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Architectures for a Blockchain-based Decentralized Marketplace for Handicrafts

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Abstract—**One of the significant problems of handicraft makers is the inability to trade with customers directly. They are forced to sell their crafts to intermediaries, which increases the final price. To avoid such an issue, peer-to-peer marketplaces are built to connect producers and customers directly. The ownership and control of these marketplaces are still in the hands of specific parties. Decentralized markets overcome these drawbacks at a reasonable level. Blockchain has become a great tool to develop decentralized markets due to solving the shortcomings of decentralized systems. We have studied, categorized, and discussed existing decentralized e-commerce platforms. To cover the shortcomings of decentralized e-commerce platforms, we designed a conceptual marketplace for trading handicrafts along with an insurance mechanism for deliveries, seller's reputation, and a guarantee system for producer's verification. Comparing the handicraft marketplace with other similar decentralized markets proves offering better and more service to marketplace actors is achievable.**

Keywords: HandiCrafts, Centralized Marketplace, Decentralized Marketplace, Blockchain Technology, Smart Contract, Ethereum.

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I. INTRODUCTION

Handicrafts are handmade products often made by individuals using and they carry a cultural heritage motif [1]. Since handicrafts are traditional and not industrial products, one of the primary problems of handicraft makers is the inability to trade directly with local or global customers. Because of this problem, many artisans either sell their products to intermediaries unwillingly or have to find a way to sell their crafts in a peer-to-peer way (e.g., peer-to-peer markets and social media marketing [2]. Therefore, we either see a significant increment in fixed price caused by selling crafts underpriced to intermediaries or a significant decrease in producer's income due to paying fees and subscriptions to peer-to-peer markets [3] The amount that could have been shared between producers and customers to decrease fixed price and increase producer's income now belongs to third parties. A critical issue for adopting social media is trust management [4]. Buyers either have to trust peer-to-peer markets or unknown individuals in social media. To solve these problems, artisans and customers need

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to trade directly without trusting any entity or paying fees to any third party.

In daily trades, trust in another party or a third party is a critical issue. Finding a trusted party to trade directly is hard, and trusting to a third party to trade in place of is risky. A solution to the trust issue is to create an environment in which parties do not need to trust each other or any third party. In such an environment, parties do not need to expose their real identity. Blockchain technology provides infrastructures to make trustless environments for trading in which parties do not need to trust any party to trade.

A centralized peer-to-peer market provides an excellent way for handicraft makers to sell their products to buyers. However, since the owners of these markets have complete control, producers cannot straightforwardly trade with customers. This issue can lead to an increase in the final price as well. Buyers and sellers still need to trust market owners, and marketplace owners can ban users on their whim [5]. Violation of user's data privacy [6], lack of transparency in different subjects [7], unfair listing and selling fees, and the capability to censor items and events by marketplace owners are problems that cannot be ignored.

In decentralized systems, the trust issue is one of the main problems caused by a lack of central authority that governs and controls the system. Blockchain technology overcomes this issue by providing multi-party consensus mechanisms, cryptography, and most importantly, transparency. Using a reputation system for sellers can increase the trust level in the marketplace. In addition to the above features, blockchain has a high resistance level against censorship.

In recent years, many decentralized peer-to-peer markets have been made using blockchain technology. Although blockchain and decentralization overcome the problems of mentioned centralized markets, the lack of central authority for governance and dispute resolution can cause its problems. These problems can be further extended into decentralized electronic commerce (e-commerce) markets in which users can trade physical products such as handicrafts. The quality and originality of some products are essential. Users need to be ensured that they get their purchased products delivered without any damage. Lack of feeless reputation system is also vital to maintain trust level of buyers to sellers. In addition to mentioned problems, verification of artisans is also a crucial matter because there are many traditional individual producers, and lack of central authority to authenticate them can cause many problems like reducing overall trust to system selling low-quality products.

This paper tries to introduce and implement a decentralized marketplace based on blockchain technology called the "Handicraft (HC) marketplace", in which handicraft makers and customers can trade directly without the need of any trusted party. In the HC marketplace, a decentralized reputation system is used to test seller's honesty. An Ethereum-based token is used for payments that can be exchanged into any similar token or cryptocurrency. We have added multiple roles to solve the addressed problems of decentralized e-commerce markets. Arbitration, auditing, affiliating, proof of origin, and decentralized insurance are the unique features of the HC marketplace.

We have separated the decentralized HC market into two different marketplaces. The first marketplace aims to reduce the cost and increase simplicity for both buyers and sellers. The second marketplace is fit to sell high-value and unique products because of using multiple parties and experts to increase trust and reliability. In this way, more users (except buyers and sellers) can have their income in this architecture.

This paper is divided in seven sections: in section 2, we attempt to explain the blockchain technology and the prerequisites of implementing a decentralized market. In section 3, the methodology underpinned to setup a HC marketplace is described. In section 4, 5 system design and implementation are discussed and finally in sections 6, conclusions are mentioned.

II. Related Work

A. *Blockchain technology*

The distributed ledger technology (DLT) is an umbrella concept that includes multiple technologies. Blockchain technology, as a DLT, consists of chained blocks, transactions, and data in the form of shared records [8]. Users can safely confirm transactions without the need of any trusted central authority [9]on a peer-to-peer network and thus transfer any valuable asset [10]. Cryptographic proof [11], immutability [12], transparency, tamper resistance, shared recordkeeping, independent validation, and most importantly, decentralization, are the main features of blockchain networks [13]. [14] explains blockchain technology and its characteristics in details.

B. *Decentralized electronic commerce markets*

The service marketplace is a type of online marketplace where customers can order and purchase software services from providers [15]. In contrast, in some other types of markets, users are only permitted to trade physical goods. In such marketplaces, users can purchase their physical goods and have them delivered in the real world. Centralized marketplaces recommend solutions that solve seller's reputations and dispute resolution problems, but they create trust issues, as well. The most critical problem with a reputation system is making barriers for new sellers [16] [17]. Trustless intermediation can be introduced in the form of service marketplaces to solve matters like transaction deployment and dispute resolution without the need for any third party [18]. [19] introduce a decentralized marketplace for trading directly without using blockchain technology. [20] introduce an Ethereum Dapp that cannot be discriminated against because of using smart contracts. Publicly verifiable transparency, lower transaction costs, high data security guaranteed by Ethereum, and safe data control by users are presented in the application. [21] present a proof of

concept for a decentralized marketplace based on Ethereum blockchain that enables users to trade directly without any intermediaries and eliminate the risk of processing user data and selling them as information by marketplace owner. Ink platform [22] helps users with the pricing of goods remain in stocks for so long, (because of lacking a place or online store to sell them) by offering an ERC-20 based token and a reputation system. Origami [23] solves trust issues with fake comments and centralized escrows by making an online decentralized marketplace. Origin protocol [24] uses Ethereum smart contracts and a decentralized storage platform like interplanetary file system (IPFS) [25] to build a decentralized marketplace that operates in any field with complete transparency. Origin protocol claims, soon, its token can be used as a governance token that gives the holders, the right to decide about the future of the system.

C. *The problems of decentralized electronic commerce markets*

Open Bazaar [26] is known as the first decentralized peer-to-peer market. This market only uses blockchain technology for cryptocurrency payments. There is no guarantee for a secure trade, quality of goods, and no breakdown of deliveries due to no use of smart contracts. Using third parties for assuring trades is also challenging. Because there is no guarantee for the honesty of these third-parties, and there will be no penalty for these parties in case of cheating.

In [19], a decentralized market was made without using blockchain technology. Therefore, to assure the honesty of sellers and buyers, they must be identified and verified by related entities such as banks and the government to establish the trust base. The biggest issue of this marketplace is the dependency on centralized authorities mentioned before. The proof of concept for designing a decentralized market offered in [21] reduced the cost of interacting with a marketplace for both seller and buyer. Nevertheless, the lack of pricing mechanism, lack of decentralized reputation system, no marketing mechanism, and no verification of originality are the shortcomings of the mentioned market.

The DMR marketplace [27] has made car trades available in a decentralized manner using the Ethereum blockchain and smart contracts. However, the lack of guarantee for the physical health of cars, fixed pricing, and lack of dispute resolution are the drawbacks of using this market. Origami [23] is a decentralized online market that is used for trading physical goods. Using oracles for releasing funds in escrows and automatic payments to sellers is the main feature of this marketplace. The oracles inter data to a smart contract and release funds right after the delivery reaches its destination. The shortcoming of this approach is that there is no mechanism to stop payment in case of goods breakdown, disputes, or other possible problems. As mentioned, Origin protocol [24] is a decentralized online marketplace that is used for trading physical goods or services. The marketplace offers a suitable marketing mechanism using affiliate marketing. However, failure to confirm the seller's honesty, lack of expert entities for approving originality of goods or services, lack of insurance mechanism for deliveries, and lack of solid decentralized reputation system are the main challenges of Origin protocol. Table 1 lists and compares the features and problems of the mentioned marketplaces.

III. METHODOLOGY

In this study, forecasting confirmed and recovered COVID-19 time-series data involves the use of deep learning techniques, which may automatically learn relevant data from time-series data. LSTM [37], CNN [38], [39], RBM [40], Generative adversarial networks based on deep fully connected neural networks (GAN-DNN) [41], GAN-GRU [41], [42], and LSTM-CNN are briefly described in this section. This paper focuses on the adaptation of blockchain technology to different decentralized marketplaces. We have studied various blockchain-based decentralized markets and made different categories of decentralized markets. Most of the studies are about markets in which users trade non-physical products or services, but a few have focused on decentralized e-commerce markets. There are more challenges in these markets than in the previous category.

TABLE I. THE COMPARISON OF EXISTING DECENTRALIZED ONLINE MARKETS

Market name / Features	Origin	Origami	Distributed Marketplace [21]	DMR [27]	Serban [19]	Open Bazaar
Technology	blockchain	blockchain	blockchain	blockchain	web 2	crypto-currency/ web 2
Market type	retail and services	retail	retail	vehicles	general market	open market
Pricing	fixed/ request for change of price from buyer	dynamic bids from buyer	fixed	fixed	fixed	fixed
Decentralized Reputation	×	×	×	×	×	×
seller's honesty confirmation	×	×	×	×	×	third-party guarantee
Affiliate	✓	×	×	×	×	×
Product verification specialist	×	×	×	×	×	×

Arbitration	✓	×	✓	×	×	×
deliveries Insurance	×	×	×	×	×	×
Oracles	×	✓	×	×	×	×

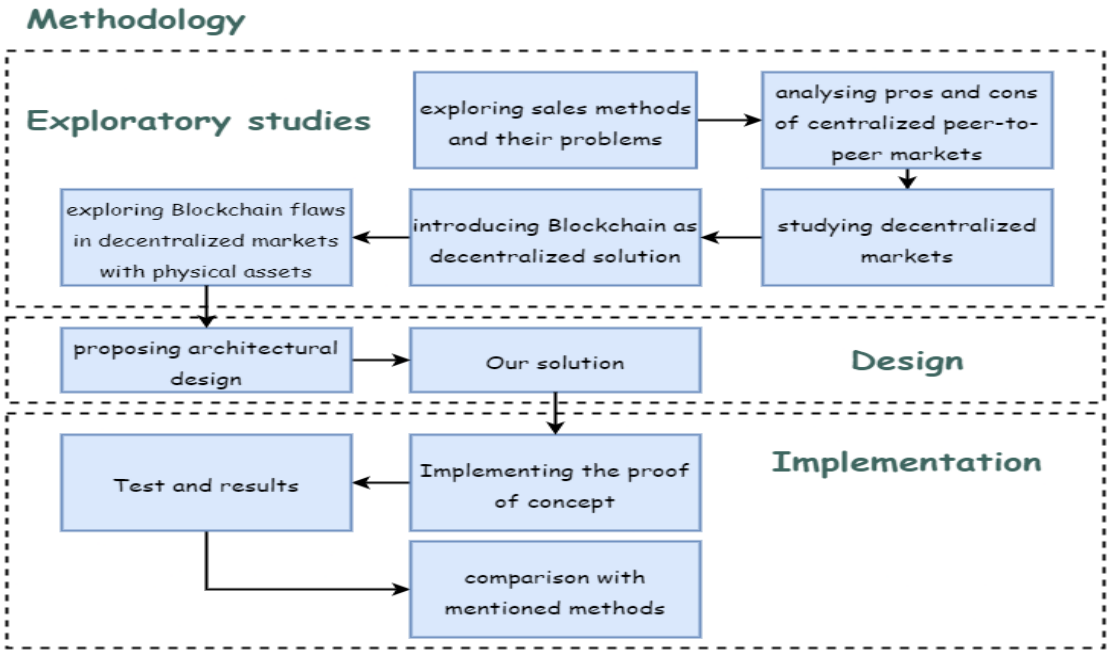

Figure 1. methodological approach of decentralized HC marketplace

There are conceptual, theoretical, and actual working cases in decentralized e-commerce markets, but none cover the mentioned problems in subsection II subsection C. We have analyzed these problems and proposed two different

markets with different approaches. The first market focuses on decreasing costs for all users while maintaining trust and reliability at a reasonable level. Receiving original orders in their perfect physical shape without getting damaged or lost is one of the most crucial concerns of buyers in e-commerce markets. This problem matters more in decentralized e-commerce markets because there is no marketplace owner to guarantee the originality and delivery of products. The second market tries to cover the mentioned concerns and problems of existing decentralized e-commerce markets to increase trust, reliability, and peace of mind in decentralized e-commerce markets more than before by introducing new decentralized roles. The full methodological approach of this paper is illustrated in Figure 1.

IV. System Design and Implementation

The market mechanism for the decentralized handicraft marketplace is separated into two different architectures and different entities in each architecture. Such a design is attributed to different categories of crafts, the difficulty with pricing works of art, dynamic pricing for pure crafts, and ease of market usage. The first architecture is a simple design with the aim of selling simple crafts without any extra difficulty. This design reduces the cost for buyers and sellers and is well suited for trading simple and cheaper crafts in higher numbers. Simple marketing is added to this design to boost the trade. The second architecture is recommended for trading more valuable original crafts that need to be originated. In this architecture, a decentralized built-in insurance platform is designed for handicraft delivery. In this design, verification of producers, origin, and quality approval of crafts are also supported with some extra cost. Features proposed in the second architecture help buyers and sellers have a more trustable trade than the first mechanism by costing them more money. In the following, a decentralized feeless portable reputation system is introduced to illustrate seller's honesty without any extra cost. Sharing a seller's reputation with the community for free and the ability to transfer this reputation to any market and smart contracts using this reputation system are the primary features of the proposed system. Next, the implementation architecture is discussed and, finally, the mentioned sections are implemented as Proof of Concept (PoC) using Ethereum smart contracts. The PoC of the decentralized HC marketplace can be found at [28].

A. The first architecture of decentralized HC marketplace

1) Different entities and roles in the first decentralized HC marketplace

- Seller: The same handicraft producer that sells the crafts in the form of posts.
- Buyer: An entity that buys handicrafts from sellers.
- Arbitrator: An entity that settles disputes between buyers and sellers by voting in favor of them.
- Auditor: An entity authenticated by marketplace developers that audit posts from sellers. If the posts created by sellers are irrelevant to handicrafts or considered spam, the auditor marks the posts, and buyers cannot

make a bid or order the posts anymore. Marking the posts will not remove them from the blockchain. In this case, the marketplace decides to ignore showing the posts to other buyers. There are two reasons for disabling the posts instead of deleting them. The post is a struct in solidity programming with multiple variables that cannot be deleted. Deleting variables in solidity would set their current value to their default variable value (e.g., 0 or null), and there is no hard deleting in the Ethereum blockchain. Besides, deleting a single variable of a post instead of disabling it would increase gas spent by the auditor.

- Affiliate: An entity authenticated by marketplace developers that introduce crafts to various buyers for sale increment.

2) Different features of the first decentralized HC marketplace

Using this architecture enables sellers to sell crafts to buyers using no intermediary and reduce the cost for producers to sell lower value handicrafts in a higher number. The simple HC marketplace is appropriate for selling cheaper handicrafts that do not need any proof of origin. Obtaining an escrow payment system and paying sellers after finalizing the sale also reduce the possibility of sellers cheating. There are different entities to ensure the better functionality of the marketplace. The arbitrators are used for dispute resolution purposes. Because the blockchain technology is used for creating the HC marketplace and there is no centralized database, we also need an entity to audit posts created by sellers, so they will not list abusive, unrelated, or illegal contents. Finally, the HC marketplace can increase sales by allowing affiliates to advertise handicrafts outside of the marketplace.

Figure 2 illustrates the first architecture recommended for selling simple lower-value handicrafts with higher numbers.

1. The seller makes a post with a specific price for selling a certain number of handicrafts. Posts are active until they run out of stock.
2. Auditors audit the new post.
3. The buyer purchases the craft and pays the price of the order (along with extra collateral tokens that guarantee the buyer will finalize orders and release funds for the seller) to be saved in post escrow.
4. If the craft is introduced by an affiliate, their wallet addresses and their commission are saved in the purchase order.
5. The seller prepares crafts to be sent.
6. The purchased craft is sent to the buyer.
7. The buyer finalizes the purchase.
8. The purchase price, affiliate share, and collateralized tokens are sent to the seller, affiliate, and buyer.
9. Any disputation cases such as "not finalized order" or "not sent orders" can be reported to arbitrate by seller and buyer.
10. The arbitrator votes in favor of the buyer or seller. If the buyer does not receive crafts, the order price, and all collateralized tokens are returned to them. If the buyer receives crafts and does not finalize the order, the price of the order is sent to the seller's wallet along with all collateralized tokens as a penalty for the buyer.

B. The second architecture of decentralized HC marketplace

The second architecture of the decentralized HC marketplace has additional entities to the first architecture. In the following, we will mention each of them separately.

1) Different entities and actors in second decentralized HC marketplace

- Handicraft expert: It is an entity authenticated and examined by marketplace developers that can take extra tokens from the seller and issue proof of origin for handicrafts off-chain. The hash of this proof can be stored on the chain to help grow trust in trades.
- Guarantee agents: It is an entity authenticated by marketplace developers that can take extra tokens from the buyer for guaranteeing the producer's skill and honesty. This role can be performed either by marketplace developers or any other agents willing to guarantee producers and receive a commission.
- Insurer: It is an entity authenticated by marketplace developers that can ensure handicraft deliveries by taking extra tokens from the seller. In case of loss or damage to crafts, they will pay the seller based on former agreements.
- Escrow agent: It is an entity that is settled at the creation of the post. They can control the post funds in case of an unsuccessful sale, order cancelation, etc.

2) Unique features of second decentralized HC marketplace

The second architecture of a decentralized HC marketplace increases the trust level for trading high-value handicrafts by creating different decentralized roles. It makes dynamic pricing for handicrafts using buyers' bids because "the art value is limitless." The affiliate role is replaced by a more advanced role called "handicraft expert." Both of these roles are made to increase the sale rate, although the handicraft expert also increases the trust level in a sale. For example, introducing an expensive carpet by a carpet expert (handicraft expert) is more suitable than a regular gaming streamer (affiliate). Enhancing trust levels for buyers can be done by adding some guarantee agents to examine and guarantee the skill and honesty of handicraft makers. Finally, integrating a decentralized insurance platform for insuring handicraft deliveries can relieve sellers from damaged or lost deliveries.

3) Decentralized insurance platform

As mentioned earlier, the second architecture supports insurance for handicraft deliveries in a decentralized way. Although anyone can register as an insurer, this is a special role and requires specialists. There is no limit for insurance companies to participate in the handicraft decentralized insurance platform. Also, there is a chance for insurance agents who work for big centralized insurance companies to participate as standalone insurers without revealing their identities. There is no way to find the identity of buyers and sellers from their wallet addresses unless they reveal it themselves. Therefore, there is a slight chance that the buyer and seller could falsely increase the price of a handicraft more than its actual value; however, the buyers should deposit the bid price into the post escrow. They have to spend real money and deposit this amount into post escrow to increase the price, although they are less likely to afford it. Even if they try to do it, the insurers can still bid their offer regardless of handicraft price, and the insurance bid is not related to handicraft price. It is noteworthy that the insurance part is optional, and handicrafts can still be traded even if sellers will not agree on bidden insurances. Handicrafts that are ready to be sent by the seller can be insured by insurers. The insurers competitively bid their amount for insuring handicrafts along with the amount of commission they are willing to receive for insuring handicraft deliveries. The bid amount will be transferred to post escrow to ensure their honesty. If the seller accepts the bid from the insurer, they should pay the commission to post escrow, and send the craft to the buyer. The insurance offers that were not accepted by the seller can be refunded by an insurer. The amount of insurance fund must be transferred to either seller or insurer. If buyers receive handicrafts without any trouble, the amount of insurance bidden by the insurer along with their commission is released from post escrow, and the insurer can transfer them into their wallet. If buyers do not receive the order or received it damaged, they can call arbitrators for further arbitrating. In case of any damage or loss of deliveries, the price of delivery is refunded to the buyer, and seller can claim the insurance fund.

4) Arbitration

The arbitrators play an essential role in this marketplace. However, in this conceptual design, either buyers offer the arbitrator, or there is no arbitrator at all. Currently, the marketplace developers can only limit this role and introduce themselves as a trusted entity to play this role, but there are benefits and problems with this model. For instance, it can be an income model for the foundation that implements and governs the marketplace (e.g., developers) and incentivize them to continue developing the marketplace. However, it will require skill (e.g., in insurance arbitration) and the adoption of different languages for worldwide support. Also, trusting a foundation for arbitration is against the existential philosophy of blockchain technology and decentralized markets. Designing a decentralized arbitration model for the conceptual HC handicraft marketplace would remain an open challenge without having these issues. Figure 3 illustrates the second architecture for a decentralized HC marketplace with the aim of increasing trust and sales for trades.

1. The hash of proof of origin generated by handicraft experts would be added to the post if there was any request from the seller.
2. The sellers make a post for specific handicrafts and put some tokens to post escrow as collateral for honesty so that they will not list fake and low-quality handicrafts. Depositing additional escrow for sold-out handicrafts can re-activate them as a post for sale, and sellers will not need to create another post to list identical handicrafts. This collateral is either returned to the seller in case of a successful sale or sent to the buyer if the sellers' cheating.
3. The auditor will audit the new post.
4. Buyer bids on the post and send the offered amount to the post escrow.
5. The arbitrator and guarantee agent can be settled for each bid.
6. If the seller accepts a particular bid, they should proceed to send the order.
7. Insurer bid on the crafts that are ready to be delivered.
8. In case of accepting or not accepting insurance bids, the order is sent to the buyer.
9. If both buyer and seller agree to finalize the order, guarantee agent fee and bid amount along with collateralized tokens are respectively sent to guarantee agent and seller.
10. In case of accepting an insurance offer in step 6, the insurance amount should either be sent to the seller or insurer based on the previous mechanism explained earlier.
11. Buyer or seller can call arbitrator for further dispute resolution if they have any objection to the order results.
12. The arbitrator votes for buyer or seller. In the case of seller dishonesty, the collateralized tokens in step 1 will be sent to the buyer's wallet. In case of loss or damaged crafts, the bid amount will be returned to the buyer, and the insurance amount is released for the seller without influencing their reputation.
13. The escrow agent can control post escrow and transfer assets if it is required.

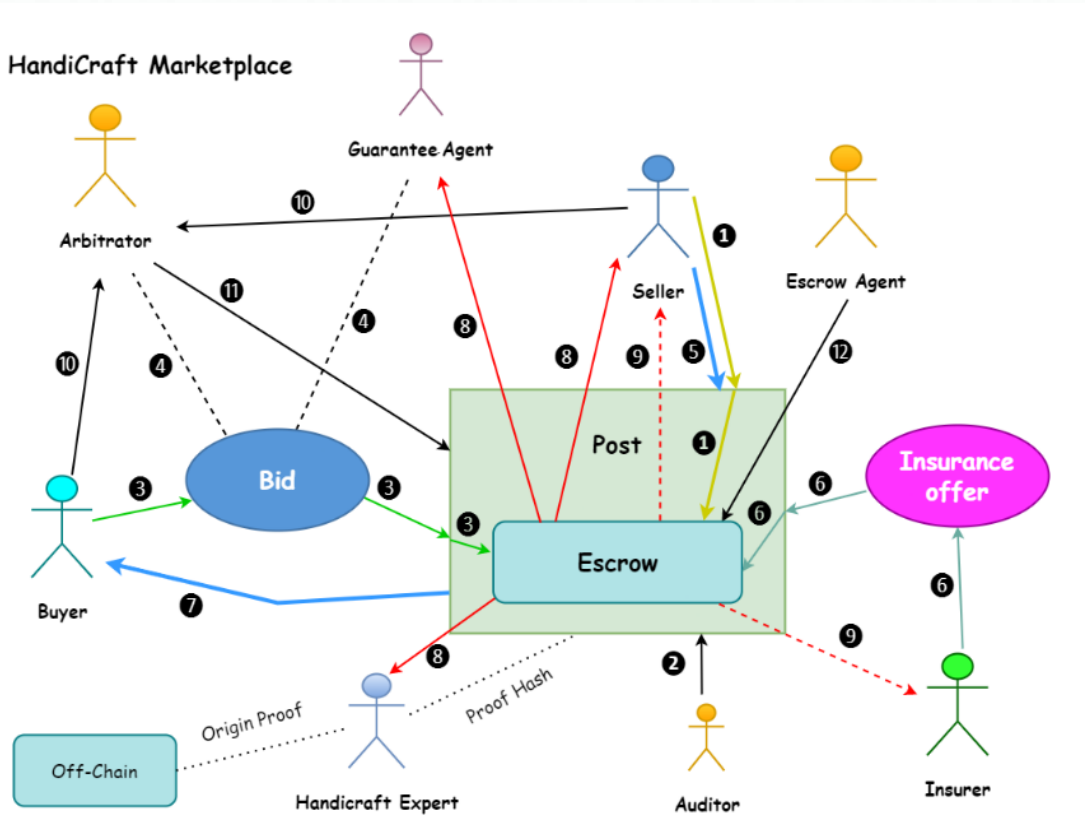

Figure 2. The second architecture suitable for selling valuable handicrafts with more cost

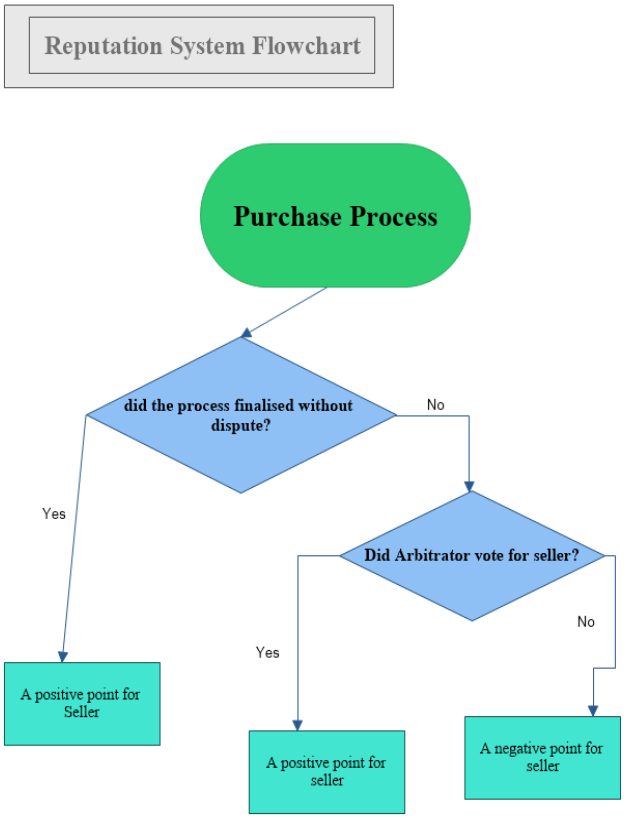

Figure 3. Decentralized reputation system flowchart for sellers in HC marketplace

C. *Decentralized reputation system*

Sellers intend to cheat in decentralized markets more often than centralized markets. In this situation, buyers can see the seller's transaction history because of the transparency provided by blockchain technology. As a result, it is possible to decide whether to purchase goods from a particular seller or not. Even if a centralized authority had existed and sellers had no intention to cheat, a reputation system would still be required to show the seller's reputation and customer satisfaction results.

Seller's reputation is measured using three functions (Figure 4). The first function measures the number of purchases without any dispute between buyers and sellers. The second function represents trades that resulted in disputes, but the arbitrator voted for the seller. The third and last one is for purchases that lead to dispute, and arbitrator voted for buyers due to the possibility of seller's cheating for not sending goods or sending fake or wrong products. The first two functions would be considered as a positive point for the seller, and the third one is a negative point for the seller's reputation. Portability and being feeless are two primary features of this reputation system. Reviewing seller's reputations is free and costless for any user in the marketplace. Since the second architecture of decentralized HC marketplace adopts a bidding model, the transaction is based on seller agreement and paying sellers to require buyers consenting that they received deliveries. We have added the same reputation model for buyers such that the sellers can check buyers' previous history and be aware of intentional nonconsenting despite receiving products.

V. RESULTS AND EVALUATION

This section measures different implementation costs and usage of decentralized HC marketplace and compares them to other similar decentralized platforms. Comparing decentralized markets is possible by comparing the gas cost required for each provided feature.

A. *Smart contracts*

All of the decentralized HC marketplace mechanisms are implemented by Ethereum's smart contracts. Deploying smart contracts in the Ethereum Network requires users to pay transaction fees to miners. In the decentralized HC marketplace, five smart contracts representing the whole marketplace ecosystem are deployed in Rinkeby test networks. Table 2 illustrates information about deploying contracts in the Rinkeby test network using ETH gas station tool [29]. Note that median gas price changes over time, and it is highly volatile. Currently, the PoW Ethereum suffers from low scalability [30]. There are few alternatives for smart contract deployments (e.g., Binance Smart Chain "BSC" [31]), but it uses only 21 validators to validate blocks. Hence, the decentralization and security level of BSC is not acceptable for the HC marketplace; we decided to choose decentralization and security over scalability.

The numbers are the same in both Ethereum main network and the Rinkeby test network. Thus, we decided to use the Rinkeby test network to avoid spending real money. Figure 5 illustrates some information about gas and confirmation time at the date of deployment.

In Ethereum, the actual cost of deploying contracts or interacting with them is the amount of gas the transaction uses. Gas price is simply the cost that the user is willing to pay for each unit of gas. For all deployment, the average gas price is set to 45 Gwei and the confirmation time is about 30 seconds.

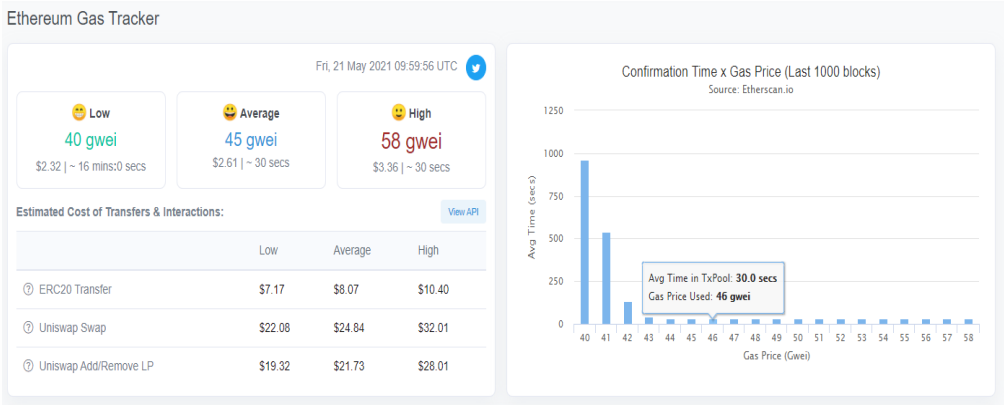

Figure 4. Ethereum gas information provided by etherscan.io

TABLE II. SMART CONTRACTS INFORMATION ABOUT THE DEPLOYMENT OF DECENTRALIZED HC MARKETPLACE

Contract name	Gas cost	Price (ETH)
HCT	590197	0.026558865
Reputation	158863	0.007148835
OwnerShip	148484	0.00668178
SimpleHCMarket	1230688	0.05538096

HCMarketplace	3436433	0.154639485
Total	5564665	0.250409925

TABLE III. THE COST OF USING THE FIRST ARCHITECTURE OF DECENTRALIZED HC MARKETPLACE

Function	Method ID	Gas cost	Price (ETH)	Payer
AddAffiliate	0x81ea4ea6	46007	0.002070315	contract owner
CreatePost	0x77fb369c	138442	0.00622989	seller
AuditPost	0xefd895cf	30827	0.000712215	contract owner
Purchase	0x466cb864	190763	0.007888725	buyer
FinalizePurchase	0x5acc7698	157117	0.00639378	buyer
Dispute	0x1f2f7fc3	53117	0.002390265	seller/ buyer
ExecuteRuling	0xdd008672 0xdd008672	101883 109550	0.003909735 0.00425475	contract owner
Total estimate cost for seller	-	191559	0.008620155	-
Total estimate cost for buyer	-	400997	0.01667277	-

TABLE IV. THE COST OF USING THE SECOND ARCHITECTURE OF DECENTRALIZED HC MARKETPLACE

Function	Method ID	Gas cost	Price (ETH)	Payer
AddHandicraftExpert	0xc62df551	46029	0.002071305	contract owner
AddGuaranteeAgent	0x0eaf9d89	46053	0.002072385	contract owner
AddInsurer	0xc1b5fb06	46095	0.002074275	contract owner
CreatePost	0xeed4b34c	212106	0.009536265	seller
AuditPost	0xefd895cf	30827	0.000712215	contract owner
CreateBid	0xeed4b34c	257023	0.01155771	buyer
FinalizeBid	0x29d26296	44006	0.00198027	seller
FinalizeBid	0x29d26296	175417	0.00789228	buyer
Dispute	0x1f2f7fc3	36398	0.00163791	seller/ buyer
ExecuteRuling	0xdd008672	92601 171682	0.004068675 0.00772569	contract owner
BuyerOrSellerRevokeBid	0x5bafd25b	82426	0.001854585	seller/ buyer
Total estimate cost for seller	-	374936	0.01500903	-
Total estimate cost for buyer	-	551264	0.022942485	-

TABLE V. A COMPARISON BETWEEN DIFFERENT DECENTRALIZED MARKETS

Market name / Feature	Decentralized HC market (first arch)	Decentralized HC market (second arch)	Distributed Marketplace (Kabi & B, 2019)	DMR (Notheisen et al., 2017)	Origin Protocol (Liu & Fraser, 2018)	Open Bazaar (OpenBazaar, 2014)
Technology	Ethereum	Ethereum	Ethereum	Ethereum	Ethereum	Crypto-currency/ without smart contract
Market type	regular handicrafts	high-value handicrafts	general market	vehicles	general market	general market
Pricing	fixed	dynamic bids from buyer	fixed	fixed	fixed/ request for change of price from buyer	fixed
Decentralized Reputation	✓	✓	×	×	×	×
Producer honesty gurantee	×	✓	×	×	×	third-party guarantee
Affiliate	✓	×	×	×	✓	×
Product verification specialist	×	✓	×	×	×	×
Arbitration	✓	✓	✓	×	✓	×
Decentralized Insurance	×	✓	×	×	×	×

Estimated cost for seller	191559	374936	208716	1022315	252139	-
Estimated cost for buyer	400997	551264	274434	403000	466430	transaction fee
Insurance cost for seller	-	140496	-	-	-	-
Insurer cost	-	344525	-	-	-	-

Information in Table 2 illustrates a reverse relation between confirmation time and transaction fee that the user is willing to pay. It is of note that, in addition to transaction fees, confirmation time is affected by other factors such as block interval time and PoW mining software at the submitting transaction moment [32]. This can lead to different confirmation times for a smart contract with the same transaction fee in different periods.

B. The marketplace interaction cost

As mentioned earlier, users need to pay a fee to make transactions in the Ethereum network. Using a decentralized HC marketplace is free such that the only cost users pay is an Ethereum transaction fee. In contrast, most centralized markets charge users a fee for using the market as a platform for trades in various ways. First, we examine the first architecture and calculate costs for using it in Table 3. Simultaneously, Table 4 examines the costs of using the second architecture of a decentralized HC marketplace.

Trades can be completed only with 3 steps for buyer and seller in case of no disputation.

If either the buyer or seller entities wishes to cancel the offer, which means neither did finalize the bid, they would call the buyerOrSellerRevokeBid function to transfer tokens back from escrow to the buyer's wallet. In the meantime, the buyer cannot call the dispute function.

After calculating the cost of using the decentralized HC marketplace, some of the existing similar decentralized markets are listed, and their cost and features are compared with our marketplace. Table 6 provides comprehensive information about different decentralized markets. [33] supplements the data generated by smart contracts for the calculation.

Figure 3 depicts the characteristics and activities of each state. In Figure 3, each state has a 1/7 chance of going to itself and other states. Due to congestion, only the edges of the S1 state are seen in this diagram.

VI. DISCUSSION

In this study, examining all the costs in decentralized markets showed that there is no extra fee for trading in decentralized markets but an Ethereum transaction fee.

Sellers, however, can incentivize buyers to buy crafts from decentralized marketplaces instead of traditional platforms by reducing the price of crafts. Nevertheless, using centralized payment systems like credit cards or universal banking transactions can charge more fees than Ethereum transactions; but, since the primary goal of making decentralized HC marketplace is price reduction along with security and trust and sharing the profits between both seller and buyer, a comparison between centralized and decentralized payment systems is called off.

VII. CONCLUSION

Peer-to-peer markets have been a way to trade directly with other users since the introduction of e-commerce. Centralized peer-to-peer marketplaces suffer from lack of transparency, high listing fees, ignoring users for trading in the marketplace by owners at their whim, the need for trust in the central authority, abuse users' data, and unfair final prices. Blockchain is a newfound technology suitable to solve such problems by creating decentralized marketplaces and supporting full transparency. Here, we studied different types of decentralized markets and introduced some platforms in each category. Different platforms in the decentralized e-commerce section were explained in detail, and the problems of the existing e-commerce platform were identified. We proposed two architectures for solving the mentioned problems. The handicrafts are chosen as physical products to trade in the decentralized HC marketplace. We used solidity and smart contracts to implement proposed markets in the Ethereum blockchain and compared the results to the existing decentralized e-commerce platforms. After comparing the actual cost of using the decentralized HC marketplace to existing centralized platforms, we found that Ethereum 1.0 is not suitable for implementing the decentralized HC marketplace due to the volatility of gas prices. We hope this problem is solved after the launch of Ethereum 2.0. We discussed the challenges and limitations of adopting blockchain technology for building a decentralized e-commerce market and proposed a trade-off for implementation in real-life environments. Although this paper lacks a suitable way to arbitrate disputes, we will consider making a reliable decentralized governance layer that can be used in all decentralized e-commerce platforms.

REFERENCES

[1] P. Covarrubia, “Geographical Indications of Traditional Handicrafts: A Cultural Element in a Predominantly Economic Activity,” IIC International Review of Intellectual Property and Competition Law, vol. 50, no. 4, pp. 441–466, May 2019, doi: 10.1007/s40319-019-00810-3.

[2] A. Pal, C. K. Tiwari, and N. Haldar, “Blockchain for business management: Applications, challenges and potentials,” Journal of High Technology Management Research, vol. 32, no. 2, Nov. 2021, doi: 10.1016/j.hitech.2021.100414.

[3] A. Klimenko, “HOW TO CREATE A WEBSITE LIKE ETSY AND BECOME THE BEST ARTISAN PLATFORM ON THE MARKET,” greenice, 2020. https://greenice.net/how-to-develop-a-peer-to-peer-marketplace-website-like-etsy/ (accessed Oct. 08, 2022).

[4] V. Kumar and P. Pradhan, “Trust Management Issues in Social-Media Marketing,” International Journal of Online Marketing, vol. 5, no. 3, pp. 47–64, 2015, doi: 10.4018/ijom.2015070104.

[5] C. Dawson, “Amazon suspended multiple Chinese sellers with $1 billion revenue – So what?,” tamebay, 2021. https://tamebay.com/2021/05/amazon-suspended-multiple-chinese-sellers-with-1-billion-revenue-so-what.html (accessed Oct. 08, 2022).

[6] R. Chakraborty, J. Lee, S. Bagchi-Sen, S. Upadhyaya, and H. Raghav Rao, “Online shopping intention in the context of data breach in online retail stores: An examination of older and younger adults,” Decis Support Syst, vol. 83, pp. 47–56, 2016, doi: 10.1016/j.dss.2015.12.007.

[7] L. Zhou, W. Wang, J. (David) Xu, T. Liu, and J. Gu, “Perceived information transparency in B2C e-commerce: An empirical investigation,” Information and Management, vol. 55, no. 7, pp. 912–927, 2018, doi: 10.1016/j.im.2018.04.005.

[8] A. Meeuw et al., “Implementing a blockchain-based local energy market: Insights on communication and scalability,” Comput Commun, vol. 160, pp. 158–171, 2020, doi: 10.1016/j.comcom.2020.04.038.

[9] M. Kowalski, Z. W. Y. Lee, and T. K. H. Chan, “Blockchain technology and trust relationships in trade finance,” Technol Forecast Soc Change, vol. 166, no. December 2020, 2021, doi: 10.1016/j.techfore.2021.120641.

[10] M. Gupta, Blockchain For Dummies. John Wiley & Sons, 2017.

[11] M. P. McBee and C. Wilcox, “Blockchain Technology: Principles and Applications in Medical Imaging,” J Digit Imaging, vol. 33, no. 3, pp. 726–734, 2020, doi: 10.1007/s10278-019-00310-3.

[12] F. Hofmann, S. Wurster, E. Ron, and M. Böhmecke-Schwafert, “The immutability concept of blockchains and benefits of early standardization,” Proceedings of the 2017 ITU Kaleidoscope Academic Conference: Challenges for a Data-Driven Society, ITU K 2017, vol. 2018-Janua, pp. 1–8, 2017, doi: 10.23919/ITU-WT.2017.8247004.

[13] M. Rauchs et al., “Distributed ledger technology systems: A conceptual framework,” Available at SSRN 3230013, p. 109, 2018, doi: https://dx.doi.org/10.2139/ssrn.3230013.

[14] Z. Zheng, S. Xie, H.-N. Dai, X. Chen, and H. Wang, “Blockchain challenges and opportunities: a survey,” International Journal of Web and Grid Services, vol. 14, no. 4, 2018, doi: 10.1504/IJWGS.2018.095647.

[15] M. P. Papazoglou, “Service-oriented computing: concepts, characteristics and directions,” in Proceedings of the Fourth International Conference on Web Information Systems Engineering, 2003. WISE 2003., Dec. 2003, pp. 3–12. doi: 10.1109/WISE.2003.1254461.

[16] S. Schlauderer and S. Overhage, “How perfect are markets for software services? An economic perspective on market deficiencies and desirable market features,” 19th European Conference on Information Systems, ECIS 2011, 2011.

[17] L. Einav, C. Farronato, and J. Levin, “Peer-to-Peer Markets,” Annu Rev Econom, vol. 8, no. 1, pp. 615–635, 2016, doi: 10.1146/annurev-economics-080315-015334.

[18] M. Klems, J. Eberhardt, S. Tai, S. Härtlein, S. Buchholz, and A. Tidjani, “Trustless Intermediation in Blockchain-Based Decentralized Service Marketplaces,” in Service-Oriented Computing, M. Maximilien, A. Vallecillo, J. Wang, and M. Oriol, Eds., Cham: Springer International Publishing, 2017, pp. 731–739. doi: 10.1007/978-3-319-69035-3_53.

[19] C. Serban, Y. Chen, W. Zhang, and N. Minsky, “The concept of decentralized and secure electronic marketplace,” Electronic Commerce Research, vol. 8, no. 1, pp. 79–101, 2008, doi: 10.1007/s10660-008-9014-0.

[20] V. P. Ranganthan, R. Dantu, A. Paul, P. Mears, and K. Morozov, “A decentralized marketplace application on the ethereum blockchain,” in Proceedings - 4th IEEE International Conference on Collaboration and Internet Computing, CIC 2018, 2018, pp. 90–97. doi: 10.1109/CIC.2018.00023.

[21] O. R. Kabi and V. N. L. F. B, Blockchain-Based Distributed Marketplace. Springer International Publishing, 2019. doi: 10.1007/978-3-030-04849-5.

[22] Ink, “Decentralized reputation and payments for peer-to-peer marketplaces,” Whitepaper, 2018. https://paywithink.com/wp-content/uploads/2018/07/Ink_Protocol_Whitepaper_V9_Listia_Inc.pdf (accessed Oct. 08, 2022).

[23] Origami, “A protocol for Bulding decentralized marketplaces using the Ethereum Blockchain.” Origami, p. 40, 2018. [Online]. Available: A protocol for Bulding decentralized marketplaces using the Ethereum Blockchain

[24] M. Liu and J. Fraser, “Origin-the Sharing Economy without Intermediaries.” Origin protocol, p. 42, 2018. [Online]. Available: https://www.originprotocol.com/en/whitepaper

[25] J. Benet, “IPFS - Content Addressed, Versioned, P2P File System.” 2014.

[26] OpenBazaar, “OpenBazaar,” 2014. https://openbazaar.org/ (accessed Oct. 08, 2022).

[27] B. Notheisen, J. B. Cholewa, and A. P. Shanmugam, “Trading Real-World Assets on Blockchain,” Business & Information Systems Engineering, vol. 59, no. 6, pp. 425–440, 2017, doi: 10.1007/s12599-017-0499-8.

[28] A. Ghasemi, “HC_Marketplace: A decentralised marketplace based on Blockchain technology for HandiCrafts,” Github, 2020. https://github.com/ARES11430/HC_marketplace (accessed Oct. 08, 2022).

[29] gasstation, “ETH Gas Station.” https://ethgasstation.info/calculatorTxV.php (accessed Oct. 08, 2022).

[30] M. Bez, G. Fornari, and T. Vardanega, “The scalability challenge of ethereum: An initial quantitative analysis,” Proceedings - 13th IEEE International Conference on Service-Oriented System Engineering, SOSE 2019, 10th International Workshop on Joint Cloud Computing, JCC 2019 and 2019 IEEE International Workshop on Cloud Computing in Robotic Systems, CCRS 2019, pp. 167–176, 2019, doi: 10.1109/SOSE.2019.00031.

[31] S. Carletti, “Binance smart chain whitepaper,” Binance, 2020. https://github.com/binance-chain/whitepaper/blob/master/WHITEPAPER.md (accessed Oct. 08, 2022).

[32] medium, “Current Dynamics of Transaction Inclusion on Ethereum,” ETH Gas station, 2017. https://medium.com/@ethgasstation/current-dynamics-of-transaction-inclusion-on-ethereum-ae8912edc960 (accessed Oct. 08, 2022).

[33] A. Ghasemi, “Data supplement of Decentralized HC Marketplace,” 2021. https://github.com/ARES11430/HC_marketplace/blob/master/README.md (accessed Oct. 08, 2022).

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