

AN ONTOLOGICAL EXPLORATION OF CENTRAL BANK DIGITAL CURRENCY GOVERNANCE DESIGN

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Abstract Financial ecosystems and their related transactions are increasingly relying on big tech payment service providers, such as ApplePay and WeChat. By offering these services, transacting in unregulated cryptocurrencies becomes easier. Consequently, big tech companies take a powerful position in the ecosystem, such dominance may be avoided by a decentralized ecosystem, in which decision making power is distributed over several actors. Emergence of several highly unregulated cryptocurrencies and increased reliance on big tech, motivates central banks to investigate alternatives, called Central Bank Digital Currency (CBDC) that can be subject to governance and rules. CBDC is specifically aimed to decrease dependency on largely uncontrolled big tech payment service providers and to limit the growth of unregulated cryptocurrencies. In this paper, we explore the key question of how to design a governance structure, we do that by applying the DECENT ontology and conceptual models to the real world use-case of CBDC.

Keywords:
decentralized
governance,
ontology,
conceptual
models.

1 Introduction

The banking landscape is rapidly changing, due to rise of big tech companies that offer financial payment instruments, which enables and promotes in transacting with unregulated cryptocurrencies as well. Next to these developments, with the introduction of Bitcoin, many parties are now offering cryptocurrencies, and that market has grown significantly. Traditionally, central banks play a centralized role in the governance of the current fiat money ecosystem, e.g. to guarantee economic and financial stability by implementing monetary policy, for example to achieve low and stable inflation. Big tech dominance in the financial domain and the growth of unregulated cryptocurrencies requires an answer from the central banks, and that answer is the CBDC, a digital currency that allows for decentralization both in operations and governance. A CBDC will allow central banks to regain control of the disparity currently occurring within the financial domain. The development of CBDC is in full swing, and the outcome, e.g. for the EU, is not very clear yet. In other words, the various CBDCs, as proposed by many countries, are very much ongoing Systems under Design (SuDs).

In (Kochergin & Dostov, 2020), several worldwide initiatives of Central Bank Digital Currency are analyzed, and it is concluded that one of the biggest challenges of implementing CBDC is designing the related governance structures. We define governance as a system in which entities set and decide about the rules, concerned with structure and processes for decision making, accountability, control and behavior of actors (Kaya, Gordijn, Wieringa, & Makkes, 2020). Decentralized governance is done by multiple parties, rather than one powerful actor. As with any design problem, and cf. Design Science (Hevner, March, Park, & Ram, 2004), an important question is which artifacts are needed to express design decisions, and how to represent them.

For CBDC, several artifact types are relevant, but in this paper, we focus on the decentralized governance artifact by taking an ontological approach. As argued, governance is important for any banking ecosystem, and in the case of CBDC, the question is how the governance should look like, and to what extent it should be decentralized. In our earlier work, we have developed and validated DECENT ontology (Kaya & Gordijn, 2021) in the domain of decentralized (peer-to-peer) energy trading. For this paper, we want to understand whether DECENT ontology

holds in another domain as well, which is the governance design of Central Bank Digital Currency (CBDC).

Specifically, we use the DECENT ontology, (Kaya & Gordijn, 2021) as a method to design a governance structure. An ontology represents graphically the relevant governance constructs and the relations between these constructs. Because we have learned, e.g. while validating the e3value ontology (see (Gordijn & Wieringa, 2021)), that visualization of the design artifact reflecting important design decisions is crucial for communication with stakeholders and establishing a common understanding of the SuD at hand, we employ graphical modelling languages. Instead of reinventing the wheel, we use existing modelling techniques, including UML, e3value, i* goal modelling (Yu, 1997), (Gordijn & Wieringa, 2021) to represent a decentralized governance structure, and we show how these relate to DECENT ontology. Goal of DECENT Ontology and the conceptual models is to accurately represent the decentralized governance artefact. This approach allows for (automated) analysis as well. This is precisely our long-term research objective: We want software-support for the design and analysis of governance constructs, and we refer to this field as computational governance. The specific research question is to what extent an ontological approach contributes in understanding and designing a decentralized governance structure for CBDC. The paper is organized as follows. Sec. 2 discusses related work regarding decentralized ontologies.

Then we explain in Sec. 3 our research set up, which is Exploratory Technical Action Research (ETAR). A crucial element in ETAR is the involvement in a real-life case, which is decentralized governance design of Central Bank Digital Currency in Sec. 4, we also introduce and apply DECENT Ontology and the conceptual models in that section. Sec. 5 reflects and discusses DECENT ontology as a method to design decentralized governance. Finally, Sec. 6 presents our conclusion.

2 Related work

An ontological commitment and formalization of governance is an emerging research field (Kim, Laskowski, & Nan, 2018). An ontological approach supports the design of governance and ultimately software tool development. Within the domain of decentralized governance, there is the notion of *Decentralized Autonomous Organization: DAO*, which operates without a central authority. A DAO is an organization that is run through rules encoded as computer programs in the form

of smart contracts (Chohan,2017). A key feature of a DAO is the execution of rules. These rules are executed via smart contracts, which are used as a mechanism to enable participation. A key distinction between DAO and our DECENT ontology is that a DAO is primarily focused on decisionmaking posed as *voting*, which is facilitated via smart contracts. A drawback of a DAO is that participants are motivated by incentives to contribute and it is not a self-governing system. DAO is rather technology focused, and not formalized with e.g. conceptual models, and is an ad-hoc driven process. As DAOs are rather technology focused and there is lack of formalization, the governance design is not easily understood by participants. Furthermore, a DAO does not describe the relationships between parties and their roles which can be *define, execute, monitor*. This is demonstrated by applying the TOVE Organization Ontology for creating a conceptual model to implement a smart contract (Kim, Fox, & Gruninger, 1995). TOVE is rather process orientated and implementation focused, and compared to DECENT Ontology, key elements of governance are not represented. TOVE takes a single actor approach, and not the complete ecosystem, governance requires coordination in the design process over a set of actors. Furthermore, it is not clear how to derive the governance design from the TOVE models. TOVE is missing DECENT concepts such as (self)regulation, legislation and consequently their decomposition into a set of rules, which are essential constructs for decentralized governance. Decentralized governance is about a multi-actor approach and focused on the role every actor plays, DECENT Ontology full-fill multi-actor requirement, for designing decentralized governance.

3 Exploratory Technical Action Research

We want to explore the decentralized governance design structure of a CBDC and, more specifically, how to design the related governance structure. The RQ for this paper is: To what extent contributes an ontological [DECENT Ontology] approach in understanding and designing a decentralized governance structure for Central Bank Digital Currency? Certain studies analyze the idea of ‘decentralized governance’ ex-post, that is when the governance is already in place and up-and-running. In contrast, we study the contrast ex-ante, as a topic of design, cf. (Erbguth & Morin, 2018) who argues that defining governance is actually a design process. To do so, we have been involved in workshop sessions regarding the development of CBDC with a central bank based in South America and with a leading commercial bank from Europe (see Sec. 4). Using this project, we explored the idea of

‘decentralized governance design’ in more detail. We call this Exploratory Technical Action Research (ETAR), following the Technical Action Research (TAR) approach, which is often used in the field of Design Sciences (Wieringa, 2014). ETAR comprises the following research activities: (1) problem analysis, (2) design theory, (3) treatment, and (4) treatment analysis. These are all explained in extensive detail in the corresponding sections.

4 Design Theory: DECENT Ontology & Conceptual Models

4.1 Problem Analysis

In our research we consider decentralized governance as a *design* problem, in the philosophy of Design Science, (Hevner et al., 2004) as an artefact to be designed. We do this by researching a case concerning Central Bank Digital Currency (CBDC). A CBDC is a digital currency, denominated in the national unit of account, which is a direct liability of the central bank, such as physical cash and central bank settlement accounts (Amaral, Sales, & Guizzardi, 2021). Only a central bank can issue CBDC and is the sole custodian. By introducing CBDC, a central bank can streamline payment transactions to protect privacy of citizens and ensure that citizens and companies have equal access to trustworthy digital payment solutions. However, how to design and introduce CBDC, since it involves a complex redesign of the financial ecosystem with many participating actors, is identified as a governance challenge. Currently, many central banks worldwide are experimenting with CBDC and it has been identified that one of the biggest challenges for CBDC is how to design the related governance structure. In Design Science, the notion of “artefacts” is key. In our research, we want to express artefacts in terms of *conceptual* models (see e.g. (Brodie, Mylopoulos, & Schmidt, 2012)) to be designed. A semi-formal specification (Ontology) and conceptual models facilitate for a better and shared understanding of the domain at hand, and supports automated proof of correctness of models and computer-assisted analysis of the domain at hand (e.g. compliance with governance rules set by law). For now, our goal is much more modest, as we want to understand whether an ontological approach and model-based artefacts can assist in designing governance (Kochergin & Dostov, 2020).

4.2 Introducing: DECENT Ontology

DECENT *Decentralized* ontology is a lightweight tractable *reference* ontology with a clearly defined set of governance concepts. Intended user-base are consultants that will actually have to design governance structures. The ontology, depicted in Fig. 1, is expressed using a semi-formal specification and represented as an UML class diagram and specifically developed to use as an instrument to develop the domain, by identifying the design requirements in order to develop the governance structure. We argue that in order to develop decentralized governance, we have to understand the to-be developed domain and the related relations. DECENT Ontology provides a clear and structured approach in defining governance constructs and the relations. DECENT Ontology is unique as it takes a multi-actor approach, which is crucial when developing decentralized governance, as there is no single actor anymore orchestrating the ecosystem at hand. Each actor has a specific role — *define, execute, monitor* — which influences how governance design decisions can be taken. We demonstrate how DECENT ontology can be used as tool to develop and increase the domain understanding by describing the governance structure of CBDC in Sec 4.3 Treatment: DECENT Ontology CBDC. Furthermore, we claim by developing the governance constructs as a starting point, this will contribute to develop and derive the governance design structure for the conceptual models. We have developed the domain of CBDC in multiple workshop sessions with a central bank from South America and a leading commercial bank from Europe. These sessions provided input for describing the domain of CBDC. For detailed explanation of DECENT ontology, please see (Kaya & Gordijn, 2021). CBDC is still an exploratory design and research field, both central bank and commercial bank identified this as a System under Design and with many design decisions to be taken along the way, which fits in the exploratory element of this paper.

4.3 Treatment: DECENT Ontology CBDC

A *Party* represents any participant in the CBDC ecosystem, for example citizens, commercial banks, big tech companies and central banks. A *Party* can be an *Actor* or a *Group*. *Actors* are entities responsible for their survival and well-being. *Actors* can take their own legal and economic decisions and are perceived by themselves and their environment as independent entities (Gordijn & Wieringa, 2021). For example, a *citizen* owning a digital wallet is an independent entity capable of making their own

economic and legal decisions. A *Group* is a collection of *Parties* that share one or more characteristics, for example decision taking method. A *Group* is, for example, several commercial banks group, who all have to comply with the same governance rules.

A *Party* can play several *Roles* with respect to governance in a particular ecosystem (e.g. a central bank plays a defining role in relation to commercial banks). In DECENT, *Roles* focus on the position of the *Party* in relation to a *Governance Construct*. The position is a selection of set, e.g., determine a rule, execute, e.g. be compliant to a rule, and monitor, e.g., collect information to check compliance to a rule. As example, the EU sets the General Data Protection Regulation (GDPR) in Europe, and the European Central Bank sets that CBDCs must safeguard consumers' privacy. The *commercial banks* ensure users' privacy when operating (executing) CBDCs, and the *Central Bank* monitors compliance of the *commercial banks* with GDPR.

The Governance Construct serves as an essential part of the ontology as it collectively represents the subject that an *Actor* or *Group* plays a *Role* in. The Governance Construct is the generalization of *Decision Making*, *Rule*, *Rule Set*, *Mechanism*, *Policy*, *Goal*, *Objective*, and *Incentive*. To prevent unnecessary cluttering of the diagram, these generalization relations are not graphically represented. Modelling this way implies that an *Actor* or *Group* can play a *Role* in all these constructs. For example, a *central bank*, via *Role* of regulator, can define a *Rule* (a Governance Construct) requiring the implementation of digital wallets.

A Governance Construct may be affected by one or more *Roles*. A *Role* uses *Decision Making* to reach agreement. *Decision Making* refers to a collection of methods used by a *party* to take a *decision* regarding a *Governance Construct*. The choice for a particular *Decision Making* depends on the *Role* a particular *Party* has in relation to the *Governance Construct* at hand.

A *Rule* expresses something required, permitted or prohibited (e.g. CBDC must consider anti-money laundering and counter financing of terrorism risks). A *Rule Set* is a coherent set of rules (e.g., EU Anti-money Laundering Directive EU 2015/849). *Legislation* and *Regulation* are specific types of *Rule Sets*. While *Legislation* is set by a government, *Regulation* can be set by a society of *actors*, a branch organization, or even can be self-imposed by one or more *actors* ('self- regulation'). Therefore, it has

not a formal legal character in the sense of laws. A *Rule-Set* is implemented by a *Policy*, which can be defined as a plan for action, consisting of a coherent set of mechanisms to implement a *Rule* that follows from a *Legislation* and *Regulation*.

A *Rule-Set* can contribute to satisfying a *Goal*, which is a desire to fulfill, for which an *Actor* has committed resources. Usually, a number of related *Rule* are needed to reach a *Goal*. Examples of central banks' *Goals* regarding CBDCs are fostering financial inclusion and ensuring financial stability.

Objectives measure satisfaction of a *Goal*. While *Goals* are stated qualitatively (e.g., implementation of digital wallets), *Objectives* allow to *measuring* achievements of the *Goal* (e.g., implement digital wallets free of charge for all citizens by 2024). In some cases, multiple *Objectives* need to be achieved for *Goal* satisfaction.

Finally, an *Incentive* is stimulation to achieve *Objectives* and indirectly obey to *Rules*. *Actors* can be motivated to strive for reaching an *Objective* and hence *Goal* satisfaction. A *Reward* is a motivation to achieve *Objectives* and indirectly adhere to *Rules* (e.g., an attractive interest rate to stimulate citizens to adopt CBDC instead of physical cash). A *Penalty* is a punishment if *Objectives* are not met and *Rules* are not adhered to (e.g., if a customer's privacy is violated, a *Penalty* can follow for the commercial bank, gives by the central bank).

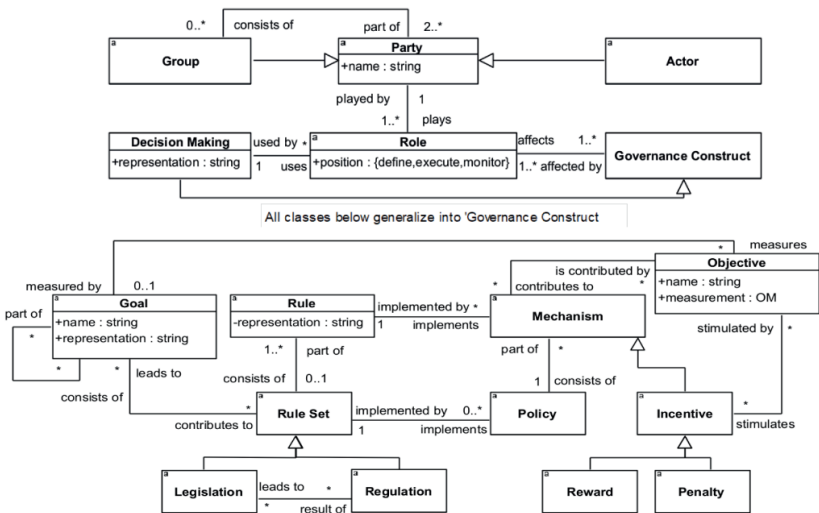


Figure 1: DECENT Ontology

Treatment analysis: DECENT Ontology How does an ontological approach contribute towards governance design? When designing a governance structure that requires input from multiple groups and actors, a graphical overview contributes to a common understanding of the developed area. With DECENT Ontology the conceptual domain of CBDC from a governance perspective have been described and also how the roles affect each other. Otherwise when developing governance, without DECENT Ontology, you risk that it becomes too broad and not structured. Having a graphical representation of the required governance constructs and the relations between them proved to be valuable to describe as it was clear to see that the relations between the governance constructs are equally as important. When developing a decentralized governance structure, a multiple actor approach is required instead of one actor. It is crucial that actors have the same viewpoint and agree on the state and the governance constructs that needs to be developed, beforehand. These design issues are usually very costly to develop, and require big investments from all parties. Therefore, it is important to agree on the initial state beforehand.

4.4 Treatment: Conceptual Models

When designing Decentralized Governance for an ecosystem with decentralized decision making, the role of actors is crucial, as close collaboration is required between actors. A method to distinguish the roles, goals and responsibilities is by creating conceptual models. For this paper we consciously selected the *e³value* business model and *i** Goal Model as these focuses and differentiate different roles per actor. Designing all governance artefacts, based on the domain description of CBDC that DECENT Ontology provided in previous section is a significant amount of work that exceeds the reporting space in this paper. Therefore, we focus in this paper on the *e³value* business model and goal artefact. Also, we consider the artefacts as representations of governance design.

Treatment: e³value Business Model CBDC In our modest view, a CBDC ecosystem should start with the business model first, as it defines how the CBDC ecosystem will generate value streams for all actors involved, how and to whom 'sales' is occurring, and what type of service/products will need to be developed. To express the business model, we require a language, from a governance perspective, and for that purpose, we apply the *e³value* methodology (Gordijn & Akkermans,

2018). This a tractable method for business development specifically designed for multi-actor approach and ecosystem design. In figure 2 we present a simplified business model for the CBDC, expressed as an *e*value model. Based on conversations with commercial and central bank we understood that a hybrid approach will be taken, in which fiat money and CBDC will co-exist. The *e*value Business Model presented in Fig. 2 is based on DECENT ontology, *italic* words refers to governance concepts of DECENT. Note that this model (and the otherstoo) show only partly the notion of CBDC, which is a domain too complex to be captured in a single publication. We specifically used the DECENT Ontology as we are interested in translating business model to a structured governance design. *Parties*: Customers *actor*, Commercial Banks *Group*, and Central Bank *Group*. By identifying the *party* we were able to identify the goal per party, namely: Access to fiat and digital money *goal*: Citizen: Provide fiat and digital money *goal*: Commercial Bank, Central Bank: Issuing digital currency *goal*:

Central Bank. By identifying the *party* and related *goal*, *party*, value exchanges between *a-party* is modelled. This is based on the role that a party fulfills to satisfy their own needs *goal*. A Customer has the *goal* to be able to transact with fiat and digital currency. Once a Customer *actor*, is able to transact with digital currency, it can engage in further economic activity such as obtaining a loan from a Commercial Bank. The *group* Commercial Bank, engages with a *Customer actor* that requests service, and executes the request of fiat money for the *Customer actor*. However, a *Commercial Bank group* can only transact with a Customer if their banking license is *defined and monitored* by a *Central Bank*. Furthermore, a *Central Bank group*, *defines, executed and monitors* the total money supply, and is the sole custodian of CBDC.

Treatment analysis: *e*value CBDC Business Model We first present a table, that provides a high-level conceptual overview on the relations between DECENT Ontology and the *e*value (Table 1). This provides a starting point in extracting the governance design based on the business model for CBDC. Italic words refer towards DECENT Ontology, this to provide a structure for a coherent design approach. When designing a new ecosystem, it is important to understand the value transfer between *actors*. Through this structured model and approach, the relevant *actors* and *groups* are identified. Furthermore, *goals* and *roles*, determine how a *party* interacts within the CBDC ecosystem. Business model identification per participating *party* is important otherwise the required governance decisions will not

be followed. This model can ensure that all involved have the same notion of which *party* and *actor* will be engaging with CBDC. The model demonstrates that coordination between *actors* is absolutely necessary. Within a CBDC setting the responsibility of distribution of CBDC will change significantly compared to the current governance structure of distributing fiat money. As the infrastructure for CBDC transactions will have to be equalized and interoperable with the financial ecosystem, the question then arises who needs to govern and develop the corresponding infrastructure. This also shifts the governing *role* of the Central Bank, as we need to develop new *mechanism* to implement the *regulatory* oversight from the Central Bank and how exactly money will be issued.

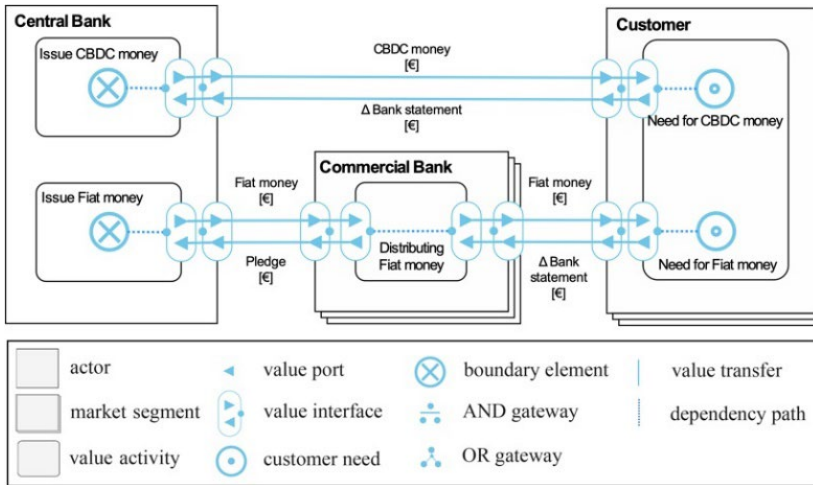


Figure 2: e3value CBDC Business Model

Table 1: Representation of DECENT concepts in e3value

Governance Concept	Representation in e3value
Party, Actor, Group	Actor or Market Segment
Goal	Value Activity or Customer Need

Treatment: CBDC *i Goal Model** The goal model is developed based on the DECENT ontology constructs *goal* and *party*. Through goal modeling it is possible to identify actors and the relations between them, the goals they intend to achieve, goal dependencies, and to represent the conflicting goals as well. Fig. 3 depicts a goal

model for the CBDC Ecosystem, using the *i** framework (Dalpiaz, Franch, & Horkoff, 2016). As we want to present a comprehensive CBDC model, we modelled a high-level goal overview. All words in *italics* refer to *governance concepts* of DECENT. In the model, the CBDC ecosystem is represented as an agent and refers to the ecosystem itself. The four parties, namely, Customer, Company, Commercial Bank and Central Bank, are represented as *actors*. Moreover, the model depicts the dependency of each of these parties within the CBDC Ecosystem. The Citizen's goals are "Transact digital currency", "Privacy preservation" and "Have access to financial services offerings". Note that there is a conflict between the two last goals, as to propose better financial services offerings, Commercial Banks in the ecosystem need to have access to more (private) information about the Citizen. The Central Bank's goals represented in the model are "Ensure financial stability" and "Foster the financial system efficiency", "Financial inclusion" and "Safeguard consumers' privacy". Here we have also conflicting goals as there is a trade-off between fostering efficiency and ensuring stability. Commercial Banks have as goals "Provide financial services" and "Comply with GDPR and Central Bank's regulation", this latter related to preserving consumers' privacy. Finally, Company has as *goals*, "Economic growth" and "Comply with GDPR" as it is required by law to preserve customers' privacy. The mapping between the ontological DECENT concepts and the representation in the *i** Goal Model is listed in Table 2.

Table 2: Representation of DECENT concepts in *i Goal Model**

Governance Concept	Representation in <i>i*</i> Goal Model
Party, Actor, Group	Actor or Agent
Goal	Goal Dependency or Quality Dependency or Conflicting Goal

Treatment Analysis: CBDC *i Goal Model** We have learned that, when designing decentralized governance, it is important to have a clear overview of the participating actors and their respective goals. Being able to identify the goals per party provides a broad view of how CBDC can be successfully implemented, from a governance perspective. By eliciting goals, we can also identify the conflicting goals, and consequently we can be more proactive in our governance approach. Goal modelling is also strategic, as it is important for any project to identify the risks (=conflicting goals) as early as possible, in order to mitigate them. Decentralized

governance design is also about clear and concise communication about rules of engagement and goals. A goal model can contribute to achieving this as with decentralized governance is that actors collaborate in deciding the rules of engagement and how decisions are made. However, each actor acts from their own goals to be realized, one of the goals of governance design is that it creates transparency between participating actors, which a goal model facilitates.

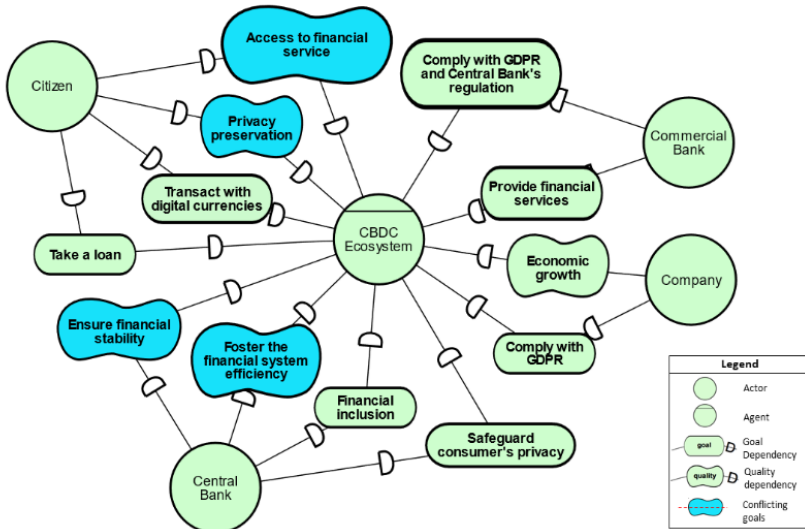


Figure 3: i* CBDC Goal Model

4.5 Treatment Evaluation: DECENT & Conceptual Models

By taking an ontological approach, we were able to instantiate and represent the governance design and the relations in the domain of CBDC. Without claiming to be exhaustive, nor claiming that the decisions are final, as both our contacts at the Central Bank and Commercial Bank stated clearly that CBDC is in full swing development. We see that the role of several important actors is changing by introducing the CBDC next to fiat money. We present below a list of governance design decisions, which is related to the treatment sections of DECENT Ontology, *e*value business- and *i** Goal model. Words in *italic* refer to DECENT Ontology CBDC domain.

- CBDC issuance will be executed by *Central Bank*
- Distribution of Fiat money will co-exist with CBDC and Fiat money will still be *executed* by *Commercial Bank*
- *Central Bank* will continue *monitoring* and *executing* audits at *Commercial Banks*
- *Central Bank* can punish via *penalty* if privacy of actors is violated with the digital currency CBDC, for instance by revoking banking license
- CBDC design by *Central Bank* will follow the open-banking PSD2 standardization to enable *actors* to have full ownership of their data and related transactions
- CBDC transactions and privacy [GDPR] will be *monitored* by *Central Bank*
- Distribution of CBDC can possible be *executed* only via the *Central Bank*
- Business model and thus the *roles* of *Commercial Bank* and *Central Bank* will change since distribution of CBDC will possibly be done only by *Central Bank*
- Withdrawal of CBDC can be processed directly possible without the *role* of a *Commercial bank*
- It is clear that current existing *roles* with fiat money compared to CBDC will change significantly mainly between the *Central Bank* and *Commercial Bank*

5 Discussion

Validity. The question raised at the start of the paper is to what extent an ontological approach contributes in understanding and designing a decentralized governance structure for CBDC. The central claim of DECENT is that it can be used as a *reference* ontology to design and develop decentralized governance. It is intended to help define the right questions to be asked during the design of a governance system. In this paper we used DECENT as a method to develop the CBDC domain and consequently to design conceptual models. It is important to note that CBDC ecosystems, as proposed by many countries, are ongoing Systems under Design (SuD), and, consequently, their design is not finished yet. The models presented here describe a minimalistic view and first step in understanding the requirements of governance design for the CBDC domain. Furthermore, decentralized governance design is a coordination process that requires different points of view, the conceptual models used (*e³value* and *i** Goal Model) capture these different perspectives, and are structured by using DECENT Ontology.

Limitations. This paper has limitations, when designing governance structure, actors play an important part because it influences governance design. Our approach is clearly not exhaustive for all actors that operate within the complex CBDC ecosystem. We have taken a first exploratory approach if we can design and model decentralized governance for certain actors. Each actor and their corresponding role need to be elaborated further in order to have the full spectrum of governance design.

6 Conclusion

DECENT is an ontological well-founded conceptualization that can be used for decentralized governance design and this exploratory study gives a first impression of how DECENT Ontology and the resulting, e3value model and *i** goal model can contribute in achieving this. We have demonstrated the usefulness of DECENT Ontology by developing the domain of CBDC, furthermore, we were able to derive governance design decisions by integrating the concepts of DECENT with the conceptual models. For future work we plan to test and validate the DECENT Ontology, in the domain of Fractional Reserve Banking and Intellectual Property.

References

- Amaral, G., Sales, T. P., & Guizzardi, G. (2021). Towards Ontological Foundations for Central Bank Digital Currencies. In 15th international workshop on value modelling and business ontologies (ymbo).
- Brodie, M. L., Mylopoulos, J., & Schmidt, J. W. (2012). On conceptual modelling: Perspectives from artificial intelligence, databases, and programming languages. Springer Science & Business Media.
- Chohan, U. (2017, 01). The decentralized autonomous organization and governance issues. SSRN Electronic Journal . doi: 10.2139/ssrn.3082055
- Dalpiaz, F., Franch, X., & Horkoff, J. (2016). iStar 2.0 language guide. arXiv:1605.07767 [cs.SE]. arXiv:1605.07767 [cs.SE]. Retrieved from dalp-fran-hork-16-istar.pdf (Accessed: 2021-11-25)
- Erbguth, J., & Morin, J.-H. (2018). Towards governance and dispute resolution for dlt and smart contracts. In 2018 IEEE 9th international conference on software engineering and service science (icse) (pp. 46–55).
- Gordijn, J., & Akkermans, H. (2018). Value webs understanding e-business innovation. The Value Engineers. Retrieved from <https://www.thevalueengineers.nl/product-category/publications/e3value-ref/>
- Gordijn, J., & Wieringa, R. (2021). E3value user guide - designing your ecosystem in a digital world (1st ed.). The Value Engineers.
- Hevner, A. R., March, S. T., Park, J., & Ram, S. (2004, mar). Design science in information systems research. *MIS Q.*, 28 (1), 75–105.
- Kaya, F., & Gordijn, J. (2021). Decent: An ontology for decentralized governance in the renewable energy sector. In 2021 IEEE 23rd conference on business informatics (cbi) (Vol. 1, pp. 11–20).

- Kaya, F., Gordijn, J., Wieringa, R., & Makkes, M. (2020). Exploring governance in a decentralized energy trading eco-system. In Proceedings of the 33rd bled e-conference: Enabling technology for a sustainable society. Retrieved from <https://dise-lab.nl/wp-content/uploads/2021/05/Kaya-Bled-2020-final-version-fk-jg-2.pdf>
- Kim, H. M., Fox, M. S., & Gruninger, M. (1995). An ontology of quality for enterprise modelling. In Proceedings 4th IEEE workshop on enabling technologies: Infrastructure for collaborative enterprises (wet ice'95) (pp. 105–116).
- Kim, H. M., Laskowski, M., & Nan, N. (2018). A first step in the co-evolution of blockchain and ontologies: Towards engineering an ontology of governance at the blockchain protocol level. arXiv preprint arXiv:1801.02027
- Kochergin, D., & Dostov, V. (2020). Central banks digital currency: Issuing and integration scenarios in the monetary and payment system. In International conference on business information systems (pp. 111–119).
- Oberle, D., Grimm, S., & Staab, S. (2009). An ontology for software. In Handbook on ontologies (pp. 383–402). Springer.
- Wieringa, R. (2014). Design science methodology for information systems and software engineering. Springer.
- Yu, E. S. K. (1997). Towards modelling and reasoning support for early-phase requirements engineering. Proceedings of ISRE '97: 3rd IEEE International Symposium on Requirements Engineering, 226-2