Digital Power of Attorney catalyzed by Software Requirements for Blockchain-based Applications

Arno Pfefferling, Theo Weigel
Hochschule Mittweida, Technikumplatz 17, 09648 Mittweida

Blockchain Technology (BT) with so-called web3 is at an inflection point between new sub-theme hypes and world-wide industrialization over last three years thanks to large companies like MicroStrategy [1], Facebook [2] and several Venture-Capital formations [3] who are already fighting over market share and community growth. Our work represents insights from Literature-based Software Requirement (SR) elicitation for a specific Blockchain-based Application, which is creation, managing and control of digital Power of Attorney (POA). The context of POA is not only a financial driven use-case it is by far a heavy weight universal legal transaction. We use a morphological box and reduced PRIMS-P to synthesis a generic specification for further Blockchain-based Application development. Formulated SRs in POA context are reflected on our core actors which are Grantor and authorized, trusted, external Entities. Proposed characteristics for relationship and effects are visualized in a reference model originally used in digital platform ecosystems [4]. This design and modelling approach facilitated closing discussion of BT and its future eCommerce perspective.

1. Introduction

Blockchain Technology (BT) and its applications are since 2016 more or less a hyped topic and described by several peer-reviewed technical as well as theoretical research contributions [5]. Financial applications are by far not the only solutions today, but they are according to Guo & Liang (2016) the ones with the greatest impact in terms of value streams and usage levels which makes BT interesting for sharing economy too, whereby the "innovative distributed ledger technologies such as for example the blockchain could support this with transparent recording and value exchange mechanisms among the involved actors" [7]. This quote is for our work the starting point to investigate how BT needs to be specified and which Software Requirements (SR) are consequences out of the involved real-world actors.

The chosen application scenario for value exchange is the topic of digital legacies, specifically digital services for the implementation and use of Powers of Attorney (POA). Digital value lays in the representation of various unilateral legal transactions and the scope of their actual release. Caruso (2018) points out that "modern unilateral contracts can expand the range of private autonomy and enable agreements that will generate net welfare gains". Generally, POA is within innovative firms already partly automated by so called Enterprise Legal Management (ELM) Software where arrangements of contracts and accounts for example in the event of death can be processed. ELM is "just as Enterprise Resource Planning has overhauled the finance function, so too there is promise that a foundational and integrated system of record can improve in-house legal operations and workflows" [9]. But POA is particularly helpful for private relatives, as important documents like living wills, bank statements and insurance documents are available and processed digitally. So, if the worst comes to the worst, the surviving dependents are relieved of stressful administrative tasks. Besides those promises processes in this context are very sensitive, since "involving incapable, isolated, institutionalized persons in research tries to prevent possible, albeit unintentional, exploitation of them as members of a vulnerable population." [10]. A machine or technical system can emotion-free transact this sensitive data, so that we anker BT with the described application context and want to catalyze technological benefits in real-world use-cases.

We follow the Research for Application-oriented contributions to uncover veritable properties of BT. According to the "Blockchain Research Framework" from Spohrer and Risius (2017) our approach can be seen as crucial prove for multidisciplinary statements. Furthermore, their prospective paradigmatic research questions:

"How do blockchain platforms differ regarding features and designs?

How can different blockchain systems complement each other to overcome individual constraints?

What are the technological interdependencies between different blockchain features (e.g., levels of permission and consensus mechanisms)?

How can the technical strengths of multiple public?"

are guiding our here proposed systematic literature review and conceptual design-oriented methodology in totality. After the introduction, this paper is explaining two core elements: 1) Smart Contract (SC) which is program code stored, processed, and used over BT – in other words SCs are acting as automated logic for the transactions on data; 2) Characteristics of BT under the context of POA – including a generic mapping of possible semantic objects. Followed by a detailed description of our applied Methodology and convicted Findings completed at

a discussion of our proposed SR. Those SR are elicited from explained source items and align with the goal to enhance the digital handling of POA, especially for Grantors, which are manifestation of our user-centric view.

2. Background and Foundations

The mystical emergence of Bitcoin has seen light over the recent years, so that the development steps and preconditions as well as the circumstances around Satoshi Nakamoto are more and more acknowledged [12]. Also, the Limitations in Bitcoin were addressed by a group led by avowed Viatlik Buterin [13] and resulted in founding the Ethereum Blockchain. The first practical applications have been implemented on the Ethereum Blockchain, starting in 2016, with the "Ethereum Request for Comments" (ERC) 20 and the standardized SC structure including the functionality to implement so-called Initial Coin Offerings, which allowed to access a global capital market direct in the creation step [14]. The combination of a distributed programmable logic on a ledger with the omnipresent need of market fit in an open innovative environment and the wide unregulated experimental setup have created application areas beyond cryptocurrencies. Academic literature defined features of distributed ledger technology are trust-free, transparent, and highly secure nature by decentralization [15]–[17].

Today, two applications are significantly present in the Ethereum eco-system. Firstly, the so-called Non-Fungible Tokens based on ERC 721, which are used to map ownership of digital or digitized values and goods, currently mainly for digital art and collectibles, as well as the entire complex of topics of so-called Decentralized Finance, which deals with the exchange and trade of decentralized values in the form of e.g., security or utility tokens [18]. SC-based decentralized exchanges such as: MDEX or Uniswap recorded a tremendous growth in sales in the process. Currently, the top 10 decentralized exchanges on Ethereum are turning over values of approximately $3 billion daily [19]. The examples of ERC 20 and ERC 721 token shows that Blockchain-based SC works and have entered a mainstream in regards of eCommerce, so that already new disruptive markets with enormous growth potential are realized [20].

In addition to these pioneering standardizations, new topics and industries are constantly being investigated regarding the use of BT by a crowd as audience and pilot applications aiming for new use-cases in being under dynamical development [21]. In supply chain management (proof of origin, tracking) and, most recently, in digital identities based on the principle of self-governance (self-sovereign identity) are particularly worth mentioning. Finally, we want to highlight that at Mittweida University of Applied Sciences other prototypes in use of BC are being investigated, such as: decentralized electronic voting, SC-automated insurance cases as well as authorization and signing of digital exam certificates. Following the archetype taxonomy from Weking et al. (2020) we have research steps in any application fields and this paper can be seen as practitioner contribution within Blockchain-based supply chains for data traceability, verification, reduction of redundancy on physical assets as a user-centric shared database for all members of the whole value chain. Involved actors in the value chain of POA are defined as the following: a) authorized Entity (in German "Bevollmächtigte"): has the right given by the Grantor to carry out a specified power for something in the real-world. This something can be a need of various actions or even state confirmations covered by a scope and underlying initial goal of the Grantor. Legal difficulty for interpretation of giving meaning to normative standards for SC is already addressed and noted [23]. To solve this interpretation, issue the authorized Entity must interact with an external Entity to achieve the execution of a specific point from a POA record. b) external Entity (in German "externe Dritte"): person or institution which validates the execution of the given POA scope and notifies all participants of a state change (e.g. "done"). c) The Grantor (in German "Vollmachtgeber"): person that creates and initially defines from himself goals for the POA. d) The Power of Attorney (in German "Vollmacht"): POA is a document or record that authorizes the holder to carry out specified power given by the Grantor. Holder in respect to digital objects means a state which is linked to one identified actor. e) trusted Entity (in German "Treuhänder"): person or institution which observes a POA dataset and knows about its validity by ensuring legal custody of a POA record. The single POA record itself is manifested by at least containing a signatory signature [24]. The core actor is the Grantor who need to have an initial goal and could name all involved actors or at least the trusted Entity to avoid fraud. Conflicts are disputed via Governance transactions as Trust building ankers within the BT system itself and reach a central design aspect as it is empirical suggested by Lewis et al. (2021).

For mapping the domain of POA with BC we defined characteristics in a morphological box, which is a creativity method for the systematic analysis of complex processes. According to [26] morphological analysis "is best suited for problems/systems of interest which cannot be adequately expressed using quantitative models and thus methods and software for mathematical optimization or simulation are nonapplicable (e.g. objective function and mathematical programming)". The domain under consideration of BT is broken down in a structured way to identify system components for which possible variants as Levels are defined (see Table 1).

The following tasks were conducted: 1) definition of characteristics (or attributes in case of physical objects) of existing components which have independence of each other, then 2) listing all cross-brainstormed expressions of respective characteristics to create a matrix in which every combination of theoretically possible values is aligned and 3) selected expression of the characteristics are chosen in each row, resulting in a minimized combination by intuitively consideration of holistically as solutions at a specific time. To get a systematic this

selection process was carried out several times and 4) new rows were iterated overall in four brainstorm sessions.

Characteristic	Level 1	Level 2	Level 3	Level 4	Level 5
Blockchain ecosystem [new - old]	Solana	IOTA	Hyperledger	Ethereum	Bitcoin
Blockchain privacy [low - high]	public	cloaked transactions	semi-permissioned	permissioned	
Blockchain dynamics [beneficial - mandatory]	popularity	lifetime	Quality of Service		
Jurisdiction [wide - narrow]	global	EU	Germany		
POA components [exact - fuzzy]	record	document	metadata	interfaces	participants
POA participants [sovereign - contractual]	Grantor	trusted Entity	authorized Entity	external Entity	
POA events [immediate – undefined]	create	validate	execute	unknown	
record storage [physical - unbound]	analog	digital local	network storage	cloud storage	distributed storage
record management [direct - undefined]	local	offline	online	distributed	gapped
record interaction [physical - unbound]	paper	in person	remote	automated	machine

Table 1: Morphological box to evaluate and classify selected source items during Screening phase.

The Level is a description of the variants for determined characteristic features. The benefit for our work by applying this creativity method was to limit the amount of source items of the SLR and leave focus for the synthesis of the SR specification. Relationship of uncertainty, vulnerability and trust are seen in the context of business processes [27]. Furthermore Müller et al. (2020) mentioned importance of reputation systems with Claims are defined as part of our core value-creation mechanism within eCommerce perspective.

3. Research Methodology

Fundamental starting point for our findings is a Systematic Literature Review (SLR) under applying the PRIMS-P flow. Terminology and scoping elements of PRIMS-P are not described in detail, since the content is repetitive to our paper structure and this work is not aimed to be fully compliant with PRISMA-P. No drawback is expected since our work is not intended to be health research [28], [29]. Between Mid of January to End of May 2022, data collection and a three staged analysis were completed (see Figure 1). To align the study and research direction, selected keywords were chosen the following "Blockchain" AND/OR "Power of Attorney". Search for data was done via google.scholar.com, aisel.aisnet.org, link.springer.com and ieeexplore.ieee.org. Data by identification of other online sources like blog, media, marketing posts are included as well. A manual forward/backward search based on identified source items was added [30]. Because BT in combination with POA is a completely new subject within Information Systems, only strong healthcare related items were strictly excluded to focus on the use of POA not the circumstances under those are triggered. For avoiding within-study bias [31] two persons from different backgrounds had to do the coding followed up by bi-weekly alignment meetings. We want to point out that the finding of a SR specification is the synthesized output of the SLR, which is adopting within the software engineering domain more and more [32].

3.1. Rationale and Objectives

Central object for rationale and derived objectives is the investigation of POA itself. Legally binding POA are informal in Germany, but they must fulfil certain requirements to be valid for a specific unilateral legal transaction. The already existing legal characteristics of POA are precisely defined and thus documented in the form of laws [33]. Classic POA in this sense are often notarized or certified, thus ensuring the integrity and validity of a POA. What is not clear, however, are the procedures and the application of these properties to a POA that is created, validated, and executed in a digital form only.

The legal and, in this context, technical BT interactions between the Entities involved are insufficiently explored. Since in ELM systems digital workflows and electronic documents are kind of used our research is trying to stay agile according to points of evidence-based decision making [34] – immutable and transparent BT can catalyze this due to its core functionality. Also the particular importance is the safeguarding of the interests of the participants in a POA [8], where in-built privacy from newer BT can strengthen the objective of POA. Based on

the legal properties of a POA, it can be assumed that it represents a series of conditional events (specified in the scope) that are triggered, validated and executed by different real-world Entities.

In conclusion the applied Jurisdiction defines the boundary conditions for the POA object itself and the SR frame must align with it. Transactions in relation to POA can be defined as legal services for challenging digital transformation of all spheres of life [35].

For BT as an object, we draw rationale mainly out of the funding source, because especially private funding-sources maybe profit-orientated for their own products [14], in that case, a source item is less legible.

Even if DAO and Community-oriented value streams were visible our objectives are on technical design and how software as a tool is used and finally realized. Business perspectives or consequences for technological decisions are subordinated. Argumentation is that we focus on goals and refinement process [36].

3.2. Eligibility Criteria and Evidence Collection

The Parameter during Identification and Screening steps are the following: Age of the source 2012 and above, Keywords evaluated with use of morphologic box Levels (see Table 1), type of source (academic paper/media post). We tried to stay in a general approach over specialized drilling. Meaning if there is a concept presented in a source item which works in more general context, that source will be preferred over specialized concepts. This was important so that specialized approaches do not influence the later implementation and avoid a foam of bias. The number of citations on source items just indicated relevant sources but did not make them standout for us.

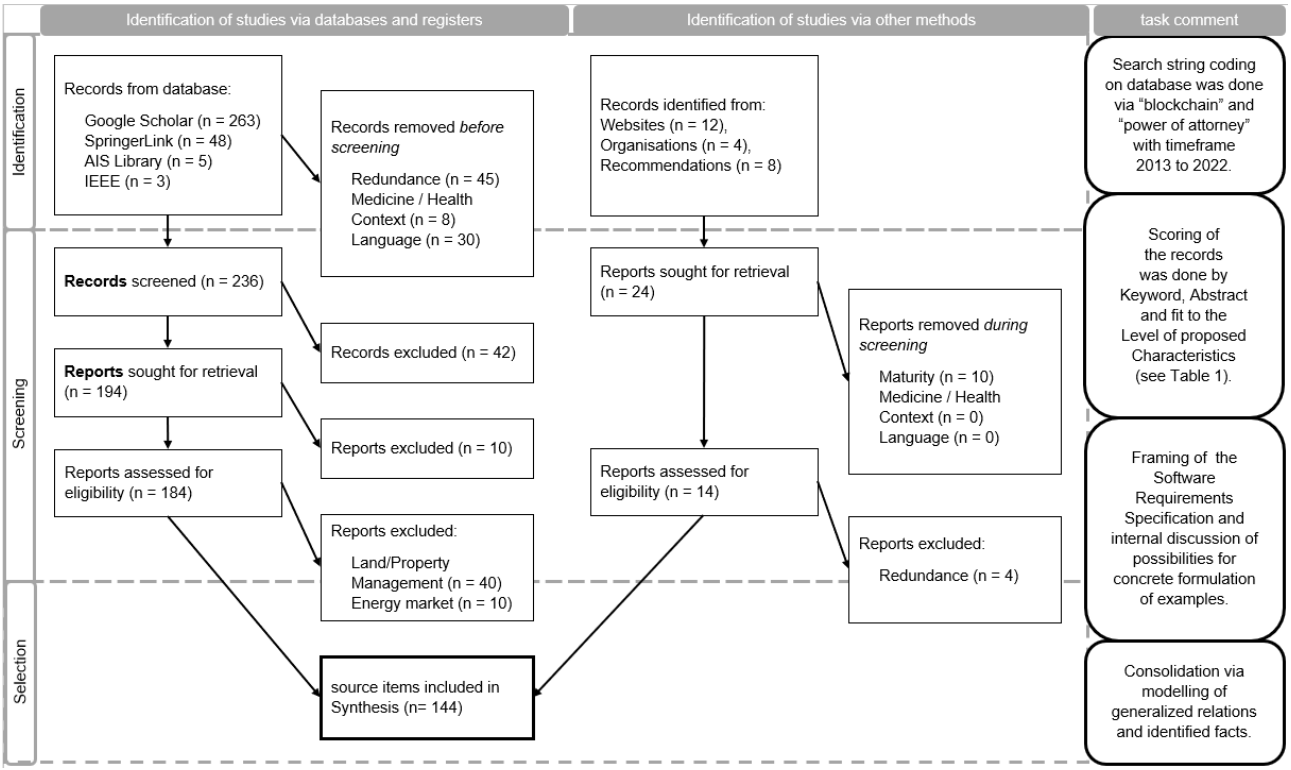

Figure 1: Three phase analysis of our SLR to synthesis SR for the Blockchain-based POA [37].

4. Results and Discussion

Our profound Findings are represented with the use of a SR specification template based on IEEE 830, ISO/IEC/IEEE 29148:{2011,2017} in combination with a goal-oriented requirements engineering [38] to build the best structure of fulfilling a widely usable specification within BT and the domain of POA. The underlying process model for the requirements engineering is adopted from [39] and starts with the application domain where system artifacts and source material represent the domain analysis – in our work completely gathered from the SLR. Developed prototypes and models were finally refined to the SR specification (see Figure 2).

Requirements itself are seen as a relation between form and context inside a system independent from the type of use like decision-support or knowledge systems are representing [40]. This independency from the type of use is in our view positive since also activities associated with requirements engineering vary widely depending on established practices of public as well as private organizations. These are sometimes presented as chronological phases considerable intertwining of real-world practical activities [41].

4.1. Synthesis of Requirements

Scope for handling digital POA were to allow users: A) Creation, validation and management of POA datasets consisting of POA records and its metadata; B) Write integrity information of POA datasets anchored per BT; C) user management with role-based privileges; D) interactions with POA records can be backtracked. Based on scope A-D we aligned the system goals and defined raw technical requirements to map those to building blocks in the reference model (see Figure 2). In addition to Hein et al. (2020) proposed value-co creation and the boundary resources of well- and ill-structured characteristic – we modified and added from the core value-creation mechanism outwards BT as catalyzer for more general representation of eCommerce platforms, were Consumer stays, but context is given by POA objects and Jurisdiction is the main inward directed effect for Boundaries.

As in between overview we want to establish a service architecture with persistence, storage, blockchain and notification layer all combined in a gateway on top of a central web user interface [42]. On this interface three pages (application root, stakeholder view of existing records and specific validated datasets) are defined as SR. A more detailed list of our defined SR is given under https://aizr1.github.io/spoa/ whereby the actual definition can vary according to the use-case. Example is the relation of a technical backend structure to end-devices for signing on the distributed ledger and a necessary onboarding procedures with focus on identification [43]

4.2. Product Overview Perspective, Functions and Constraints

The value stream is the interaction of POA with BT going through value-creating mechanism triggered by Innovation which comes from the Consumers itself since each POA scope and reasoning comes from Grantors itself. This loop-in-loop relation is a core functional SR like user management with account and resource assignment, storage management with record access and validation management with integrity mapping for POA datasets. Outcome is the major goal 1) to secure the Grantor's interests of a POA by enabling Entities to validate its integrity, contents and history of interaction fully digitally. 2) enforced default that Entities use disclosed context and avoid green-washing policies [44].

In detail, a user can create or interact with a POA dataset and enter metadata (e.g., names of participants, execution, or termination dates). This dataset will be cryptographically signed and stored securely in a versioned object storage. The system will take the cryptographic data and store it on BT using on-chain transactions. A trusted or external Entity is now enabled to validate the POAs integrity, contents, and history of interaction digitally. This brings us to goal 2) where processes that require POA need to be more secure, by providing a purpose-built system using the auditing capabilities and tamper-proof properties like BT but realized in an Event-driven architecture since the system achieves to handle various heterogenies legal content, such as POA record information with private user data, local data or other content which falls under privacy protection laws.

Another feature or required constraints is the integrable of an existing cloud environment to maximize scalability of the whole system [45]. If a feature requires non-standard protocols or software, it might constrain the overall system and should be excluded.

4.3. User Characteristics, Assumptions and Dependencies

Central objects are POA datasets, which are digital representation of documents or records that authorizes the holder to carry out a specified power given by the Grantor. The digital representation is allowing and enforcing "smart regulation by conditions to nudge individuals" [46] so that object-based value-creating mechanism is depending on a user-centric view. Integrity of information about the power and scope are cryptographically verifiable data of POA record, which is created automatically to every active dataset. A dataset in short is a collection of POA records, metadata, and additional information. According to Hegadekatti (2017) main task is a Proof for the existence of documents. We tackle this by POA records which can be linked to any file (e.g. PDF, Video, Audio), containing the actual POA legacy as created and initial scoped by the Grantor. Such a record has defined and maybe changing participants by a SC without negotiation [48]. A user is a representation of a real-world person and can assume various roles based on the type of interaction with a POA record. Assumption in the synthesis is the dependency of specific BT implementations since very different maturity degrees and characteristics were noticed. Furthermore, the many different BT on the market show lack of evidence-based realization of use-cases. Most fitting source items use SC in production usage.

4.4. Quality of Service

The Quality of Service (QoS) refers to the quality of a communication service from the user point of view. Since our users are the Consumer itself we set security general as goal 3) and resulting SR that central parts of the system will be written in Rust, which was developed to eliminate classes of critical bugs, while being performant [49]. For traffic definition any connection between services must be encrypted, regardless of the underlying network architecture as well as a reverse-proxy which should take care of SSL Termination instead of the backend itself. For storage in general any data stored or buffered must be encrypted. Regarding authentication no personal identifiable information is stored on any browser persistence [50], [51].

For reliability, the SR of automated testing in critical part and shall ensure basic functionality as well as integration of coded services added by manual testing of all user actions shall ensure correct end-functionality. Specifically

SC have a need by inter-SC communication operation that can pave the way for several coding irregularities like reentrancy, denial of service, mishandled exception [52]. Additional we see auditing of the system design, which aims to trace every interaction of POA datasets. Audit logs shall be written to a tamper-proof, historically verifiable system (e.g. again Event-based architecture or BT).

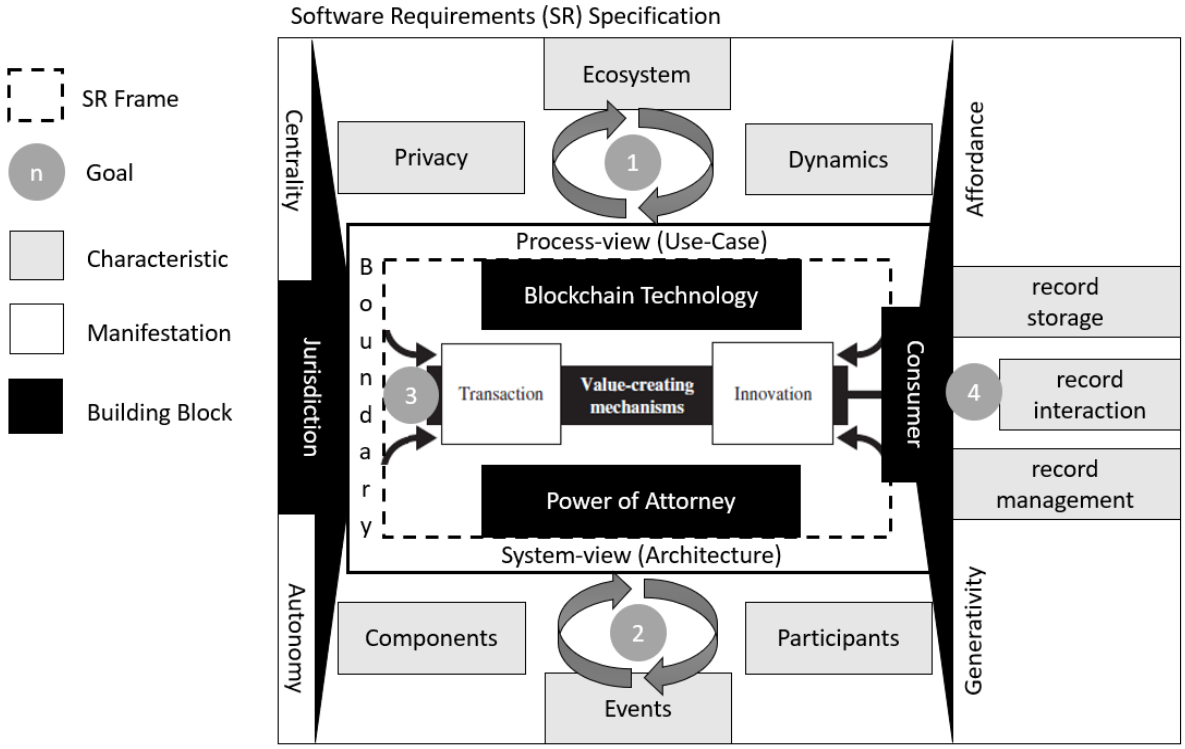

Figure 2: Visualization of our proposed SR specification with core element adapted by Hein et al. [53].

This means our resulting design is not excluding a combination of two or more Blockchain solutions, which can be declared as a strength [11]. Paik et al. (2019) analysis shows a "unique design of the ledger structure, network, consensus protocol and cryptographic mechanisms it uses", so that single Blockchain solutions definitely have benefits against their competitors and a combination of those is a win-win for eCommerce position. System as well as user configuration is externalized in files to ensure full modularity. For the user aka Consumer we propose goal 4) by end-device flexibility and inbuild authentication over SC. These are confirmed suggestions in practical studies [14], [55].

5. Conclusion and Outlook

In summary our work presents a design and model for software engineering domain in building Blockchain-based Application on the context of digital POA. The design and model are a SR specification which uses a SLR and morphological box to synthesis a structure of relations by Process- and System-view. The generosity of our SR specification was one modeling aspect so that our approach can be adjusted for other use-cases. This is important since SC security shows domain specific invoking methods [52]. SC Security stretches over the whole BT system since SC have vulnerabilities in the process of development, deployment as well as interaction [56].

Affordance represents a high market need like an industry must-have versus Generativity a market portability as easy to use system to work with from Consumer view. On the contrary Centrality stands for the degree of decentralization versus Autonomy as gauge for self-sovereign POA from Jurisdiction view. Characteristics of Building Blocks are unordered triad for the goals and development stage independent orientation of agile sprint planning. Future research could be done in building a framework to define SR dynamically within the triad.

5.1. Limitations

Our current work and research project future are oriented mainly for German Jurisdiction so that some thoughts might not fit to other more restriction-less regions and we lose the benefit of "develop suitable legal frameworks to cope with the upsurge and hefty volume of online transactions" [57]. Still, if we look at the electronic transactions it can be noted that we are very close to the eIDAS regulations [58] and a shift for our SR specification to European Jurisdiction is very well possible. For more comprehensive formulation of SR our work can be extended by other research methods like semi-structured interviews to e.g. reveal more details of accounting practice [59]. Also, the SLR is not trying to propose new research questions neither an unknown gap, but it is at least in our understanding a practical tool to define a specification systematic by use-case depending

on SR. As soon as the research community has more increments of technical Blockchain-based Applications further understanding of the "trade-off between system usability and values" can be investigated [60]. Our work is in this view tightened to more practical research than theory.

Acknowledgements

Special thanks to the German Research Foundation who supplied financial the WIR! showcase region Mittweida and us as the smartPOA sub-project (FKZ: 03WIR1317B). Furthermore, we are grateful for our industry partner Memoresa GmbH and their practical experienced software engineers who always had a sympathetic ear.

References

[1] N. Kessler, "MicroStrategy kauft den Dip – so viele Bitcoins waren es diesmal," Apr. 22, 2022. https://www.deraktionaer.de/artikel/aktien/microstrategy-kauft-den-dip-so-viele-bitcoins-waren-es-diesmal-20248591.html (accessed May 08, 2022).

[2] E. Kühl, "Facebook-Kryptowährung: Kapp den Diem!," *Die Zeit*, Hamburg, Jan. 28, 2022. Accessed: May 08, 2022. [Online]. Available: https://www.zeit.de/digital/internet/2022-01/facebook-kryptowaehrung-diem-libra-aus

[3] R. Rai, "An Overview Of Web3 Venture Capital Activity In 2021," Jan. 02, 2022. https://www.forbes.com/sites/rahulrai/2022/01/02/an-overview-of-web3-venture-capital-activity-in-2021/ (accessed May 08, 2022).

[4] A. Hein *et al.*, "Digital platform ecosystems," *Electron Markets*, vol. 30, no. 1, pp. 87–98, Mar. 2020, doi: 10.1007/s12525-019-00377-4.

[5] J. Yli-Huumo, D. Ko, S. Choi, S. Park, and K. Smolander, "Where Is Current Research on Blockchain Technology?—A Systematic Review," *PLoS ONE*, vol. 11, no. 10, p. e0163477, Oct. 2016, doi: 10.1371/journal.pone.0163477.

[6] Y. Guo and C. Liang, "Blockchain application and outlook in the banking industry," *Financ Innov*, vol. 2, no. 1, p. 24, Dec. 2016, doi: 10.1186/s40854-016-0034-9.

[7] T. Puschmann and R. Alt, "Sharing Economy," *Bus Inf Syst Eng*, vol. 58, no. 1, pp. 93–99, Feb. 2016, doi: 10.1007/s12599-015-0420-2.

[8] D. Caruso, "Then and Now: Mark Pettit's Modern Unilateral Contracts in the 1980s and in the Age of Blockchains," *B.U. L. Rev.*, vol. 98, p. 1789, 2018.

[9] R. van der Meulen, "Gartner Insights," *4 Key Trends in the Gartner Hype Cycle for Legal and Compliance Technologies, 2020*, Sep. 21, 2020. https://www.gartner.com/smarterwithgartner/4-key-trends-in-the-gartner-hype-cycle-for-legal-and-compliance-technologies-2020 (accessed Apr. 15, 2022).

[10] A. M. Heesters, D. Z. Buchman, K. W. Anstey, J. A. H. Bell, B. J. Russell, and L. Wright, "Power of Attorney for Research: The Need for a Clear Legal Mechanism," *Public Health Ethics*, vol. 10, no. 1, pp. 100–104, 2017.

[11] M. Risius and K. Spohrer, "A Blockchain Research Framework: What We (don't) Know, Where We Go from Here, and How We Will Get There," *Bus Inf Syst Eng*, vol. 59, no. 6, pp. 385–409, Dec. 2017, doi: 10.1007/s12599-017-0506-0.

[12] U. W. Chohan, "A History of Bitcoin," *SSRN Journal*, Feb. 2022, doi: 10.2139/ssrn.3047875.

[13] V. Buterin, "A NEXT GENERATION SMART CONTRACT & DECENTRALIZED APPLICATION PLATFORM," Ethereum Foundation, 2015. [Online]. Available: https://blockchain-lab.com/pdf/Ethereum_white_paper-a_next_generation_smart_contract_and_decentralized_application_platform-vitalik-buterin.pdf

[14] K. Lauslahti, J. Mattila, T. Hukkinen, and T. Seppälä, "Expanding the Platform: Smart Contracts as Boundary Resources," in *Collaborative Value Co-creation in the Platform Economy*, A. Smedlund, A. Lindblom, and L. Mitronen, Eds. Singapore: Springer, 2018, pp. 65–90. doi: 10.1007/978-981-10-8956-5_4.

[15] R. Beck, J. S. Czepluch, N. Lollike, and S. Malone, "BLOCKCHAIN – THE GATEWAY TO TRUST-FREE CRYPTOGRAPHIC TRANSACTIONS," *Research Papers*, May 2016, [Online]. Available: https://aisel.aisnet.org/ecis2016_rp/153

[16] M. Marchesi, L. Marchesi, and R. Tonelli, "An Agile Software Engineering Method to Design Blockchain Applications," *CEE-SECR '18*, 2018, doi: 10.1145/3290621.3290627.

[17] T. Rathee and P. Singh, "A systematic literature mapping on secure identity management using blockchain technology," *Journal of King Saud University - Computer and Information Sciences*, p. S1319157821000690, Mar. 2021, doi: 10.1016/j.jksuci.2021.03.005.

[18] A. Miglo, "STO vs. ICO: A Theory of Token Issues under Moral Hazard and Demand Uncertainty," *Journal of Risk and Financial Management*, vol. 14, no. 6, Art. no. 6, Jun. 2021, doi: 10.3390/jrfm14060232.

[19] Binance Capital, "CoinMarketCap," *Die Rangliste der besten dezentralen Kryptowährungsbörsen*, May 01, 2022. https://coinmarketcap.com/de/rankings/exchanges/dex/ (accessed May 01, 2022).

[20] K. P. Jørgensen and R. Beck, "Universal Wallets," *Bus Inf Syst Eng*, vol. 64, no. 1, pp. 115–125, Feb. 2022, doi: 10.1007/s12599-021-00736-6.

[21] J. Weking, M. Stöcker, M. Kowalkiewicz, M. Böhm, and H. Krcmar, "Archetypes for Industry 4.0 Business Model Innovations," presented at the StrategicIT, Hyatt Regency New Orleans, Aug. 16, 2018. Accessed: May 25, 2022. [Online]. Available: https://aisel.aisnet.org/amcis2018/StrategicIT/Presentations/3/

[22] J. Weking, M. Mandalenakis, A. Hein, S. Hermes, M.

Böhm, and H. Krcmar, "The impact of blockchain technology on business models – a taxonomy and archetypal patterns," *Electron Markets*, vol. 30, no. 2, pp. 285–305, Jun. 2020, doi: 10.1007/s12525-019-00386-3.

[23] M. Giancaspro, "Is a 'smart contract' really a smart idea? Insights from a legal perspective," *Computer Law & Security Review*, vol. 33, no. 6, pp. 825–835, Dec. 2017, doi: 10.1016/j.clsr.2017.05.007.

[24] S. Vattaparambil Sudarsan, O. Schelén, and U. Bodin, "A Model for Signatories in Cyber-Physical Systems," in *2020 25th IEEE International Conference on Emerging Technologies and Factory Automation (ETFA)*, Sep. 2020, vol. 1, pp. 15–21. doi: 10.1109/ETFA46521.2020.9212081.

[25] S. Leewis, K. Smit, and J. van Meerten, "An Explorative Dive into Decision Rights and Governance of Blockchain: A Literature Review and Empirical Study," *Pacific Asia Journal of the Association for Information Systems*, vol. 13, no. 3, Sep. 2021, doi: 10.17705/1pais.13302.

[26] M. Zec, A. Schneider, and F. Matthes, "Towards a Process Model for Computer-Supported Collaborative Morphological Analysis," *AMCIS 2015 Proceedings*, Jun. 2015, [Online]. Available: https://aisel.aisnet.org/amcis2015/SystemsAnalysis/GeneralPresentations/9

[27] M. Müller, N. Ostern, and M. Rosemann, "Silver Bullet for All Trust Issues? Blockchain-Based Trust Patterns for Collaborative Business Processes," in *Business Process Management: Blockchain and Robotic Process Automation Forum*, vol. 393, A. Asatiani, J. M. García, N. Helander, A. Jiménez-Ramírez, A. Koschmider, J. Mendling, G. Meroni, and H. A. Reijers, Eds. Cham: Springer International Publishing, 2020, pp. 3–18. doi: 10.1007/978-3-030-58779-6_1.

[28] PRISMA-P Group *et al.*, "Preferred reporting items for systematic review and meta-analysis protocols (PRISMA-P) 2015 statement," *Syst Rev*, vol. 4, no. 1, p. 1, Dec. 2015, doi: 10.1186/2046-4053-4-1.

[29] L. Shamseer *et al.*, "Preferred reporting items for systematic review and meta-analysis protocols (PRISMA-P) 2015: elaboration and explanation," *BMJ*, vol. 349, no. jan02 1, pp. g7647–g7647, Jan. 2015, doi: 10.1136/bmj.g7647.

[30] J. Webster and R. T. Watson, "Analyzing the Past to Prepare for the Future: Writing a Literature Review," *MIS Quarterly*, vol. 26, no. 2, pp. xiii–xxiii, 2002.

[31] C. F. Durach, J. Kembro, and A. Wieland, "A New Paradigm for Systematic Literature Reviews in Supply Chain Management," *J Supply Chain Manag*, vol. 53, no. 4, pp. 67–85, Oct. 2017, doi: 10.1111/jscm.12145.

[32] P. Brereton, B. A. Kitchenham, D. Budgen, M. Turner, and M. Khalil, "Lessons from applying the systematic literature review process within the software engineering domain," *Journal of Systems and Software*, vol. 80, no. 4, pp. 571–583, Apr. 2007, doi: 10.1016/j.jss.2006.07.009.

[33] M. J. Pettit, "Modern Unilateral Contracts," *B.U. L. Rev.*, vol. 63, p. 551, 1983.

[34] M. Milkovich, J. A. Nicholson, and D. B. Nicholson, "Applied Learning of Emerging Technology: Using Business-Relevant Examples of Blockchain," *Journal of Information Systems Education*, vol. 31, no. 3, p. 187, Sep. 2020.

[35] Y. A. Tymchuk and A. V. Shkalenko, "Analysis of the Impact of Robotic Legal Services on the Changing Institutional Environment of Economy and Law," in *"Smart Technologies" for Society, State and Economy*, Cham, 2021, pp. 1146–1158. doi: 10.1007/978-3-030-59126-7_125.

[36] D. Alrajeh, A. Cailliau, and A. van Lamsweerde, "Adapting Requirements Models to Varying Environments," in *2020 IEEE/ACM 42nd International Conference on Software Engineering (ICSE)*, Oct. 2020, pp. 50–61. doi: 10.1145/3377811.3380927.

[37] M. J. Page *et al.*, "The PRISMA 2020 statement: an updated guideline for reporting systematic reviews," *BMJ*, p. n71, Mar. 2021, doi: 10.1136/bmj.n71.

[38] A. van Lamsweerde, "Goal-oriented requirements engineering: a guided tour," in *Proceedings Fifth IEEE International Symposium on Requirements Engineering*, Aug. 2001, pp. 249–262. doi: 10.1109/ISRE.2001.948567.

[39] H. F. Hofmann and F. Lehner, "Requirements engineering as a success factor in software projects," *IEEE Software*, vol. 18, no. 4, pp. 58–66, Jul. 2001, doi: 10.1109/MS.2001.936219.

[40] H. F. Hofmann, *Requirements Engineering: A Situated Discovery Process*. Springer-Verlag, 2013.

[41] Jay, "The Hardest thing about Engineering is Requirements," Mar. 03, 2022. https://jaybs.medium.com/the-hardest-thing-about-engineering-is-requirements-28a6a70c4db4 (accessed Mar. 14, 2022).

[42] J. Lockl, V. Schlatt, A. Schweizer, N. Urbach, and N. Harth, "Toward Trust in Internet of Things Ecosystems: Design Principles for Blockchain-Based IoT Applications," *IEEE Trans. Eng. Manage.*, vol. 67, no. 4, pp. 1256–1270, Nov. 2020, doi: 10.1109/TEM.2020.2978014.

[43] C. Klikovits, P. Abraham, and R. Rambacher, "A Framework to identify People, Devices and Services in Cyber-physical system of systems," in *2021 IFIP/IEEE International Symposium on Integrated Network Management (IM)*, May 2021, pp. 914–919.

[44] M. Bellucci, D. C. Bianchi, and G. Manetti, "Blockchain in accounting practice and research: systematic literature review," *Meditari Accountancy Research*, 2022, doi: 10.1108/medar-10-2021-1477.

[45] D. Li, L. Deng, Z. Cai, and A. Souri, "Blockchain as a service models in the Internet of Things management: Systematic review," *Transactions on Emerging Telecommunications Technologies*, vol. 33, no. 4, p. e4139, 2022, doi: 10.1002/ett.4139.

[46] M. Yu. Kozlova, "Accessibility of Register Information as an Element of Smart Regulation of Entrepreneurial Relations in the Digital Society," in *Towards an Increased Security: Green Innovations, Intellectual Property Protection and Information Security*, Cham, 2022, pp. 387–396. doi: 10.1007/978-3-030-93155-1_43.

[47] K. Hegadekatti, "Legal Systems and Blockchain Interactions," Social Science Research Network, Rochester, NY, SSRN Scholarly Paper 2893128, Feb. 2017. doi: 10.2139/ssrn.2893128.

[48] S. Williams, "Smart Contracts don't negate Power of Attorney or the need for one.," Apr. 11, 2019. https://www.linkedin.com/pulse/smart-contracts-dont-negate-power-attorney-need-one-samson-williams (accessed May 08, 2022).

[49] J. Goulding, "What is Rust and why is it so popular?," *Stack Overflow*, Jan. 20, 2020. https://stackoverflow.blog/2020/01/20/what-is-rust-and-why-is-it-so-popular/ (accessed Mar. 16, 2022).

[50] A. Hindle, "Impact of GDPR on Identity and Access Management," *IDPro Body of Knowledge*, vol. 1, no. 1, Art. no. 1, Mar. 2020, doi: 10.55621/idpro.24.

[51] S. Schwerin, "Blockchain and Privacy Protection in the Case of the European General Data Protection Regulation (GDPR): A Delphi Study," *The JBBA*, vol. 1, no. 1, pp. 1–77, Jul. 2018, doi: 10.31585/jbba-1-1-(4)2018.

[52] Z. A. Khan and A. S. Namin, "A Survey on Vulnerabilities of Ethereum Smart Contracts," arXiv, arXiv:2012.14481, Dec. 2020. doi: 10.48550/arXiv.2012.14481.

[53] A. Hein, J. Weking, M. Schreieck, M. Wiesche, M. Böhm, and H. Krcmar, "Value co-creation practices in business-to-business platform ecosystems," *Electron Markets*, vol. 29, no. 3, pp. 503–518, Sep. 2019, doi: 10.1007/s12525-019-00337-y.

[54] H.-Y. Paik, X. Xu, H. M. N. D. Bandara, S. U. Lee, and S. K. Lo, "Analysis of Data Management in Blockchain-Based Systems: From Architecture to Governance," *IEEE Access*, vol. 7, pp. 186091–186107, 2019, doi: 10.1109/ACCESS.2019.2961404.

[55] A. Bogner, M. Chanson, and A. Meeuw, "A Decentralised Sharing App running a Smart Contract on the Ethereum Blockchain," in *Proceedings of the 6th International Conference on the Internet of Things*, New York, NY, USA, Nov. 2016, pp. 177–178. doi: 10.1145/2991561.2998465.

[56] X. Li, P. Jiang, T. Chen, X. Luo, and Q. Wen, "A survey on the security of blockchain systems," *Future Generation Computer Systems*, vol. 107, pp. 841–853, Jun. 2020, doi: 10.1016/j.future.2017.08.020.

[57] W. C. Iheme, "A Comparative Assessment of the Legal Frameworks on Cross-Border Consumer Disputes," in *The Indian Yearbook of Comparative Law 2019*, M. John, V. H. Devaiah, P. Baruah, M. Tundawala, and N. Kumar, Eds. Singapore: Springer, 2021, pp. 61–93. doi: 10.1007/978-981-16-2175-8_4.

[58] T. Vogt, "Die neue eIDAS-Verordnung – Chance und Herausforderung für die öffentliche Verwaltung in Deutschland," *Information - Wissenschaft & Praxis*, vol. 67, no. 1, pp. 61–68, Feb. 2016, doi: 10.1515/iwp-2016-0011.

[59] R. Esmander, P. Lafourcade, M. Lombard-Platet, and C. Negri-Ribalta, "A silver bullet?: a comparison of accountants and developers mental models in the raise of blockchain," in *Proceedings of the 15th International Conference on Availability, Reliability and Security*, Virtual Event Ireland, Aug. 2020, pp. 1–10. doi: 10.1145/3407023.3409193.

[60] K. Cousins, H. Subramanian, and P. Esmaeilzadeh, "A Value-sensitive Design Perspective of Cryptocurrencies: A Research Agenda," *CAIS*, pp. 511–547, 2019, doi: 10.17705/1CAIS.04527.