Using Blockchain For Optimal and Transparent Resource Allocation

A Proposed Solution for Fund Allocation: Brief overview

1 INTRODUCTION

Blockchain allows for multiple use-cases incorporating basic concepts like asset digitization and consensus management. Starting from the definition of consensus as “the degree of agreement among point predictions aimed at the same target by different individuals and "uncertainty" as the diffuseness of the corresponding probability distributions” (Zarnowitz&Lambros, 1987), and building by providing a blockchain layer of technological solution for consensus management, the paper proposes a solution for consensual allocation of resources within a designated “game”. This game, seen as a closed environment, with set conditions, maps a collaborative, consensus-based society, in which assets are digitized, transparency, traceability and immutability of records are essential elements, there is information symmetry among all parties, as well as an incentive for peer-to-peer collaboration for a “greater good” – a systemic value-added approach. The efficiency is perceived not as a single driver, but as an add-on, while the closed environment is behaving like a complex adaptive system, driven via a set of governance conditions (automated smart contracts). The initial research on this game may be found in the Udokwu pre-print proposal of a tool for explaining the mechanism of consensus management and the technical instrumentalization of blockchain for it (Udokwu, 2020). The potential use-cases for this optimal allocation of resources are numerous, as long as the system relies on clear rules, implementable in smart contracts, on consensus-based decision making and systemic value-added, instead of individual efficiency. In this respect, use cases may be (but are not limited to) resource allocation within a limited boundary system (for instance, grant allocation in a defined governance framework, supporting a primary layer of algorithmic governance in a public-private setting), database optimization, algorithmic discovery (i.e. discovery of new algorithms). The second stage of the research is the translation into practice of such a game: an example of a potential allocation of funds at the governmental level / private funding level.

2 CONTEXT AND STATE OF THE ART

This type of fund allocation builds upon previous literature, such as (Kovalenko et al., 2020) who propose a smart contract allocating funds from the organization to its instances, (Faisal et al., 2020) who talk about an accountable just-in-time network resource allocation based on smart contracts, (Nell, 2020) introducing the need for risk allocation in private-public partnerships, and the thesis of (Wall & Malm, 2016) introducing blockchain’s link to a distributed securities depository. Of particular importance is the seminal work of (Iyer, 2018) about building games on Ethereum. Also relevant is (Suciu et al., 2020) introducing a knowledge transfer system with digital assets. Similar research is done by (Mohite & Acharya, 2018) who suggest a blockchain-based solution for government fund tracking using Hyperledger. The fund allocation game proposed in this article stems from a need for automation and transparency in funding projects. It may be applicable at the governmental level, when allocating budget funds or working with distributing European funds at the national level (in case of EU Member States), in private-public partnerships (when the state joins private actors in bringing financing for specific issues) or in private funding (particularly for non-governmental organizations, associations and foundations). The increased transparency is a fundamental characteristic (as well as a competitive advantage) of using blockchain and smart contracts, which, in turn, allows for decreased corruption and discretionary fund allocation, particularly at the governmental level (de Souza et al., 2018). Current funding follows a three-stage process: (1) A request for funding is issued – for instance in an application – usually with a deadline, but there are rolling-based funding mechanisms as well; (2) An evaluation of the funding request is made by the funding entity which leads to three possible types of answers: positive (in which case funding is allocated according to the application), altered positive (in which case funding is allocated but with alterations from the application) and negative (in which case funding is not allocated); (3) The implementation of the project is rolled-out and financing may come: Fully at the initialization of the project – not customary; A percentage at the initialization of the project and then in instalments provisioned by the fulfilment of stages/requirements/requests/thresholds in project implementation. These thresholds are set at the beginning of the project, agreed upon by all parties, and that require validation of intermediary (and then final) project results.; Fully at the end of the project, provided the project requirements are met – not customary. The most common method is the second, with provisioned instalments, based on verification of intermediary project results. This method brings into discussion the need for automation, as the verification of results may take place objectively (usually in an inter-organizational context, as per (Kim& Laskowski, 2017), in a formal - smart contract setting.

The validation of project results shall have to be done by a critical mass of participants (that number of validators to be set at the initiation of the contract) in the network for the next-stage funding to be released. Exceptionally, the validation may be fully automated if the project impact allows, for instance, the project may refer to providing scholarships to research students, with the impact result being a certain number of published articles. The process of internet searching for published articles by a specified author within a set time frame may be automated, and no further validation needed, other than the results of the search. However, for more complex project requirements, the concepts of decentralized agents usually referred to as blockchain Oracles can automatically gather such real-world data (weather, exchange rates etc.) in a transparent and trusted manner and provide such input into the blockchain smart contract. When describing a blockchain application (DApp), it is always necessary to capture all aspects of the functions (both functions that are performed on-chain and off-chain), and identify actors (human and software agents, including oracles). The projects by (George et al., 2020) and (Liu et al., 2018) already demonstrated the applicability of these Oracles with multiple cases. They may be software-based, hardware-based or human-based, computation, inbound/outbound, contract-specific or consensus-based (Beniiche, 2020). The Oracles, per se, are not part of the blockchain, they are off-chain external data sources, interfacing the blockchain with the world. Their main role is the collection of data for the smart contract, but there is a significant level of uncertainty related to the provision of inaccurate data (either corrupt, malicious, incomplete or simply faulty) (Al-Breiki et al., 2020), (Heiss et al., 2019), (Kochovski et al., 2019). Rather, these Oracles, are services which are accessible to the Actor-Roles on the blockchain. It should also be noted that an Oracle which does not have "independently embodied and independently registered" variants (functional replica), we are faced with the moral hazard of having a single point of failure of market trust (SPoF of Market Trust). For demonstrating the use of automated payment when specific project conditions have been achieved, an example of such an automated payment release is provided by (Hamledari & Fischer, 2020), who propose a smart contract-based solution for autonomous administration of construction progress payments. Also, the conceptual design of a blockchain-based collaborative construction project management platform (CoPM), proposed by (Udokwu, Norta & Wenna, 2021), clearly captures the concepts of automated payment for building projects based on well-defined milestones.

Regardless of the format of the project results, the solution stands. Unlike the previously mentioned work of (Mohite & Acharya, 2018), our solution, working with specific smart contracts, may be used by private funding entities in permissioned blockchains such as Hyperledger, as well as in public blockchains such as Ethereum network.

3 PROPOSED SOLUTION

As already established in the first part of this article, developing a blockchain system for optimal and autonomous resource allocation for public-funded projects involve the use of both human and automated software agents in performing different tasks in the project management process. A system that consists of several human and non-human actors is referred to as socio-technical systems (STS) (Appelbaum, 1997). A STS that involves actors and software actors residing in different organizational pools performing different functions for the achievement of a common objective of a given process is a good example of inter-organizational collaboration (IOC) systems. The research conducted by (Udokwu & Norta, 2021) developed an approach for designing and developing such complex blockchain-based IOC systems. The approach referred to as the decentralized agent-oriented modelling (DAOM) framework provides a well-structured and systematic guideline for building complex blockchain systems involving several parties from different organizations. Therefore, we apply the principles of the DAOM framework in describing various aspects of the proposed blockchain system for optimal and automated resource allocation in the management of public-funded projects. The main aspects of the blockchain system are outlined by the following *what, who* and *how* questions. (a) What functions are performed in the proposed blockchain system for automated resource allocation? (b) Who perform(s) what specific functions? (c) How are the functions performed? The first question outlines the goals of the proposed system and how they are derived from the main objective. The second question outlines specific human and software actors that perform a given function for the accomplishment of the associated goal. The last question explains how a given goal/function is achieved.

Main functions in the system: To enable automated resource allocation and transparent monitoring of public-funded projects, the following is proposed as the top-level functions of the proposed system, *initiate new-project, submit application, assess applications,* and *monitor project.* The function *initiate new-project* allows government funding agencies to launch a new (research) project and define the success criteria for the projects. The *submit application* allows entities from different organizations to submit their applications and have a prospect to be selected as the executor of the project. The function *assess applications* allows the funding entities to examine submitted applications and select the winning application. The last function *monitor application* allows the funding entity to assess the progress of the projects and allocate funds when the defined success criteria have been achieved.

Actors and Software agents that perform the functions: The following are identified as the actors in the proposed system, *project manager, research entities* and *auditor agent.* The project manager represents the government funding entities that initiate new projects, assess submitted applications and allocate funds when specific success criteria have been achieved. The research entities are institutions and researchers that submit funding applications. The auditor agent is a software agent that verifies (audits) the information contained in submitted applications and also checks the completion of the project. The roles of human actors such as the project manager and research entities are quite clear since they only perform manual activities, the same as the functions performed in the traditional systems for public project management. However, the function by the auditor software agent is highly automated, involving data gathering and verification checks. The data-gathering part of the software agent can be implemented using a decentralized agent referred to as blockchain oracles. These oracles provide the possibility for a transparent gathering of real-world data without depending on a trusted/ centralized authority for data provision. The verification checks perform by the software agent to audit the project completions can be implemented with a smart-contract. The conditions for the project success can be coded into a smart-contract. With input from blockchain oracles, an automated decision regarding the status of the project completion can easily be made without or partially depending on a human actor (such as the project manager).

4 CONCLUSIONS

The paper provides an overview of the context in which a game (bounded setting) of resource allocation may exist, with the proposed initial solution (with actors and rules of engagement) provided for a financial resource allocation system. The smart contract / blockchain-based solution is presented here as a starting point, its complex landscape, incorporating AI and machine-learning for validation of project results, under blockchain oracles, being the subject of future research by the team.

ACKNOWLEDGMENTS

This article is based on research from the Erasmus+ Strategic Partnerships Project - 2018-1-RO01-KA203-049510 "Blockchain for Entrepreneurs - a non-traditional Industry 4.0 curriculum for Higher Education".

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