Revolutionizing Crowdworking Campaigns: Conquering Adverse Selection and Moral Hazard with the Help of Smart Contracts

Completed Research Paper

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Abstract

Crowdworking is increasingly being applied by companies to outsource tasks beyond their core competencies flexibly and cost-effectively to an unknown group. However, the anonymous and financially incentivized nature of crowdworkers creates information asymmetries and conflicts of interest, leading to inefficiencies and intensifying the principal-agent problem. Our paper offers a solution to the widespread problem of inefficient Crowdworking campaigns. We first derive the currently applied Crowdworking campaign process based on a qualitative study. Subsequently, we identify the broadest adverse selection and moral hazard problems in the process. We then analyze how the blockchain application of smart contracts can counteract those challenges and develop a process model that maps a Crowdworking campaign using smart contracts. We explain how our developed process significantly reduces adverse selection and moral hazard at each stage. Thus, our research provides approaches to make online labor more attractive and transparent for companies and online workers.

Keywords: Crowdwork, Principal Agent Theorem, Adverse Selection, Moral Hazard, Smart Contract

Introduction

Next to traditional outsourcing, many organizations use crowdsourcing and crowdwork to deploy labor flexibly and to benefit from swarm intelligence (Durward et al. 2016a). Crowdsourcing refers to the practice of obtaining ideas, services, or content from a large group, typically through the internet (Durward et al. 2016a). It involves outsourcing tasks to a multitude of unknown people or communities, usually in the form of an open call. Crowdsourcing can take various forms, such as collecting ideas, funding projects, or performing tasks. It has become increasingly popular due to the ease of access to large groups of people (the crowd) through the internet and the ability to harness the collective intelligence and creativity (Yun et al. 2021). Some common examples of crowdsourcing include open innovation, crowdfunding, citizen science, and social media campaigns (Avital et al. 2014; Basiri et al. 2019; Pollok et al. 2019).

Similarly to crowdsourcing, crowdwork describes outsourcing tasks to an anonymous crowd that is reached via an open call on a platform (Durward et al. 2016a). While crowd*sourcing* is characterized by the intrinsic motivation of the crowd, their main intention in the field of crowd*working* is to earn money (Chris Zhao and Zhu 2014; Rogstadius et al. 2011). Pongratz (2018) describes crowdworking as "*the outsourcing of digitally processible tasks as paid work to a global workforce via Internet platforms such as Amazon Mechanical Turk (AMT), Upwork or Freelancer*". Since crowdsourcing and crowdworking can clearly be distinguished from each other, the processes of a crowdworking and a crowdsourcing campaign must also be differentiated and clearly separated from each other. In our study, we focus on crowdworking, as companies in this context can incur greater financial damage due to inefficiencies than in the context of crowdsourcing. This is because the financial effort of managing and paying the crowd in a crowdworking campaign is greater than in a crowdsourcing campaign.

Crowdwork is also known as *online labor* because the open call, the task definition, the distribution of tasks as well as the processing of tasks is completed digitally (Durward et al. 2016a; Jäger et al. 2019). Besides, the evaluation and payment are completed online through an IT-based platform, the so-called crowdworking platform. Although the use of crowdworking reaches a large and diverse group of individuals with various skills and knowledge, the crowdworking construct is particularly affected by the principal-agent problem and the associated inefficiencies. he ad hoc nature of the work relationship involving the three parties (crowdsourcers, who assign tasks; crowdworkers, who complete tasks; and platform providers, who mediate) accentuates issues related to conflicts of interest, information asymmetry, as well as the resultant problems of adverse selection and moral hazard. These conflicts of interest can result in inefficiencies, as each party involved - crowdsourcers, crowdworkers, and crowdworking platform providers - seeks to maximize their individual benefit. Whereas the crowdsourcer (the "*principal*") aims to have tasks performed at a level of quality comparable to in-house execution but at a lower cost, the crowdworker (the "*agent*") strives to complete these tasks with minimal effort while earning the highest possible remuneration.

The aim of this paper is to explore how blockchain technology and more precisely smart contracts can help to overcome the mentioned problems in crowdsourcer-crowdworker relationships. We analyze how including smart contracts in a crowdworking campaign can contribute to making crowdwork more transparent for involved parties and identify new opportunities that arise for involved parties. With our research, we target to answer the following research question: "*Which adverse selection and moral hazard problems occur in a crowdworking process and how can smart contracts help to overcome these?*". To address and answer the research question, we proceed in three steps. 1) First, based on a qualitative study, we derive empirically and theoretically derive the current state of the process of a crowdworking campaign. 2) Based on the derived process, we identify which steps of the process are particularly characterized by information asymmetry moral hazard and adverse selection. 3) Based on the insights gained from our prior theoretical and empirical investigations, we examine how smart contracts can solve the identified problems surrounding moral hazard and adverse selection. As a result, we derive a second process that represents how crowdworking campaigns look like when including smart contracts.

Theoretical Background

Crowdwork

As indicated in the introduction, crowdwork is a form of digital employment and is a subcategory of crowdsourcing (Durward et al. 2016a, 2020; Jäger et al. 2019). Crowdsourcing is composed of "*crowd*" and "*outsourcing*" and was introduced by Jeff Howe (2006). It describes outsourcing of tasks to an undefined mass through an open call on a IT-based platform (Arnold 2011; Barnes et al. 2015). Crowdsourcing makes use of swarm intelligence and involves customers in product or company development often organized as a competition among individuals. In a crowdsourcing setting, the following shareholders are present: (1) the crowdsourcer, (2) the crowdsource(s), and (3) the platform provider (Al-Ani and Stumpp 2016). Crowdsourcers are organizations that submit a task to the crowd. Crowdsourcees are those who take on the task and contribute to a crowdsourcing campaign. A crowdsourcing platform provider matches both parties and acts as an intermediary.

While individuals participating in crowd*sourcing* campaigns are primarily driven by intrinsic motivation, crowd*workers* rely on extrinsic incentives, with monetary rewards playing the major role (Durward et al. 2016b). Crowdworkers are motivated to maximize their earnings while minimizing the time and effort required to complete tasks (Al-Ani and Stumpp 2016). This is because they don't see any incentive in delivering exceptional performance, as there is no additional compensation for outstanding results.

The relationship between crowdsourcers and crowdworkers differs from a traditional employer-employee setting since crowdworkers don't receive an employment contract from crowdsourcers. Both parties only enter into an agreement with the crowdworking platform. Thus, legal obligations do not exist to the extent of a working contract (Jäger et al. 2019). In return, crowdworking platforms take over the role of the intermediary and assist crowdsourcers in defining tasks and solution requirements (Blohm et al. 2014). Platforms also handle the payment of crowdworkers and act as arbitration in case of conflicts. As with all intermediaries, also platforms need to be trusted and cannot guarantee full objectivity (Li 2010). Although the concept of crowdworking brings about significant inefficiencies, outsourcing work to an unknown crowd is becoming more and more popular (Kittur et al. 2013; Vuurens and Vries 2012). Assigning supportive tasks to the crowd allows full-time employees to focus on value-creating activities within their organizations. Additionally, tasks can be completed faster when a crowd is completing them as tasks are divided up into small clearly defined working packages and thus can be completed simultaneously. Assignments that are particularly suitable for crowdworking are those that are outside of one's own core competency (Schulte et al. 2020). Core competencies are those tasks that a firm is generating most of its revenue and/or profit with (Groth and Kinney 1994).

As the focus of our paper deals with the phenomenon of crowdworking, it is important to reiterate the distinction between crowdworking and the sharing economy. (1) In the realm of crowdworking, the entire process – spanning from task solicitation and matching to task completion – unfolds in the online domain (Howcroft and Bergvall-Kåreborn 2019). In contrast, the sharing economy primarily centers around offline applications (Schlagwein et al. 2020). (2) While interactions between contracting parties in crowdworking campaigns are exclusively digital, the sharing economy involves tangible goods (e.g., houses in the context of Airbnb) (Schlagwein et al. 2020). (3) Crowdworking allows dividing up tasks into smallest subtasks, often referred to as microtasks (Durward et al. 2020), whereas the sharing economy encompasses only "complete" goods or services (Sanasi et al. 2020). Sharing economy is the result of the latest enhancement of interactive internet technologies, where globally dispersed users leverage the features of the digital platforms to exchange their (under-utilized) assets, provide services or share skills, digitally mediated by a platform owner (Martin 2016; Richardson 2015).

Principal Agent Theory and Information Asymmetry in Crowdwork

The principal agent theory, which emerged in the 1970s from a number of economists and theorists, is often used in literature to describe relationships of individuals in working environments (Jensen and Meckling 1976; Ross 1973). Whenever one entity delegates a task (the "*principal*") to another entity (the "*agent*") and acts on behalf of it, the principal-agent problem arises (Arrow 1986). It emerges because both parties have different interests; they are not perfectly aligned (Jensen and Meckling 1976; Ross 1973; Slivkins and Vaughan 2014). The less close the relationship between the principal and the agent is, the more diverge their interests and the stronger are the inefficiencies that arise (Jensen and Meckling 1976; Ross 1973). Whereas the principal has the intention to get tasks done as precisely as possible and as cheaply as feasible, the agent has the objective to complete tasks with as little effort as possible while receiving maximum remuneration. In addition to information asymmetry, adverse selection and moral hazard must also be mentioned in the context of the principal-agent problem (Rauchhaus 2009). In the case of *adverse selection*, one party has information that the other party does not possess and exploit it to its own advantage (Guesnerie et al. 1989; Picard 1987). This unequal distribution of information is an essential part of the principal-agent problem and can even lead to market failure (Picard 1987). Whereas the concept of adverse selection is prior to a conclusion of contract, the effects of the principal-agent problem after an agreement are referred to as *moral hazard* (Dobson 1993; Rauchhaus 2009). The moral hazard problem describes situations in which a person takes excessive risks and/or behaves recklessly because s/he will not be held responsible for his/her actions (Dobson 1993). Since agents only act on behalf of and for the principal, they take on a greater (moral) risk than if they were acting in their own name and in their own responsibility (Rauchhaus 2009). This phenomenon is another aspect that leads to inefficiencies and can have far-reaching negative consequences.

As mentioned, the principal agent problem typically occurs in working environments within organizations. In this setting, employees' (the agent's) and management's (the principal's) interests diverge where the principal depends on the agent's actions and does not have full information. To reduce the principal agent theorem in a traditional employee-employer setting, management and psychological research has developed solutions such as performance-based payment and team evaluations (Grossman and Hart 1992; Haubrich 1994). In the context of crowdworking, the classical employee-employer setting does not exist; the relationship between crowdsourcer and crowdworker can rather be described as a temporary work arrangement. Nevertheless, the principal agent problem also occurs in this setting, thereby, the divergence of interests and asymmetric information even gets intensified. Existent approaches from traditional work environments to reduce the principal-agent problem in crowdworking settings do not find application due to different circumstances, e.g., anonymity.

Instead of only relying on monetary incentives, crowdworking platforms employ various governance and control mechanisms to address the principal agent problem (Möhlmann et al. 2021). For example, platforms allow clients to rate crowdworkers based on various criteria (e.g., communication with the crowdworker, accuracy in completing tasks, etc.) after the task has been completed (Gol et al. 2019). The better the resulting one-to-five-star rating, the higher the crowdworkers are listed (Vallas and Schor 2020). The aim is to enable crowdsourcers to identify good and reliable crowdworkers. The likelihood of a crowdworker being able to demand increased financial compensation for future tasks rises in proportion to the number of tasks they undertake and the level of satisfaction expressed by crowdsourcers regarding the outcomes (Ho et al. 2015). This evaluation and rating mechanism is intended to reduce the principal-agent problem and is a widely used control tool among crowdworking platforms (Möhlmann et al. 2021).

An example of a recently introduced governance mechanism by one of the world's largest crowdworking platforms, Upwork, are on-demand reports that are available since December 2022 (Upwork, 2022). These are intended to provide more transparency and control for clients. It is possible to quickly contact former crowdworkers and see how many tasks they are currently working on and how much they have earned through the platform. This allows the crowdsourcer to see how experienced and successful the individual crowdworkers have been so far. However, with this measure and the other steering and controlling mechanisms, transparency, and equal information between the principal (crowdsourcer) and agent (crowdworker) is not guaranteed. Adverse selection and moral hazard can only be slightly limited which as such still creates significant inefficiencies. And this, even though the goal of outsourcing including crowdsourcing and crowdworking is to increase overall organizational efficiency. In our analysis, we want to demonstrate how smart contracts can be used to reduce inefficiencies in the context of a crowdworking campaign.

Smart Contracts

Automation technologies, including workflow management systems, enterprise resource management (ERM) systems, and robotic process automation, represent a few instances of well-established automation solutions extensively utilized by companies (Eggers et al. 2021). Although Szabo defined *smart contracts* in 1996 for the first time, their current application remain inadequately explored in the field of information systems (IS) research (Eggers et al. 2021). In accordance with Szabo, "*A smart contract is a set of promises, specified in digital form, including protocols within which the parties perform on these promises*" (1996). In 2016, Tapscott and Tapscott expanded Szabo's definition: "*smart contracts are computer programs that secure, enforce, and execute the settlement of recorded agreements between people and organizations*" (Tapscott and Tapscott 2016). Szabo (1996) and Tapscott and Tapscott (2016) concur that smart contracts are simple or complex if-then-else relationships.

If a situation and its corresponding action can be unambiguously specified, the deployment of a smart contract becomes a viable option (Negara et al. 2021). The difference between incumbent automation technologies and smart contracts is that the secondary are programmed on a blockchain and thus are characterized as decentralized, self-executing and transparent (Negara et al. 2021). The blockchain is a continuously updated, chronologically organized, and publicly accessible ledger containing data about ownership and transactions (Sahai and Pandey 2020). The use of cryptographic principles guarantees the enduring immutability of records and establishes smart contracts as a highly secure automation technology (Shailak Jani 2020). Within the realm of smart contracts, the blockchain enables agreements to be transparent to the involved contracting parties and to be automatically activated when predefined conditions arise (Mohanta et al. 2018). This provides full transparency and makes intermediaries redundant (Lin et al. 2020). Thus, smart contracts increase efficiency, security and create trust between two or more involved contracting parties.

Putting a smart contract into practice can be divided into four steps: (1) creating, (2) deploying, (3) executing, and (4) completing (Shailak Jani 2020) (figure 1).

As a first step (1), the parties involved in the contract agree on contingencies and contractual terms. It's important to encompass all potential scenarios and specify the actions that the contract should initiate (Hu et al. 2020). After included parties come to an agreement and complete their negotiation, the smart

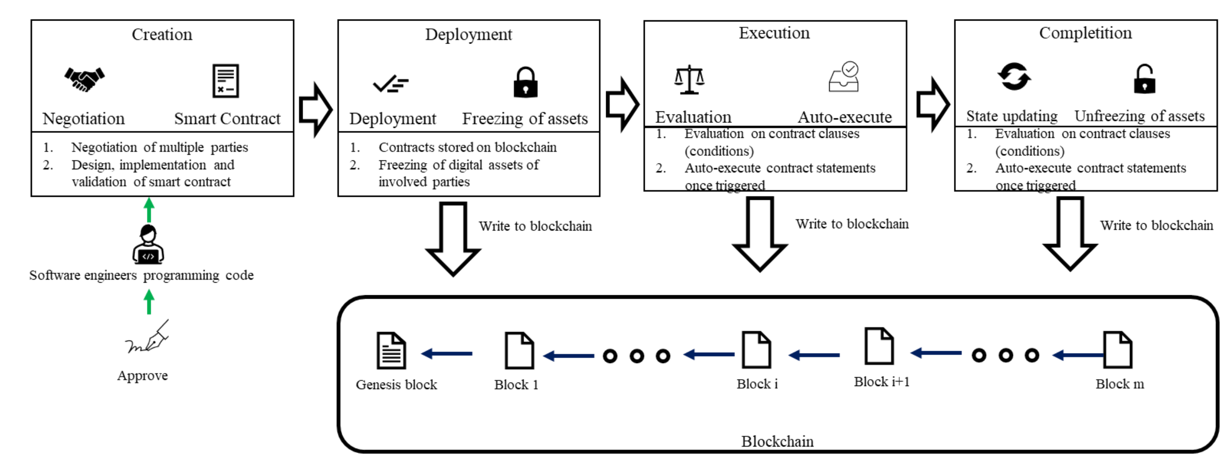

Figure 1. Setting up a Smart Contract, inspired by Shailak Jani (2020)

contract needs to be approved by a lawyer. To legally validate those, an additional qualification is required, which only a very few lawyers have acquired so far (Zou et al. 2021). This currently makes the step of legal examination costly (Gilcrest and Carvalho 2018). Once the smart contract is considered as legally binding and validated, it is programmed accordingly. The most common blockchain for smart contracts is Ethereum and the most common programming language is *Solidity* (Ferreira et al. 2020). Having smart contracts written on Ethereum ensures the retroactive immutability of transactions (Kim and Shin 2019). Whenever the agreed terms and/or situation(s) occur, the smart contract completes the related and predefined action(s) (Shailak Jani 2020). An exact (pre) specified execution is guaranteed which provides security to involved parties.

Once a smart contract has been programmed, it (2) gets deployed. This second step (2) involves placing the smart contract onto a blockchain, rendering it transparent to all parties involved (figure 1). As it is customary in blockchain technology, each transaction and completion of the smart contract are recorded in the genesis block, allowing for easy tracing at any given time (Shailak Jani 2020). This technology provides the transparency and security discussed earlier. In the (3) execution phase, the smart contract consistently checks whether predefined situations arise (e.g., crowdworker completed a task satisfactory). As soon as the contract identifies a defined condition, it executes the connected task (e.g., transferring predefined remuneration to crowdworker's account) (Christidis and Devetsikiotis 2016). In the final step, (4) the completion of the transaction, the computer protocol allocates the digital assets that are triggered by the smart contract (Shailak Jani 2020).

To reduce the complexity of programming and constructing smart contracts, some startups are working on setting up a low-code platform for smart contracts (Hurlburt 2021; Rosa-Bilbao et al. 2023). These platforms are intended to target individual industries and enable companies to initiate smart contracts themselves for widely used processes across multiple companies for instance the automated reordering and payment of components (Rosa-Bilbao et al. 2023). Smart contracts are not only transparent and reduce information asymmetry but also automate business processes visible to all contract partners (Eggers et al. 2021). Therefore, smart contracts enable the reduction of dependence on intermediaries or even bypassing them. Intentions for bypassing intermediaries are diverse and often relate to financial, time, and/or political considerations (Shahab and Allam 2020). In our case analyzed, financial, time, and efficiency-related reasons are particularly noteworthy for bypassing the intermediary, crowdworking platform provider.

Our research aims to identify the stages within a crowdworking campaign where smart contracts can be integrated to enhance the process and address prevailing challenges such as trust issues, information asymmetry, moral hazard and conflict of interest between related parties.

Research Design

To answer our research question "*Which adverse selection and moral hazard problems occur in a crowdworking process and how can smart contracts help to overcome these?*", we proceed in three steps (figure 2). In a first step and based on a qualitative study, we derive the currently conventional process of a crowdworking campaign. Subsequently, we identify the process steps in which the adverse selection and moral hazard problem are particularly pronounced by consulting and analyzing existing literature. In a third step, we derive, first theoretically and then qualitatively, how the use of smart contracts in the crowdworking process can counteract the previously identified problems related to adverse selection, moral hazard, and the principal-agent problem. This two-stage process ensures the validity of our research.

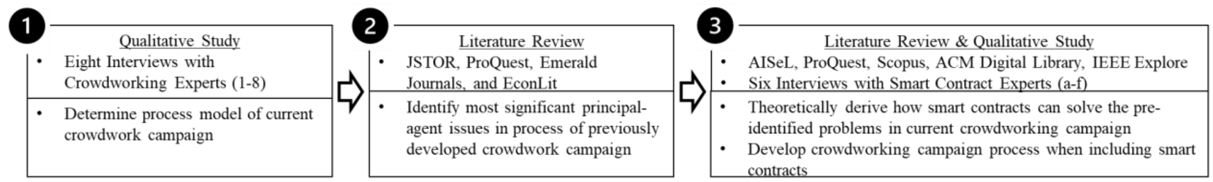

Figure 2. Methodological Procedure of our Study

In step (1), we conducted a qualitative study to determine a process model of a crowdwork campaign. Conducting eight interviews with managers representing six distinct crowdworking platform providers provided us with valuable insights into the processes, challenges, and daily operational complexities of their online labor platforms. Among our interviewees, half were affiliated with crowdworking platforms that primarily offer microtasks, while the remaining four were associated with platforms specializing in macrotasks. All interviews were conducted virtually, lasting approximately one hour each, and recorded with the participants' prior consent. Following the interview and transcription phase, we applied Carroll's five-stage analysis process (2000) to examine the collected data.

To start, we analyze the interview transcripts obtained from our data collection process in the first stage. We use MAXQDA to assign specific codes to each unit. Moving on to the second stage, we examine the coded units and group them based on related topics and issues through category analysis, sorting, and clustering (code aggregation). Finally, in the third stage, we evaluate the strength of these categories through testing their inter-subjective resistance by creating a coding scheme where classifications and exemplary indicators are defined (Carroll 2000). Transitioning to the fourth stage, we delve into a comprehensive discussion of the findings from the preceding step to determine the best course of action: either (1) reaching a consensus, (2) excluding them from further analysis, or (3) establishing a new category. By involving authors from varied backgrounds and experiences in the analysis, we enhance the objectivity of the results, even within the context of qualitative research. In the fifth stage, known as the axial coding process, we strive to identify credible relationships between all the categories we determined, resulting in the organization of theoretical components into higher-level (or core) categories (Olsson et al. 2008). With this approach, we identify a crowdworking campaign process as well as challenges that arise throughout the procedure (figure 4).

Based on the process derived in step 1, we used it as a foundation for step 2 to identify phases where the principal-agent problem is most significant. To do so, we consulted literature in general economics with a focus on new institutional economics, health economics regarding moral hazard, and the economics of market mechanisms. We also involved literature around contract theory and economics. As a basis for our research, we included the databases JSTOR, ProQuest, Emerald Journals, and EconLit. The quality of the peer-reviewed and published papers in those journals ensures that only high-quality findings are included in our analysis.

After identifying five aspects in the developed process as those where the principal-agent problem, information asymmetries, and the moral hazard problem are most pronounced, we consulted literature in the areas of smart contracts, blockchains, and process management. This enabled us to theoretically derive how smart contracts can solve the pre-identified problems surrounding the principal agent theorem, which are particularly striking in a crowdworking campaign. For our literature review, we used the databases AIS Electronic Library (AISeL), ProQuest, Scopus, ACM Digital Library, and IEEE Explore for high-ranking articles. Thus, we were able to cover an extensive theoretical background to recognize how identified challenges of a current crowdworking campaign can be solved by applying smart contracts. As a result, we defined a second process that incorporates the use of smart contracts in the context of a crowdworking campaign. In doing so, we used the decision path from Carvalho and Karimi (2021) as well as the "Ten-Step Decision Path" to determine when to use blockchain technologies (figure 3) (Pedersen et al. 2019).

According Carvalho and Karimis (2021) one can determine whether a blockchain solution is necessary by posing the following questions: (1) "*Do you need to store data?*", (2) "*Are there multiple writers?*", (3) "*Can you rely on a third party?*" and (4) "*Are all writers known?*". Pedersen et al. (2019) define a blockchain decision path consisting of 10 guiding questions to determine whether a blockchain solution is appropriate and advisable for the respective case (figure 3).

Following Carvalho and Karimis' decision path (2021), a crowdworking campaign can benefit from applying blockchain solutions. This is because (1) a crowdworking campaign involves two or more parties (crowdsourcer and crowdworker), (2) their relationship is characterized by anonymity as well as (3) divergent interests, and they (4) rely on a third party (crowdworking platform). Also, a common database between crowdworker and crowdsourcer is necessary (to get an insight in certificates of the crowdworker, work orders already done/completed, additional information for task). This is a further reason why bringing the crowdworking process to the blockchain is suitable.

In addition to the approach of Carvalho and Karimi, the 10 Step Blockchain Decision Path according to Pedersen et al. (2019) also confirms that the use of a blockchain in a crowdworking campaign is recommended. In addition to the already established need for a common database between crowdworker and crowdsourcer (step 1), the involvement of multiple parties with different interests (crowdworker, crowdsourcer) (steps 2 and 3), and the efficiencies of bypassing a third party (crowdworking platform provider) (phase 4), the process also highlights different rules for system access between participants (phase 5). By crowdworkers not operating in the crowdsourcer's ecosystem, two system accesses are present. In the context of oracels and implemented by smart contracts solutions, these system accesses can be synchronized. Similarly, the use of blockchain solutions, more specifically by smart contracts, enables repetitive processes such as a crowdwork campaign to be automated through clear if-then-else relationships (step 6). An immutable log of all activities (phase 7) allows tasks, solutions, competencies, and experiences of crowdworkers to be traced. This increases transparency for all parties involved and creates trust between crowdworker and crowdsourcer. Depending on the constellation, a permissionless shared blockchain (for public transactions) or a permissioned public blockchain (for inter-organizational) can be considered for a crowdworking campaign (step 10).

After applying both decision tools to infer that a crowdworking campaign is suitable for the use of blockchain solution, we used the above mentioned IS and computer science literature as the basis for our analysis to identify how to include smart contracts in the existing process. After deriving the process for a crowdworking campaign using smart contract solutions in this way, we presented it to six smart contract experts to ensure validity. The experts we interviewed are active in the business sector and work with smart contracts on a daily basis. Two of the experts are involved in the development and implementation of smart contracts; the other four interviewees use smart contracts for standard processes in their companies. We divided the interviews into two parts: first, we asked the interviewees about their experience with smart contracts. Second, we presented the crowdworking campaign process using smart contracts that we derived from the literature and asked for their critical evaluation. For each comment and suggestion, we asked for background information to incorporate additional practical understanding. We included all recurring suggestions into the revision and refinement of the process. As a further research step, the developed process can be tested in practice.

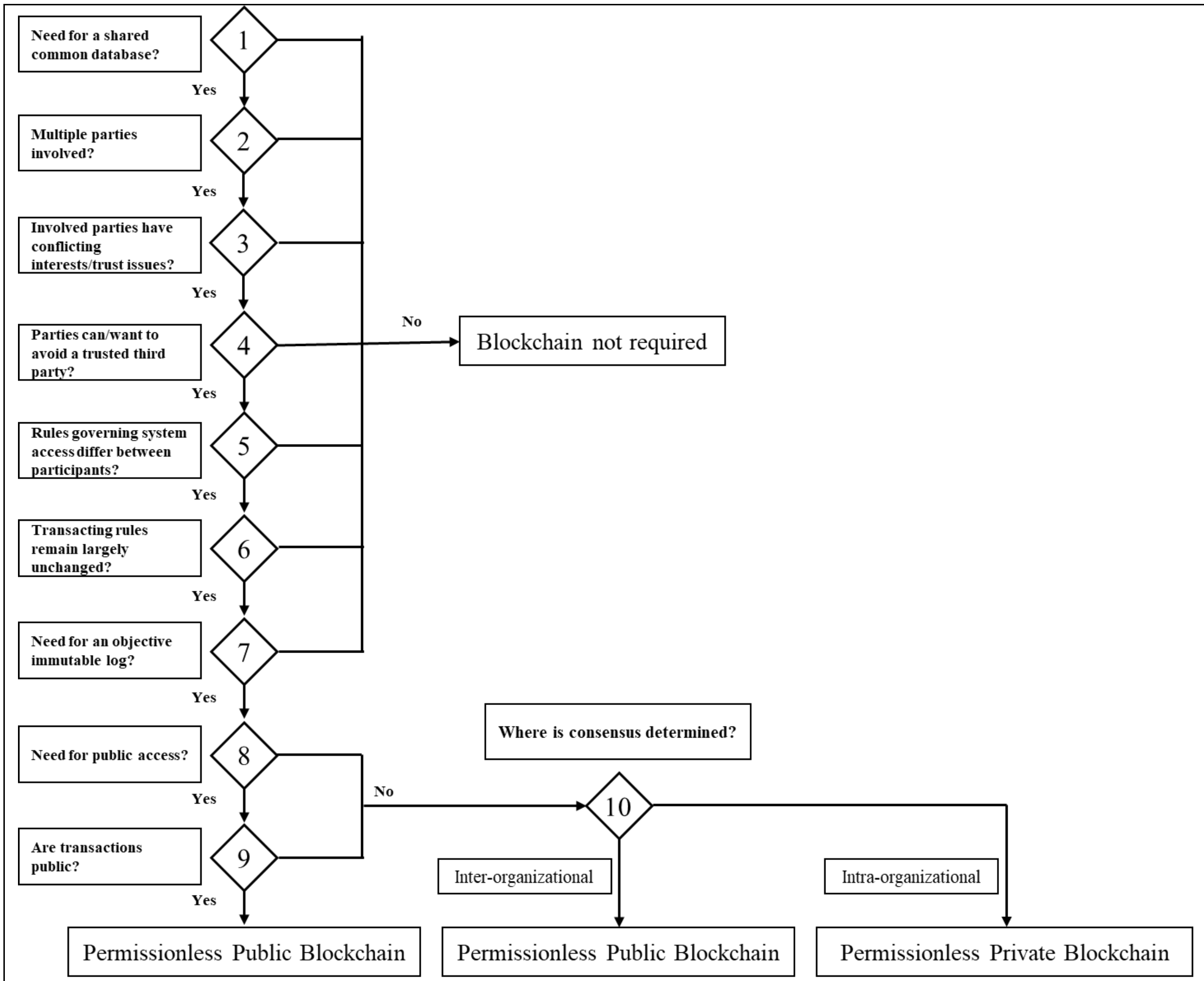

Figure 3. Ten-Step Decision Path to Determine When to Use Blockchain Technologies Inspired by Pedersen et al. (2019)

Findings

Process Model of a Crowdwork Campaign

After analyzing the data that we were able to collect during the interviews, we developed the following five-phase crowdworking campaign process (figure 4). Before the crowdworking process as such starts, crowdworkers need to create an account indicating their qualifications, degrees, special knowledge, and skills on the relative platform (interviewees 4, 5, 7). Documents proving the capabilities are also uploaded. To validate these profiles, platforms require crowdworkers to undergo tests before their profiles become visible online. To ensure an accurate representation of their capabilities, crowdworkers are unaware that the tasks they perform do not correspond to actual employment opportunities ("*We ensure that crowdworkers do not know that they are completing a trial task*", interviewee 3). Even with these quality assurance measures in place, the authenticity of certificates cannot be guaranteed, as they can be easily forged without detection by crowdsourcers or platforms (interviewees 1, 5, 6, 7). Verifying and confirming the legitimacy of uploaded certificates poses a significant challenge for platform providers, particularly since assessments provided by previous contracting authorities are often subjective (interviewees 1, 2, 3, 4, 8).

Figure 4 illustrates the five-phase model of a crowdwork campaign that has been developed. In the *initiation phase*, the crowdsourcer the crowdsourcer formulates a task, provides a detailed description of it, selects a crowdworking platform, and prepares an open call ("*Our goal is to only have job descriptions uploaded that are clearly defined to ensure the best fit with the crowdworker*", interviewee 6). During this phase, it is crucial for crowdsourcers to make an informed choice regarding an appropriate platform because different crowdworking platform providers attract distinct types of crowdworkers (interviewees 1, 4). Moving on to the second phase, known as the *bidding phase*, once an open call is published, platforms take one of the following approaches: (1) they invite crowdworkers to submit proposals for completing the uploaded task (applicable to macro tasks) (interviewees 1, 3, 5), (2) crowdworkers select the tasks they wish to complete (relevant to microtasks) (interviewees 2, 4, 6), or (3) crowdworkers apply for executing the task (macrotasks) (interviewees 1, 3, 5). The third phase is exclusive to macrotasks and centers around the selection of a crowdworker. This *decision-making phase* can begin either by (1) crowdworkers submitting their proposals, after which the crowdsourcer assesses and rates all submissions, or by (2) crowdsourcers directly identifying the most suitable crowdworker for a task (interviewees 1, 3, 8). Based on the crowdworker's competence profile and rating, the platform provides recommendations to assist crowdsourcers in their decision-making process. Utilizing these matching principles enables platforms to

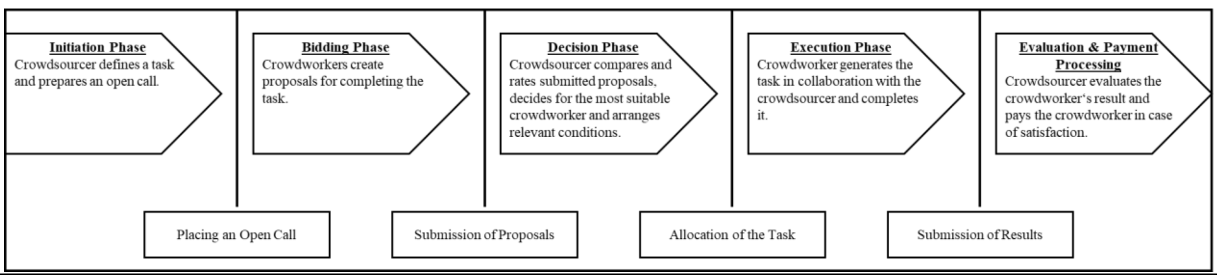

Figure 4. Five-phase Process Model of a Crowdwork Campaign

offer suggestions regarding which crowdworker is well-suited for a specific task ("*This matching presents great value for crowdsourcers as they get offered the best candidates that fit a certain task*", interviewee 8). The criteria for selecting the most appropriate crowdworker typically involve a blend of demographic attributes (such as age, gender, and location), skills (such as IT proficiency and language abilities), and their track record of previous task completions (interviewees 1, 3, 6, 7). In the second-to-last phase, known as the *execution phase*, tasks are assigned and carried out by the designated crowdworker (for macrotasks) or the crowdworker who accepted the microtask. If necessary, additional information is shared with the crowdworker to facilitate task completion (interviewees 2, 3, 8). Once the results have been finalized, they are uploaded through the platform. Subsequently, crowdsourcers have the option to request modifications and adjustments as needed ("*In that step, crowdsourcers have the chance to ask for improvements and edits. The only requirement is that they are precisely stated in the initial task description*", interviewee 5). Submitting the solutions successfully initiates the *evaluation and payment processing phase*. During this concluding stage, the crowdsourcer assesses the performance of the crowdworker. Criteria are inter alia his/her performance, and communication during the handling time. Crowdsourcers assign a ranking ranging from one to five stars (interviewees 1, 2, 3, 4, 5, 6). In this phase crowdworkers receive their remuneration ("*Crowdsourcers can only upload tasks if they have enough liquidity uploaded to the platform. We then subtract the value of the task and transfer it to the crowdworker's account as soon as a task is completed satisfactorily or after the expiration of the reviews. This ensures that crowdworkers get paid*", interviewee 1).

The process of a crowdworking campaign can be characterized as repetitive. However, a significant number of crowdworking platform providers do not employ automation for pairing crowdsourcers and crowdworkers. Instead, they rely on manual processes, involving employees who match crowdworkers and crowdsourcers (interviewees 3, 5). This is because existing tested algorithms have not delivered the originally envisioned support for crowdworking platforms. In order to keep crowdworking an affordable and cost-efficient concept for businesses, the incorporation of automation technologies is imperative.

Nevertheless, current digitalization solutions have proven insufficient, prompting an exploration of smart contract solutions and their potential value within the crowdworking process (interviewees 3, 5). We theoretically identify areas in the crowdworking process where the integration of smart contracts can enhance the mechanism. These computer protocols offer several advantages over traditional automation, including the acceleration of crowdworker and crowdsourcer matching, the mitigation of principal-agent problems, such as adverse selection and moral hazard, due to complete transparency, and a reduction in administrative costs for intermediaries. Payment processes are automated and secured through blockchain technology, not only minimizing manual effort but also addressing principal-agent and moral hazard concerns between parties. By utilizing smart contracts, the crowdworking concept is improved for both crowdworkers and crowdsourcers.

Adverse Selection and Moral Hazard Dilemmas in the Crowdworking Process

Throughout the entire process of a crowdworking campaign (figure 4, phase 1-5), the relationship between the crowdworker and the crowdsourcer is characterized by an information asymmetry (Silberman et al. 2010). In the initiation phase and bidding phase, crowdworkers (agents) have more information about their abilities and skills, while the crowdsourcer (principal) has complete information about the relevance the crowdsourced task has for the company. Since the information asymmetry exists before the contract between the crowdsourcer and the crowdworker is concluded, it is referred to as adverse selection (Rauchhaus 2009). As the principal can only evaluate the performance of the submitted task, the third phase of the process, the decision phase, is characterized by a high conflict of interest. It is not guaranteed that the willingness to work and the skills are similar as indicated by the crowdworker. Since this occurs before the contract is concluded between the crowdworker and crowdsourcer, it is also an adverse selection phenomenon. Once the crowdsourcer has decided for a crowdworker (figure 4, phase 3), the information asymmetry that exists as of now is commonly referred to as the moral hazard problem (Rauchhaus 2009). The moral hazard problem is amplified by the ad hoc working relationship between the crowdworker and crowdsourcer (Dutta and Radner 1994). When paid on an hourly basis, crowdworkers tend to perform tasks slower than they would normally take. It is often difficult for clients to accurately estimate whether the crowdworker needs the billed time to complete the task (Hall et al. 2022). To counteract this, many crowdsourcers prefer to assign a task at a fixed price. However, due to the continuing information asymmetry and conflict of interest, crowdworkers also aim to accomplish the job as quickly as possible to maximize their own benefit, leading to risky decisions. To minimize the moral hazard problem, continuous monitoring by the crowdsourcer would be necessary (Liu et al. 2021). However, this is not possible because it is uneconomical, and tasks could be taken over internally. Even when completing tasks inhouse, the moral hazard problem would still be present (Dobson 1993). The fundamental problem that can be found in the existing process of a crowdworking campaign is that the opportunistic behavior of the better-informed partner (agent, crowdworker) negatively affects the costs of the less informed one (principal, crowdsourcer). In the following, we explain how the use of smart contracts in a crowdworking campaign can help solve the challenges of the principal-agent theorem.

As previously noted, management research provides numerous mechanisms for aligning the interests of agents with those of principals in order to reduce information asymmetry (Grossman and Hart 1992; Haubrich 1994). These mechanisms encompass financial incentives such as performance-based commissions, profit-sharing arrangements, and performance metrics, as well as non-monetary motivators like group commitment initiatives (Chan and Lam 2011; Miller 2005). Since our research centers on crowdwork, conventional methods for aligning the interests of agents and principals are not applicable, given the anonymity and ad hoc nature of work relationships in crowdwork.

Application of Smart Contracts in Crowdwork Campaign Processes

The relationship between a crowdworker and a crowdsourcer is characterized by high anonymity. This anonymity exacerbates the principal-agent theorem, as crowdworkers are primarily motivated to maximize their self-interest and complete tasks as quickly as possible (Amanor-Boadu and Starbird 2005). Platforms act as intermediaries and try to ensure quality control by only paying crowdworkers if crowdsourcers are satisfied with the delivered solutions (figure 4, phase 5). However, according to interviewees, crowdsourcers frequently invest little time in reviewing results, potentially resulting in crowdworkers receiving payment despite incomplete or unsatisfactory tasks (interviewees 3, 5, 8).

In the following sections, we illustrate how the incorporation of smart contracts into the previously outlined process diminishes the principal-agent problem, specifically addressing the issues of adverse selection and moral hazard. We identify further advantages that smart contracts bring when integrated into the crowdwork campaign process. Besides, we provide a benchmark including (1) accuracy, quality of completed tasks, (2) cost, (3) completion rate and (4) fairness related metrics that depicts the effectiveness of smart contracts in the context of crowdworking campaigns. Our research depicts that including smart contracts in the crowdworking process provides greater transparency, objectivity, and efficiency. This enables the establishment of trust-based relationships between crowdworkers and crowdsourcers, a connection that, in a traditional setting, is often characterized by skepticism. Unlike smart contracts, conventional automation technologies do not offer remedies for the problem of distrust between contract partners belonging to different organizations (Astill et al. 2019).

In the current applied process, crowdworkers upload their certificates, (academic) degrees, work experiences to the crowdworking platform. Additional tests that crowdworkers are asked to take to appear on the crowdworking platform are intended to validate their skills, e.g. writing a few lines of code (interviewees 3, 4, 6, 8). However, as already described, there are still extreme information asymmetries between crowdworkers and crowdsourcers as certificates can be fake (interviewees 1, 5, 6, 7). Deploying smart contracts and storing certificates on a blockchain enables a transparent representation of which competencies a person has acquired and where and when they have been developed. This reduces the information asymmetry between crowdworkers and crowdsourcers, as the crowdsourcer can get a more accurate picture of the crowdworker's skills. Because the source and issuer of certificates can be easily traced due to the transparency of the underlying blockchain technology, counterfeit certificates can be promptly identified (Golosova and Romanovs 2018; Yasin and Liu 2016). Granting permission for crowdsourcers to inspect the crowdworkers' documents can be one of the prerequisites to apply for a task (Christidis and Devetsikiotis 2016). This measure helps reduce the information gap regarding the skills of participants in a traditional crowdworker-crowdsourcer setup, consequently mitigating the adverse selection issue.

Besides offering great transparency, smart contracts can propose solutions for matching crowdworkers and crowdsourcers (figure 5, step 2). Leveraging certificates, experience, and other pertinent information accessible to the smart contract, the algorithm impartially suggests one or a predetermined quantity of crowdworkers with e.g., programing skills. Depending on the preferences of crowdsourcers and the programming of the smart contract, contracting authorities can either choose from the proposed options or

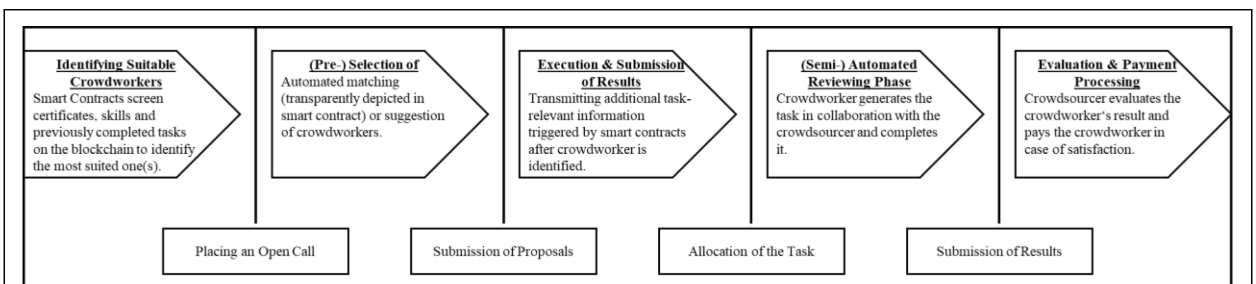

Figure 5. Process Model of a Crowdwork Campaign When Including Smart Contracts

delegate the decision to the algorithm. With access to comprehensive and well-defined decision-making criteria for various situations (if-then-else relationships), smart contracts operate objectively (Kim and Laskowski 2017). The transparency fostered by objective matchmaking through computer protocols enables the reduction of the adverse selection issue (Hui et al. 2018). Additionally, the matching process is rapid as suitable crowdworkers can be identified within seconds by screening relevant candidates. Smart contracts offer enhanced security compared to conventional automation solutions, because they are stored on a blockchain. After a crowdsourcer has chosen a crowdworker, crowdworking platforms currently offer to regularly share screenshots of the worker's progress with the crowdsourcer during the task (interviewees 5, 6, 8). This is intended to ensure quality management and reduce the moral hazard problem. With the use of smart contracts, these quality controls can be permanently or periodically shared with the principal to provide updates on the current state of the solution, e.g. the current progress of the website to be programmed by the crowdworker (figure 5, step 3). It allows reducing information asymmetries between the principal and the agent and thus helps to reduce the selfish behavior of the agent (the crowdworker) within the scope of the moral hazard. This transparency allows the crowdsourcer to contact the crowdworker directly if tasks are not completed as specified or desired, thereby reducing duplicate work for the crowdworker. Due to the complete transparency and objectivity provided by smart contracts, fairness related metrics are to be ranked higher than in currently applied crowdworking campaigns. Besides, the accuracy and the quality of completed tasks are higher than in the currently applied process. This is because the principal can transparently follow the crowdworker's workflow. It allows communicating quality issues or errors in task processing immediately back to the crowdworker which results in a great accuracy and quality of completed tasks.

As crowdworkers play the major role in the execution phase (figure 4, phase 4), smart contracts find application in automatically transmitting additional information required to complete a task, often facilitated through an oracle. This process is initiated as soon as a crowdworker is identified. Letting smart contracts share additional information reduces the manual effort and costs for crowdsourcers. Depending on the complexity of the task assigned to crowdworkers, the submitted solution can either be reviewed by a crowdsourcer's employee (complex task such as checking the corporate identity features, layout etc. of a website) or by the algorithm itself (simple task such as whether all pictures are classified). Another option is to incorporate a two-stage quality control process, wherein an impartial smart contract initially oversees the task, followed by an internal employee reviewing the solution. This approach reduces the effort required from the crowdsourcer and enhances the likelihood that tasks assigned to the crowd meet the quality expectations set by the crowdsourcer. In combination with having an insight into the work progress of the crowdworkers, their moral hazard behavior can be greatly reduced (interviewees b, d, e).

In the conventional crowdworking process derived by us, the evaluation and payment procedures are implemented and ensured through the platform (figure 4, phase 5). In this way, clients deposit at least the amount on the platform that the task is worth (interviewees 1, 2, 3, 4). Only after that, they can upload the task description to the platform. However, processing and transaction costs are incurred in this case. Using smart contracts, the liquidity of the clients (crowdsourcers) is automatically checked in this process step, and upon successful completion of the task by crowdworkers, payment is automatically ensured by the predefined if-then-else relationship (Shahab and Allam 2020; Vatiero 2018), interviewees a, b, c). The cost metrics as one benchmark thus is lower in the derived process when applying smart contracts than in the currently applied process. Furthermore, the aspect of fairness in the context of crowdworking campaigns can be better addressed through the implementation of smart contracts. This can be attributed to the fact that crowdworkers are saved from unnecessary additional work, and their payment is accordingly secured (interviewees a, b, c, d, e, f).

As shown in figure 5, the use of smart contracts enables the reduction of challenges in the area of adverse selection problems, information asymmetry, and moral hazard behavior in a crowdworking campaign. Inefficiencies that exist in the derived conventional process (figure 4) can be reduced and (partially) eliminated. Thus, the concept of crowdworking becomes even more attractive for companies, as additional tasks that lie outside the core competencies can be delegated to the crowd. Internal employees can then focus on all the tasks that provide the greatest value to the company and fall within their core competencies. This, in turn, ensures a sustainable competitive advantage (Barney 1995). For crowdworkers, the use of smart contracts has the advantage that there is clear transparency and thus good performance is remunerated additionally and fairly. The matching principle is also defined in a smart contract which again, provides great transparency for crowdsourcers and crowdworkers.

Contribution

Our research offers new knowledge on new application areas of blockchain and smart contract technology, namely the crowdworking environment. Profound knowledge on this is not only important for science to better understand this phenomenon, but also to build on these insights in research and practice. Thereby, our study not only provides theoretical but also practical contribution, which are described in the following.

Contribution to Theory

Our research is the pioneer in illustrating precise application potentials for smart contracts within crowdworking campaigns and presenting strategies to mitigate the principal-agent dilemma in this context, all the while enhancing the process's efficiency. Our study contributes to the literature by presenting new theoretical approaches for addressing issues related to the principal-agent theorem, moral hazard, and information asymmetries in the realm of crowdworking. Thus, we make a conceptual contribution by rethinking existing steering and governance mechanisms, thereby creating added value within the context of prevailing business approaches. Our research helps to advance the field by providing new insights and avenues for research. We demonstrate how smart contracts can successfully address issues of moral hazard, information asymmetry, and adverse selection in crowdworking campaigns. Our research highlights that those conventional measures such as monitoring, and sanctions become redundant due to the transparency enabled by the implementation of smart contractsblockchain solutions. Thus, our research presents new opportunities for conquering adverse selection and moral hazard with the help of smart contracts.

We particularly demonstrate the great and diverse possibilities and potentials that smart contracts possess. Besides, we illustrate how the principal-agent problem can be reduced with blockchain solutions, thus decreasing significant inefficiencies. Scaling down this ineffectiveness makes it possible to further exploit the potential of crowdworking and make it more relevant for both crowdsourcers (organizations) and crowdworkers. For organizations crowdworking becomes more attractive because they can expect high-quality processing and solutions from the crowd. Crowdworkers, on the other hand, are rewarded for good work as the transparency ensured by the smart contract and the blockchain reveals dishonest or inefficiently working crowdworkers. At the same time, online workers are free to choose which tasks they want to accept. Transparency-focused blockchain solutions address significant challenges inherent in the current crowdworking environment. These challenges include issues like anonymity, the principal-agent problem encompassing information asymmetry, adverse selection, moral hazard, and conflicts of interest. For instance, employing smart contracts streamlines the process of matching crowdworkers with particular tasks while maintaining a transparent record of the selection and working processes. This, in turn, can expand the pool of available crowdworkers, thereby enhancing the likelihood that crowdsourcers will find a suitable worker for their specific task.

So far, IS research has mainly focused on smart contract use cases in the finance and insurance industry (Eggers et al. 2021). Our research combines online labor platforms with the opportunities that blockchains and smart contracts provide to combat inefficiencies caused by the principal agent theorem. Thus, our research additionally contributes to the field of institutional economics. As the application of smart contracts in online labor platform setting is novel, further research is needed to determine potential challenges and solutions to implementing smart contracts in this context. Our paper, however, provides a starting point for further research in the areas of online labor platforms, use cases for the blockchain application of smart contracts, and institutional economics. Additionally, privacy and legal challenges, technical barriers, and analyzing the acceptance of smart contracts as well as reasons for reluctance need to be studied in the future. By addressing these challenges, the field of crowdworking can continue to evolve and benefit from the advantages of the analyzed computer protocols. Our benchmark analysis shows that accuracy and quality of completed tasks, the overall included tasks, the completion rate and the fairness related metrics outperform those in the currently applied process.

Contribution to Practice

In addition to our theoretical contribution and the conceptually derived process for a crowdworking campaign with and without the application of smart contracts, our research also provides relevant insights for practitioners. We demonstrate how efficiency can be increased with smart contracts and how it can create a basis for a more transparent interaction between crowdsourcers and crowdworkers. Therefore, we enable organizations that have previously relied on crowdworking to continue using it more easily and securely in the future. With the possibility of including low-code platforms in this area and thus decreasing set up costs, it will also be possible for companies to create their own smart contract tailored to their needs and use it to conduct a crowdworking campaign. With our paper, we provide an important initial conceptional contribution to further possible applications for smart contracts in the business context, beyond the previously analyzed cases in the areas of, for instance, finance and logistics sectors. In addition, our approach enables companies that have not previously used crowdsourcing due to the anonymity of the crowd start benefitting from online labor and use it as a sustainable and meaningful tool for outsourcing, generating ideas, and creating value. Our research allows us to consider existing platforms in new ways. We demonstrated that (1) the use of smart contracts can lead to new decentralized business models, (2) crowdworking can be implemented without monopolistic platform providers, and (3) as a result, the concept of crowdworking can be made more transparent, cost-effective, and thus more relevant for organizations.

Conclusion

Our findings suggest that smart contracts based on the blockchain technology have the potential to transform the crowdworking process by providing a decentralized, immutable, and transparent way to automate tasks and transactions while providing complete transparency. This can address principal agent theorem key challenges such as information asymmetry, adverse selection, and moral hazard due to traceability of all actions on the blockchain. Thus, the information that the crowdworker has is aligned with the one of the crowdsourcer. This (almost) full transparency of information reduces the motivation of crowdworkers to submit faulty and inadequate solutions. When applying blockchain solutions in a crowdworking campaign, matching mechanisms are also exclusively objective and transparent, which increases overall efficiency. As neither crowdworkers nor crowdsourcers need to trust an intermediary as all terms and conditions are clearly defined in the smart contract, those computer protocols have the potential to transform and improve the existent process. Likewise, the payment procedure is simplified. For this, a smart contract gets programmed in a way that the payment gets triggered autonomously as soon as crowdsourcers accept the solutions handed in by crowdworkers. Having all transactions indicated on the blockchain eliminates uncertainties between crowdworkers and crowdsourcers. Evaluations as well as completed payments are visible for included parties. The resulting transparency leads to greater security and trust among crowdsourcer and crowdworker as information asymmetry, adverse selection and moral hazard is reduced while efficiency is increased.

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