The Decentralized Autonomous Organization Breaks Up Economic Boundaries—New Organizational Possibilities through Blockchain Innovation

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Abstract. Under current general conditions and the state of the art, the decentralized autonomous organization (DAO) is not yet researched sufficiently to generate practical value-adding benefits as a form of business organization. Therefore, the goal of this research is to identify these benefits in order to overcome theoretical economic problems. In addition, this paper aims at making the existing theoretical concept of a DAO usable for business applications, thus opening up the current state of science in this area for future business cases. Firstly, classical economic problems, such as the principal-agent problem, are analyzed with regard to their existing limitations in practical implementation and thereupon compared to a first realization of a DAO. The derived findings provide a basis for the further development of the business model of a software service company. An example is used to show how the disruptive potential of the DAO can be used for a software service company in order to be competitive in this area. This academic paper is geared toward a professional audience in the field of strategic innovation management as well as for companies looking for access to utilize blockchain technology.

Keywords. innovation management · blockchain · decentralized autonomous organization

1. Introduction

For a very long period of time, the classic forms of business, which often provide for a division of ownership and management, seemed basically always to be the same and unchangeable in the economy. The focus was usually on discussions about the relationship between owners and managers of a company. This relationship was considered to be the greatest difficulty, especially in large listed stock corporations. The question of the personal objectives of the managing director, who does not risk his personal capital but rather controls foreign assets in confidence, was always at the center of these discussions. The basis for this is trust and control.

With the help of new technologies, efforts are being made to close this gap between the management and the owner of a company. One technology that has a disruptive potential is blockchain. With increasing progress, it makes it possible to simplify or even replace increasingly more business processes. A well-known example is the takeover of financial transactions with the help of crypto currencies (Rothe & Schmidt, 2016). But also further applications of blockchain are gaining ground in business practice. These include, for example, smart contracts as self-fulfilling—automated contracts in the Internet of Things (Voshmgir, 2016). The increasingly established forms of application of both blockchain and blockchain-based technologies also affect the classical theories of economics, such as the principal-agent problem. Thus, a new, digital form of enterprise, a decentralized autonomous organization (DAO), can be created by using these technologies. A DAO creates location-independent companies and gives the owners full control and decision-making authority as management is terminated on the basis of trust (Schiller, 2018). This breaks up prevailing approaches in economic research, such as the information asymmetry from the principal-agent theory.

1.1. Problem

On this basis, a DAO can offer solutions to central economic problems that the currently prevailing structures cannot overcome. As an alternative to the currently existing forms of companies, such as a stock corporation, which is divided into an owner and a board of directors, a DAO opens up new possibilities for cooperation. Due to its numerous advantages over traditional corporate forms, it could be superior especially in international competition and in times of rapid global change and could go beyond the limits of today's corporate management. Nevertheless, the DAO is still at the beginning of its development, which can be seen in practice and science due to the small number of successful applications and projects. Therefore, this paper concentrates on answering the following questions: How can a DAO be used under the current social and legal framework and the current state of technology?

How can it look like in practice and which theoretical economic problems does it face? In this context, a software service company is considered as a case study in order to work out implications and a first recommendation for action for actors from the economy.

1.2. *Objective and course of the research*

This paper examines the effects of blockchain-based DAOs on the economy and illustrates the development of the technology using the example of a software service company. The aim of the study is to work out an approach for the economic integration of a DAO into existing business models, such as that of a software service company, and to derive recommendations for action from this. First, blockchain technologies and conceptual principles relevant for a DAO are explained in order to present the current practical relevance and an applied example of a DAO. The example primarily serves the critical examination of this digital form of organization and the derivation of findings for future projects. The advantages that a DAO as a form of enterprise offers will be explained in regard to the basics and practical relevance. Based on the insights gained, implications for practice are derived, which serve as a basis for the concluding discussion of this paper. At this point, a concrete recommendation for action in the form of a business model innovation for the software service company is given, and the technology of the DAO is critically reflected upon and potentials and challenges are pointed out. The conclusion summarizes the central findings of the article. In the limitations section, the constraints on innovation for society and research are pointed out. Finally, the findings of this paper are summarized, and an outlook on the developments in the field of blockchain technology and DAOs is given.

2.   Theoretical background

For a fundamental understanding of the technological developments in the field of blockchain and DAOa, it is important to explain the theoretical approaches to be considered against this background. Firstly, the economic problems and limitations of current business models will be examined, which arise from the area of conflict between the different interests of the managing director and the owner. Subsequently, relevant technologies necessary as a basis for the establishment of a DAO will be explained. On the basis of these economic and technological aspects, an attempt will be made to overcome the existing problems by the developments in the blockchain.

2.1. *Underlying economic theories*

2.1.1. *Contract theory*
Fundamental to contract theory is the assumption that a company consists merely of the composition of a large number of contracts. The theory therefore focuses on the optimal design of contracts between different economic actors. Here, too, information asymmetries and individual benefit maximization determine the resulting opportunistic behavior of the parties involved (Schäfer, 2016). However, the optimal design of contracts can control the behavior of the actors in such a way that both the available resources and the risk are optimally distributed.

2.1.2. *Principal-agent theory*
Principal-agent theory essentially describes the relationship between two or more cooperation partners, each of whom strives to maximize its own benefit. The partners are on different hierarchical levels, whereby the principal delegates tasks to the agent. The core of the theory in this relationship is the unequal distribution of information between the principal and the agent and the existence of a conflict of goals between the two parties. In this context, there is an information deficit for the principal, as he cannot fully view all the activities, intentions, and information of the agent. To make this more transparent, a balance must be struck between the costs and benefits of obtaining information (Baker, 2010).

2.1.3. *Transaction cost theory*
The transaction cost theory focuses on economic exchange relationships, that is, transactions of goods or services. Transaction costs are incurred in the processing and organization of these more economic activities. These include search, initiation, negotiation, agreement, and control costs (Heyd et al., 2013). The higher the specificity of a transaction or service, the higher the transaction costs. This is due to the increasing mutual dependence of the contracting parties and the associated growing probability of opportunistic behavior as future developments are difficult to detect (Heyd et al., 2013).

2.2. Blockchain and first application areas

2.2.1. Blockchain

Since blockchain is still a young technology, no uniform definition of it has yet emerged (Moritz, Redlich & Wulfsberg, 2018; Swan, 2015). However, all definitions generally subsume a novel technology under the term blockchain, which serves the verification of data or transactions. Verification is the task of the network participants, who carry out direct transactions among themselves and thus form a decentralized peer-to-peer network in which computers are connected to each other on an equal footing. For this purpose, each participant first acquires a so-called public key, which can be shared with other members, comparable to an account number. In addition, each member of the network receives a second, private/secret key, which is used to authorize outgoing transactions. This guarantees the anonymity of the participants (Voshmgir, 2016). According to Rothe and Schmidt (2016), this type of exchange is made possible by three mechanisms. Firstly, the blockchain stores transactions that have been carried out in a register that is sent to all participants via the peer-to-peer network and can be viewed by everyone and traced back to their origin thanks to the decentralized data storage. Cryptographic functions also provide additional security. A large number of blocks, which are inseparably linked together, contains a list of one or more transactions as well as a summary of all previous blocks in the form of so-called hash values. An attempt to change or manipulate the hash value immediately changes the hash value and is therefore visible to all participants. To permanently store a transaction or change in a blockchain, it must be validated by the majority of the network. Only then are the data stored anonymously and are unchangeable from that point on (Rothe & Schmidt, 2017). Accordingly, the security of a blockchain increases with the number of participants. In addition, an incentive system induces the players to ensure a functioning overall system and to act in its interest (Rothe & Schmidt, 2017).

2.2.2. Smart contracts

As explained above, a company is a network of contracts that can in principle be defined as if-then relationships. A simple example would be the payment of salary to employee A when he or she has performed his or her agreed duties. In this case, smart contracts can replace classic contracts (Grassegger, 2016). They represent self-executing programs based on blockchain technology in which transaction rules are defined with program codes. A transaction defined in smart contracts is not executed automatically until the conditions defined beforehand have been met by the parties involved. Since smart contracts provide security for both parties, the need for an intermediary becomes superfluous (Voshmgir, 2016). One example of such intermediaries are notaries— since the purchase amount is automatically transferred to one party to the contract only once a property has been transferred to the second party (Grassegger, 2016), a notary is unnecessary.

2.2.3. Crypto currencies

Crypto currencies are virtual currencies aimed at easy, digital, and anonymous payment for users worldwide. The basis of digital and cryptographic algorithms determines, on one hand, the direct payment transfer between the participants and, on the other hand, the process of money creation. Payment transactions use private and public keys that guarantee the security of the currency (Rothe & Schmidt, 2016). In the meantime, a large number of crypto currencies have become established, such as ether, ripple, litecoin, and dogecoin. In the financial sector, too, especially in banks, virtual currency is being used increasingly more frequently for global transactions despite the high exchange rate fluctuations (Rothe & Schmidt, 2016). The main reasons for this are the lower transaction costs and simplified processes as well as the high speed of processing.

2.2.4. Democracy 2.0 and e-voting

Through the principles of blockchain technology, a change to Democracy 2.0 becomes possible, in which no longer individual persons or representatives make decisions and bear responsibility for them but all network participants make determinations together. This procedure enables an absolute democracy in which previously elected representatives are no longer necessary. To realize this, an election process based on blockchain technology runs by means of a so-called electronic voting (e-voting) system. Special crypto currencies are issued, which are representative of digital votes. The process ensures that only one vote can be cast for each authorized voter. Cryptographic encryptions ensure that the vote remains anonymous. In conclusion, Democracy 2.0 and e-voting allow all individual opinions of the participants to be included without time-consuming and costly elections. It is also possible to tie the voting proportions, for example, to the ownership of shares or the resulting majority (Mayer, 2018).

2.3. The concept of the DAO

2.3.1. Functioning of a DAO and economic considerations

A DAO is a new form of organization in which the rules of procedure and statutes are laid down unalterably in a code at the time of foundation. In doing so, it combines the previously mentioned technologies. According to contract theory, contracts are based on contracts that, in the case of a DAO, are represented by smart contracts, and thus processes are predefined and automated.

Furthermore, a DAO differs in its heterarchic organizational structure in its lack of superordination or subordination of its members. Due to this lack of hierarchies, decisions are made democratically. Here, the outlined procedure of e-voting is applied. Crypto currencies, which process internal business processes and can also be traded externally, serve as a further basic technology (Schiller, 2018; Voshmgir, 2016).

2.3.2. *Creation phase*

A DAO currently represents the most complex implication and combination of smart contracts (Voshmgir, 2016). The initial code of a DAO has a number of parameters that need to be defined before the DAO is created and activated. These include, among other things, periods of voting procedures or the duration of the creation phase until the start of business activities, also known as the "creation phase." During the initial period of the creation phase, which is defined in the code, corresponding crypto currencies can be sent to the address of the smart contract of a DAO and thus serve as an equity capital contribution. With the start of this phase, the establishment of a DAO begins. In the initiation phase, the organization finances itself by selling automatically generated tokens to the shareholders of the DAO, the so-called token holders. The tokens represent both voting shares and ownership rights and are issued to the shareholders in exchange for a freely tradable crypto currency. Within the creation phase, the price for the acquisition of tokens is fixed and unchangeable by the code. At the end of this phase, it is still possible to purchase tokens from a DAO, but the issuance of tokens for the free market decreases, which should increase the price in the long term. However, at a later date, the shareholders will be able to trade their shares freely, for example, by selling them (Jentzsch, 2016a).

2.3.3. *Business activity*

The shareholders or token holders have the opportunity to submit motions for strategic decisions and to vote on these in an e-voting procedure. The sum of the tokens that a shareholder owns corresponds to his voting share within the DAO. Accordingly, owners, equivalent to the known voting rights of shareholders in a stock corporation (Bundesrepublik Deutschland, 2009), are weighted according to their contributions in the voting process. There is no limitation on the voting shares for one person. All entrepreneurial decisions within the activities of the DAO are democratically decided by a vote of all token holders (Jentzsch, 2016a). Each proposal is linked to smart contracts from the outset so that if accepted, it is implemented immediately and autonomously by the DAO itself or by the code. Once a proposal has been submitted, it is open to debate within the community of all shareholders, and all token holders have the opportunity to vote for or against the proposal according to their shareholding. The duration of this phase is already defined in the code of the DAO before it is established and is therefore constant for each vote. If, at the end of the phase, there is a qualified majority of at least 51%, the proposal is deemed to be accepted (Jentzsch, 2016a).

2.3.4. *Advantages over traditional forms of organization*

Based on the above-mentioned principles, a DAO differs rudimentarily from classical forms of enterprise and their hierarchical structures. Strategic decisions can be made more quickly within the simple voting procedure, creating a flexible organization. Disruptive developments and a globalized economy in constant change require this higher degree of agility. In addition, the new type of organization solves the principal-agent problem. The shareholder as principal no longer has to rely on the company acting according to his interests and motives despite information asymmetries. In a DAO, the decision-making power is returned to the shareholder by the agent. Through the grassroots democratic voting procedure using e-voting, a DAO makes use of the intelligence of the majority, the so-called swarm intelligence. The direct involvement in decision-making processes, as well as the direct influence of the operating result on the value of the tokens, also increases the motivation of the shareholders to make well thought-out decisions (Schiller, 2018). A further advantage of a DAO compared to traditional forms of companies is evident in the cost structure. The autonomous running of processes results in a massive reduction of ongoing coordination costs. Furthermore, opportunistic behavior based on smart contracts becomes practically impossible. If a shareholder does not adhere to the rules in the code of the DAO, he is automatically excluded from the organization and loses his paid-up capital. Transaction costs are also reduced due to the enormous reduction of control costs and costs of risk coverage. The concept of the DAO is also particularly worth mentioning against the background of international cooperation. As a decentralized organization without a fixed office, a DAO is not bound to a state, which makes global cooperation within the DAO network immensely easier. At this point, however, the problem of the unclarified legal framework should not be ignored (Schiller, 2018).

2.3.5. *Legal framework*

As a decentralized organization, a DAO by definition has no headquarters or central management and operates internationally across national borders. Currently, there is no adequate solution for this form of enterprise in company law. The question of the legal form involves, among other things, ambiguities regarding limitations of liability and legal claims as well as tax and labor law aspects. Furthermore, it is still unclear whether and which national law should be applied to a DAO. A legal framework for the trade with tokens is also not yet in place. Smart contracts have practically the same effect as conventional contracts. Nevertheless, the question arises at this point as to how these can be created in a legally secure and legally compliant manner (Voshmgir, 2016). Furthermore,

central approaches to data protection, such as the right to forget, are not compatible with the characteristics of the blockchain since all transactions are stored in the application of this technology (Deloitte GmbH, 2018). Furthermore, the EU basic data protection regulation introduced in 2018 makes the further development of the technology in the context of a DAO more difficult. A clarification in this area would give shareholders, founders, and developers more legal certainty and could positively support the development. However, over-regulation should be avoided at this point to prevent restricting innovation right from the start. However, the development here is the responsibility of the legislature and therefore remains to be seen (Voshmgir, 2016).

2.3.6. *Application areas*

Due to the numerous advantages compared to traditional forms of business, a DAO can, in summary, carry out economic and bureaucratic transactions much more cost-effectively, quickly, and securely than is currently possible with centrally based information systems. Centrally organized management instances and the roles of specialists are thus eliminated and taken over by the partners.

Comparable to traditional forms of business, DAOs can purchase products and services from third-party providers in accordance with the smart contracts laid down in the code and pay with the crypto currency used by them. The products or services are then manufactured by this business partner and brought to market and sold by the DAO. The proceeds can be reinvested or distributed to the shareholders by a decision of the token holders (LEADVISE Reply GmbH, 2018). The simplified structures and associated cost savings will allow for more capital-intensive and complex business activities that in today's centralized economy can only be carried out by large corporations or governments that have access to the appropriate capital, infrastructure, and personnel. This will greatly facilitate market entry (Epstein, 2017). Based on the way crowdfunding works, a DAO can also be used as a platform on which different investments can be coordinated, and, in the course of which, capital can be raised for the options available. The decentralized and autonomous processes mean that a central fund manager as intermediary can be dispensed with. Accordingly, investment decisions are made according to the consensus model, or so-called Democracy 2.0 (LEADVISE Reply GmbH, 2018). Looking at the current state of technological development, this is the closest and most relevant area of application as only intangible assets are managed in the blockchain, and such ownership rights can already be mapped completely digitally.

Nevertheless, blockchain technologies as a basis for a DAO are still at the beginning of their development (Voshmgir, 2016), and the question of the economic viability of DAOs is therefore still open (Prinz et al., 2017). At this point it becomes particularly apparent that companies do not yet have an explicit idea of how a DAO can create added value. This is mainly due to the lack of established use cases and the high volatility of crypto currencies (Panetta, 2017). Nevertheless, first applications for DAOs have already appeared on the market, which may become increasingly relevant and have potential for further development.

2.3.7. *Potentials and challenges*

The management consultancy Gartner estimated in 2017 that blockchain technologies will be a disruptive innovation in the long term, which could lead to the restructuring of entire industries and sectors of the economy and thus present them with new challenges (Panetta, 2017). The technology will become relevant earlier for some areas and later for others but will be relevant wherever network effects create greater benefits and also where trust is essential. Despite the ambiguities about the business models of a DAO, the greatest potential can be identified in transaction efficiency and decentralization. In view of the progressive shortening of trend and product life cycles, increased agility and responsiveness become necessary and thus an increasingly relevant competitive advantage. Companies can realize enormous cost savings in the form of a DAO and react faster to changes. The importance of central interfaces will decrease and their role will change, while the relevance of decentralized solutions will increase (Voshmgir, 2016). Within the framework of a DAO, smart contracts can replace central management, intermediaries, and standardized processes (Deloitte GmbH, 2018; Voshmgir, 2016). Similarly, activities such as auditing, bookkeeping, and taxation can be controlled by autonomous smart contracts in the future (Voshmgir, 2016). This development could lead to the loss of the competitive advantage of traditional, hierarchical, centralized forms of organization (Epstein, 2017) and open up opportunities for new business models. The IT sector still lacks successful use cases and perspectives for controlling the technology. Nevertheless, companies will have to adapt their digital strategies to survive in the market—especially in order to meet the latest requirements in the area of investor relations (Panetta, 2017).

Central challenges at this point are above all to strengthen the acceptance of the technology as well as to clarify economic and corporate law issues and thus create security in all areas. Uniform standards that are accepted and used throughout are still missing, both for crypto currencies and for blockchain. The volatility of crypto currencies reflects the uncertainty in the market and thus makes development more difficult (Panetta, 2017). In addition, the central question of a corporate form and the economic viability of DAOs still remains largely unresolved since the transactions are not validated centrally and the source code is usually open source (Voshmgir, 2016). Nevertheless, in addition to the monetary evaluation, qualitative potential benefits should also be taken into account for a holistic assessment (Prinz & Schulte, 2017). However, these current challenges with regard to blockchain only show that the technology is still in its infancy and that there is still a great need for research and development. Nevertheless, it can be assumed that it has the potential to become the next great disruptive innovation (Panetta, 2017; Voshmgir, 2016).

3.   Methodology

The underlying methodology can be divided into three phases. First, an analysis of the potentials of blockchain technologies and a DAO was carried out, starting from which classical economic problems were identified, and finally a comparison of the findings was made with reference to the case study of a software service company. The case study was conducted over a period of about two months. Basically, all information was obtained from appropriate literature.

In the first phase of the study, a comprehensive literature search on current findings in the field of blockchain technology and DAOs was conducted to open up the possibilities of blockchain technologies and a DAO as an organizational form based on them. Subsequently, the project "The DAO" was used as a practical example for the first implementation of a DAO. Here, the basic structure of this business model was of particular importance. The characteristics of a DAO identified in the process provided information on how to overcome the current restrictions of classical forms of organization. Based on this, models and theories of economics were selected in the second phase with regard to currently unsolved problems for the further procedure. In the third phase, a comparison was made in order to apply the solutions of a DAO to the identified economic problems, such as the principal-agent dilemma. In the next step, these solutions were examined in terms of their effects on practice. To investigate in a practical context, a company was used as a case study for this work. With the help of a software service company, theoretical research approaches could be transferred into practice to show practical approaches in the area of blockchain and DAOs. As a result, implications for future effects and potentials for a software service company could be derived.

4.   Practical example "The DAO"

The project "The DAO" was created in 2015 in the environment of the German start-up named Slock.it. Increasingly complex smart contract structures designed to raise capital for Slock.it eventually led to the founding idea of an autonomous decentralized organization that would automate all activities (Jentzsch, 2016b). The first implementation of the resulting white paper was a corresponding fundraising organization called The DAO. This was the first implementation of the theoretical and technical principles discussed in the previous sections. However, the concept paper by Jentzsch (2016a) and the associated code is to be considered independent of the business field. The later tasks and characteristics are first defined by the founders and later determined by the shareholders in a democratic process. It is possible that the business field may change during the course of the company life cycle. The code is available as open source (Jentzsch, 2016a).

4.1.   Preliminary considerations and foundation

The DAO's white paper is of central importance for this new form of organization as it can be seen as a starting point and general approach for the establishment of a DAO. It refers firstly to the present basis of interpersonal life, which exists through rules, laws, and agreements and their administration, and in the course of this it also points to the weaknesses of this model of social relations. On one hand, according to Jentzsch (2016a), people do not always adhere to fixed rules, and, on the other hand, they do not always agree on what the rules really require. This is also reflected in the principal-agent problem explained above (see 2.1 Underlying economic theories; principal-agent theory). In the design of the company, Jentzsch used not only the principal-agent theory but also the contract theory as a basis (Shier et al., 2017), as is the consensus of most DAO definitions. In the course of the publication of the white paper, the authors identified potential problems in business operations and drafted corresponding solutions (Jentzsch, 2016a). Problems arose from the possibility of the excessive filing of applications as well as the lack of protection of minority shareholders and inactive token holders.

The DAO was activated on the blockchain platform Ethereum shortly after the white paper was published. Consequently, the crypto currency ether was chosen as a means of payment to acquire shares in the DAO. Already in this pre-foundation phase, a starting capital of approximately 12 million ether could be raised, which at that time corresponded to an equivalent of more than 150 million US dollars (Jentzsch, 2016b). The reason for this success was a correspondingly high level of media attention, especially within the specialist field of blockchain technology.

4.2.   Security instruments

A possible excess of applications is seen as a difficulty in daily business, which could lead to the occurrence of irrelevant applications that are not target-oriented for the company, thus overburdening the token holders as decision makers and causing essential applications to be lost. Accordingly, parameters have been implemented in the code that allow a fee to be charged for the application. Only in the case of an acceptance in the voting process is this fee reimbursed (Jentzsch, 2016a).

Furthermore, the white paper (Jentzsch, 2016a) and the program code contain critical reflections on the design of the voting procedure with regard to the resulting power relations. The shareholders are therefore offered three protective mechanisms to prevent distortions and the exploitation of power imbalances.

An instrument has been created to counter the problem of "majority robs minority" attack, resulting from the imbalance in voting shares (Jentzsch, 2016a). The problem occurs when a single shareholder or a closed group of owners abuse their dominant voting position for personal purposes. The minority shareholders are at a disadvantage and may lose capital they have invested (Shier et al., 2017). To prevent this, the white paper model uses the solution approach by Viktor Buterin (2013), which provides for the possibility of splitting a DAO. This enables minorities to reject the proposal even if it is accepted. It follows from this that if the proposal is actually accepted, these owners will separate from the previous DAO and will be able to act independently and autonomously in a new subsidiary DAO in the future. The subsidiary will then start operating at the level the parent company had before the vote. The original capital contribution of the retiring owners plus profit shares serve as the capital for this. The capital of the parent company is reduced accordingly (Jentzsch, 2016a). An additional identified problem is the protection of token holders who do not participate in voting processes and are therefore classified as "inactive." For these, the previous protection mechanism does not apply, and their capital investments are unprotected against possible wrong decisions or abuse of power (Jentzsch, 2016a). To protect this "inactive capital," a curator with special rights is provided for within a DAO. Within the DAO he acts as representative and administrator of all inactive voting shares and is obliged to vote for them in a benevolent manner. The curator himself is to be elected by shareholder vote, and a new election can be requested at any time and by any shareholder (DuPont, 2018).

All three instruments were created from the perspective of and to protect minority shareholders. Within the framework of the assumption of mistrust and against the background of the original idea of resolving the weaknesses of interpersonal life, an attempt was made to satisfy all members in their need for protection (Jentzsch, 2016a). They offer solid foundations and solutions for the development of future DAO projects.

4.3. Crisis case

Just one month after the successful launch of "The DAO," an error in the code became known, making it possible to exchange tokens back into ether several times. Thus more capital could be withdrawn from the DAO than the shareholder himself was entitled to. The loss was caused by the remaining shareholders. An update of the DAO code was immediately created and submitted for approval so that the error could be corrected (Jentzsch, 2016b). However, this vulnerability was exploited by an unknown shareholder before the end of the reconciliation. As a result, the attacker was able to steal approximately $70 million worth of ether and transfer it to an anonymous account (Romano & Schmid, 2017). A subsequent discussion within the Ethereum community revealed three basic positions on how to deal with the attack and how to proceed (Shier et al., 2017). Basically, positions were taken between not reacting (the so-called "code-is-law" approach), a one-time intervention to render the stolen tokens unusable (the so-called "soft-fork" approach), or the complete migration into a new blockchain by an intervening instance (the so-called "hard-fork" approach). In particular, the assumed "hard fork" met with massive criticism because it contradicted the principle of independence and thus undermined the integrity of the system because a higher instance intervened. Independence and the blockchain's protection against manipulation were thus massively questioned. Nevertheless, this approach was chosen, which led to a split in the Ethereum network (Shier et al., 2017).

5. Case analysis of a software service company

5.1. Implications of the development of DAOs

The current developments in the blockchain and DAO area hold some disruptive change potentials for many industries and companies. These will also have an impact on software service companies in the future. With its core competencies in software development and data management, as well as acting as a central intermediary between various institutions, the cooperative lies in the target area of technological change through blockchain technology. In the business areas, central data management and standardized processes are the focus of the company's activities. In view of the economic potential offered by blockchains and DAOs, software service companies in particular are facing a radical change in their business environment. For example, the importance of the company as a central interface will decrease or at least change, and the relevance of decentralized solutions will increase. Furthermore, DAOs offer the advantage of replacing central intermediaries and standardized processes with automated smart contracts and of defining and controlling activities such as auditing or accounting via these. The speed and impact of these disruptive changes in the business areas of a software service company is still unclear. Nevertheless, the company can take action to prepare itself for change and take appropriate measures to remain a pioneer.

5.2. Business model innovation DAO Consulting

At this point, the focus is on cooperation with external DAOs and the assumption of a partnership role by the software service company. Basically, the investors of a DAO are the target group of this recommendation for action. While in a classic stock investment the investor entrusts a manager (agent) with the task of managing the business in his or her interest, the decision-making authority in a DAO is transferred back to the owner (principal). However, a corresponding decision requires professional knowledge and time resources to work out and weigh decisions. In the literature, reference is often made at this point to so-called "swarm intelligence," which produces a good solution from the mass of voters (Schiller, 2018). However, discussion platforms are susceptible to manipulation by individual, supposedly trustworthy sources that can significantly influence the general public, as Jentzsch (2016b) still defines it as an open problem area. A verification of alleged facts is hardly possible (Jentzsch, 2016b). This results in the need for a neutral analysis tool that contributes to the quick and easy evaluation of alternatives and that can be used independently by any token holder. The systematic processing of company-related data and the prognoses of decision alternatives is suitable for the requirements mentioned above. The resulting objective forecasts can be clearly displayed in a computer user interface, also known as a dashboard, and can be called up by the user. The outputted forecasts of both alternative decision options, the acceptance and the rejection of an application, are presented in a comparative way without any evaluation. This evaluation of the alternatives is at the discretion of the user.

Such a technical solution is still to be considered visionary from the current perspective, but necessary building blocks for the implementation can already be identified. A differentiation of the necessary components is possible on the basis of their current availability or the necessity of future development. The existing components, which only require integration, include the resources of the software service company and the history of the DAO itself. The history of a DAO is reliably reflected in its blockchain and can therefore be analyzed without gaps based on all decisions made. This serves as a basis for the future development of such an organization. This retrospective analysis is supplemented by the resources of the software service company itself. On one hand, the software service company already has access to countless data from past corporate incidents, and on the other hand, it has experience and has correspondingly grown know-how in dealing with a wide variety of corporate incidents. This know-how is complemented by the expertise of the employees, who can combine and incorporate specialist knowledge in various corporate competencies. The evaluation of existing data, together with specialist knowledge, enables a far-reaching analysis of comparable business decisions. Macroeconomic correlations and other market data can also be included. However, there are technical, currently still missing abilities to make the existing data evaluable, comparable, and usable. This results in the need to develop further components for implementation. Since classical algorithms reach their limits when analyzing such data volumes and a corresponding complexity of the analysis, new solutions must be used. A key technology at this point is artificial intelligence (AI), which is far superior to classical algorithms. One facet of AI is deep learning. This enables machines to improve their capabilities independently, meaning without human assistance. New information is linked and related to previous knowledge. In this way, the machine learns from experience and is ultimately able to make its own decisions and make forecasts based on the knowledge gained. In connection with DAO Consulting, AI and deep learning enable pattern recognition to be carried out using the existing data from the software service provider and the integrated know-how. Furthermore, the technologies perform the corresponding identification and evaluation of correlations to create resulting forecasts in the context of the specific DAO history. The validity is constantly increasing. Due to the high learning effect of these systems of technological progress, increasingly valid statements about developments can therefore be made (LeCun, Bengio & Hinton, 2015). The user is thus enabled to make independent decisions based on objective factual analysis.

By creating such transparency and simplifying portfolio management, customer groups can be addressed depending on the structure and complexity of the presentations in the dashboard. In addition to professional economic advisors, these include small investors who want to enter the DAO sector and invest there as minority owners in sideline activities. The dashboard addresses investors who make individual investments as well as owners of a portfolio of different investments. The central added value for the customer lies in the simplification of complex decision alternatives, which make it possible to have an overview of individual investments as well as entire portfolios.

Cost and revenue structures also need to be examined. Both sides need to carry out more in-depth checks, and these must be examined in greater depth before implementation. In principle, however, there are initial and follow-up expenses on the cost side. The initial expenses include massive development costs, training costs, and costs for creating the infrastructure. In addition, there are running costs for support and maintenance, further developments, and the provision of computing capacity. On the revenue side, it is possible to pursue different approaches. On one hand, a license model is possible, which promises calculable and constant revenues. On the other hand, profit sharing through a commission model is conceivable, which is dependent on the economic gain. Here, depending on the overall economic situation, significantly higher revenues can possibly be generated. However, reference should be made to the strong dependence of economic development and the associated lower level of security. In addition to this, possible additional local consulting services are a further source of income. This can offer the end customer significant added value. The designed model should therefore be regarded as a hybrid business model, consisting of product and service.

5.3. Result

The central difficulty of a self-determined DAO lies in influencing the coordination processes. The limited access to the information of the shareholders or token holders, respectively, ensures a considerable receptivity to erroneous information and conclusions (Jentzsch, 2016b). On the basis of the recommended action, the solvability of this currently still-existing problem in the environment of a DAO can be identified. A self-determined DAO is the key resource with regard to the legally compliant design of the dashboard as well as the central source of necessary know-how within the analysis process. They are also the connection to the end customer and serve as a local contact person. In addition, there are opportunities for cooperation with other companies that enable further analysis perspectives, such as consumer research, trend research, or other market-influencing aspects, to further increase the predictive power. Such cooperative integration of partners offers the opportunity to generate key partnerships that are unique in the market. The existing, specific resources of the software service company and possible partnerships can be identified at this point as decisive competitive advantages that cannot be copied by potential competitors. Thus, the software service company has the opportunity to invalidate the disruptive potential of a DAO for today's core business at an early stage and to position itself for the future by continuous development. It is necessary to develop appropriate pioneering technologies and to build up know-how starting today in order to create the basis for a future business model according to a DAO.

6.   Discussion

The results show that a DAO, regardless of its form, has considerable potential for changing current economic relations. Current trust-oriented principal-agent relationships can be reorganized by means of a DAO. However, when considering this potential, the experiences from the context of the practical example "The DAO" must also be taken into account. This first application provides starting points for problems that currently limit the theoretical ability of DAOs in practice.

Firstly, natural human behavior must be considered in terms of absolute democracy. A transfer of all decision-making competence also requires the possession of the appropriate expertise to be able to make adequate decisions, especially in a business context. In the literature, reference is often made at this point to the ability of swarm intelligence, which comes to a supposedly correct answer by the collective of all those taking part in the vote (Schiller, 2018). However, there are always risks here with regard to the swarm's ignorance. For example, informationlessness and cluelessness can undermine this intelligence. There is a danger that individual opinion leaders can influence the masses through disinformation. This is particularly encouraged by modern fast-moving media. Such influence can lead to a situation in which not one's own interests are safeguarded, but rather a few individual market participants profit through manipulative activities (Jentzsch, 2016b). Derivatively, a DAO in its current form cannot yet provide a complete solution to information asymmetries. In precisely this vacuum of information deficit and the resulting receptivity to misinformation and external influence, new approaches to solutions are needed. A solution approach can be given by the elaborated recommendation for action. Here, as a neutral authority, the possibility arises to provide comprehensive analyses that can close the vacuum that has arisen.

A further aspect is the lack of a crisis authority, which enables a company to react quickly. The attack on "The DAO" showed the disadvantages such a form of democracy has in terms of a company's ability to act (Shier et al., 2017). While regular incidents can be planned for and thus coordinated at an early stage, crisis situations require a rapid, targeted response. Jentzsch (2016b) refers in this context to the binding nature of the code and thus to the exclusion of any authorized authority. According to his approach, the speed of the coordination process must therefore be increased without changing the content of the procedure. It remains questionable, however, whether such an approach is meaningful or whether, in whatever form, a crisis intervention with more far-reaching competences must ultimately be made possible. This could also be a field for the legislative bodies of a country or supranational organization since DAOs in general are currently still in a legal gray area as they are not yet fully covered and regulated by the legislature.

The listed unresolved problems cannot as of yet be conclusively solved. In addition, other factors must be taken into account. Particularly against the background of the great market dynamics, there are still developments required at this point that cannot be fully implemented by companies. However, it is crucial to take the first steps in this direction without setting a strict target for the final result. Thereby a constant adaptation of the development to changing environmental situations is necessary. The already developed fields of development can be applied arbitrarily to further business activities and used economically. However, for the creation of a DAO, the developments, whose sequence of which is shown in the roadmap below, must be regarded as unchanging. Only after the successful development of previous stages does the next development step become technically possible. Nevertheless, possible use cases are already conceivable today and should be discussed in order to maintain the incentive for further development.
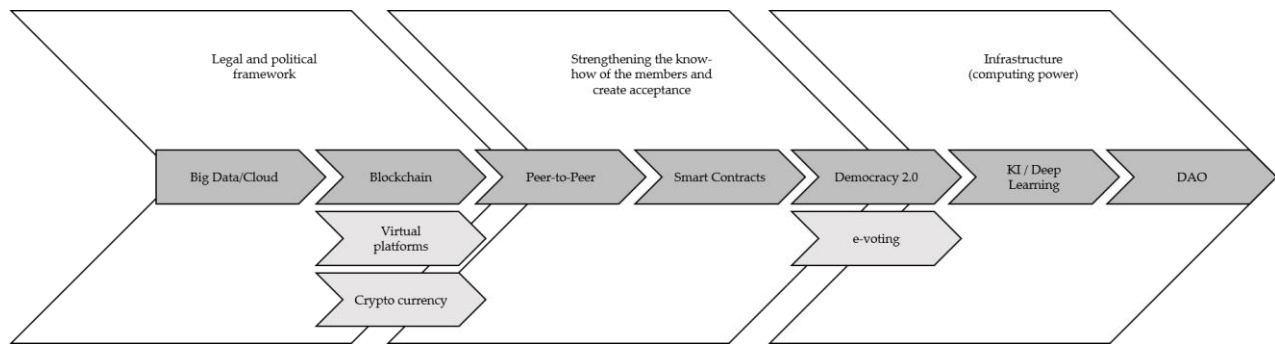
Figure 1. Roadmap structure of DAO competence.

For the DAO Consulting platform, there is a further need to create the necessary conditions for implementation in the background. Only this makes a successful implementation in practice possible. In addition, appropriate infrastructures must be set up at the same time in order to be able to operate such complex systems productively.

7.   Conclusion and outlook

The development of the DAO has the potential to push the boundaries of today's business management. Nevertheless, due to little known practical examples, the legal framework conditions in particular are still unclear, and possible forms of application have not yet been sufficiently researched. In the context of this paper, the functionality and the potentials of a DAO were therefore processed to derive implications as well as opportunities and challenges for a software service company, which as an IT company sees itself directly affected by the disruptive character of a DAO.

In general, the basic blockchain technology can generate an enormous competitive advantage for companies through the decentralized exchange of values via peer-to-peer networks without central instances. As an important component of Web 3.0 (the concept of Web 3.0 is that of a more comprehensible network for the analysis of data and information), the disruptive technology solves the problem of central data storage and enables companies to be agile and responsive. DAOs are based on the key technologies derived from this—crypto currency, smart contracts, and e-voting. The organization is based on smart contracts, which automatically regulate the flow of business processes. In grassroots democratic voting procedures, shareholders who have previously acquired voting rights via a crypto currency decide on strategic decisions via e-voting. With their numerous advantages over traditional forms of enterprise, DAOs represent a clear alternative to traditional forms of organization. A DAO not only combines the advantages of blockchain-based technologies but also offers solutions to central economic problems, such as eliminating the principal-agent problem, designing optimal contracts, and reducing transaction and coordination costs. A clarification of the legal framework is nevertheless necessary to provide more security in the field and thus positively support the further development of the innovation. The problem of the non-applicability of national law as well as the outstanding clarification of central legal questions limits the development in this respect. The economic benefits of a DAO have also not yet been sufficiently researched due to the lack of established applications in practice. It is clear that economic and bureaucratic transactions are carried out much more cost-effectively, quickly, and securely with a DAO. Thus, application potentials can be seen above all in areas where standardized processes and central instances play a key role. A simplified cost structure enables more capital-intensive and complex business activities. A DAO as a platform for crowdfunding is currently the primary application example, as was also the case with The DAO. Another example of a DAO implemented in practice is Bitcoin, whose technology should pose a particular threat to the banking sector. In any case, a DAO is a disruptive innovation that could transform entire industries. However, its potential lies in particular in reducing the importance of interface functions and standardized processes so that they may even become redundant. However, before the opportunities for the development of new business models and forms of organization can be exploited in their entirety, the DAO model must be accepted both in the economy and in society. In addition to clarifying legal aspects, uniform standards must also be established in the blockchain. Initial problems outside of these framework conditions became apparent during the implementation of The DAO. The approaches to solving the complications that have arisen serve as insights and form the basis for further developments. Furthermore, they show the need for additional research due to problems that still exist at present.

8.   Limitations and further research

As a young and disruptive trend, the DAO as a business form has not yet been sufficiently researched and still needs to be developed. For this reason, the implementation of the concepts presented here is currently dependent on a number of factors that are not fully developed. The developments dealt with in this paper, such as the legal framework as well as potentials and challenges, play a decisive role in this context. In addition to the high development and research costs for a corresponding expansion of the IT infrastructure, additional consulting and information and coordination costs are initially incurred. In the foreground of these

framework conditions, however, are the technologies to be researched in order to be able to offer long-term solutions in the DAO environment. For this reason, the basic technologies of the blockchain itself and peer to peer as a basis for Web 3.0 must first be developed. In these areas, numerous applications have been published so far, and their development is already in an advanced stage. Both technologies are to be regarded as the basis for the practical implementation of smart contracts and their use in the practical business world. Smart contracts in combination with e-voting can form the basis for a DAO. For the implementation of a service, in the form of DAO Consulting, the last decisive technology so far is AI. In general, however, mutual dependencies of developments cannot be excluded at this point. The developed technologies can not only be seen as the basis for the next development stage of this roadmap but can also be applied in other areas. Consequently, this major innovative step into the future can only succeed with the appropriate framework conditions and with the interaction of the core technologies mentioned. The recommendations for action for the case study of the software service company are limited in that the company and its business activities were only viewed from the outside. This perspective should be supplemented by an internal view to gain deeper and more comprehensive insights into the opportunities offered by DAO competence and the challenges created by disruptive development.

At this point in time, it is still open as to what significance the blockchain technology and also the DAO will have in the future in the economy and society and to what extent its disruptive potential can be identified. Further research questions arise, especially in the area of economic design and legal framework conditions. At this point, the question of the legal form of a DAO as well as the application of a legal framework to its business activities are in the focus of attention. Furthermore, it should be made clear which approaches to data protection a DAO must pursue. Although the economic viability of a DAO cannot yet be precisely determined, this is only a sign that the technology is still very young. What will ultimately become established in the future is not yet foreseeable. It is certain, however, that the development of DAOs has the potential to transform fundamental economic structures.

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