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Potentials Of Blockchain In Crowdsourcing Platforms – An Outlook For Industrial Services

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Abstract

Companies increasingly outsource services with the intention to disseminate risks and workload (problem) with other organizations. Reasons for that may be the lack of internal expertise, reduced execution costs, and network effects such as focus on the core business. Crowdsourcing is a way of disseminate the workload, utilizing external expertise and solving problems of a project with other, partly unknown, network participants. The goal of crowdsourcing is to separate responsibility and to balance the workload of employees (peer) or to make use of suitable external workforces coordinated by network mechanisms (platform). Crowdsourcing appears in an ambivalent way and needs regulating and participatory structures of employment. Due to the fact that a failure of a single entity may lead to the failure of the whole project, the mutually unknown participants have to rely on each other's quality (performance). Cooperations are prone to information asymmetry and its corresponding uncertainty in terms of the partners' behaviour which leads to the question of trust between the cooperating partners (principal and peer). This paper addresses the entities of a crowdsourcing system under the scope of the principal agent theory and its underlying behavioural assumptions. Five essential elements will be derived: principal, peer, problem, platform and performance (5 Ps). Based on this, the potentials of the blockchain technology will be explored by reflecting its functionalities to the derived elements and its contributions to ensure trust despite of information asymmetry in crowdsourcing platforms.

Keywords

Crowdworking; Regulation; Behavioural Uncertainty; Industrial Services; Blockchain; Trust

1. Introduction

In the course of the "fourth industrial revolution" [1] or the "Second machine age" [2], companies in industrial sectors must adapt to their changing environments. One of the most challenging changes in the digitalized industry and in the development of smart maintenance [3] is the growing complexity of machines and plants (assets) as well as the intensive usage of data and new technologies [4, 5]. Despite this complexity, industrial services and the in-house maintenance departments have to guarantee the reliability and availability of all assets which are required for the production [3]. The growth of complexity combined with the increasing demand of skilled workers [6] requires adaptability also for industrial services and in-house maintenance departments [7]. These developments and changes, in addition to rationalization efforts, are causing companies to reduce complexity, e.g. through intelligent technology and data usage, and through the recruitment of external personnel which is appropriately qualified. As an alternative to the "onboarding" of highly qualified skilled workers, the widely increasing use of crowdsourcing platforms is an option [8]. On those platforms, tasks and jobs are offered (or outsourced) to an undefined mass of potential (crowd-)workers which indicates the change in work organization [9].

Within those economic relations or networks there are lots of uncertainties and the risk of a lack of trust. Against the background of the principal-agent theory (P.A. theory), the aim of this paper is, firstly, to analyze and redefine the core elements that characterize the interaction of the network around the phenomenon of crowdworking and, secondly, to answer the question of how the trust deficits can be overcome by using the potentials of the "Blockchain Technology" (BCT) in the case of crowdworking platforms. This contribution begins by analyzing the theoretical background which consist of the outline of the P.A. theory and its core-elements as well as the definition of relevant and necessary terms which are essential for a general understanding (**chapter 2**). Subsequently, we analyze the core elements of network-like crowdworking platforms and elaborate which elements should be added in the sense of the P.A. theory as well as how crowdworking platforms can be regulated by participatory mechanisms. For that purpose, we summarize the elements as the 5 Ps of a crowdworking ecosystem and focus on the option of implementing such an ecosystem in the economic segment of industrial services (**chapter 3**). In the next section, we work out the potential of BCT and how it can mitigate or eliminate behavioural uncertainties in the case of industrial services (**chapter 4**). This is followed by a conclusion of the paper which consists of a short summary of our findings and an outlook (**chapter 5**).

2. Theoretical background

The following chapter deals with the context specification and the underlying theoretical basis of the paper. This chapter briefly introduces the terms network and crowd, and explains its linkages to the aspects of trust and information asymmetry in such environments. The chapter is concluded by reviewing recent works about past research dealing with the consideration of blockchain and crowdsourcing.

Crowdsourcing can be described as an outsourcing activity and is a composition of the words 'Crowd' and 'Outsourcing' and implies the outsourcing of a task or a plenty of human workers (Crowd) [10,11]. The main idea behind crowdsourcing is to exploit the potential of knowledge and competence of internal and external employees [11]. The coordination structure of the crowdsourcing settles in the hybrid form between market and hierarchy [11] can be compared to the hybrid form called networks [12,13]. Networks in turn are basically social networks or arrangements and can be differentiated based on their kind of orientations such as knowledge networks, intercompany networks etc. [14]. For that reason, terms such as intercompany networks and crowd will be used synonymously in this paper.

The success of a cooperation in such an environment depends on the underlying coordination effort which can be quantified through transaction costs [15,16]. The amount of transaction costs is affected by the information asymmetry [17]. Managing such crowdsourcing arrangements poses challenges in terms of uncertainties among the network participants due information asymmetry which can be described via the PA theory [18,9]. An increased uncertainty about the participants' behaviour mitigates trust in network cooperations [16]. On an interorganizational level, trust consists of personal and systemic trust (organization) [19]. Due to that, the emergence and maintenance of trust in such an environment is essential for preventing the occurrence of negative-scenarios such as adverse selection [20] which is characterised by a total displacement of honest participants and hidden characteristics [21]. This scenario is also an indicator for instability of such an arrangement [17]. For that reason, infrastructures such as the BCT receive closer consideration in terms of information asymmetries in interorganizational arrangements [22,23]. Blockchain, a subset of Distributed Ledger Technologies (DLT), can be described as a "*distributed database that is practically immutable by being maintained by a decentralized P2P network using a consensus mechanism, cryptography and back-referencing blocks to order and validate transactions*" [24, p.13].

Past research investigated the potentials of blockchain in crowdsourcing environments such as in the fields of energy systems for finding an equilibrium in the energy allocation [25]. Another example is the application on reputation systems to ensure trust within crowdsourcing platforms [26]. Further contributions are coping with challenges in terms of user-generated content, but without reference to blockchain [27]. In the fields of industrial services, there are attempts in which crowdsourcing is considered in the domain of maintenance scenarios. However, only a few studies dealt with blockchain-based applications in the fields of the maintenance [28], even less in combination with crowdsourcing such as *DING ET AL*. [29]. The contributions from those studies serve as a basis and motivation for considering them in regard to the themes addressed in this paper.

3. Crowdsourcing ecosystems and regulating participation mechanisms

The following section of the paper provides definitions of crowdsourcing and outlines the crowdsourcing environment. With regard to the organization of work, we also focus on the regulating mechanisms which can enhance the participation of crowdworkers. Additionally, we list up the core elements of a crowdsourcing ecosystem and expand those elements by adding two more elements which describe the system of crowdsourcing more precisely. The basis for this is the above mentioned PA theory.

3.1 Definition and environment of crowdsourcing ecosystem

The term "crowdsourcing" appeared in 2006 for the first time and is associated with *JEFF HOWE* who used it in the Wired Magazine [10]. In a first alignment of the term, crowdsourcing is defined in our contribution as follows: "Crowdsourcing refers to the outsourcing of certain tasks by a company or generally an institution to an undefined mass of people by an open call, which is mostly made via the Internet" [9, p. 87]. The basic technology is of course the internet as well as information and communication technologies which connects the different elements with each other [30].

For the principal or contractor, the concept of crowdsourcing subsequently leads to lower transaction costs for receiving information and knowledge and thus to flexible, fast and favourable employment options. Hence, hierarchy related coordination mechanisms in an organization are therefore replaced by a market-based form of coordination [31, 9]. Examples for crowdsourcing platforms are: InnoCentive, NineSigma, Amazon Mechanical Turk, Microworkers, Crowdworx, ChaCha, Atizo etc., which cover several parts of the value chain (e.g. computer science, research and development, finance, marketing, engineering) [9, 30]. It has to be noted that there is a difference between internal and external crowdsourcing. The former focuses on internal employment which uses an intra-organizational and often global platform, whereas the latter crowdsourcing form consists of employees external to the company [30, 9]. For this article, especially the external crowdsourcing is relevant. Furthermore, crowdsourcing can be differentiated into a cooperative-based approach and a competition-based (e.g. 99 designs) approach which can be further differentiated into an outcome- or time-oriented form of crowdsourcing [9]. Typically, the crowdsourcing process takes place in the following phases: concretisation of tasks (1), selection of the crowdworker (2), task performance (3), aggregation and solution (4), payment (5) [9, 31].

With regard to the domain of industrial services or field services, we found only a few platforms which coordinate the interests of principals and contractors which shows that crowdsourcing in this economic sector is new but growing. In the case of field services, the app of the eponymous company "mila" is worth mentioning [32]. This platform-like network brings private clients, who order different solution for technical problems as well as small and medium sized or even big companies (e. g. Vodafone, Swisscom, Conrad etc.), together with private contractors or professional service technicians. Depending on the problem, the professional technician works remote or on-site. The example of the "mila" platform operates in combination with a field service management app which coordinates the data and information about order, location, problem, payment etc. Another example for platform- or market-based coordination of principals and contractors in the domain of industrial maintenance services is the software-based platform for field service management called "crowd service". Registered customers can book certified and highly qualified service technicians and hire them using a field service management app which connects the freelance service technician with the customer [33]. The booked technician scans the QR-code of the broken asset or machine which has to be maintained or repaired, obtaining the relevant data-set via app [34]. Especially for the principal, the usage of crowdsourcing platforms brings some advantages. On the one hand, the following aspects are beneficial to the principal: access to (external) know-how, innovative solutions, high process velocity, decrease of costs, increase of flexibility, customer satisfaction etc. On the other hand, there are some disadvantages such as: high effort of defining tasks, in-transparency of the cost structure, loss of control regarding the activity, knowledge drain etc. [9, 30].

3.2 Regulating crowdsourcing as a new form of work organization

"*Crowdsourcing is not merely an innovative concept for the distribution and execution of corporate tasks, but rather a completely new way of organizing work, which can be accompanied by (sometimes radical) changes on both the employee and employer side*" [9, p.11]. The more market-based coordinated than hierarchy-based crowdsourcing networks implicate huge changes for work and the organization of work which can be differentiated in beneficial and conflictual changes [31]. Beneficial changes for crowdsources are: new employment opportunities, autonomous work, peer exchange and greater flexibility, whereas conflictual changes occur in the following forms: low payment, monotonous and standardized activities, increased potential for control and lack of legal framework (working) conditions [31].

Crowdsourcing obtains its power from the knowledge and decentral-located resources of various independent and parallel working people which enable fragmentation, standardization and automation of tasks [31]. Unspecified working time, employee participation rights and qualification opportunities lead to further questions of better working conditions and how they can be enabled or regulated. Union representatives have been interested in issues related to crowdsourcing for some time [35, 30, 36] and of how "good work" should be designed in digitalized workspaces [35]. The critic of unions focuses on unfavourable working conditions and the unregulated forms of earning. The usage of (unknown) external workforces has enormous consequences for the internal and often union regulated workforces (e. g. decreasing wages or "precarity" [30]). "*In the context of crowdsourcing initiatives, work activities are removed from a legally regulated, company employment relationships and shifted into a kind of legal vacuum*" [30, p. 3]. Work and employment on platforms do neither take place in institutions which are regulated by labour- or collective bargaining law nor do they provide for participation rights [30].

Another question that unions try to answer is how much responsibility platforms take to implement fair working conditions, because the responsibility diffuses into the (digital) market and does not lie in the hands of employer associations and unions anymore, but to the crowdsourcing platform. To avoid the establishment of so called "sweatshops", unions search the dialogue with crowdsourcing platforms, adapt labour and social law and try to articulate a new employment and company definition [35; 36]. For employee representatives, crowdsourcing as a digitalized form of outsourcing means: competitive pressure, competition for locations, disputes with relocation and often a lowering of working standards in terms of pay or working hours in order to save jobs [35]. Regarding the network of principals, platforms and crowdsourcing peers, the challenge is to bridge the existing gap of information asymmetries between those stakeholders which could lead to, on the one hand, fairer working conditions for employees and, on the other hand, to lower risks and more transparency for the principal. The platforms fulfil a key role in this network, because they are coordinating and controlling the affairs of the other two stakeholders. This leads to the question of how to unlock positive aspects and creative potential of the crowdsourcing phenomenon, while at the same time fair conditions of digital work needs to be shaped and designed [35].

3.3 5 P´s of a crowdsourcing ecosystem in industrial services

Against the background of the P.A. theory, *LEIMEISTER AND ZOGAJ* [9, p. 18-21] collect various definitions of crowdsourcing and they work out core elements which are observable within this network-like interaction. The network consists of: the crowdsourcer offering the order who we define as the *principal*; the crowdsourcee executing the order for payment who we define as the *peer*; the (external) crowdsourcing *platform* which is an intermediary institution organizing and coordinating orders and fitting activities as well as the process which contains the transaction, communication and execution of the formulated *problem* and its solution [9]. With regard to the underlying research question of this article, we assume that within the focused network of a crowdsourcing ecosystem there is one more element which could have an influence on the network. Focusing the economic sector of industrial services, those elements have to be redefined and must be supplemented by one element: the *performance*. Hence, we will define all five elements in an enhanced concept which we call the 5 Ps of crowdsourced industrial service. In the following paragraphs, the five elements are described and illustrated in Figure 1:

Platform: The connecting structural element between principals and peers is the (external) IT platform which shifts the hierarchy-based to a market-based coordination of labor [9]. The platform processes, coordinates and controls the interactions. Platforms can either be established by the principal itself or by an external provider to fulfil the required tasks and projects as a service. Such an external provider is also called an "intermediary" [30]. In contrast to internal crowdsourcing platforms, external platforms do not guarantee employee rights such as: regulating termination, vacation, minimum wage, social insurance etc. [35] which poses challenge in the next years for platforms, principals and peers. For platforms which provide industrial or field services we found only a few existing providers, yet. The above mentioned platforms "mila" and "Crowd Service" [32; 34] are first platforms which use a field service management software or app to connect the stakeholders with each other. This allows a platform-based allocation of the principal's needs (e.g. fixing a broken machine) with the required service technician, mechanic or mechatronic engineer whose appropriate qualifications and profile fit to the described problem [34]. Platforms pave the way to a pool of favourable resources such as: know-how and abilities (of service technicians) and mitigate the risks of communication between the peers and the principal [9].

Principal: The crowdsourcer or the principal initiates the process by defining the problem to be solved and by specifying the tasks to be processed. Furthermore, the principal determines incentives and exploits possible solutions while the peers select and process the tasks provided. The principal formulates an order and communicates it to the platform. After receiving the solution, the principal has to verify the right quantity and quality of the outcome, controls and evaluates the result of the peer [9]. The strategy of the principals is to use external workforces via internet or cloud services to decouple the tasks and knowledge and to make use of the external resources which are independent from time, place and organizational boundaries [30].

Peer: The crowd is defined as an undetermined amount of people which we call peer. The peer group could probably consist of all potential internet users, but those are in most cases specific and often certified peers. Hence, the size and structure of the peer group is determined by the call which could be completely open or restricted. In the case of a restricted call a specific group of peers is addressed who is "*characterized, for example, by certain qualifications or personal characteristics*" [30, p.9]. In the focused economic sector of industrial or field services, the group of peers consists of a "*pool of skilled, freelance service technicians"*, mechanics, mechatronics engineers, who are *"available to respond to service calls*" by using their necessary know-how and abilities to handle various problems [34, p. 7].

Problem (and solution): The problem and the definition or the concrete framework of the required tasks to be worked on determines the incentive structures and evaluates the solutions [9]. The principal defines the problem and peers generate a concrete and customized solution for it. For the quantitative definition of the right output or solution (e.g. scheduled working time to repair a broken machine) there are often so called

"Service-Level Agreements" or "Service specifications" which fix time, used material, wages, tools, needed certifications or rights of access [37].

Performance: The performance is the fifth core element we found to be established in a redefined concept of crowdsourcing regarding the economic sector of industrial and field services. In contrast to the usage of only quantitative elements like the "Service-Level-Agreements", qualitative elements of a service technician have to be taken into account as well. Those are for example: the ability of guaranteeing the customer's satisfaction, process or market orientation [37]. Other factors which are of great importance for a good performance are know-how, work experience, qualifications and certified skills as well as a sense for business which are requirements of a well performing service technician [26]. Therefore self-marketing and flexibility become more and more meaningful as well as the profiling of required skills, know-how and experience, qualifications etc. on corresponding platforms like the above mentioned. The skill set of the freelance service technicians must be transparent to get picked by a principal [37, p. 10].

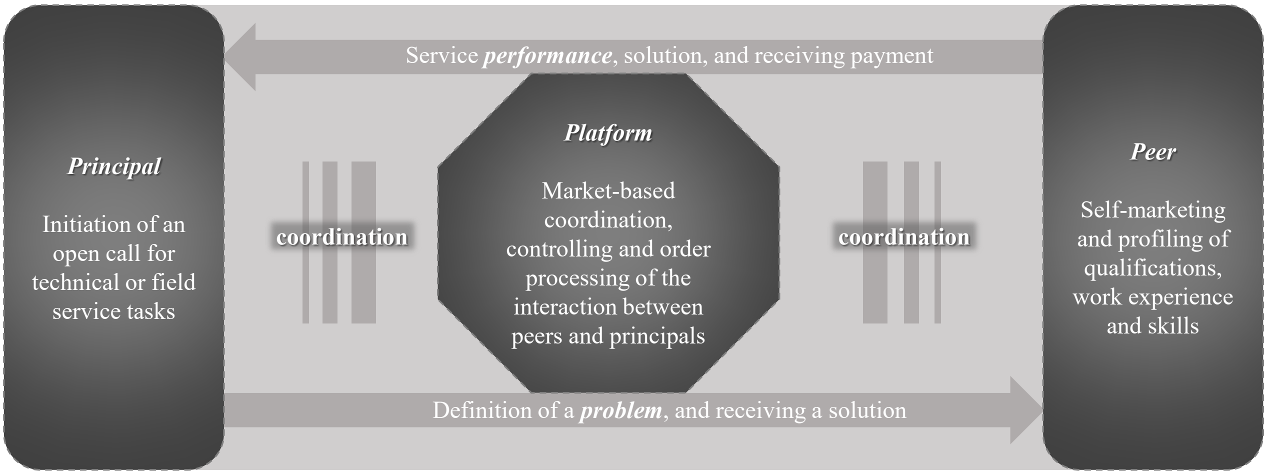

Figure 1: 5 P s of a crowdsouring ecosystem: Focusing the industrial service; own illustration; in accordance with: [9, p.17-21]

4. Potentials of BCT for crowdsourcing in industrial services

In the following chapter, the projection of the derived system features of crowdsourcing systems with regard to the BCT adoption receives closer consideration. The chapter consists of three subsections. First, based on recent literature, a short introduction into the trust-building components of a blockchain is introduced, followed by an alignment of the system features into the correlations between the system components. To propose how the trust-inherent functionalities of BCT can be considered and applied within a specific application field, the industrial service will be used as an example.

4.1 Short introduction into the trust-building properties of a blockchain

Past research repeatedly showed that a blockchain consists of trust-building characteristics which are analyzed by *Wieninger* [23] who states that blockchains are on a technological layer *consensus mechanism*, *decentralization* and *cryptography*, whose combinations can lead to the systemic characteristics *transparency* and *immutability*, serving as a basis for application-based trust-characteristics described by *data-integrity* and *process-integrity* (cf. Figure 2) [23]. *Decentralization* indicates that no central authority is needed for the network organization [38]. *Consensus mechanisms* serve as a way to ensure 'shared truth' about the content shared within the distributed network [39]. *Cryptography* refers to the techniques of how information are prepared and to what extent an insight into the information can be achieved via concepts such asymmetric *cryptography* [24]. The Public-Key-Infrastructure (PKI) allows the deposition of digital signatures within the distributed network [38]. According to *Wieninger* the combination of *decentralization* and *consensus mechanisms* contributes to the emergence of *transparency* as a trust-relating characteristic [21]. *Transparency* about the transactions inside a distributed network is an important characteristic to ensure trust due to the mitigation of trust or information asymmetry among the network participants, but also provides a source for exposure in terms of opportunistic behaviour of certain malicious participants [22]. *Immutability* refers to the information stored within the blockchain and prevents subsequent modifications of the content stored within the blockchain [38,23]. Immutability can be influenced by the combination of *consensus mechanisms*, *decentralization* and *cryptography* and the previously mentioned *transparency* [23]. Its unalterability in changing these information ensures trust due to the fact that any attempts to change these information will be detected and can be traced back to the origin of malicious activities [23]. *Data-Integrity* ensures that the data sets shared along the blockchain are complete, consistent and valid, whereas the *process- integrity* which is affected by *data-integrity* can be seen as the ability to IT-processes according to quantity and amount [23]. *Process-integrity* can be assured with the help of predefined execution codes, the so-called 'smart contracts' [24,38].The correlations of the seven trust-inherent characteristics are initially derived from the perspective of intercompany networks [23]. As mentioned in chapter 2, intercompany networks and crowds are assumed to be similar and thus allow the transferability of the seven characteristics within the context of crowdsourcing platforms.

4.2 Linkage to the 5P's (functionality mapping)

The previously mentioned characteristics are now projected on the 5 Ps (cf. section 3.3), using the threefold layer-structure proposed by *WIENINGER* [23] which are the technical-, systemical- and application-based layer. As already mentioned in section 3.3, the *platform* consists of the technical components which are *consensus mechanisms*, *decentralization* and *cryptography* [23]. *Peers* and *principals* are the users or rather the stakeholders of the crowdsourcing platform and thus equal to the participants of such an ecosystem and close to the application layer which consist of the elements *data-integrity* and *process-integrity* as essential trust-inherent characteristics. The *problem* as well as the *performance* are object- and result-oriented parts represented by information revealed and shared in the crowdworking system and thus aligned to the characteristics on a systemic-layer such as *transparency* and *immutability*. Figure 2 illustrates the assignments of the 5 Ps based on the seven trust-inherent characteristics. The mapping allows the derivation of provisional suggestions about the interdependencies between the system features which is part of the subsequent section using the maintenance scenario as an example.

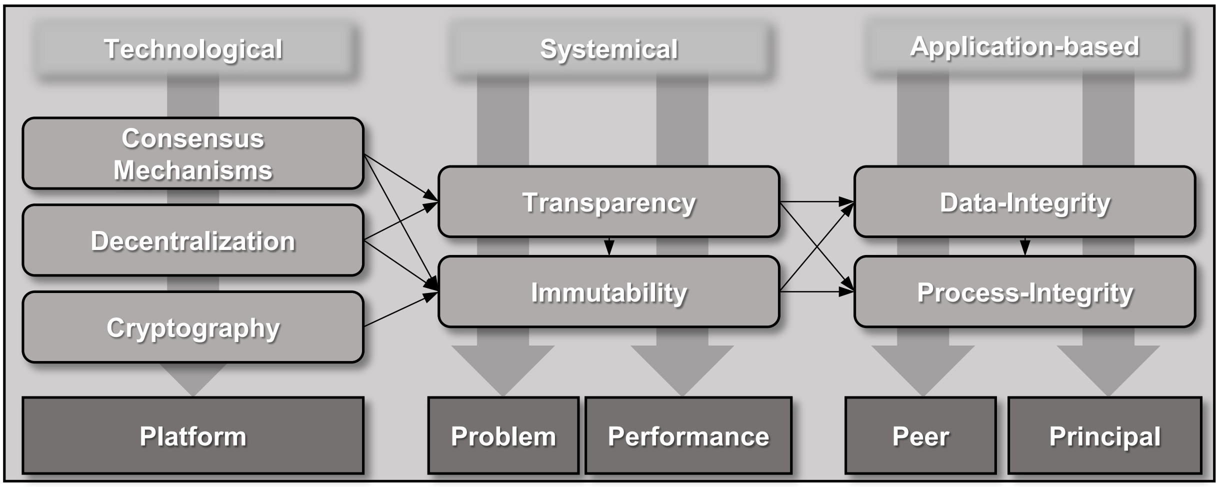

Figure 2: Assignment of the 5Ps onto the trust-inherent characteristics based on [23]

4.3 Use-Case: towards a BCT based crowdsourcing platform for industrial maintenance tasks

To give insights about how the relations illustrated in Figure 2 can be utilised for the industrial service, a short fictional example for demonstration is proposed. Using the example of a maintenance scenario in which an operator of a wind park is receiving unexpected malfunctions of a set of wind turbines which cannot be intercepted by his or her own personal capacity, different sets of competences and tasks are required: spare part installation, disposal of the removed components, electricity handling etc. Due to that the wind park operator (principal) decided to request additional workforce from a crowdsourcing *platform*. Challenges occur due to the lack of transparency about the workers (*peers*) quality and the reliability, so a transparent platform is required to ensure trust into the cooperation. The *problem* is specified by the information about services which are required (type, quantity, time), and the *performance* is determined deadline compliance.

As mentioned in section 4.2, BCT offers a decentralized sharing of the *problem* description to all participants of the crowd. The *process-integrity* can be assured via smart contracts which allows a *decentralized* and automatic fulfilment of transactions based on pre-defined conditions [29]. Following *DING ET AL.*, the use of credit scores and arbitration mechanisms can serve an evaluation of the performance of the tasks fulfilled by the participants (*peer*) and gives a "*set of reasonable evaluation criteria for users*" [29, p. 491]. In addition, *SCHÜTZ ET AL.* propose the use of reputation mechanisms achieved by a mixture of smart contracts on a functional layer and consensus among the participants to ensure trust along the participants in such a network [26]. *Process-integrity* can be assured by smart contracts. The asymmetric *cryptography* ensures that only permitted user can get access to the information shared from the *principal*. This secures the *principal* from being oppressed or exploited by the *peers*. The tamper-proofed blockchain storage ensures valid data storage inside the blockchain history and ensures that malicious attempts are not falsifying the basis for *performance* evaluation. *Process-* and *data-integrity* ensures that the wind park operator can proof whether the qualifications of the applicants are based on valid data which were previously ensured by *consensus mechanisms*. The *peers* in return can ensure that they are not exploited by the *principal* because the BCT as a neutral platform [38] is regulated by the network participants which are represented by the crowd. Malicious participants can be detected and punished [29]. Even the *peer* gain trust in the performance evaluation done by the *principal* because the transactions are validated by the network through *consensus mechanisms* [24,38]. Summarized, BCT offers both the *peers* and the *principal* a sufficient trust basis.

5. Conclusion

To reduce complexity, crowdsourcing platforms offer plenty of possibilities for the organization to work in a decentralized manner. However, challenges such as information asymmetry hamper the success, coordination effort and moreover the trust among participants within such an ecosystem. With the intention of coping with the challenges in terms of information asymmetry along the participants of such a crowdsourcing ecosystem, the BCT must receive more attention. Based on past research, five essential features of a crowdsourcing system were derived and proposed in this paper (5 P s): *Platform*, *Principal*, *Peer*, *Problem* and *Performance* (see Figure 1). In order to show to what extent trust-inherent functionalities can be adapted, seven blockchain-inherent trust-building characteristics were derived from contributions on intercompany networks in association with the BCT are mapped in Figure 2, followed by a projection on the fields of industrial services. Designers of such a crowdsourcing concept can use these assignments as a basis for deriving concrete solutions for each system feature. In this context, also socio-technical design criteria such as: adaptivity, transparency, complementarity, holism, polyvalence and decentralization [40] need to be regarded as core elements in the case of implementing the BCT. Therefore a socio-technical view on platform ecosystems is the basis for a proper implementation of the BCT in such environments [41]. While implementing BCT criteria relating to business conduct (*problem* and *performance*) have to be taken into account as well as criteria relating to stakeholders (*peer*, *principal*, *platform*) and their mutual working relationships (fair pay, working conditions, contracts, management processes and fair participation) [35,42]. Future research should also aim at elaborating concrete blockchain-solutions within the crowdsourcing environment, followed by the derivation of metrics to measure and analyze the cause-effect relationships of implemented functionalities. In the future, the digital world of work will rely on decentralized, heterogeneous and flexible working relationships which will develop in the direction of a so called "crowd economy" [43].

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References

[1] Botthof, A., 2015. Zukunft der Arbeit im Kontext von Autonomik und Industrie 4.0, in: Botthof, A., Hartmann, E.A. (Eds.), Zukunft der Arbeit in Industrie 4.0. Springer Berlin Heidelberg, Berlin, Heidelberg, pp. 3–8.

[2] Brynjolfsson, E., McAfee, A., 2014. The second machine age: Work, progress, and prosperity in a time of brilliant technologies. Norton, New York, NY, 306 pp.

[3] Henke, M., Heller, T., Stich, V., 2019. Smart Maintenance - Der Weg vom Status quo zur Zielvision (acatech STUDIE). (acatech STUDIE).

[4] Evangelista, R., Guerrieri, P., Meliciani, V., 2014. The Economic Impact of Digital Technologies in Europe. Economics of Innovation and New Technology 23 (8), 802–824.

[5] Baethge-Kinsky, V., Marquardsen, K., Tullius, K., 2018. Perspektiven industrieller Instandhaltungsarbeit. WSI 71 (3), 174–181.

[6] Richter, T., 2017. Industrie 4.0 - Risiken und Chancen für die Berufsbildung -: Betriebliche Weiterbildung als Antwort auf die Implementierung von Industrie 4.0. wbv; W. Bertelsmann Verlag; ProQuest E-Book Central, Bielefeld, Ann Arbor, Michigan, 304 pp.

[7] Schenk, M. (Ed.), 2016. 9. Fachtagung »Anlagenbau der Zukunft«: 19. IFF-Wissenschaftstage 22.-23. Juni 2016.

[8] Mrass, V., Peters, C., 2017. Crowdworking-Plattformen in Deutschland. Working Paper Series 16, Kassel/Germany. https://www.alexandria.unisg.ch/250739/1/JML_615.pdf.

[9] Leimeister, J.M., Zogaj, S., 2013. Neue Arbeitsorganisation durch Crowdsourcing: Eine Literaturstudie. Arbeitspapiere 287, Düsseldorf. https://www.boeckler.de/pdf/p_arbp_287.pdf. Accessed 26 January 2021.

[10] Howe, J., 2006. The rise of crowdsourcing. Wired magazine 14 (6), 1–4.

[11] Leimeister, J.M., 2012. Crowdsourcing, Crowdfunding, Crowdvoting, Crowdcreation. 388-bis 392. St. Gallen, CH: Zeitschrift für Controlling und Management, 388–392.

[12] Siebert, H., 2010. Ökonomische Analyse von Unternehmensnetzwerken, in: Sydow, J. (Ed.), Management von Netzwerkorganisationen. Gabler Verlag, Wiesbaden, pp. 7–27.

[13] Williamson, O.E., 1991. Comparative economic organization: The analysis of discrete structural alternatives. Administrative science quarterly, 269–296.

[14] Aderhold, J., 2005. Unternehmen zwischen Netzwerk und Kooperation, in: , Modernes Netzwerkmanagement. Springer, pp. 113–142.

[15] Clement, R., Schreiber, D., Bossauer, P., Pakusch, C., 2019. Internet-Ökonomie. Springer Berlin Heidelberg, Berlin, Heidelberg.

[16] Cai, R., 2004. Trust and transaction costs in industrial districts.

[17] Spremann, K., 1990. Asymmetrische information. Zeitschrift für Betriebswirtschaft 60 (5/6), 561–586.

[18] Eisenhardt, K.M., 1989. Agency theory: An assessment and review. Academy of management review 14 (1), 57–74.

[19] Schweer, M.K.W., 2012. Vertrauen als Organisationsprinzip in interorganisationalen Kooperationen, in: Schilcher, C., Will-Zocholl, M., Ziegler, M. (Eds.), Vertrauen und Kooperation in der Arbeitswelt. VS Verlag für Sozialwissenschaften, Wiesbaden, pp. 103–121.

[20] Akerlof, G.A., 1970. The Market for "Lemons": Quality Uncertainty and the Market Mechanism. The Quarterly Journal of Economics 84 (3), 488.

[21] Clement, R., Schreiber, D., Bossauer, P., Pakusch, C., 2019. Intermediation: Direkte und indirekte Verknüpfung von Angebot und Nachfrage, in: Clement, R., Schreiber, D., Bossauer, P., Pakusch, C. (Eds.), Internet-Ökonomie. Springer Berlin Heidelberg, Berlin, Heidelberg, pp. 153–204.

[22] Notheisen, B., Weinhardt, C., 2019. The blockchain, plums, and lemons: Information asymmetries & transparency in decentralized markets.

[23] Wieninger, S., 2020. Vertrauen in Unternehmensnetzwerken durch Blockchain-Technologie. Apprimus Wissenschaftsverlag.

[24] DIN Deutsches Institut für Normung E.V. DIN SPEC 16597 - 2018: 02: Termonology for blockchains; Text in English. Beuth Verlag, Berlin.

[25] Wang, S., Taha, A.F., Wang, J., 2018. Blockchain-assisted crowdsourced energy systems, in: 2018 IEEE Power & Energy Society General Meeting (PESGM), pp. 1–5.

[26] Schütz, A.E., Fertig, T., Weber, K., Vu, H., Hirth, M., Tran-Gia, T., 2018. Vertrauen ist gut, Blockchain ist besser – Einsatzmöglichkeiten von Blockchain für Vertrauensprobleme im Crowdsourcing. HMD 55 (6), 1155–1166.

[27] Rhyn, M., Blohm, I., 2017. Combining collective and artificial intelligence: towards a design theory for decision support in crowdsourcing.

[28] Abbas, Y., Martinetti, A., Moerman, J.-J., Hamberg, T., van Dongen, L.A., 2020. Do you have confidence in how your rolling stock has been maintained? A blockchain-led knowledge-sharing platform for building trust between stakeholders. International Journal of Information Management 55, 102228.

[29] Ding, Y., Chen, Z., Lin, F., Tang, C., 2019. Blockchain-based credit and arbitration mechanisms in crowdsourcing, in: 2019 3rd International Symposium on Autonomous Systems (ISAS), pp. 490–495.

[30] Vogl, E., 2018. Crowdsourcing-Plattformen als neue Marktplätze für Arbeit: Die Neuorganisation von Arbeit im Informationsraum und ihre Implikationen, 1. Auflage, 11 Abb ed. Rainer Hampp Verlag, Mering, 120 pp.

[31] Leimeister, J.M., Zogaj, S., Durward, D., Blohm, I., September/ 2015. Arbeit und IT: Crowdsourcing und Crowdwork als neue Arbeits- und Beschäftigungsformen. Gute Arbeit und Digitalisierung Prozessanalysen und Gestaltungsperspektiven für eine humane digitale Arbeitswelt, Berlin.

[32] Albert, A., 2017. Kombination von Field Service Management-Apps mit Crowd-Diensten. https://blog.mila.com/de/2017/02/21/combining-field-service-management-apps-with-crowd-service/. Accessed 8 February 2021.

[33] Weinzierl, S., 2020. Per Crowd Service dem Kunden Echtzeit-Hilfe bieten. https://www.instandhaltung.de/instandhaltung-4-0/per-crowd-service-dem-kunden-echtzeit-hilfe-bieten-104.html. Accessed 9 February 2021.

[34] SAP, 2018. Understanding Crowd Service: Leveraging the Gig Economy for Greater Field Service Agility and Better Customer Experiences. https://www.sap.com/products/crowd-service.html. Accessed 8 February 2021.

[35] Benner, C. (Ed.), 2015. Crowdwork - zurück in die Zukunft?: Perspektiven digitaler Arbeit. Bund-Verl., Frankfurt am Main, 420 pp.

[36] Bormann, S., 2017. Crowdwork Erfahrungen von ver.di-Mitgliedern mit der Arbeit auf Online-Plattformen, Berlin. https://innovation-gute-arbeit.verdi.de/++file++5970616824ac060330fe6df7/download/Fact-Sheet_Crowdwork_final.pdf. Accessed 10 February 2021.

[37] Venschott, M., Vogl, H., 2020. Beschaffung technischer Dienstleistungen am Beispiel Instandhaltung: Auch vermeintlich einfache Tätigkeiten können zum Desaster führen. Business & Management, IUBH Discussion Papers No. 4/2020. IUBH Internationale Hochschule, Erfurt.

[38] Fridgen, G., Guggenberger, N., Hoeren, T., Prinz, W., Urbach, N., Baur, J., Brockmeyer, H., Gräther, W., Rabovskaja, E., Schlatt, V., others, 2019. Chancen und Herausforderungen von DLT (Blockchain) in Mobilität und Logistik.

[39] Zhang, P., Schmidt, D.C., White, J., Dubey, A., 2019. Consensus mechanisms and information security technologies. Advances in Computers 115, 181–209.

[40] Hirsch-Kreinsen, H., 2020. Digitale Transformation der Arbeit: Entwicklungstrends und Gestaltungsansätze, 1. Auflage ed., 164eiten.

[41] Kapoor, K., Ziaee Bigdeli, A., Dwivedi, Y.K., Schroeder, A., Beltagui, A., Baines, T., 2021. A socio-technical view of platform ecosystems: Systematic review and research agenda. Journal of Business Research 128, 94–108.

[42] Fairwork, 2020. Fairwork Germany Ratings 2020: Arbeitsstandards in der Plattformökonomie.Großbritannien. Fairwork, Berlin, Deutschland, Oxford, Großbritannien. https://fair.work/wp-content/uploads/sites/97/2020/05/German. Accessed 18 February 2021.

[43] Deutscher Crowdsourcing Verband e. V. Kompetenz für crowdbasierte Geschäftsmodelle. https://www.crowdsourcingverband.de. https://www.crowdsourcingverband.de. Accessed 23 March 2021.

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