

# Building an Electronic Auction Platform for Recyclable Waste Trading with Gamification Implementation

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**Abstract:** Waste is becoming a prevalent problem in Indonesia. Waste is overproduced to the point that waste landfills are constantly struggling to keep up, and are forced to do destructive, polluting methods. Recycling campaigns have been organized and socialized into the society to promote and motivate recycling in order to tackle waste problems, but failed to do any significant impact. Difficulties in finding recyclable waste buyers and insufficient information of recyclable waste market price further demotivates society to recycle. This paper introduces eLDUS, an electronic auction for recyclable waste auctions, as a solution to attract and motivate society to recycle their waste. A prototype is developed in the form of mobile applications and a web service to facilitate e-auctions for prospective sellers and buyers. To further engage and retain users in continuing the usage of eLDUS, gamification is implemented into the system with the help of the Octalysis framework. A closed beta test involving ten respondents are then conducted. Respondents' responses are analyzed to find insights and draw conclusions. The concept is well-received and can attract and motivate respondents to recycle. The prototype has been evaluated to be very intuitive, easy to use, safe, and convenient in general. The implementation of gamification has been found to provide positive impact to the respondents' experience.

**Keywords:** Electronic Auction, Gamification, Recyclable Waste, Software Development

## 1. Introduction

### 1.1. Background

Waste is becoming a prevalent problem in Indonesia. On average, a person produces 700 grams of waste each day, totaling 175 thousand tons of waste produced in Indonesia every day (Jong, 2015). 69% of the waste goes to landfills or final disposal sites. Those disposal sites are constantly struggling to cope with the ever-growing waste amount, and are forced to do quick, destructive methods, such as burning the waste (which causes air pollution) or simply throwing the waste into the sea (which causes sea pollution) instead of preservative, albeit slower methods such as recycling.

The core problem that needs to be solved is society's motivation to do proper waste management. There are several organizations and communities who have committed themselves in collecting and sorting recyclable waste, ranging from Bank Sampah (translated into Waste Bank, where they will purchase recyclable waste from residents nearby), educational institutions, and informal communities. The waste they collected is usually sold to a buyer for fundraising.

However, it is difficult to find a suitable recyclable waste buyer for new entrants. They often do not have information about their whereabouts and when they do find one, price is usually skewed to the buyer's advantage, leaving the seller with a smaller earning, which may demotivate them.

### 1.2. Objectives

The main objective of this research is to develop an electronic auction platform which is exclusive to recyclable waste. Gamification will then be implemented to this platform to increase overall user engagement. Additionally, interviews will be done to find society's interest towards the concept.

### *1.3. Significance of Study*

This research tests and observes whether the novel idea of an electronic auction platform can attract and motivate society to recycle. Additionally, this study studies whether the implementation of gamification can provide positive impact to user's experience in using the application provided.

## **2. Literature Review**

### *2.1. Auctions and Electronic Auctions*

Auction is a process of selling or buying goods and services in the form of participants entering a bid with the intention of finalizing the transaction to the highest bidder. Electronic auction, as the name implies, is an auction held online, with eBay as a popular example. Among all existing types, the most common type of e-Auction is the English auction (Wahaballa et al., 2015).

A typical auction is either a forward auction or a reverse auction. Forward auctions are auctions whose primary goal is to drive the price to the highest attainable. On the other hand, reverse auctions attempt to drive the price to the lowest attainable, and is usually used in procurement processes.

Aside from single-unit auctions, there are also multi-unit auctions, where multiple units of item (be it heterogeneous or homogeneous) are sold together in a single auction. Multi-unit auctions are usually done with sealed bids, with each buyer writing down their desired quantity and the price per unit. The auctioneer then gives the requested number of items to the highest bidder, continues to the second highest bidder, and so forth until the stock is exhausted. The price to be paid differs according to the auction type, which are either a uniform-price auction or discriminatory-price auction (Baisa & Burkett, 2018).

### *2.2. Gamification*

Gamification is a process of incorporating game elements into a non-game environment to improve overall user engagement (Oprescu et al., 2014). It tries to include game mechanics, such as levels, progression, statuses, and others, into an established environment, in hope to encourage and motivate users in continuing the use of the application.

Octalysis is a popular gamification framework created by Yu-Kai Chou. According to Octalysis, there are eight core drives of gamification, which are Epic Meaning & Calling, Development & Accomplishment, Empowerment of Creativity & Feedback, Ownership & Possession, Social Influence, 3. Relatedness, Scarcity & Impatience, Unpredictability & Curiosity, and Loss & Avoidance (Chou, 2015).

### *2.3. Octalysis-based Gamification Example*

Interactivia.ro is a non-formal educational platform situated in Romania. The platform has an average daily page-view of 170 and average time spent of two minutes. Unsatisfied with this result, the developers decided to gamify their platform with the services of CaptainUp, a loyalty program platform which offers gamification features to their clients. CaptainUp's gamification features implements all eight Octalysis' core drives and successfully expands and integrates them into website-based platforms.

After careful testing and analysis for about fifteen months, it has been concluded that the inclusion of CaptainUp has resulted in a 12.5 times increase in Interactivia.ro's platform traffic (Maican et al., 2016).

### *2.4. Existing Waste-related Businesses and Applications*

The researchers have found four waste-related businesses in Indonesia which has released their services in the form of web pages or mobile applications. The businesses are named Angkuts, Sampahmuda, Gringo, and Simalu.

### 3. Analysis and Design

#### 3.1. Research Overview

Before starting the prototype development, business requirements have to be established first. The requirements are analyzed and then translated into a set of diagrams as the basis of the prototype development. The first prototype is then alpha tested to ensure that all business requirements are met.

Results of the alpha test is then analyzed and considered for improvements in the second development cycle. The second prototype is then used for the closed beta test. Ten respondents have been selected and interviewed. Their answers are then used to find further insights and draw conclusions. Figure 1 illustrates the research overview.

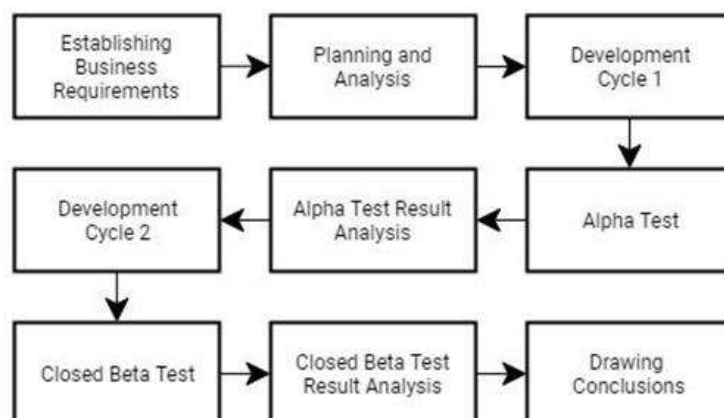


Figure 1: Research overview

#### 3.2. Business Model Considerations

There are two considerations: eLDUS being a C2C (Consumer-to-Consumer) e-commerce or C2B (Consumer-to-Business) e-commerce, and then eLDUS built with an online marketplace infrastructure or an electronic auction infrastructure.

Due to the conditions requiring eLDUS to be easily scalable and with minimum capital provided, it is decided that eLDUS will be a C2C e-commerce, acting only as an intermediary platform between sellers and buyers.

The electronic auction infrastructure is chosen over online marketplace because the sellers (which are new entrants to the recyclable waste market) are not informed with the current market price. With auction infrastructure, we let buyers (who knows the market value) set the prices and compete against each other in biddings. In optimal condition, the bidding should continue increasing until the highest bid has reached near the market value.

#### 3.3. Gamification Implementation

Based on the Octalysis framework, eLDUS will implement seven out of eight core drives, which can be seen in detail in Table 1.

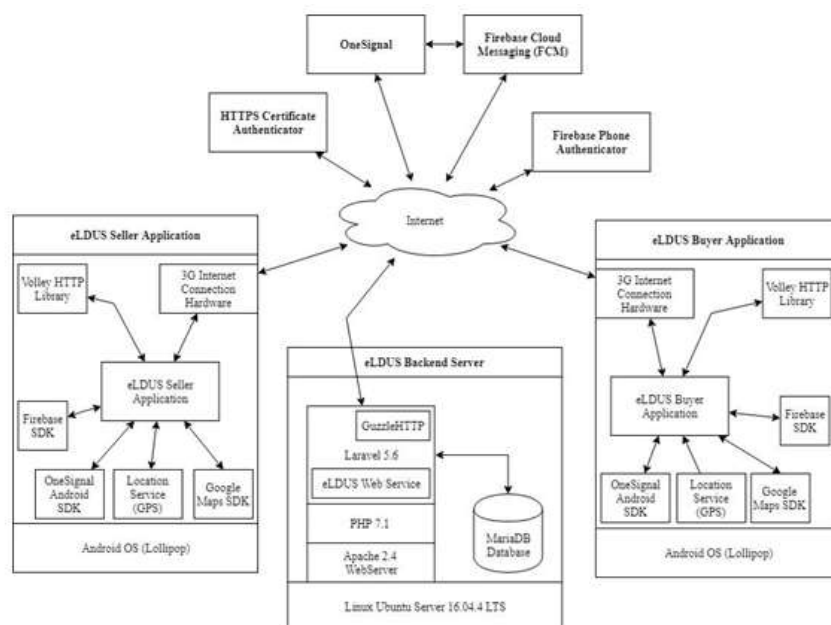
Table 1: Implementation of gamification in eLDUS

Core Drive	Implementation
Epic Meaning & Calling	Indirectly motivate users that they are saving the environment by reducing waste problems.
Development & Accomplishment	Level, badges, points, leaderboard standings.
Empowerment of Creativity & Feedback	Not implemented as no correlation between this core drive and eLDUS' base design can be found.
Ownership & Possession	Badges, points, sense of investment.
Social Influence & Relatedness	Ability to share profile or achievements to social medias.

Scarcity & Impatience	Exclusive or limited badges.
Unpredictability & Curiosity	Nature of auction systems – biddings.
Loss & Avoidance	Nature of auction systems – fear of missing out.

### 3.4. Architecture Diagram

The architecture of eLDUS can be seen in Figure 2. eLDUS are divided into three subsystems, which are eLDUS Penjual (Buyer) mobile application, eLDUS Pembeli (Seller) mobile application, and eLDUS backend server which also serves as the API endpoints for the mobile applications.



**Figure 2:** Architecture diagram of eLDUS

### 3.5. Workflow Overview

The process in eLDUS to complete a single transaction is divided into four main phases, which are configuration phase, bidding phase, handshaking phase, and transaction phase. In configuration phase, sellers will list their waste to be auctioned and set several configurations of their auction. In bidding phase, buyers will bid on available auctions. Sellers will choose by themselves which offer they want to take.

Buyers who have their offer accepted by a seller will continue to the handshaking phase, and will be send to a negotiation room, where the buyer and seller will further negotiate additional details, such as delivery cost, delivery methods, etc. If an agreement is reached, then they will continue to the transaction phase, where the actual transaction is done. Table 2 describes in detail what buyers and sellers can do in each main phase.

**Table 2:** Use cases of eLDUS' users in each phase

Phase	Sellers can	Buyers can
Configuration	List waste to be auctioned. Configure their auction settings. Open their auctions.	Receive notification of a new open auction.
Bidding	Accept or reject a buyer's bid (offer).	Participate in an open auction. Place initial bid. Edit or retract existing bids. Reconfirm accepted bid. Decline accepted bid.

Handshaking	Receive other party's information. Communicate and negotiate with the other party. Offer handshake (agree). Retract handshake (cancel agreement). Call off negotiation.	
Transaction	Accept or decline transaction content changes. Call off transaction.	Issue a transaction content change request. Finalize the transaction.

### 3.6. Design of Experiment

There are two tests: the alpha test and the closed beta test. The alpha test aims to ensure that the prototype has fulfilled all initial business requirements. The closed beta test aims to find the general impression of the concept and the prototype in the perspective of end-users.

The closed beta test is conducted with a face-to-face interview. A questionnaire and a single ease question form, which are made with a 5-point Likert scale answers, are given to the respondent. The answers provided are then collected and used to derive a conclusion on three parameters: concept strength (ability of concept to attract and motivate respondent), application quality, and gamification impact.

The respondents are required to give their answer against the statements from 1 (strongly disagree) to 5 (strongly agree). All respondents are given equal weight irrespective of their background, finding the global average of all respondents who participated in the closed beta test. Furthermore, statements are given different weights based on how relevant they are when included in the calculation to find a specific conclusion and answer.

## 4. Results

### 4.1. Development Results

The development has resulted in a prototype of a system composed of two Android-based mobile applications, each dedicated for sellers (eLDUS Penjual) and buyers (eLDUS Pembeli), and a Laravel-based application acting as the web service (API endpoints) for eLDUS' mobile applications and as eLDUS' website.

### 4.2. Closed Beta Test Results

A closed beta test is done with ten participants of diverse backgrounds. They are given a set of questionnaires, and then interviewed to extract more information. Additionally, they are given the chance to use the prototype to judge its simplicity and intuitiveness. A scoring based on 5-point Likert scales are done, and the result is expanded as written in the following sections.

#### 4.2.1. Concept Strength

Respondents are interested (4.1) with the concept of recyclable waste electronic auction. Respondents think that their colleagues and friends will be slightly interested (3.7) with the concept of recyclable waste electronic auction. Respondents are slightly motivated (3.8) to participate in recycling waste, given that the implementation of the concept exists.

In conclusion, the concept of a public electronic auction which is exclusive to recyclable waste can (3.9) attract and motivate society to recycle.

#### 4.2.2. Application Quality

Respondents feel that the implementation of rekber slightly provides (3.6) them with a safe environment for transactions in eLDUS. Respondents strongly agree (4.7) that eLDUS applications are simple and convenient. eLDUS' applications are very intuitive (4.83) and are very to use (4.81).

In conclusion, eLDUS applications are very intuitive, easy to use, convenient, and safe in general (4.48).



#### 4.2.3. Gamification Impact

Respondents strongly agree (4.7) that level and point implementation have benefits, and agree (4.3) that it brings positive impact to their experience. Respondents agree (4.3) that achievements and badges implementation have benefits, and agree (4.3) that it brings positive impact to their experience. Respondents slightly agree (3.67) that leaderboards and exclusive badges implementation has benefits, and are quite mixed (3.44) about its positive impact to their experience.

Respondents agree (4.1) that social media sharing implementation has benefits, and slightly agree (3.7) that it brings positive impact to their experience. Respondents realize (4.1) that by using eLDUS, they become a member of a community sharing the same goal of preserving the environment from waste problems. Respondents feel slightly motivated and called (3.5) to recycle waste by using eLDUS. Respondents strongly agree (4.6) that as a seller, the auction format results in offers with the highest price possible. Respondents agree (4.1) that as a buyer, the auction format lets them find great deals and opportunities.

In conclusion, gamification implementations in eLDUS provide (4.05) positive impact to eLDUS' users' experience.

#### 4.3. Correlation Analysis

This section analyzes correlations between concept strength, application quality in general (intuitiveness, ease of use, safety, and convenience), gamification impact, and willingness to use eLDUS. A correlation coefficient (linear relationship) is calculated to find the strength and direction of a linear relationship between those variables and respondent's willingness to use eLDUS, as answered in Q5.

The analysis results are as following. The correlation coefficient between respondents' gamification impact in general and their willingness to use eLDUS is 0.72, indicating a strong positive linear relationship. The correlation coefficient between application quality in general and respondents' willingness to use eLDUS is 0.36, indicating a slightly moderate positive linear relationship. The correlation coefficient between concept's strength and respondents' willingness to use eLDUS is -0.03, indicating no linear relationship.

This analysis has shown that gamification plays a huge part in an application's attractiveness. The application's quality also plays a part, but is less significant compared with gamification impact.

### 5. Conclusion

The development of eLDUS as a platform for electronic auctions exclusive to recyclable waste has resulted in a prototype divided into four parts, which are eLDUS Penjual (seller) mobile application, eLDUS Pembeli (buyer) mobile application, eLDUS Web Service (API Endpoints), and eLDUS simple Admin Panel.

A closed beta test with ten selected respondents with varying backgrounds are done with the latest prototype. The concept of recyclable waste electronic auction is well-received and can attract and motivate respondents to recycle (average score of 3.9 out of 5). Respondents have tried to use eLDUS' mobile applications and evaluated that eLDUS is very intuitive, easy to use, safe, and convenient in general (average score of 4.48 out of 5). The implementation of gamification has been found to provide positive impact to the respondents' experience in using eLDUS (average score of 4.05 out of 5).

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