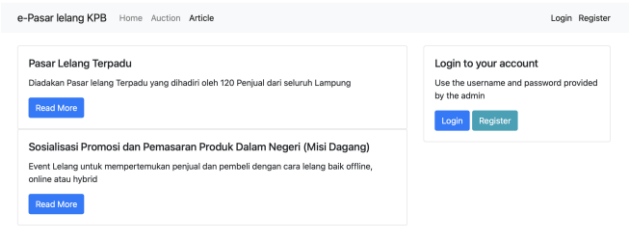

Figure 3. Auction Session Announcement

Announcement interface - In this stage, the auction committee announces upcoming auction sessions to the public through social media, web pages, and email [24]. This feature allows dissemination of key details, including date, time, location, and items to be auctioned [25]. The purpose of this interface is to ensure that comprehensive auction information reaches a wide audience efficiently [26]. Details of the announcement interface are presented in Figure 3.

Execution interface - This is the core stage where auction participants submit bids for the listed goods or services [27]. The interface must be capable of recording each incoming bid, displaying the current highest bid, and notifying participants when higher bids are submitted [28]. This feature is designed to enhance transparency and accountability during the bidding process [9]. Details of the bidding interface are illustrated in Figure 4.

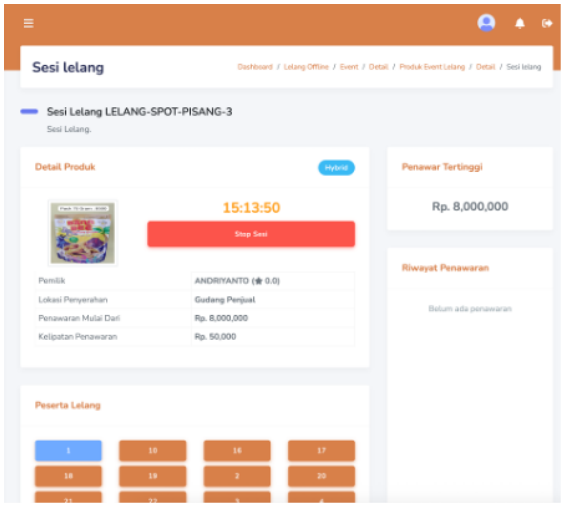

Figure 4. Auction Implementation

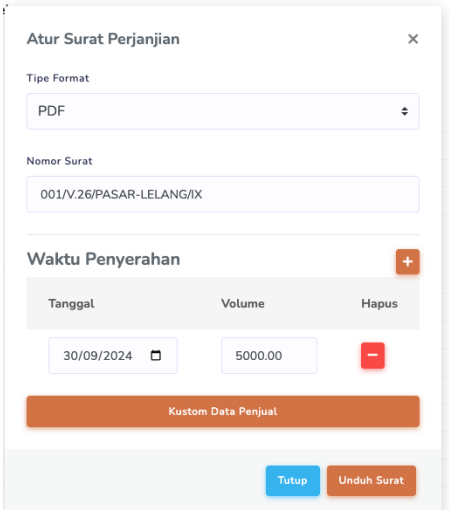

Figure 5. Determination of Auction Winner

Determination of auction winner interface - This stage involves determining the winner based on the highest valid bid submitted and fulfillment of auction requirements [29]. The interface allows the committee to evaluate all submitted bids and fairly select the winning bidder [1]. This ensures the selection process adheres to clear, objective criteria. Details of this interface can be seen in Figure 5.

Auction transaction interface - This final stage occurs after the winner is determined. It includes payment by the winning bidder, delivery of the auctioned items, and completion of administrative procedures [30]. The interface enables users to make payments and track the status of their transactions [31]. It supports efficient and transparent transactions between the auction organizer and the winning bidder [32][33]. Details of the transaction interface are provided in Figure 6.

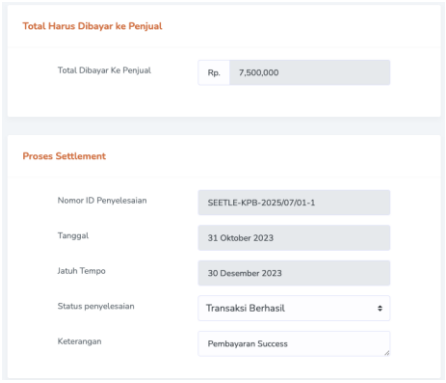

Figure 6. Auction Transaction

3.4. Implementation Phase

The proposed system is developed as a web-based application. It is built using the PHP programming language with the Laravel framework, and employs PostgreSQL as the database management system. The system functionalities were tested using the Black-Box Testing method to evaluate whether each feature performs according to its intended function.

The following are the features tested using Black-Box Testing:

1. Auction Session Master Data
   Test procedure: The auction committee inputs the session date, operator details, and licensing documents through the form.
   Result: The data was successfully stored in the system, indicating that the feature performs as expected.
2. News, Articles, and Announcements
   Test procedure: The committee inputs auction-related news, articles, and announcements.
   Result: The data was saved in the system and displayed to the public, confirming expected behavior.
3. Auction Bidding Feature
   Test procedure: During an active session, a participant presses the bid button to submit an offer.
   Result: The bid was successfully recorded in the system, and the current highest bid was updated accordingly demonstrating expected functionality.

4. Winner Determination Feature
   Test procedure: The system automatically identifies the participant with the highest bid. The committee then generates an official report to be signed, and the system announces the winner.
   Result: All processes executed correctly, indicating that the feature functioned as intended [15].
5. Auction Payment Feature
   Test procedure: The system displays the payment details required from the auction winner. The winner uploads proof of payment after transferring funds via bank.
   Result: The system successfully validated the payment and updated the transaction status [34].

4. Conclusion

Throughout the development of the Integrated Auction Market System, the researchers gathered relevant data and applied the Rapid Application Development (RAD) methodology. As a result, the system has been implemented by the provincial government to support domestic trade processes. The Integrated Auction Market System has the potential to attract wider public participation in auctions, contributing to local economic growth. Transaction status updates and related information are consistently relayed to the committee, ensuring smooth and well-monitored processes.

The system successfully addresses previous challenges such as difficulties in managing product catalogs, assessing item quality, accessing physical auction venues, and minimizing inefficiencies in time and cost. These issues have been mitigated through the digitalization and automation offered by the system. In the future, the system can be further enhanced—not only through the adoption of microservices architecture, but also by integrating blockchain technology to monitor the logistics and supply chain of auctioned commodities in a secure and transparent manner.

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