

Automated Decentralized Compartmental Proprietorship System (ADCPS)

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Abstract: Real Estate properties and lands have been at the center of interest for humans for ages. A well-established system for Real Estate properties is already in existence and even though the conventional system is very consistent, it needs to be changed due to major problems like the time it consumes, extra expenses taken by third-party agents, unreliable property dealers, and many more. This paper focuses on providing a better alternative system for all the transactions in the real estate by making use of blockchain technology as its foundation. ADCPS (Automated Decentralized Compartmental Proprietorship System) will be a Decentralized Application Service-Oriented System hosted on Private Blockchain that runs on an Ethereum Client. Users of this service will be the nodes of the network. It gives clients a platform to exchange, sell, purchase, and invest in Non-Residential-Properties for all intents and purposes with non-basic and fractional proprietorship with no contribution of outside organizations. It replaces the customary land exchanging stages with new highlights, for example, Fractional possession, Trading and putting resources into an encoded medium, and managing each exchange with the assistance of cryptocurrencies in our framework, which will be accessible with the first ICO. The framework is composed of seamless and sound interactions made possible by partitioning the clients of ADCPS into three distinct classes: buyers, vendors, and specialists. With the Blockchain's property of Immutability, this framework precludes any unapproved clients to bet and gamble in the system. The business industries should update and repair the conventional framework in unison with the newest technologies and ADCPS will help in it.

Index Terms: Barter-Junction, Blockchain, Bricks, Consensus Algorithms, Decentralization, Ethereum, ICO, Investors, Non-Residential Properties, Real-Estate, RE-Panel, Smart-Contracts, Tradesman, Wallet, Walls

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LIST OF FIGURES & FOOTNOTES

1. Fig. 1.1: This figure indicates user-specified flow of all transactions in the system carried out by smart contracts.
 2. Fig. 1.2: This figure indicates the work-flow or path of system from seller's point of view.
 3. Fig. 1.3: This figure indicates the work-flow or path of system from buyer's point of view.
 4. Fig 2.: The figure explains the scenario mentioned with the connectivity and flow of functions when system is functional
- **Bricks:** A cryptocurrency token acquired by buyers which are used for investing in the properties.
 - **Walls:** A cryptocurrency token which gives the manifestation of ownership of properties to the buyers, it is given by the sellers to the buyers after the successful transaction.
 - **RE-Panel:** The group of users who are Real-estate specialists whom are given the authority to give suggestions, consult and propose the final solutions to given query/queries.
 - **Barter-Junction:** A place for property dealers to sell their properties in the form of an auction, and for potential investors to view the properties.
 - **Fast-50-Auction:** A type of time-bounded auction conducted by the seller to sell his property worth half the value in a fractional manner where individual bidders cannot hold ownership of more than 50%.

1. INTRODUCTION

The Real Estate area is one in all the foremost globally known sectors. The expansion of this space is well complemented through the growth withinside the corporate atmosphere and also the incorporate geographic point area additionally to urban and semi-urban accommodations. Demand for investing in Non-Residential properties is expanding step by step, as the market is getting progressively open and worldwide. However, there are such huge numbers of issues related with the traditional framework, its methodology and techniques. In the hour of worldwide emergency or considering the current situation of pandemic, these old highlights are making the procedure increasingly intricate. Including the Blockchain and Ethereum Technology in the commercial real estate market will change right from its way to deal with its execution.

1.1 WHAT IS BLOCKCHAIN AND ETHEREUM?

Blockchain is the underlying technology behind cryptocurrencies like Bitcoin. The simplest way to think of blockchain is as a large distributed ledger of sorts that stores records of transactions. This "ledger" is replicated hundreds of times throughout the public network so it is available to everyone. Every time a transaction occurs, it is updated in ALL of these replicated ledgers, so everyone can see it.

Ethereum is an open-source platform that uses blockchain technology to create and run decentralized digital applications, or "DAPPS" that enable users to make agreements and conduct transactions directly with each other to buy, sell and trade goods and services without a middle man.

2. LITERATURE REVIEW

Here are some of the research papers that guided along the project. These papers are listed down below:

1. Blockchain White Paper

2. Ethereum White Paper: A Next Generation Smart Contract & Decentralized Application Platform
3. Blockchain Consensus Algorithms: A Survey
4. Assessing Security and Performances of Consensus algorithms for Permissioned Blockchains
5. Understanding Modern Banking Ledgers through Blockchain Technologies: Future of Transaction Processing and Smart Contracts on the Internet of Money
6. A Concurrent Perspective on Smart Contracts

3. MOTIVATION

Our framework utilizes Blockchain and Ethereum innovation together.

The time and cost benefits of blockchain and Ethereum, as well as increased security and transparency, give heaps of advantages to the clients. Blockchain and Ethereum based smart contracts can play a much larger role in the world of real estate. The immutable nature of smart contracts and transactions deployed in the blockchain reduces the chance of fraud in our system. Blockchain technology can potentially transform core operations such as property transactions like purchase, sale, financing, leasing, and management transactions. Our system is being deployed on decentralized web applications instead of an Android or IOS platform for securing the smart contract from any kind of adulteration. Also, web applications can be accessed easily from anywhere all around the globe which makes the client utilize our framework anytime in any system.

4. PROPOSED MODEL

Our Proposed Model includes different fragments that cooperate to run the entire ADCPS immaculately.

4.1 ICO & CRYPTOCURRENCY

An Initial Coin Offering (ICO) is the digital currency industry's proportionate to an Initial Public Offering (IPO). ICOs act as a way to raise funds, where a company looking to raise money to create a new coin, app, or service launches an ICO. Intrigued financial investors can get tied up with the contribution and receive a new cryptocurrency token issued by the company.

So, the first step for our user or client is to interact, trade and transact in our system and to participate in our custom ICO and buy the offered cryptocurrency. This will offer two new Crypto-Tokens, namely 'Bricks' and 'Walls'. These will keep the flow of money in the system and all the transactions in the form of UTXOs will be mined in the blockchain making it secure and immutable. These two cryptocurrencies are user-specified and will be accessible to authorized and classified users. Bricks, the first type of token in the system will be the correspondent unit for all Buyer/Investor related transactions.

Any buyer or investor can invest in a property of his/her choice by sending the proportionate Bricks to the wallet of the respective seller. These Bricks are convertible to Ether and Gwei as standard unit of conversion. Walls, the second cryptocurrency tokens introduced by ADCPS will play an important role in proving the fractional and shared ownership of a property that exists in our blockchain. These 'Walls' tokens will be available in the ICO for property Sellers and tradesmen only, thus making a two-way flow in our buyer-seller and seller-buyer transactions.

4.2. BARTER JUNCTION

A Barter-Junction will be a place where property dealers will be given two alternatives of selling their property in the framework, similarly, it will also be a spot where financial investors could look, sort, and view the properties in a virtual-assortment. This marketplace will be a common hub for both types of users and will be available as soon as they have completed ICO or other authorization checks carried out by the system. Barter Junction and Fast-50-Auction will be two techniques provided by ADCPS to the property sellers to gain profit and trade their assets. Barter Junction is comparable and analogous to the Bitcoin-Mempools. Fast-50-Auction is a unique type of auction, which is an alternative for selling a property in which investors cannot buy or invest in property more than 50% of the total value of the asset.

4.3 CONSENSUS ALGORITHMS:

A consensus algorithm is a procedure through which all the peers of the Blockchain network reach a common agreement about the present state of the distributed ledger. In ADCPS Consensus Algorithms will assume a significant job for the keeping up and overseeing all the procedures and capacities that are answerable for all the exchanges and transactions in our framework. Algorithms used are:

- **POS: Proof Of Stake** algorithm expresses that any client might be given approval or ability to trade and transact in our framework just on the off chance that he possesses or purchases the stake, here that is our cryptographic money tokens. Contrasted with POW (Proof Of Work), POS is productive, energy efficient and secure.
- **POA: The Proof Of Authority** Algorithm expresses that any client or customer must have a substantial Digital Identity on the Blockchain Network and should likewise fulfill POS. POA gives a vender power to really sell and exchange his/her property in the framework. POA is obligatory for users to turn into a verified Seller in the framework.
- **POB: Proof Of Burn** is an algorithm that will be actualized in ADCPS straightforwardly. This calculation deals with the guideline of consuming or pulverizing the stake to

increase additional advantages and extra services for the individual assistance. POB is both utilized by Investors and Sellers; however, the reason may differ.

- **POH: Proof Of History** will be useful when any users apply for exclusive features such as Automated Mortgage and Lease System. POH will be helpful to determine past transactions and exchanges of each individual's Asset and Stake. POH will approve the validity of forthcoming exchanges.
- **PBFT: Practical Byzantine Fault Tolerance** will supervise the working of nodes in the network and will help to track malicious nodes trying to tamper with the blocks. PBFT will take care of number of nodes per network.

4.4 SMART CONTRACTS:

A smart contract is a self-executing contract with the terms of the agreement between buyer and seller being directly written into lines of code. The code and the agreements contained therein exist across a distributed, decentralized blockchain network. In the conventional real estate transactions, every process is governed by Banks and other third parties, here in ADCPS each individual's contract will be responsible for smooth and flawless exchanges.

ADCPS, being the decentralized assistance facilitated on Ethereum Network is completely administered and made completely useful with the assistance of conveyed smart contracts. From ICO to Wallet creation and from Investing in Properties to mortgaging it, everything works on a respective smart contract. Each smart contract will hold a public address on the blockchain and invoking it will initiate the functionalities and will be mined in the blockchain.

4.5 CUSTOMERS & USERS:

Our System provides unique identities to every user on the Blockchain Network in the form of addresses. The clients of our framework are being isolated into three classes for simple administration of each profile. These three classes speak of the errands, duties, and specialists given by the framework to the clients. Three classifications to be specific as Tradesmen or Sellers (who need to sell properties), Investors (who need to invest), and RE-Panel (Real-Estate specialists and experts). These three sorts of clients are autonomous and can convey and communicate legitimately in the framework with the assistance of their public addresses.

5. WORKING

5.1 CONSENSUS ALGORITHM

- **Proof of Stake (POS):** POS works as a necessary condition in ADCPS. There will be a smart contract that will be called when the user initiates his/her public key, a double hashing algorithm will be verifying those keys. After that, the public key will be mapped to the respective smart contracts which will check the balance in BRICKS/WALLS and ETH respectively. Only if the stakes are available according to ADCPS terms then only any user might be given approval or ability to trade and transact in our framework.
- **Proof of Authority (POA):** POA helps the network to categorize and identify users into verified buyers and sellers. Digital Identity is the address of the first smart contract that the user will-call, which is ICO smart contract. The address associated with an individual's ICO participation will be mapped to the network and an individual wallet will be created with public and private keys, thus giving a profile to the user. POA will be verifying those addresses and keys and then will give the authority to really sell and exchange his/her property in the ADCPS framework.
- **Proof of Burn (POB):** POB works as per the requirements of the users of ADCPS. In this algorithm, the user specifies a certain amount and this amount is being carried through a smart contract and then it is being transferred to an address which is so-called 'No one's wallet'. So, the amount is being burnt and this pulverizing of stakes will give extra advantages and services available in the system such as Loyalty Badges, Preference, and Priority in Barter Junction table, Lease & Mortgage facilities.
- **Proof of History (POH):** POH algorithm will be executed by the chain itself, accessing older mined blocks and comparing all the transaction hashes with transactions done with private keys by the users who are applying for exclusive features such as Automated Mortgage and Lease System. POH will also be called and checking other consensus algorithms such as POS & POB.

5.2 SMART CONTRACTS

```

1 // bricks ICO
2 pragma solidity ^ 0.6.1;
3
4 contract bricks ICO {
5     // introducing the total number bricks available for sale
6     uint public max_bricks = 1000000;
7     //introducing ruppees to bricks conversion rate
8     //1rs = 100bricks (assumption)
9     uint public rs_to_bricks = 100;
10    //introducing the total number of bricks bought by investors
11    uint public total_bricks_bought = 0;
12
13    mapping(address => uint) equity_bricks;
14    mapping(address => uint) equity_rs;
15
16    //check if the investors can buy bricks
17    modifier can_buy_bricks(uint rs_invested) {
18        require(rs_invested*rs_to_bricks + total_bricks_bought <= max_bricks,"You cannot purchase any bricks");
19        _;
20    }
21    modifier can_sell_bricks(address investor,uint bricks_to_sell)
22    {
23        require(equity_bricks[investor]!=0, "You cannot sell any bricks");
24        require(bricks_to_sell < equity_bricks[investor],"LIMIT EXCEEDED");
25        _;
26    }
27
28    function equity_in_bricks(address investor) public view returns (uint) {
29        return equity_bricks[investor];
30    }
31
32    function equity_in_rs(address investor) public view returns (uint) {
33        return equity_rs[investor];
34    }
35
36    //buying bricks
37
38    function buy_bricks(address investor,uint rs_invested) external can_buy_bricks(rs_invested) {
39        uint bricks_bought = rs_invested*rs_to_bricks;
40        equity_bricks[investor] += bricks_bought;
41        equity_rs[investor] = equity_bricks[investor]/100; //rs invested
42        total_bricks_bought += bricks_bought;
43    }
44
45    //selling bricks
46
47    function sell_bricks(address investor,uint bricks_to_sell) external can_sell_bricks(investor,bricks_to_sell)
48    {
49        equity_bricks[investor] -= bricks_to_sell;
50        equity_rs[investor] = equity_bricks[investor]/100;
51        total_bricks_bought -= bricks_to_sell;
52    }
53
54 }

```

[Further Snapshots of Bricks ICO with Bytecode and ABI](#)

The above image is a Solidity file of Initial Coin Offering (ICO) of Bricks (our cryptocurrency). This Smart Contract deployment will be the first step taken by any user in the system to initialize the wallet and start carrying out transactions.

This Smart Contract offers four public functions, that is "sell_bricks","buy_bricks", "equity_in_any_other_currency" ,"equity_in_bricks" that takes the address of the wallet as an input. Each individual user would be able to call this smart contract and get the equivalent bricks as invested. This smart contract would be deployed in the Ethereum main blockchain and the contract address will be made available to all the users who are willing to trade in the system. All the transactions registered through this ICO would be mined in the blockchain and would be verified for the next consensus algorithm i.e.,

POS (Proof of Stake). All the equity functions would be giving real-time output of the current value of Ether. Users can call this smart contract only once. With the help of this ICO smart contract, users can both transfer Bricks into their wallets and see the total number of Bricks available in the system.

Just like this ICO smart contract, many other smart contracts such as "Wallet-creation smart contract", "Fractional ownership smart contract", "Fast-50 smart contract", etc. will be deployed in the Ethereum blockchain and the public addresses for the aforementioned contracts will all be made available on the system. Consensus algorithms will also be calling these smart contracts to verify and check the authenticity of user transactions.

All the components of the system, the smart contracts, the consensus algorithms, blockchain will operate in unison to give the users a seamless experience.

6. ALGORITHMS & FLOWCHARTS

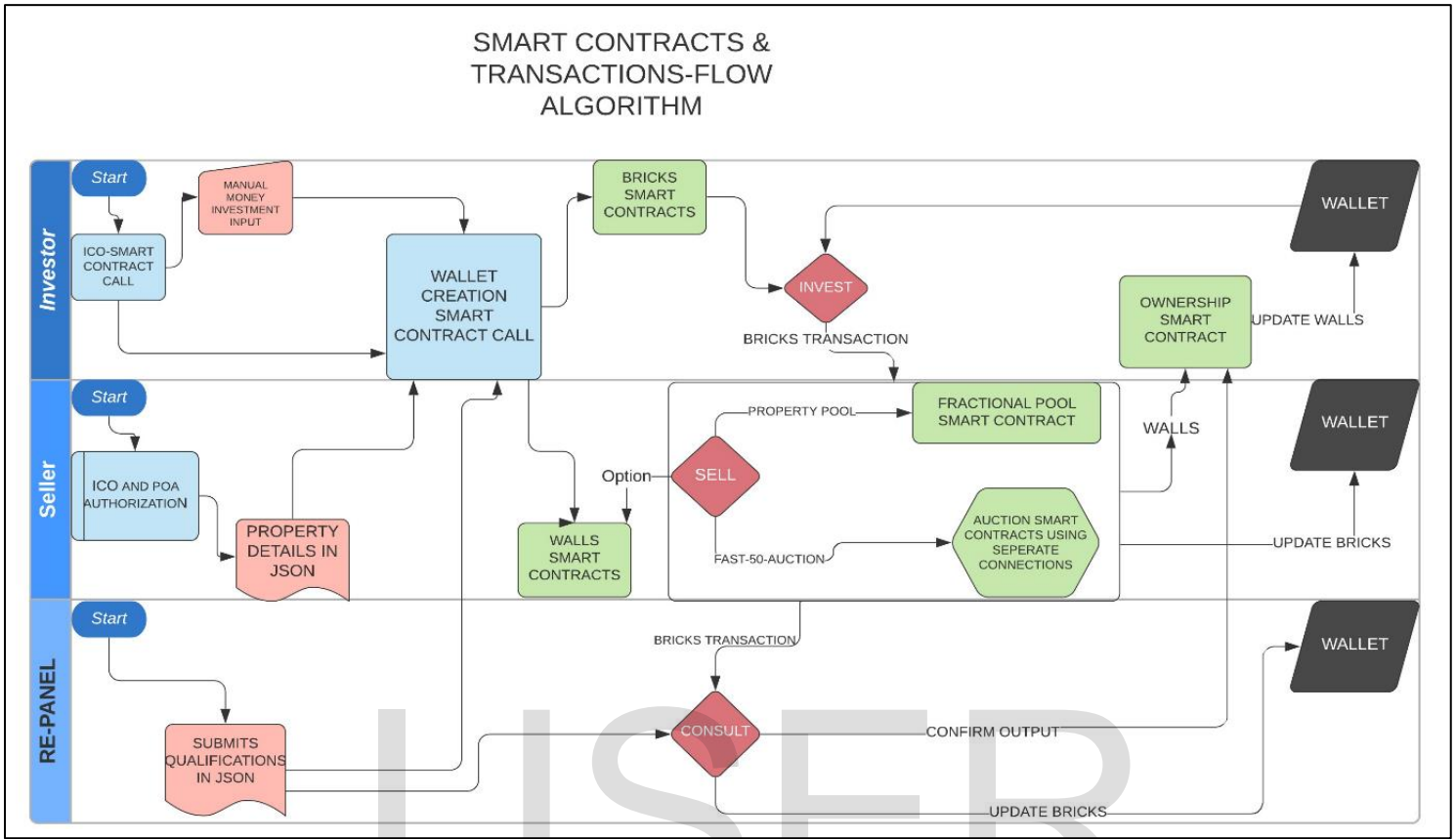


Fig 1.1

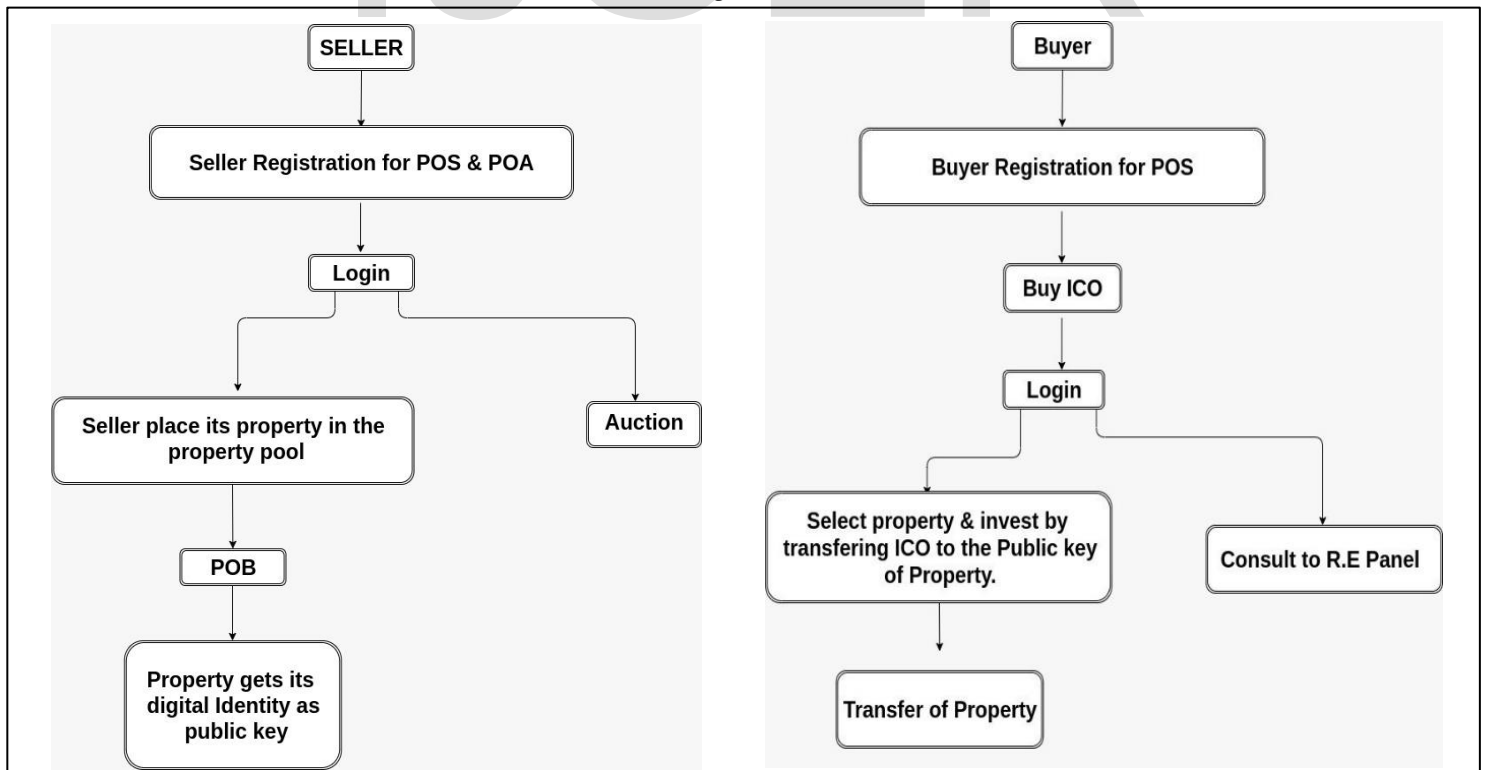


Fig. 1.2

Fig. 1.3

7. EXAMPLE

This framework comprises of three significant clients in particular Buyer, Seller, and RE-Panel. Let the B1, S1 and P1 be buyer, seller and a member of RE-Panel respectively. These three clients will have direct interaction with one another without the intervention of any third man or any external medium. B1 can legitimately speak with S1 about the property and the other way around. Both the B1 and the S1 can consult with the RE-Panel about the property which is beneficial for him/her to invest in. The seller shares their public key of the property which will be available in Barter Junction and accessible to the buyer. If the buyer is interested in his/her property, the transaction is done with the help of the private key of the buyer. The buyer buys the property with the Bricks, but the transactions will be done in equivalent unit Ether/Gwei in the system.

Scenario 1: B1 comes in the framework and takes an interest in the ICO and purchases 45 Bricks in the wallet with address A1. S1 comes in the framework, purchases N Tokens (least no of tokens in anybody's wallet) and registers for POS and POA. After enlistment and login process, S1 transfers the subtleties for the Property P1 and selects to place it in the Barter Junction. When S1 places the details in the pool, P1 gets its digital identity on the blockchain with an address, known as Public Key. In the interim B1 is talking with the R1 about the properties in the Barter Junction. With the positive recommendation from R1, B1 chooses to invest 10 bricks in P1, he gets the public key from the Barter Junction and invokes it to get the wallet address of S1. With A1 accessible, B1 at that point sends 10 bricks with the assistance of smart contracts and loads Public key of P1 and A1 for the flawless exchange. S1 on the opposite side, produces a different private key of P1 to show and to give the partial possession to B1, and sends the appropriate Walls to B1.

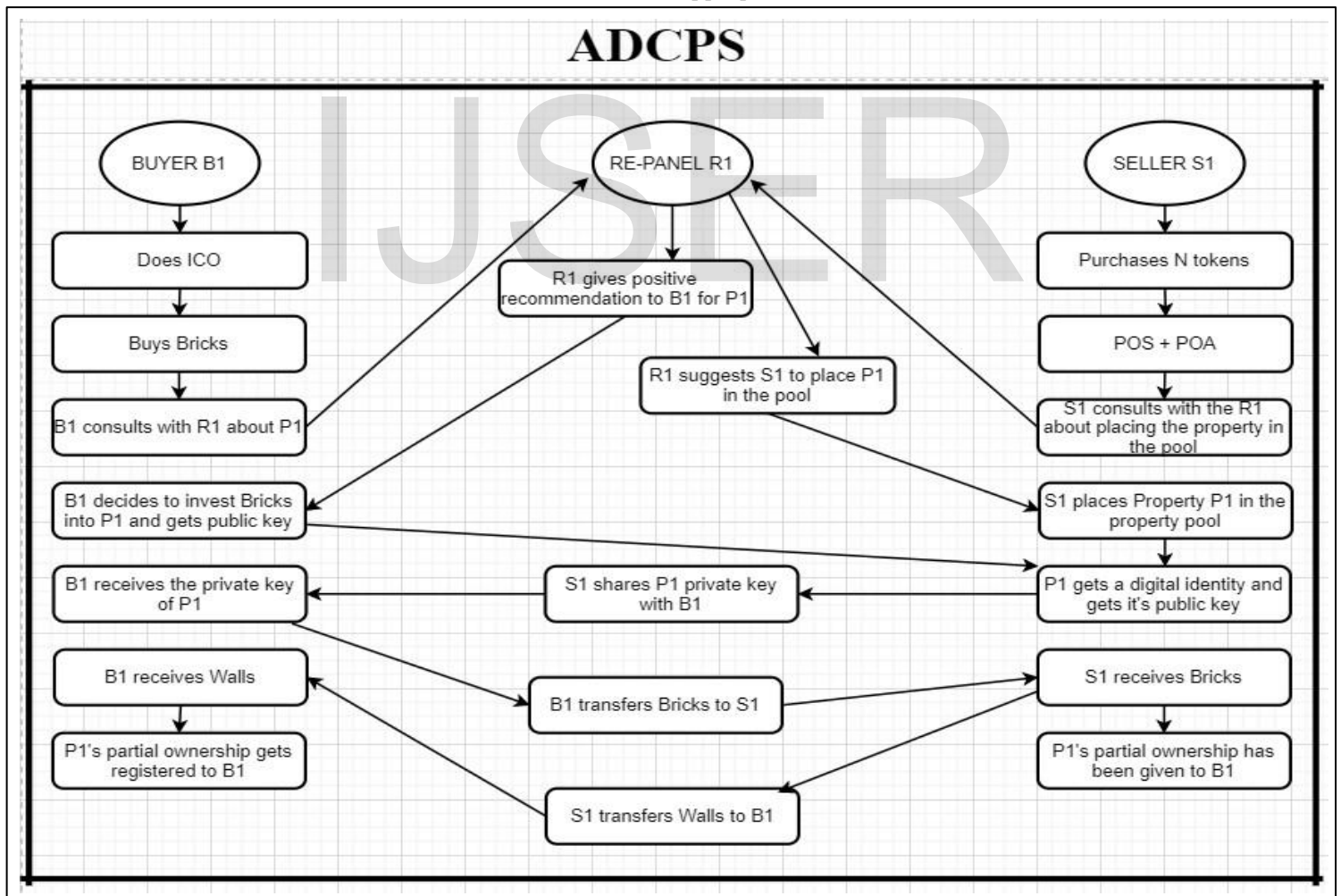


Fig. 2

8. SPECIFICATIONS AND PLATFORMS

1. Ganache v2.4.0
2. Pragma Solidity 0.5.1-0.6.6 nightly commits
3. Truffle v5.1.34
4. Python v3.8.2
5. Node v12.16.2
6. Web3.py 5.12.0
7. Visual Studio 2020
8. Pymongo v3.10.1
9. Postman v7.29.1
10. Operating System: Windows 10
11. Remix – Ethereum IDE v0.10.3
12. Spyder v4.1.4

9. IMPLEMENTATION

Here are some of the screenshots of the first page of the ADCPS web-application, the initial step of login in our framework. Link below

[SNAPSHOTS OF THE FIRST PAGE OF ADCPS](#)

10. FUTURE SCOPE

ADCPS can be deployed on the Ethereum Main-net in the near future. Also, Ethereum provides license for creating Decentralized applications (DAPPS). This will enable us to extend our reach to more of the public, as the Ethereum users and nodes are increasing day by day. Blockchain can be considered an alternative to the traditional licensing approach, as using smart contracts for software licensing allows tracking the ownership of the license and moving its value around, so Ethereum gives license and copyrights for a particular system. Also included among the future scopes are a way to attract investors using Initial Coin Offering (ICO). Interested investors can buy into the offering and receive a new cryptocurrency token issued by our system. It would represent the investors having a stake in the system.

Employing data analysts as the third kind of User-Profile, would allow for the system data to be analyzed and reveal valuable insights into their behavior, trends and as such can be used to predict future outcomes. All of this will grant large scale deployment of further versions of ADCPS.

Registering and selling a property via already existing Land Registry blockchain system is a tedious and sometimes unreliable procedure, that takes at least three months to complete. The next rendition will have Blockchain powered Land-Registry System.

11. RESULT ANALYSIS

Our system aims to shorten the process and make it more reliable and accurate by both removing the need of a third party, such as banks and agents, and enabling the buyer and the seller to interact directly, and the RE-Panel is the unanimous advisor in regards to any disputes arising over a property.

Also, the existing online real estate trading platforms do not enable fractional ownership of a property, they do not allow a buyer to invest in simply a part of the property. Our system however, allows a buyer to invest in a part of a property and attain fractional ownership of it using tokens called 'Walls'.

The conventional trading system involves a person or entity other than the main participants-the seller and the buyer. However, the functionalities of our system are of a hybrid version. There is no involvement of third party since the rules and regulations would be in-built within smart contracts and the whole trading will be done by means of cryptocurrency (i.e. the Bricks and the Walls) between the buyer and seller. Hence the currency flow remains strictly restricted to two people and therefore the flow is bi-directional in nature.

Lastly, in case of conventional trading systems there are chances of occurrence of fraud by means of illegal documents. Our system however, provides security by making the transactions encrypted and cryptographically secured. This altogether prevents any occurrences of fraud.

12. DRAWBACKS

1. The main flaw of the system is immutable transactions, once it is done, these will be mined in the blockchain. In real-life scenarios, there are some cases where the deal is reverted and the option of rolling back the decisions and transactions is an option. But in our system, there is no rolling back as the transactions tend to stay immutable due to consensus algorithms.
2. Our system does not support Residential-Properties to trade and invest as it is not practically possible to carry out fractional and shared ownership in such properties.
3. The system, once deployed on the main-net network, cannot be taken down due to Ethereum's Policy.
4. ADCPS does not provide the guarantee of private keys of an individual's wallet. It is one's own responsibility to save these keys and keep them safe.
5. Users cannot create multiple accounts and wallets.
6. The decision of Forks in the system doesn't depend on the user's will, it is solely based on the system's administrators.

13. CONCLUSION

1. The existing conventional methods, both online and offline, will be revolutionized by our method.
2. There is no third party interference, which makes using blockchain extremely advantageous. A favorable feature of Ethereum is the smart contract, which means that we can exchange stock, property, money etc. without needing to employ a lawyer or notary, thus decreasing the expensive third party costs abundantly.
3. Our system supports fractional ownership of land. This allows people to invest in a part of the property, according to their own choice. A person having any social or financial status can invest freely. They may not have to take any loans either. In the conventional method, due to third party involvement, a

lot of time is wasted. In our system, there is no third party. Thus, delay is less and time is saved.

4. We use Ethereum technology, which has a lot of advantages. Ethereum allows its users to build and execute smart contracts and deliver independent applications without third party censorship making it exceedingly easy to finalize transactions. Ethereum provides developers with an inclusive set of tools to build decentralized applications.

5. The extensive aim of smart contracts is to satisfy common contractual conditions (such as confidentiality, payment terms, liens, and even enforcement), minimize third party involvement, and minimize exceptions (both malicious and accidental).

6. The Ethereum blockchain transactions are unchangeable and irreversible. This means that data, once written, cannot be changed. As such, it is nearly impossible to hack. Even the uploader can't edit the data once it is uploaded.

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