Developing an Evaluation Framework for Blockchain in the Public Sector: The Example of the German Asylum Process

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ABSTRACT

The public sector presents several promising applications for blockchain technology. Global organizations and innovative ministries in countries such as Dubai, Sweden, Finland, the Netherlands, and Germany have recognized these potentials and have initiated projects to evaluate the adoption of blockchain technology. As these projects can have a far-reaching impact on crucial government services and processes, they should involve a particularly thorough evaluation. In this paper, we provide insights into the development of a framework to support such an evaluation for the German asylum process. We built this framework evolutionarily together with the Federal Office for Migration and Refugees. Its final version consists of three levels and eighteen categories of evaluation criteria across the technical, functional and legal domains and allows specifying use-case specific key performance indicators or knockout criteria.

Author Keywords

Blockchain; Public Sector; Migration; Asylum; Evaluation Criteria; Use Case Evaluation

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INTRODUCTION

With digitalization rapidly advancing, organizations both public and private increasingly face emerging digital technologies with the potential to improve their processes, products, and services. At the same time, these technologies can also disrupt current business models and change external expectations [7, 21, 43, 45]. One of these emerging technologies currently dominating public perception is blockchain [4, 23]. It first appeared as the technological backbone behind bitcoin [36]. Since then, blockchain has evolved rapidly, and 2nd generation blockchains such as Ethereum provide smart contract functionalities which enable considerably broader applications [5, 51]. These smart contracts, or "chain-code", allow embedding of executable logics on a blockchain [48, 51]. Exemplary applications of these 2nd generation blockchains include crowdfunding [45], supply chain processes and mechanisms [28, 35], security as well as privacy in the internet of things [12, 47], and the energy sector [30, 33]. Initiatives such as decentralized autonomous organizations (DAOs) take an even further step and leverage smart contracts to automate the organization's processual logic entirely [15]. Based on this increasing number of options, both academia and practitioners increasingly argue that blockchain could have a groundbreaking impact on society [4, 29, 37, 45].

Opinions on the merits of blockchain differ, however. Whereas some organizations worry about its effects, others consider it a promising IT infrastructure [14, 23, 45]. While this ambiguity effectively calls for guidelines on how to assess the impact of blockchain [43], research is still predominantly invested in exploring its theoretical foundations [3, 5, 45] and technological details [6, 11, 44]. In contrast, evaluation guidelines and criteria are only available for selected applications in the financial sector [19, 20], cryptocurrency security [13], social businesses (e.g., crowdlending) [45], logistics [35], or the evaluation of smart data projects [2].

For the public sector, however, such criteria and guidelines do not yet exist [17, 29, 41, 44]. Our research aims to fill this gap and support evaluation of potential use cases of blockchain technology in the public sector. We thus took an action design research (ADR) approach [46] to develop a blockchain use case (BUC) evaluation framework and validated it as part of a proof of concept project with the Federal Office for Migration and Refugees (Bundesamt für Migration und Flüchtlinge – BAMF). This project aims to evaluate the applicability of blockchain in the German asylum process.

We began our framework development by conducting a systematic literature review, following the methodology of Okoli and Schabram (2010), in the area of blockchain, emerging technologies, and evaluation criteria to derive valid ex-ante criteria [39]. Based on these criteria, we developed an ex-ante framework (i.e., the α-cycle of our ADR approach) which we validated in interviews and stakeholder workshops (i.e., the β-cycle of our ADR approach) to derive an ex-post framework of BUC evaluation criteria.

We acknowledge that these evaluation criteria present only a first step towards a general framework for the evaluation of blockchain technology in the public sector. Nevertheless, we are confident that they can support our BAMF use case and offer guidance for comparable use cases.

The remainder of this paper is structured as follows: First, we introduce blockchain technology, present selected examples of successful blockchain applications in asylum processes, and ultimately explain challenges in the German asylum process. After that, we explain our methodological approach. In the findings section, we describe the ex-ante framework, offer insights from the proof of concept project, and present the resulting ex-post framework. We also explain the identified criteria in detail. Finally, we discuss generalizability, rigor, and relevance of our findings, provide managerial implications, and offer an outline for further research.

THEORETICAL BACKGROUND

Blockchain

Satoshi Nakamoto introduced blockchain technology in 2008 to provide a distributed digital ledger for Bitcoin transactions [4, 5, 36]. Since 2008, global interest in blockchain has increased substantially, and many practitioners and researchers believe that it has the potential to change various industries radically [4]. As of 2018, blockchain has evolved into a multipurpose technology, and researchers and practitioners are exploring its applicability in many areas beyond cryptocurrencies [4].

A blockchain is a transparent, transactional, distributed database stored redundantly on the nodes of a peer-to-peer (P2P) network [22]. Research also describes it as an electronic registry for digital records, events, or transactions managed by the participants of a distributed computer network [45]. Blockchains store data in blocks with a chronological, structured order in which each block contains a reference to the previous block [18]. A so-called consensus algorithm run by selected or all participating nodes provides consistency and determines the correct order of the blocks (in the "chain") [22]. A large number of these consensus algorithms exist, and each of them provides slightly varying levels of security, latency, and energy consumption [9, 53]. Aside from their consensus mechanisms, blockchain systems also differ in their level of read/write permissions, centralization, and efficiency [9, 40, 53]. In general, blockchains emphasize data redundancy [42], use of cryptography [42] and consensus algorithms [18, 42], as well as decentralization [53] and auditability [53]. A more detailed description of these characteristics can be found, e.g., in [45]. Many blockchains also offer "smart contract" functionalities [17]. Smart contracts are "self-executing scripts" that incorporate exogenous effects or check exogenous conditions [9].

International Applications of Blockchain in Asylum Processes

Many ideas have emerged on how the public sector could capitalize on blockchain. The German Competence Center on Public IT ("Kompetenzzentrum Öffentliche IT") [50], for instance, expects promising potential in the context of:

- electronic parliamentary elections,
- cooperation between different administrations (i.e., digitization and acceleration of administrative processes),
- publicly managed registers and the administration of legal titles such as cadastral offices or land registers,
- integrity of data and documents (e.g., replacing the (digital) signature),
- origin of (pre-)products, and
- legally compliant inter-organizational collaboration.

Governments and international organizations have already begun to adopt blockchain technology, in particular, to support asylum processes. In Jordan, for example, the UN uses blockchain in a refugee camp to identify refugees unambiguously. Upon arrival, the camp's managing organization assigns and stores on a blockchain a unique refugee ID based on iris scans. The managing organization then couples the ID with a specific financial balance that allows refugees to purchase groceries in the camp's supermarket. The system has proven successful and has reduced identity fraud perceptibly [16, 24].

Finland similarly introduced a blockchain solution for refugees. As refugees often do not possess valid IDs, they cannot open bank accounts. The Finish blockchain solution provides such an ID to refugees and allows them to obtain

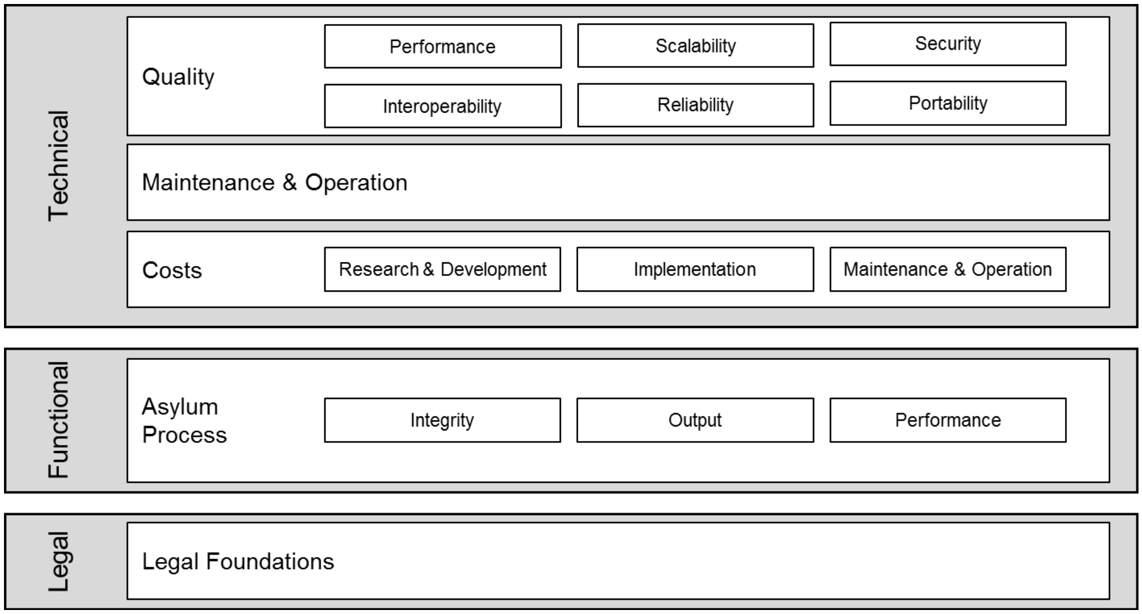

Figure 1. Evaluation Framework (Stage 1)

maestro cards linked to this ID. The card grants a certain degree of financial independence and serves both as a means of payment and as an identification instrument [31]. Moreover, Dubai considers a broad adoption for government services, including visa applications [10].

Challenges in the German Asylum Process

Ministries and organizations involved in the German asylum process face various challenges that present both opportunities and hurdles to the adoption of blockchain technology. Importantly, these organizations operate under a considerably stricter set of statutes and laws than private sector companies do. These laws effectively govern processes, responsibilities, and information exchange. They also change at frequent intervals and necessitate adjustments of processes and technologies supporting these processes. In federal systems, such as Germany, public sector organizations are also subject to different bodies of state and federal law. At the same time, proximity to lawmakers and frequent legal overhauls can present fertile opportunities to create a beneficial basis for the adoption of blockchain technology.

The involved organizations often operate different IT-systems with little mutual integration. They also partly rely on non-automated information exchange, even though considerable operational dependencies exist. This lack of integration can threaten process integrity and can lead to delays and errors. At the same time, it presents promising applications for technologies such as blockchain that can integrate various systems without requiring significant adjustments to legacy infrastructure. Process integration between these organizations is also often challenging due to separate jurisdictions. At the same time, the law requires that these organizations collaborate effectively. Hence, a technology that enables such cooperation offers essential benefits.

Table 1. Used literature for stage 1

Author(s)	Sector
Abramova and Böhme (2016) [1]	E-Commerce
Akoka and Comyn-Wattiau (2017) [2]	IT/IS
Brenig et al. (2016) [8]	IT/IS
Eskandari et al. (2015) [13]	Finance
Fridgen et al. (2018) [19]	Finance
Fridgen et al. (2018) [20]	Finance
Glaser (2017) [22]	IT/IS
Hyvärinen et al. (2017) [26]	Public Finance
Janze (2017) [27]	Publishing
Nærland et al. (2017) [35]	Logistics
Notheisen et al. (2017) [38]	Finance
Pilkington et al. (2017) [41]	Politics
Schweizer et al. (2017) [45]	Finance
Smith and Dhillon (2017) [47]	Law

METHODOLOGICAL APPROACH

Public sector organizations require suitable evaluation criteria to assess the benefits of different blockchain solutions for the asylum process. These criteria need to reflect all relevant technical aspects as well as functional (use case related) requirements. Moreover, the involved

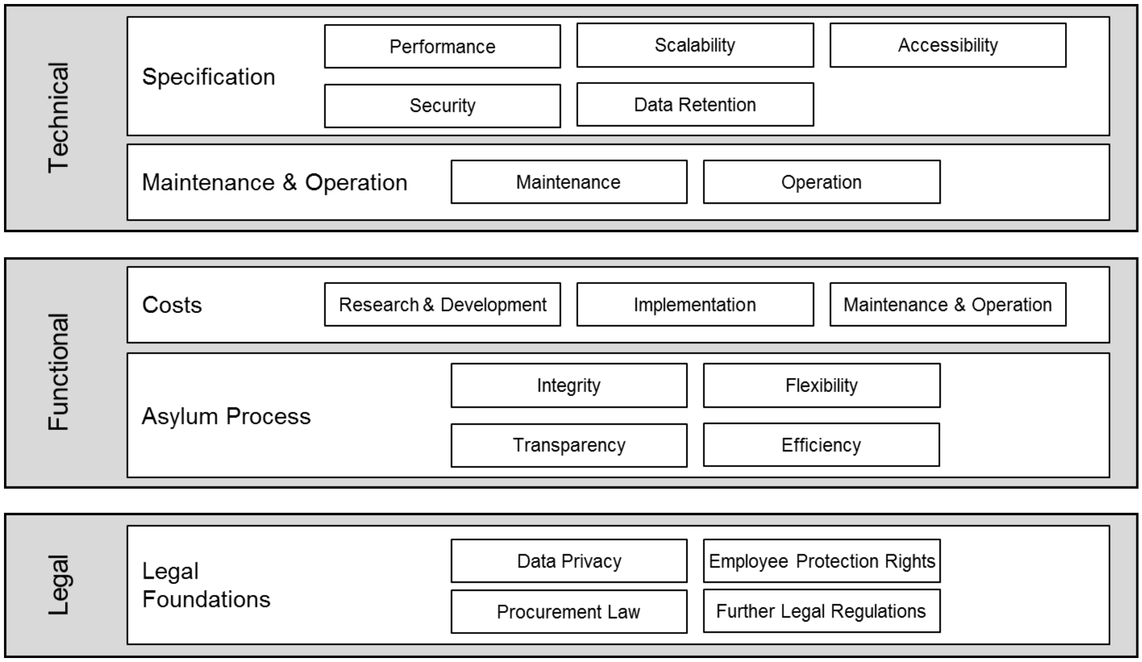

Figure 2. Evaluation Framework (Stage 3)

organizations must consider legal frameworks and statutes. To derive such evaluation criteria, we followed an ADR approach and a pragmatist paradigm, meaning that we co-developed our criteria with asylum process experts and stakeholders. To ground our evaluation framework, we followed the guidelines of Webster and Watson (2002) [49] and first conducted a systematic literature review [39]. To increase the reliability of this review, we did a structured database search. Our all fields search of the search terms blockchain AND (criteri* OR evaluat*) in the AIS Electronic Library (AISeL) yielded 51 hits. Further in-depth screening reduced this number to 14. Solely screening abstracts was not sufficient, however, as none of the papers in the AISeL embraced the aforementioned combination of search terms within their title, abstract, or keywords. With a forward search [49], we additionally identified five papers. Table 1 presents an overview of the papers we used to develop the first draft of the ex-ante framework.

As a parallel initial step, we followed the blockchain use case development (BUD) method of Fridgen et al. (2018) to derive a suitable BUC [18]. The BUD method stipulates that organizations follow six steps, from ideation methods to the conceptual phase before prototyping begins, to generate BUCs. Organizations should perform these steps within one-day or two-day workshops. After the first step, we developed an initial ex-ante framework. We frequently challenged our BUC evaluation criteria according to our ADR approach [46]. ADR consists of several iteration loops – mainly the α- and β-Cycle. The α-Cycle serves to develop a robust ex-ante framework while simultaneously integrating user feedback. In the α-Cycle of the ADR approach, we enhanced and validated our findings through semi-structured interviews [34]. The β-Cycle serves to validate the ex-ante framework. Hevner et al. (2004) recommend that researchers follow design science approaches to derive insights that allow generalization of their work [25]. Sein et al. (2011) extend this recommendation to the ADR approach by introducing a so-called β-Cycle that tests and improves the results of the α-Cycle using several novel sources of evidence [46]. Consequently, we added a β-Cycle consisting of two separate loops for which we conducted additional interviews, held further workshops and added participant observation [52]. The workshops helped us to understand the nature of BUCs in the asylum process better. We aligned those insights by pragmatically applying them within the project (i.e., we added participant observation). Thereby, we validated the ex-ante framework a first time. As we found new criteria in this first loop, we conducted a second β-Cycle consisting of additional workshops. These workshops verified the framework from the first loop as they confirmed all criteria and only suggested marginal adjustments.

FINDINGS: EX-ANTE CRITERIA, EVALUATION & EX-POST CRITERIA

As indicated in the previous sections, we developed our evaluation criteria in three stages.

Stage 1: In a first step, we selected a preliminary set of blockchain evaluation criteria from prior scientific (e.g., [13, 45]) and practical literature (e.g., [32]). This preliminary set already included three levels (domain, subdomain, and category – see Figure 1). At the highest level, we differentiated between the three domains “technical”, “functional”, and “legal”. We divided the technical domain into three subdomains (quality, maintenance & operation, and costs). On the third level, the subdomain “quality” had six categories (performance, interoperability, scalability, reliability, security, and portability). The quality subdomain included essential technical design aspects: IT security (reliability and security), transaction duration (performance), and the interaction of the blockchain solution with existing systems (interoperability and portability). Importantly, it also considered how a blockchain solution would perform if extended from a small prototype to a large-scale operational system (scalability). We did not divide the maintenance & operation subdomain into smaller categories. It considered whether 'non-specialized' employees could maintain and operate the blockchain system. We further divided the subdomain costs into three categories (research and development, implementation, maintenance & operation). We split the functional domain into the three categories "integrity", "output", and "performance". We did not subdivide the domain legal and only included a category "legal foundation(s)". It summarized all legal framework conditions that affect the feasibility of the blockchain.

Stage 2: After deriving our ex-ante set of evaluation criteria, we discussed our framework with experts and stakeholders in the Federal Office for Migration and Refugees. In particular, we used interviews and hosted interactive workshops to gather feedback from all relevant stakeholders (technical, functional, and legal). Stage 2 resulted in several changes to our framework (see figure 2). While the three domains (technical, functional, and legal) remained unchanged, we reduced the number of technical subdomains to two. Additionally, we shifted the subdomain costs to the functional domain. The costs of implementation strongly depend on the pre-existing infrastructure and therefore explicitly belong to the specific BUC. Also, the number and complexity of the blockchain applications that organizations need to develop strongly relate to the particular BUC. Given the changes in the subdomain "quality", we decided to rename it "specification". On the third level, the subdomain "specification" then included only four categories namely "performance", "scalability", "security", and "data retention" (new category). We also included "reliability" in security. Finally, we shifted "interoperability" and "portability" to the functional domain. Furthermore, we divided the subdomain "maintenance & operation" into two categories "maintenance" and "operation". As already mentioned, we shifted the subdomain "costs" to the functional domain. Therefore, the functional domain then included two subdomains (costs and asylum process). All cost categories remained unchanged, but we defined changes to the asylum process subdomain. The category "integrity" remained unchanged, but we renamed "performance" into "efficiency". Furthermore, we added two new categories ("flexibility" and "transparency"). These categories are important to evaluate whether a blockchain can serve different instances of the asylum process and whether it is possible to track the current process status. Finally, we divided the subdomain "legal foundation" respectively the legal domain into three categories (data privacy, employee protection rights, and further legal regulations).

Stage 3: After the first round of evaluations (stage 2), we held another interactive workshop with BAMF stakeholders from various departments. This workshop resulted only in minor adjustments and additions to the framework (see figure 3). We added the category "accessibility" to the subdomain specification. Accessibility is an essential feature in the public sector and guarantees that hearing and visually impaired persons can use information and IT system. Another essential requirement for software procurement in the public sector is the observance of competitive tenders. Therefore, we added the category "procurement law" to the legal domain. The functional domain remained unchanged.

DISCUSSION

Theoretical Contribution

This paper makes three theoretical contributions. First, we present insights from developing a framework to evaluate the applicability of blockchain along the German asylum process. Using semi-structured interviews, interactive workshops, and participant observation, we developed our framework in an evolutionary process. The final framework considers three primary domains, namely technical, functional, and legal. While the technical domain covers general technical aspects, the functional and legal domain relate to the investigated use case (i.e., asylum process). The final framework divides these domains into five subdomains that again group into 18 categories. Second, this paper provides a structured overview of BUC evaluation criteria. Although these criteria do not yet allow assessing BUCs in the true sense, they present a solid basis for the development of a key performance indicator system. Third, we enhance knowledge at the cutting edge of blockchain, prototype evaluation, and e-government (i.e., digitalization of the public sector) as well as refugee politics. Prior work provides helpful insights into how to define BUCs, into how to implement blockchain prototypes, or how to introduce and operate blockchain solutions in private and less in public sector. However, to the best of our knowledge, there is no work on how to evaluate the benefit of future blockchain solutions in a structured way. Therefore, this framework creates a new value in this field of research.

Limitations and Future Research

Naturally, our framework has its limitations. Importantly, we only identified categories of evaluation criteria. For a rating of these criteria, however, future research must specify these criteria in more detail. Alternatively, an extended framework would have to include defined key figures. We are currently working on this step and are identifying key figures, such as the number of (active) users or the bandwidth of the network, and their effects on the categories. The second limitation is that our present framework weighs each domain, subdomain, and category equally. In reality, however, some factors outweigh others, and especially legal requirements present knockout criteria. Moreover, public sector organizations generally do not seek to maximize profit (e.g., by reducing staff) but to maintain jobs or create new ones. Therefore, public sector adopters must consider and weigh highly social aspects that we included in the employee protection rights category. For further research, we plan to extend our framework with weights for each category, subdomain, and domain as provided by experts. Ultimately, we also only investigated a single use case. To validate and generalize our framework, future research must examine additional BUCs. Exemplary, we recommend studying inter-organizational processes in integrating new citizens (i.e., the processes following a completed asylum and naturalization process).

Conclusion

From our evaluation, we conclude that technical, functional, and legal aspects play an equally important role. Overall, this paper is a first step in developing a general framework for the evaluation of blockchain uses cases. This preliminary version supports decision makers in the public sector and offers essential managerial implications.

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