Blockchain Mirage or Silver Bullet? A Requirements-driven Comparative Analysis of Business and Developers' Perceptions in the Accountancy Domain

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Abstract

Over the last decade, blockchain has gained popularity and researchers, as well as companies, are investigating new fields that could be impacted by blockchain technology. Among them, accounting has been identified as a promising field, as blockchain is said to bring trust and transparency to data, as well as tamper-resistance. However, there might be some issues in the adoption of such a new technology, for instance for misunderstanding the goals of using blockchain based accounting systems. Hence, the goal of this exploratory paper is to investigate, based on the question of whether blockchain will impact accounting, the differences in the developers and accountants mental models, and to identify goals and high level requirements for blockchain-based accounting software. For this, we used semi-structured interviews, concept analysis and goal based requirement engineering, on the concepts related to transparency and trust, on blockchain potential and challenges. Even though further research is needed, our results highlight that accounting is a socio-technical field, and that blockchain will shift the conception of trust and transparency, but not completely revolutionize the field, rather make it evolve.

Keywords: Blockchain, Accounting, Mental Models, Requirements, Software Engineering

1 Introduction and Related Work

Blockchain has become an important theme in scientific research and public discourse since the implementation of Bitcoin in 2009 [53]. Since then, its applicability to different areas apart from cryptocurrencies has been tested, including finance [72], healthcare [2] and more. In [45] the author shows that blockchain is a top priority for more than 52% of the companies. However, elements such as regulation or supply chain are still concerns for organizations [8].

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It has been suggested in mainstream media that blockchain can solve the issues of trust, transparency, privacy among others [19, 71]. However, most of these claims seem to be a by-product of the tamper-resistant nature of blockchain, and little evidence support them. Furthermore, given that blockchain usually do not have a central authority -such as banks- and that every node can have a copy of the ledger, the technology has been portrayed as being trust-less.

However, these remarks mostly come from technical companies, rather than from companies for which these topics are primordial, such as accounting. Hence, there seems to be a discrepancy between technical and accounting people on the question of whether blockchain can be a valuable asset in the field of accounting. This discrepancy can originate from different points: accountants are not (yet) aware of blockchain and its potential, technical people have an incorrect or incomplete view of the field of accounting, blockchain is either hyped or criticized as it might change the current state of accounting, or a mix of all these reasons.

We investigate the gap between accountants and blockchain developers on the impact that blockchain technology might have on accounting. Accounting has been chosen as the field of study, as at a first glance, it is intrinsically related to trust and transparency, and has been identified as a field that could be deeply impacted by blockchain. For instance, by allowing real-time accounting [78, 14, 27], or even by automating the job [18]. In order to investigate the gap between developers and accountants, we aim to address three questions:

- is there a divergence in the mental models of trust and transparency between blockchain developers and accountants?
- how are blockchain applications effects perceived in the accounting domain?
- discover the requirements that blockchain applications should include for adoption by accountancy?

As a matter of fact, new technology adoption is highly correlated with the technology perceived value [40]: if the user thinks that the software is not adapted, they are less likely to continue using it. As such, it is critical for blockchain developers to understand accountants requirements in order to create a good blockchain based accounting software. The requirements can be partially derived from users mental models [46], however developers might have a different model, thus altering the retention rate.

Thus, we intend to bring together and compare the vision of two different worlds on the same technology and the concepts of transparency and trust, to explore their resemblances and differences in perceptions, and to specify what requirements are essential for developing a blockchain based software for accounting. As such, our paper has an interdisciplinary focus, and intends to bring together to areas that are usually not studied together.

Our hypothesis is that, if blockchain systems requirements are properly elicited, modeled and specified, a blockchain infrastructure - even with its disadvantages - can act as a support for accountants and auditors. Blockchain can help accountants and auditors as a tool, in different areas such, as sampling, checking the accounts entries metadata, among others. However, because the domain of accounting mostly relies on human processing for entering data, it is a reasonable assumption that any blockchain based accounting solution will not be able to tackle all of the mistakes, such as human mistakes in the entries or the data interpretation in a financial report. The preliminary findings of this article supports this hypothesis.

This article is an extended and revisited version of an article which the authors published at ARES 2020 Conference, at the Interdisciplinary Workshop on Privacy and Trust [25]. In this version, we fully reorganized the introduction, we added a section on what is a blockchain and a smart contract (Section 2.3), and more importantly we added a whole section, in Section 5.4, introducing a formal model of requirements for building an accounting application based on blockchain. The additional methodology for this new section has been documented in Section 3. We also give additional clarifications on the goal of our interview questions (Table 1), as well as some details about obfuscation in Section 2.4.

Related work. While literature on blockchain for accounting is starting to appear [60, 41, 9], it mostly focuses on the potential and implementation of such solutions. However, in order to avoid any surprises in the adoption of any new technology, it might be interesting to look into the requirements of the target public for such systems. In this context, it means examining accountants' mental model of their job, and how it compares to developers mental model to see if a naively developed system would be greeted with enthusiasm or skepticism. New technology adoption has been modeled [21], but from a very theoretical point of view, and not taking into account human factors such as confidence in the innovation.

As far as we are aware, our paper is the first contribution in the field of systematic comparison between the users' (here, the accountants) and the developers for a blockchain-related product. As such, the results presented here do not pretend to carry definitive results, but rather preliminary results. We believe that our research can be of interest for future development of blockchain systems, as the product owner stakes and interests must be comprehended in order to deliver a meaningful product, thus increasing its chances of adoption.

Paper organization. We present our work as follows. In Section 2, we give a formal definition of the concepts that we use throughout the paper. Then, we expose our methodology: the questions we designed and why we chose them, and the interviews format. In Section 4, we present and analyze our results, and in a last section, we conclude our work and briefly discuss the limits of our work.

2 Background

We start by defining the main properties that offer a blockchain, then we explain how blockchain and smart contracts work and how trust and transparency are two important properties of such tools.

2.1 Transparency

While being, at a first glance, a simple concept, there is no single agreed definition of transparency in academia. However, there is a large amount of research on the topic, its meaning and operationalization has not yet reached consensus in the literature [65, 50]. One of the issues preventing consensus is that the concept of transparency encompasses too many different conceptualizations, and as such has fallen into conceptual stretching [50, 5, 63]. We thus present clearly the definition we use in our work.

First of all, even though there is no global consensus, there is however unanimity that transparency is related to information and its disclosure. In different spoken languages, transparency defines the fact that an item can be "*seen through*". Taking into account these two definitions, one can conclude that, at its bare minimum, transparency is about disclosure, or access, to information [65, 50, 5, 3].

Note that information availability, in itself and without an objective, context or substance, is not sufficient to guarantee inferability about the related objects. In short, information availability does not necessarily allow to "*see through*". This limitation has pushed various authors to propose another key variable for transparency, namely, information quality [65, 50, 36, 55]. Notably, [65] identifies a gap in research on canonical definition of information quality, because many academics disagree on whether the concept is related to disclosure, clarity, or accuracy of information.

From these observations, we then propose the concept of transparency that we use throughout this paper. Our definition relies on a "a three-dimensional model of transparency" that identifies it as a "perception of the quality of intentionally shared information from a sender and emphasizes that transparency is a function of information disclosure, clarity and accuracy" [65]. In this context, disclosure means that the information available is relevant and shared in a timely way [65], available and accessible [36, 50]. Clarity is defined as allowing for information inferrability [50, 36], that the receiver can comprehend [65] without the use of industry terms [55], while still being understandable (McGaughey, 2002 in [65]). Finally, the concept of accuracy is defined as information reliability, meaning it that the information has not been tampered [65, 36].

We believe that this definition of transparency and the related sub-terms is wide enough for a general use, but avoids the trap of concept stretching [63]. Furthermore, this definition allows us to clearly how transparency is used and perceived in both accounting and blockchain, as the definition focuses on the information rather than how and by whom information is distributed.

On a final note, we observe that the concepts mentioned (and defined) in this section are, in their core, intrinsically related to the IFRS's CC5 and CC19 (standards in the accounting field) definitions of relevance, faithful representation, comparability, verifiability, opportunity and comprehensibility [39]. We did not use the IFRS definitions, as our work is not limited to the field of accounting, but also includes the field of blockchain. As such, limiting ourselves to the IFRS definition framework might cause some issues when dealing with the technological applications.

2.2 Trust

In the same way, trust is a concept which is not easy to define [31], and various definitions exist throughout the literature [44]. Moreover, many of these rely on specific empirical testing rather than conceptual analysis [49].

It can be noted that, in a lot of cases, trust is defined as "a psychological state compromising the intention to accept vulnerability based upon positive expectations of the intention of the behavior of another" [17, 11]. Another approach [73] offers the following definition: "the adoption of a belief by one party in a relationship that the other party will not act against his own interests… with the absence of detailed information about the actions of the other party". This definition is the result of a careful examination of the relationship between accounting information and trust, in inter-organizational environments. Finally [54] defines trust as "social and constitutive expectations common to all exchange participants and consists of process based, character based, and institutional based".

In the same line, Giddens has extensively written on the domain of system trust [33, 34]. In these works, the main characteristic that distinguishes trust is the lack of information about something. Consequently the entity (let it be a person, an organization, system) must rely that the outcome or events to follow, will develop correctly. In simpler words, in a scenario with limited information, it is the degree of confidence or faith an entity has in that something will evolve as expected.

It then been suggested by [37] that blockchain is a trust-free technology, considering that all the information is in the chain. However, this design isn't always the case, as there can be information obfuscation or some critical information can be off-chain. In addition, [47] and [30] have challenge the idea that blockchains are trust-free.

Other areas of knowledge have different ideas of what trust is. In computer security, there is a concept of "honest user" and "trusted parties", who always follow exactly the protocol specifications, without trying to gain or retain information from the protocol that they are not supposed to have [16]. This mental model does not consider information as a variable, but does focus on rules and outcomes. In cryptography, it is common that protocols are created taking into account trust issues.

2.3 Blockchain and smart contracts

A blockchain is a decentralised data structure, with flat hierarchy. This means that several copies of the same blockchain are operating at the same time, and need to be constantly synchronised. However, the flat hierachy implies that no copy has authority over the other copies: the instances running the copies (the nodes) must agree on the current state, with what is called a consensus mechanism.

Consensus algorithms have been thoroughly studied in the past [42]. In a decentralised system, a consensus algorithm ensures that the data stays coherent, and as such prevents possible attacks such as double spending - in which the attacker manages to spend twice the same token, by making each victim believe they are the sole new owner of the said token [12]. In Bitcoin [53], the consensus relies on a proof of work [23], which basically proves that each new block has costed its crafter some amount of computing power. In order to modify this block, an attacker must spend at least as much ressources.

As such, Bitcoin is protected against history rewriting by the proof of work: in order to rewrite blocks of history, an attacker must compute blocks faster than the rest of the network – including other attackers. For an attack to succeed against Proof-of-work blockchains, the attacker must dispose of at least 50% of the network computing power. Which is unthinkable for bitcoin, but much easier for smaller blockchains [13]. Hence, blockchain can be described as a tamper-resistant append only data structure.

On top of the data structure, it has been suggested –and implemented– an automatic processing of the data written in the blockchain. Smart contracts were first described by Szabo [70] in 1996, then implemented in blockchain by Ethereum [76]. A smart contract is a piece of code written on the blockchain, which can be triggered by a special transaction. It can interact with the blockchain data, create new transactions, and as such alter the state of the blockchain.

2.4 Trust and Transparency in Smart Contracts

Thanks to the replicability property of smart contracts, one does not need to trust that another party has correctly executed a piece of code. Moreover, in most blockchains, the smart contract source code is also publicly available on the blockchain. As such, the verifier can not only attest the good execution, but also the correctness of a smart contract. This is the main reason why smart contracts are pushed by some authors as a solution for increasing transparency in many applications, ranging from notary to finance, or even gaming [29, 24].

Even though the verifiability is indeed hard to dispute, we argue that having the source code of a smart contract does not necessarily ensure its correctness to external specificaitons, which in its turn voids the accuracy properties. For instance, classic computer science results have determined that no algorithm can check the correctness of any smart contract (or more generally of any piece of code) [74, 62]. Hence, a smart contract must often be verified by hand, and one must look for one of the three possibilities of incorrect execution: a malicious payload, a genuine bug, or a correct smart contract, but following bad or ambiguous specifications.

Malicious smart contracts are, it seems, in their very early days, as limited literature talks about the topic [26], but we believe these attacks will grow in frequency. As a matter of fact, malicious software is common in the open-source community, especially in open-source libraries [51, 1, 10, 57, 80, 75]. Sometimes, the vulnerability might avoid detection even by a trained eye, for instance if it implies a mathematical weakness. For instance, the cryptosystem DUAL_EC_DRBG is widely believed [7] to embed such a vulnerability, so that the NSA could efforlessly spy on anyone using that scheme. Bugs in a code sometimes lead to dramatic consequences, such as, in 2014, the undetectable Heartbleed attack [22] which allowed an attacker to completely bypass any SSL (HTTPS) encryption. This kind of situation also happened in the world of blockchain, with the DAO hack, causing a loss of 3 million Ether (then worth 54 millions euros) [20].

Furthermore, even though most current smart contracts can be easily understood by a programmer, it is possible to obfuscate code, thus hiding its inner logic. Code obfuscation is an active field of research in cryptography. It is interesting to note that perfect obfuscation cannot be reached [4], notably because some programs such as quines (programs which, upon execution, print their own source code) cannot be obfuscated in any way. However, a new notion of indistinguishability obfuscation (iO) has been proposed [4], which is satisfying for most practical cases. However, for the moment no primitive is known to guarantee iO, even though some candidates are under scrutiny [32].

Looking back at our transparency definition, we conclude that obfbuscated code is not transparent, as the clarity (or inferrability) of the smart contract is missing. Given that smart contract reverse engineering is already an activity in some contests [38], we conclude that even smart contracts can be obscure by design.

Similarly, information disclosure can be lowered to its strict minimum thanks to zero-knowledge (ZK) cryptography. For instance, ZCash [64] is a blockchain-based cryptocurrency in which every transaction can be ZK: the public disclosure is that a payment of an unknown amount has been made between two undsclosed users, and that the payment is valid. While we get accuracy (everyone can verify the validity of the payment with the attacked ZK proof), there is little to none information disclosure. Furthermore, there is no clarity either, as ZK proofs are not human readable, as they rely on complicated mathematical problems. As a matter of fact, trust in this systems can also be penalized by the structural lack of information disclosure. Last year, the ZCash team disclosed [69] that they fixed a bug in their code that allowed malicious users to generate infinite amounts of money. Because the blockchain is zero-knowledge, the authors acknowledge that there is no way of knowing whether this vulnerability has been exploited.

Therefore, we see that transparency in code is not an immediate consequence of open-source algorithms, even for smart contracts. It remains an open question on what properties could make a smart contract considered ‘trustless’, with work initiated on the topic by [30]. For instance, they discuss about how the execution flow must be protected, what guarantees must be held to certify integrity over time, and so on.

3 Methodology

In the previous sections we tried to explore which variables were part of transparency and trust, and narrow down a definition for both concepts. These values tend to have big extension, thus losing their intention [63], allowing them to travel more than necessary, risking to become buzzwords [61, 6]. As this is an exploratory study, qualitative research with a grounded theory approach was deemed the best approach.

In the field of grounded theory, the theoretical sensitivity (following [67] remarks) is obtained through literature reviews, professional experience and analytic processes. Consequently, we first reviewed - before the interviews- the literature on transparency, trust and accounting and security in smart contracts.

Our two study groups are chartered accountants and blockchain developers and our sample size is of 13 chartered accountants and 14 blockchain developers. Inside each group, the subjects had different levels of experience, which we divided into junior, mid-level and senior level based on their own perception for more diversity in our sample. In addition, our sample from accountants include accountants from different sectors, such as financial or forensics[1]. From a developer's perspective, there is a lack of blockchain developers and thus, in order to reach a saturation level as satisfactory as possible, and compensate for variability due to low amounts of interviewees, project managers (PM) and security professors (prof.)

[1] This implies a trade-off that gives us a better insight and saturation [67, 56] on the accountant group's mental model towards the subject of study at the expense of explanatory power.

working on blockchain were also interviewed. It is a possibility that both of these additions might have impacts in our results.

The interview questions were specifically conceived so that their bias would be minimal, as in not suggesting any specific expected answer to the question. Both groups were asked the same seven question and for developers we asked two more questions. The questions can be read in the Table 1. When interviewees were invited to the study, they were told we were looking for subjects for a study about the relationship between accounting and blockchain before they accepted to participate. If they accepted, we would schedule a meeting. Given that these research was partially done through confinement, more than half of these interviews were carried out through video conferences. Once the interview started, the subjects were explained the objective of the research, that there were no right or wrong answers, their rights, that we would record the interview and to sign a consent form. If they asked questions about blockchain or accounting, we told them we would answer them at the end of the interview. We decided not to debrief them on these subjects, as this could affect our results. We recorded the interviews and a special attention was made to not influence the interviewees answers in a way or another, nor make them feel uncomfortable while answering [43]. Finally, no compensation was given for participating in the study. The data was gathered through semi-structured interview, using theoretical sampling method. This methods implies that “researchers seek and sample data that informs their theoretical categories” [68, p. 375]. “Theoretical sampling is a tool that allows the researcher to generate theoretical insights by drawing on comparisons among samples of data” [35, p.874].

We decided to gather out data through interviews, as it is a method that can give a good insight on the mental models of transparency and trust. It is also a well used method in requirement engineering for electing requirements, specially for requirements that are not well understood and where the stakeholders might want to give their opinion [58]. Thus, in order to identify the common elements of the different mental models and compare them, we followed semi-structured interviews. This implies that all interviewees were asked the same question in the same order, however if interesting elements appeared through the interview, we would further inquiry about it. Furthermore, as one of our research objectives is to discover what are the perceptions of the perceived effects of blockchain in accounting, the goals of using a blockchain based accounting system from the accountants views and a first round of requirements, we required the interviewees to express their opinions freely and without constraints. Consequently, a survey would limit their ability for this and our research could lose fundamental data. Finally, the article is a preliminary research, given that there is a gap in the literature about the subject particularly from an interdisciplinary perspective, therefore we were missing data for carrying out quantitative research.

After the interviews were finished, they were transcribed and anonymized. The anonymization prevents analysis bias. Transcript analysis was carried by two of the authors, who identified main keywords, concepts, messages, evoked in each interview. These keywords have been fed to the NVivo software. To analyze the data, we used the 3 stages of coding identified in grounded theory [67]. Firstly, we did the open coding process, which implies we kept a open mind regarding the concepts that the interviewees used and we were constantly comparing the transcripts with the other transcripts. Our guiding questions for this process were: What are the main ideas of these phrase? What is the interviewee trying to say here? What does it mean when referring to - for example - transparency and what does it imply? Is it possible to break up in more concept what the interviewee is saying? In detail, as outlined by Scott and Usher [66, p. 89] we are utilizing coding and classifying our interview transcripts by inferring concept’s significance, patterns and repetitions that develop.

We then proceeded to the second stage of coding, axial coding, were we combine and categorize the codes we identified. For example, “transparency” can be categorize as a higher level code, which can be decomposed on codes such as “see through”, “see everything”, “clear”. Then we make these patterns explicit and we elaborate a set of categories that hold firm in the setting being examined; the third stage - selective coding - of grounded theory method of coding approach by [67]. We relate how the informant’s

Question	Goal of the question
What is your definition of trust?	Discover the definition of trust of the intervewees. Furthermore, it gives us insight of the attitude of the respondants towards this issue.
"Blockchain isn't the end of trust, it is the future of trust". What is your opinion on that phrase?	Further eliciting the definition of trust of respondants, in an indirect way. At the same time, we can also start gathering the perception on how blockchain might affect trust.
What is the link between blockchain and trust?	Understand directly if intervewees perceived there will be a change in the concept of trust due to blockchain.
What issues can blockchain address? How and why?	Gather what are the areas or challenges that interviewees think blockchain might address, either in a positive or negative fashion.
What does the word transparency mean to you?	Same as first question, this time for transparency.
Do you think blockchain will affect accounting? Why? How?	Gather how accountants percieve blockchain in accounting and what are expecting from blockchain systems (goals)
What are the problems that blockchain could address in the field of accounting? How?	Identify the perceptions of stakeholders of areas where blockchain could be useful and as a byproduct, how could blockchain impact these areas .
What has been your experience with non-blockchain people, when implementing blockchain systems? (devs only)	Discover possible challenges when building blockchain system.
What have been your problems when implementing blockchain systems? (devs only)	Discover what are the current issues when building the blockchain system, extrapolate them to accounting system. Reinforcement of the previous question.

Table 1: Questions asked to interviewees, and the motivation behind each question.

terms associate to the theoretical ideas that we have developed, and how the same categories (for example transparency) have different codes between accountants and blockchain developers, affecting their mental model. The specialized software used helped us carry out the two last steps.

Finally, we used different techniques to identify high level goals and a some requirements from accountants for blockchain systems. Based on the analysis carried out for mental models and impacts on accounting, we also identify goals that are important for accountants that a blockchain system should achieve. Goals were identified if such topic was recurrent throughout the answers of the accountants; that's to say, more than a couple of accountants should mention the topic in their answers.

We then proceeded to map the accountant's job, goals, decomposition of the goals and their dependencies using the i* 2.0 framework [15]. The i* 2.0 is an evolution of the i* [79] presented by Yu in the late 90's. i* is a goal-oriented technique [52] widely accepted by the requirements engineering domain. i* focuses in the intentionality of stakeholders and it is based on actors. It constitutes on goals, softgoals, resources and tasks, and seeks to model the dependency between actors and the intentionality of stakeholders. The two main models that works with are the Strategic Dependency (SD) and Strategic Rationale (SR) [79]. The SD models the dependencies - or better the "intentional dependencies" - between actors (depender and dependee) , that allow the requirement engineering understand better the whys of a system and it's requirements[79]. The second model is the SR, not only maps the external dependencies between the actors, but also the internal intentions, what are the actors' intentions, goals and "how they might be met" [79]. This framework is specially useful for early phases of requirement engineering, which is this research situation.

In addition, we elicit some early high level requirements, which are expressed in the EARS framework [48]. EARS is a natural language based boilerplate for writing requirements, in an easy manner. Although writing requirements in natural language has disadvantages [58], by constraining the language to a set of specific words in English that helps write requirements in an easy way. The logic behind this idea, is that requirements can be categorized into 5 different classes: "Event-driven, State-driven, Ubiquitous, Unwanted behaviors and Optional features" [48]. Consequently, the EARS framework proposes that most requirements can be easily written under their scheme, in natural-language, which is suitable

Interviewee	Source	Length	Interviewee	Source	Length
Developer 1 and PM	Sample frame	25 mins	Accountant 1	Sample frame	17 mins
Developer 2	Sample frame	22 mins	Accountant 2 and prof.	Sample frame	35 mins
Developer 3 and PM	Sample frame	29 mins	Accountant 3	Sample frame	28 mins
Developer 4	Sample frame	24 mins	Accountant 4 and prof.	Sample frame	21 mins
Developer 5 and PM	Sample frame	27 mins	Accountant 5	Sample frame	26 mins
Developer 6 and prof.	Sample frame	20 mins	Accountant 6	Sample frame	37 mins
Developer 7 and postdoc	Referred by Dev. 6	25 mins	Accountants 7 and 8	Sample frame	23 mins
Developer 8	Sample frame	12 mins	Accountant 9	Sample frame	13 mins
Developer 9	Sample frame	21 mins	Accountant 10	Sample frame	13 mins
Developer 10	Sample frame	20 mins	Accountant 11	Sample frame	18 mins
Developer 11	Sample frame	20 mins	Accountant 12	Referred by Acct. 11	15 mins
Developer 12	Sample frame	15 mins	Accountant 13	Referred by Acct. 11	8 mins
Developer 13	Sample frame	43 mins			
Developer 14	Sample frame	17 mins			
Developer 15	Sample frame	Refused			

Table 3: Interview details of developers and accountants, with their experience. Accountants 7 and 8 were answering together. PM means the subject is also a project manager, prof. stands for professor, postdoc for postdoctoral student. Developer #15 declined to answer.

if they are high level requirements from stakeholders.

We have chosen the EARS framework, as our work aims to a broader audience apart from requirement engineers and thus can be read by English speakers. Although using a specific and formalized language for modeling requirements could help with ambiguity and more precise understanding of requirements, this research aims at identifying initial high level stakeholder's requirements. Thus, using a specialized language create a language barrier [48].

Furthermore, in order to give less ambiguity to the identify requirements, we have modeled the goals of auditors - our stakeholder of interest - in i* 2.0 framework.

4 Interview results

From December 2019 to April 2020, we carried 27 interviews, a summary of the repartition can be found in Table 3. From the transcripts, we then realized the word coding with NVivo[2]: first an open coding, which then was processed into an axial coding. A summary of the results of axial coding can be found in Table 2. In the process of axial coding, we observed that accountants were often using the same terms when talking about transparency and trust, whereas blockchain developers had more divergent codes.

Topic	Sub-topic	Accountants	Developers
Transparency	Information accuracy	9	6
	Information clarity	11	6
	Information disclosure	12	5
	Technical aspects	2	6
	Trust & transparency	5	6
Trust	Accuracy	6	3
	Reliability	10	8
	Human vs Computer trust	1	11
	History	3	5
Trust and blockchain	New form of trust	1	7
	Improves trust	7	2
	Trust more efficient or transparent	3	5
	Decentralization	1	11
Blockchain effects on accounting	Automatization	0	7
	Efficiency and speed	4	4
	Availability, reliability	7	4
	Elimination of middle-man	0	7
	Real time accounting	4	3
	Trust shift to technology	5	3
	Tamper-proof	4	3
	Tool	9	7
	Traceability	9	4

Table 2: For each code, the number of accountants and developers who evoked the said code. We had 14 developers and 13 accountants.

[2]https://www.qsrinternational.com/nvivo-qualitative-data-analysis-software/home

We now present over results. Because this study is preliminary, and because of the variety of codes used by our interviewees, it is not possible to succinctly report and analyze all the highlights of this study. Instead, we chose to focus on the most significant ones, that are presented in the next sections. A simplified mind model map, summarizing our findings, can be found in Figure 1, page 97.

4.1 Trust

Accountants. When they were asked for their definition of trust, accountants were prone to give elaborated descriptions, saying trust was a process-oriented concept, that evolves with the client, market or organization. For them, one cannot quantify trust, as it is a qualitative concept, related to the actor reputation, and the accuracy of the information. Most common codes were first *reliability*, as expressed by 10 accountants, and that they define as having expectation from other actors actions, reputation. Second came the code *accuracy* (6 accountants), that they defined as having complete accurate or truthful information, that follows standards (i.e., the data provided a good representation of the organization). The third most common code, identified by 3 accountants, was the importance of the history of the previous interactions with the other actor.

Other codes, not mentioned by more than one accountant, were traceability, difference between humans and computer trust and action delegation.

When asked about a possible relationship between trust and blockchain, accountants #6, #10 and #13 could not see any relation. On the 10 other answers, 7 said they viewed blockchain as a way of improving trust. Their motivation for saying so is that the tamper-proof nature of blockchain, along with data traceability, were playing a key role in this increase of trust. However, 3 accountants precised that at the time of the interview, they did not trust the blockchain technology, and that they would wait for adoption by influential companies for giving it trust. We observe that this statement matches our definition of trust and reliability.

On a different topic, 3 accountants said they think blockchain can improve the transparency or efficiency of trust, as they have access to the history of data, giving tamperproof and accuracy guarantees. Once again, we observe a close intersection between these arguments and our definition of transparency.

Developers. On the other hand, we giving their personal definition of trust, 12 out of the 14 developers we interviewed conceptually differentiated trust in a person and trust in a system (see Table 2). When defining trust in a person, they gave a similar answer than the one given by accountants, with the other actor reliability being a predominant concern (mentioned by 8 developers), as well as historical experience (mentioned by 5).

However, the developers' concept of reliability differs from the accountants', as developers often link reliability to a system property rather than a participant property. While they agree on checking the source of data, they were less concerned about checking the participants authenticity, because, as 3 developers mentioned, dishonest participants would be ruled out by the system. Hence, developers trust the system, and more specifically the code and the protocol (mentioned by 6).

We observe that 11 developers mentioned that, because blockchain is decentralised, or that it does not depend on a central authority, blockchain provides trust in data. When prompted for further details, 6 developers answered that trust can be brought by information traceability, as well as by the fact that the code would execute correctly. As a matter of fact, 7 developers said that they think blockchain will provide a new form of trust. Please refer to Table 2 for more details.

Verbatim	Interpretation
"…open the record like this [click] and you're going to have all the data. You'll be able to understand immediately"	This is an answer to the question of blockchain effect on accounting by an accountant. We interpreted this data gives the codes "Availability, reliability" and "Efficiency, speed" of effects of blockchain in accounting. It also shows the importance of data being recorded in the format that accountants require, and that it should be relevant. It also manifest goals.
"…accountability as a discipline should disappear. As a matter of fact, I find it impossible to justify why the profession still exists nowadays"	Answer given to blockchain effects on accounting by blockchain developer. Coded as elimination of middleman
"Blockchain is going to be the future of reliability, to the extent that you parameterize and style the information, and gives you the requirements necessary for you to trust this type of information"	Answer given to the question of blockchain effect on accounting. We coded this with "Availability, reliability" and "trust shift to technology". This quote is of our particular interest, as it show that the parametrization of information is a requirement, that trust is a goal, and the relationship of parametrization of information with trust
"It's broad, I think there's more trust depending on whether we're in a social context between humans or in a computer context. I don't think I have the definition right off the bat, I have to think about it. [...] OK, for me, in an IT context, it's mostly about data. On a social level, it's a bit stupid. It's different because socially, I can ask someone I can trust. For I don't know, as a favour?"	This was the answer a developer gave when discussing about it's definition of trust. It shows that for developers, there is a difference in trust, depending on the context (IT versus humans). It was coded as Humans vs Computer trust.
"For me transparency is information that I can easily get, that the user can easily get, that you can see everything, where we can infer more info and get conclusions about this data that tells me more about the company or another topic... It is eh also related to information, in the sense that, obviously, yeah the information can be transparent, but it is also linked how easily the user can get this information and what they can infer, conclude with it... I think it goes hand by hand if the ehh user doesn't know how to get access to it"	This is the answer given by an accountant about its definition of transparency. What is interesting, is that this definition goes in line with our transparency framework and theorized mental model. It was coded as information accuracy, information clarity and information disclosure

Table 4: Some example of verbatims from interviews, and how they were analyzed.

4.2 Transparency

Accountants. When asked about their definition of transparency, there was an unanimous consensus among accountants that transparency is related to information. The four principal codes mentioned by accountants were information- clarity, accuracy, disclosure and trust. This is summed up in Table 2. Once again, there is a good match between the accountant's definition of transparency and our own.

Furthermore, all accountants but one (Accountant #4) related transparency to information disclosure, and all accountants but two related transparency to clarity of information.

More precisely, 6 interviewees said information should be 'meaningful' (with this exact code), and another interviewee precised that the information should be about "how the algorithm works", thus emphasizing that having access to information is not enough to guarantee clarity. 9 accountants also said that accuracy was related to transparency. When directly asked about trust, only one accountant made a connection between trust and transparency. However, when asked about transparency (*what's your definition of transparency*), 5 accountants said it was related to trust. Moreover, while answering to other questions, accountants seemed to indeed associate trust and transparency.

When giving their definition of transparency, 7 accountants also talked about traceability, without however stating that traceability was a necessity for obtaining transparency.

Furthermore, based on our transcripts, accountants gave significantly long and detailed definitions of transparency, when compared to their other answers.

Developers. Developers, on their side, were not spontaneously associating transparency with information, and had divergent opinions on the meaning of the concept. For instance, developers #1 and #3 had a similar definition of transparency than our own, while others, such as #5 and #7, related transparency to trust. As a matter of fact, in most cases, developers used a variety of concept to express their definition of trust, which we cannot give here for page limit reasons.

6 developers mentioned at several occasions that technical precisions on the system in use can bring transparency. For this, they used codes as the system design, the protocol in usage, the knowledge on how the system works and even smart contracts. Other codes used by developers to define transparency was that the blockchain can allow transparency natively, verifiability, unlimited access to data or auditability. All of these codes were mentioned by at most 2 developers.

Our transcripts reveal that most developers, safe developer #1 gave straightforward, short and concise definitions of transparency. When asked to elaborate on the topic, the developers would use the same codes as they did in their initial answer.

4.3 Effects of blockchain into accounting

Accountants. First, we note that three accountants did not answer the related questions, or could not relate accounting to blockchain. For instance, accountant #6 said he knew nothing about blockchain, while accountants #10 and #13 saw no connection, as they viewed blockchain as a tool for cryptocurrencies only. Among the 10 remaining accountants, two main areas were identified: the traceability of the information and blockchain acting as a tool, each identified by 9 participants. Another area, agreed on by 7 respondants, was that blockchain could help with availability and reliability of information (which relates to transparency).

Less frequently, developers also mentioned the following codes: shift of trust, efficiency and speed of information processing and tamper-proof information, as seen in Table 2.

From our interviews, we see that the majority of accountants know the fundamentals of blockchain, even though they might relate it to cryptocurrencies. While some accountants were extensively knowledgeable on the topic (such as accountant #12), some had some knowledge, but with strong misconceptions (accountants #2 and #10, who only related blockchain to cryptocurrencies). The rest of the interviewees had an intermediate knowledge, but still answered our question, by giving high-level and general answers.

Developers. When asked which area of accounting would be most impacted by blockchain, developers did not come to a consensus in their answers. As we point in Table 2, no code was mentioned by more than 7 developers. However, we note that the most identified topics were that blockchain will: automatize the accountant's practice, eliminate middle-man (as a consequence of decentralization and smart contracts) and act as a tool. Less popular answers include efficiency and speed, availability and reliability of the information, and traceability.

In developers' opinion, the biggest challenges for blockchain to become widespread are mostly technical, especially when compared to the accountants' answers. As a matter of fact, 13 developers stated that technical obstacles will be the biggest challenge.

Technical challenges include, but are not limited to, interaction with other systems, consensus algorithms or developping a "fully-fledged solution". On the other hand, less than a third of the developers said that they perceived security and data management, privacy and regulations as challenges.

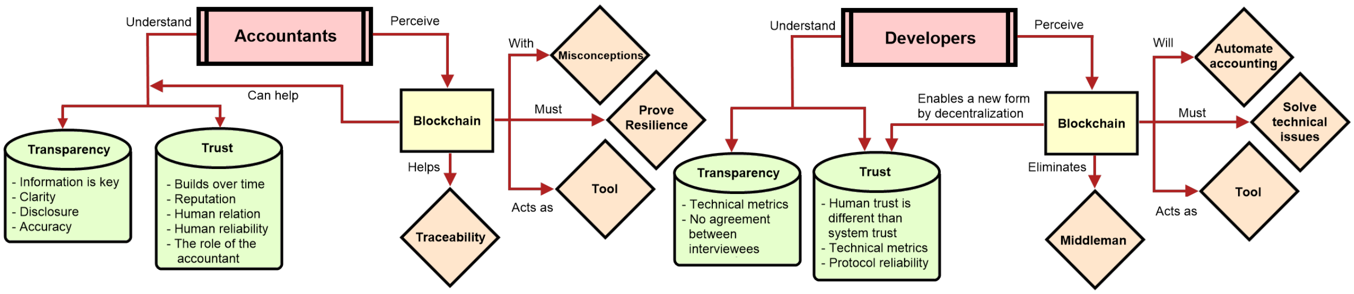

Figure 1: Simplified representation of accountants and developers mind models. For instance, accountants perceive that blockchain can help transparency, in which (in their opinion) information is key. Reproduced from our previous paper [25].

Furthermore, all developers said that explaining blockchain to laypeople was a difficult task, and that once they succeeded into explaining, people would often have unreasonable expectations about the technology. Finally, for 5 developers, non-blockchain enthusiasts have a tendency to assimilate blockchain with cryptocurrencies. This is correlated with some of our accountants' answers.

5 Analysis

5.1 Trust

From our interviews, it stems that trust is a concept that builds over itself over time, and is not usually spontaneous. For developers, there is a difference between trust in systems and trust in humans. On the other hand, accountants have the opinion that trust in the system is a consequence of the trust one can have in human relations, as well as of other parameters, not directly related to the system in itself. However, there was an agreement between accountants and developers that reliability was an essential requirement for trust, which aligns with Giddens' definition of trust [33, 34]. Nevertheless, most developers agreed that reliability on human and reliability on computers were different. This distinction was the topic on which developers agreed the most between themselves.

Accountants say that, in order to trust that all the information was provided, they needed to rely on both their expertise and standards, as well as quantitative data such as the history of previous interactions with the other actors, as well as their reputation, which was their most prevalent criterion. This was determined based on the context in which the object of trust is situated. Developers, on their side, said that reliability is a system feature, allowing to ensure accurate communication between parties. As such, their definition of reliability relies on protocol and code functionalities, to ensure that the system works as expected. This definition leads to a decentralized system, in which consensus is also decentralized. As such, and to the contrary of accountants who acknowledge importance to relational trust, developers view authenticity of involved parties as secondary. By consequence, there is a clear difference between the accountants and developers view of what means reliability.

Accounting is a practice that aims to check regulation compliance, but also increasing trust in processes, by human analysis. This has an impact on our accountants' answers, who emphasize on the vital importance of their role in analyzing and checking data presented to them for it to be deemed trustworthy. The fact that accountants have to interpret the data leads to another challenge, namely the accountants' subjectivity, shaped by their own perceptions. While, according to Porter [59], quantification is an important determiner of modernity and reproducibility of evidence and facts, and therefore trust, another opinion is brought by Fligstein [28], who states that quantification is embedded in political and economic arrangements that could lead to multiple interpretations of the same set of data based on the subjectivity of those telling the story using this data. It is the case in accounting, as accountants do not only report data, they tell a story with this data, and as such play both the role of trust controllers and producers. Then, one can logically expect that in accountants minds, reliability (and hence trust) relies on non quantitative but rather subjective concepts such as reputation, historical interaction and standards.

Developers acknowledge the importance of incoming data certification, certification which is done by assessing the reputation of the entities inputting the data. However, developers only view certification as one step of trust building. Once the data has been entered, only blockchain, technical properties impact the trust in data: consensus, decentralization and tamper-resistance. With this definition, history of a relationship is no longer required for building trust, as blockchain protocol natively encourage good behavior, and makes it difficult to actors to divert the protocol from its designed execution. Because trust is then reduced to technological aspects, developers have a different mental model than accountants, as trust is enabled by different mechanisms. As a matter of fact, developers believe that trust is enabled by technology itself, while accountants believe trust is rather a socio-technical issue. In summary, even though accountants and developers both give significant credit to the role of reliability for establishing trust with another actor, but each group has a different conception of what reliability is. For accountants, trust relies on the fact that organization provide full information, and also relies on external factors such as accuracy of the information, reputation, historical data. Developers place their trust in the system itself, and its ability to properly follow the protocol specifications and execute the functions correctly. However, as accountants point out by highlighting the importance of reputation, accounting is not only about gather numbers and data, but also about explaining and analyzing these numbers, thus adding human value to the process of trust in the data. For blockchain developers, there is a difference between trust in people and trust in systems. Developers have a different mind model in which the human plays no role in establishing trust, but the soundness of the protocol for executing transaction plays a predominant role.

5.2 Transparency

From our results, blockchain is not expected to change the mental model of non blockchain enthusiasts. It also seems that our two groups, the developers and the accountants, have a different mental model of what transparency implies. As a matter of fact, the group disagree on some transparency related topics. For instance, accountants give highest priority to information disclosure and clarity: they argue that they must have a complete access to the data, which in turn allows them to make conclusions on said data. On the other hand, developers did not identify these two codes as critical. Especially, information disclosure was particularly little mentioned.

During the interviews, accountants emphasized repeatedly that their role was to bring an “added” value to the information, thus saying that for them to deliver solid conclusions, they need a good quality of upstream information. This is fully in line with our three-dimension definition of transparency, were clarity on information is vital [65, 50, 36, 55]. In opposition, most developers did not mention clarity or quality, as less than 50% of them related transparency to the quality of the information, which shows a clear difference between developers and accountants mind models, one of the most important misalignments we found in this study. This misalignment might cause possible clash on the expectations of what an accounting automated system should provide. Especially, as Accountant #2 noted, the top criteria for the success of a blockchain based system is parametrization of information available on the blockchain.

Because accountants’ job is deeply related to data analysis, it was expected from us that accountants would expess concerns about the nature of the data to be recorded on the blockchain systems. As such, some of the main features of blockchain, such as traceability, availability and reliability of information, are not attractive to accountants if they do not, in the same time, guarantee that the information is correctly formatted and meaningful, and is in accordance with the law, or even that the information is trusted by accountants. As such, to be useful to and adopted by accountants, any blockchain system must be taking into account their specifications, especially on the data format, the standards to follow etc. We observe that this is true for any other software, relying on blockchain or not. In the same vein, developers must clearly take into account information disclosure and clarity, if they want their system to have transparency properties.

This requirement is all the more strong that accountants need to be convinced that blockchain might directly affect transparency: in our interview, none of the accountants thought it would be the case. From the point of view of the 4 developers who linked transparency and blockchain, they were mainly discussing about information traceability and availability, rather than blockchain itself providing transparency. As such, developers had the opinion that blockchain could increase, but not completely solve, the transparency of the data stored on it. For them, blockchain is rather a tool to help in the information clarity aspect of transparency and transparency: they view traceability as an increased confidence that the data is right. As such, developers place the emphasis on the information, and not the system systems design, architecture or technology. However, we acknowledge that developers also stated that technical tools could provide transparency by themselves as well.

Finally, we can draw three conclusions. First, accountants clearly relate transparency to availability, clarity (and quality) of information. The accountants mental model is in line with our three-dimensional definition of transparency. Second, that one core issue that blockchain will have to solve to reach adoption by accountant is information parametrization. It seems that this is one of the most important issues when adopting certain systems, though this conclusion requires further research. As such, and third, blockchain developers should first elicit the requirements issued by accountants before developing their product. Otherwise, if the blockchain fails to take into account the requirements on data formats and type, its adoption might be hindered. It is all the more true that accountants emphasize how they transparency might be increased with blockchain, under the condition that the information inputted is correcly parametrized.

5.3 Blockchain's impact of accounting

While it seems that blockchain might not be a fundamental game-changer in the world of transparency, there is still a lack of consensus between the developers and accountants on what would be the prospective impacts of blockchain on accounting.

For instance, all accountants except three (Accountants #6, #10 and #13) think that their field will be impacted by blockchain. Note however that developer #6 did not answer positively, as he said not knowing anything about blockchain, and accountants #10 and #13 equated blockchain to cryptocurrencies. For the sake of simplicity, we exclude these three accountants for the rest of this section.

This might be related to the fact that all developers expressed that it was difficult for them to explain blockchain to a non blockchain-enthusiast. The main difficulties mentioned by the developers were that people would tend to overfantacize blockchain functionalities, and in general don't really understand how the technology works. This is related to our interviews with accountants, as some of them had misconceptions on the functionalities of blockchain, and some had some big expectations of the technology. The feature most known by accountants is the immutability of data and traceability, however several misconceptions were also identified. A good amount of misconceptions were related to the smart contracts, as with Accountant #2, who perceives smart contracts as legally binding. Accountants were mostly focusing on the data that is stored in the blockchain, which is logical, considering their job. As such, they talked about parametrization of data, as says Accountant #2: "*Blockchain is going to be the future of trust to the extent that you parameterize and style the information correctly [...] The only thing that is going to affect is the parameterization of the system, so that it delivers the information*". In this view, blockchain operates as an Enterprise Resource Planning (ERP) system, which confirms that developers must together with accountants efficiently address their problems, which was in fact suggested by Accountant #8. Accountant #4 adds that the blockchain should pass some certification processes.

With these requirements in mind, accountants were mostly expecting changes in their field thanks to data traceability, as blockchain will serve as a tool to ensure the traceability feature of data. We assume that traceability is the issue most accountants were coming up with because they are mostly aware of the blockchain tamper-resistance feature.Traceability can affect accounting, as usually audits are carried through random sampling techniques. Data sampling is slow, and by nature incomplete. By providing all available information, blockchain might help accountants to close the blind gaps in their audits, thus blockchain would be used as a tool to improve traceability. Having better traceability, accountants will be able (as highlighted by more than half of our interviewed accountants) to obtain new kinds of information, such as compliance or even detect anomalies (such as fraud). In summary, accountants acknowledge the role that blockchain can have as a tool for increasing efficiency, especially since blockchain increases data availability and reliability.

As such, accountants view blockchain not as a tool that will automate their job, nor replace them, because –as highlighted before– accountants main perceived role is to add human value and interpretation to raw data. On a side note, there already exists partial automation of the accountants' job on the market, and they do not rely on blockchain.

On this topic, it is fundamental to observe that the added guarantees of availability and reliability are not given by the blockchain in itself, but rather by the fact that the information is entered into one unique automatized system. In many cases, databases and in all generality computers, are extremely efficient in storing, processing and sharing data. As such, blockchain is not always required when building a system, even for accounting. Moreover, blockchains have drawback when compared to other data storage systems. For instance, when there is only one entity furnishing the data, or data ownership is undisputed, blockchain is not the best tool to use [77].

On the other side of the spectrum, when asked the same question (*Do you think blockchain will affect accounting?*), developers pointed topics that accountants clearly identified as not likely to be affected. The most flagrant disagreement between developers and accountants concerns the automatization of the accountants' job, as well as the elimination of the middleman. Most developers, when talking about automatization, most developers did not seem to know that many of the automatization features they mention already exist in ERP softwares. Developers have a tendency to believe that the field of accounting will be revolutionized by blockchain, without having an extensive comprehension of current accountability systems, or about the already existing softwares. In this thought, half of the developers we interviewed thought that, in the future, accountancy would be replaced by a blockchain system, thus eliminating the middleman. Their justification was that a middleman is required for bringing trust in a system, but that this role would be made redundant by a blockchain. Quoting developer #10: "*accountability as a discipline should disappear. As a matter of fact, I find it impossible to justify why the profession still exists nowadays*", or Developer #2: "*I think blockchain can do a lot, especially in banking obviously insurance, loans, notaries, it can... uhm... short cut all the intermediaries*".

While accountants were saying blockchain is a promising tool, they also insisted on the fact that before being accepted and trusted by the public, blockchain will have to prove its resilience. This principle of precaution in front of new technologies stems from the fact that accountants job is foremost to ensure information reliability, hence some conservatism when talking about a new way of storing and processing data. Thus, it seems that for blockchain to be adopted within accounting roles, two criterion must be met. First, to clarify what are the blockchain role and usecases, to evacuate possible misconceptions from accountants. Second, to pass the trial of time, in which a blockchain accounting software would prove its efficiency and reliability, before being widely used for critical data.

This sentiment from accountants is at a complete opposition from the view of developers, who think that the main issue blockchain will face is related to programming, regulations and security. This difference can be explained as the role of developers in the product is technical, whereas accountants are the end users and as such don't have the same priorities. Yet, this highlights the differences in the mental models of the two studied groups.

Thus, we conclude that there is a significant disagreement between accountants' and developers expectations of what would be the challenges on adopting blockchain for accounting. For instance, no developers mentioned data parametrization or information issues as a problem, and the only topic on which both groups were agreeing was that blockchain would be used as a tool.

5.4 Requirements from accountants for blockchain based applications

Based on the data and the analysis of our interviews, we were able to identify a first round of goals and high-level requirements from accountants, the stakeholder of interest. Although we did not question directly the accountants about their requirements - as most accountants did not have enough knowledge on the system domain - we did ask them about their goals of using a blockchain system was available (for this, check Table 1). Consequently, we were able to elucidate some goals and high-level requirements. Furthermore, accountants are experts in their domain and thus understand what they need; in comparison with developers, whose domains is blockchain systems.

In Table 5 we provide a table with the goals, sub-goals and goal dependencies. It's important to repeat that accountants did not have a sound knowledge on the domain of blockchain system, as presented in Sections 4.3 and 5.3. Thus, some of these goals and requirements might be incomplete. Consequently, in further phases of the requirement engineer phase, it would be critical to help the stakeholders better understand their goals.

Goal term	Goal
Easy to use	G.1: The user shall be able to use the system easily. • G.1.1: The user should be able to use the system without major training. • G1.2: The system must have a GUI
Availability of information	G.2: The information shall be always available to the user on demand. Dependencies: requires G.3
Traceability of information	G.3: The information history (logs) shall be available to the user. • G.3.1: The information's metadata should be written in the blockchain • G.3.2: Logs about the system should be written in the blockchain • G.3.3: The information shall be difficult to tamper. Dependencies: G.3.2 obstructs G.4.1.
Trust in information	G.4: The system should be trustful. • G.4.1: The system shall comply with regulations • G.4.2: The system should be secure • G.4.3: The information should be reliable

Table 5: Goals from accountants for blockchain based systems.

Based on the table, it is possible to understand that there are certain dependencies between the goals. Indeed, the traceability goal (G.3) requires for the availability goal (G.2); if the information is available for the users (in this case, accountants) the goal of traceability is partially fulfilled, as users should be able to see some history of the information. There might also be an obstruction dependency between G.3 (specifically, G.3.2) and G.4 (specifically, G.4.1). Depending on the regulations of each country and which type of data is written in the blockchain, certain types of information need to be deleted after certain period of type; something usually called retention period. This goal is obstructed by G.3.2, given that if information shall be difficult to tamper with, its deletion should be difficult. This dependency link should be further studied when designing the system.

Figure 2 is a SR model using the i* 2.0 framework, for better illustrating the accountants goals and their decomposition, and the relationship with other actors (mainly, the organization being audited and the blockchain system). For the sake of simplicity, we focused on a common accounting practice part of the financial branch: the annual analysis of balance sheets. As the model shows, most of the goals are depender on the blockchain network, in some way or another. For example, “Security” is a softgoal that helps fulfilling the “Trust” goal on the system. Yet, Security is a depender of the blockchain system, by the dependum safety. Indeed, if security (or at least, critical security) issues are found in the blockchain, this breaks the security softgoal and negatively impacts trust. As explained in Section 2.4, critical security issues in blockchain have been found before. On another note, the task “Create GUI”, which helps achieve the goal of “Easy to use”, depends on the blockchain network, as a blockchain software needs to be created and should be able to interact with the blockchain network. Finally, it is critical for accountants to have the data available (goal) in the blockchain. This goal is achieved by collecting the data from the blockchain and having the access rights to read them. Collecting the data from the blockchain, depends on the organization actually writing the data in the system. On the other side, the access rights depend on the blockchain network granting these rights to the accountant who wishes to collect such data.

Furthermore, the model sheds lights on other important relationships between the actors and the goals. For example, accountants need the information of previous years - as they have rightly stated in the interviews - to compare data. This task depends on the organizations making available the resource balance sheet -or the asset in question - on the blockchain. However, at the same time, writing the data in the blockchain from the organization point of view, depends on the accountant writing the data in the blockchain and at the same time, having a software that enables to interact with the blockchain.

Consequently, some early requirements are possible to identify based on the model of Figure 2. These requirements are here expressed in natural language, using the EARS framework, as expressed in the section 3. Each requirement is linked to an identified goal.

We also give Table 6, in which we give a selection of verbatims from accountants, that manifest the identified requirements from their side. This list does not intend to be extensive nor complete, but to open the paths to identify early requirements for blockchain based accounting systems.

Table 6: Examples of the verbatims that lead to the corresponding goals and requirements.

Goal	Verbatim	Requirement
Easy to use	“So when you make a double click here, click and click here [...] So you have this tool where you can go and click for the data and check eeh check if the information is traceable, if it is true that all the documentation is true” (Accountant #2)	The blockchain system shall have a GUI for interacting with the blockchain network.
Availability of information	“[About blockchain]..and it makes all the information available to the users [...] that that information about, like dunno, like you medical data, is available to any interested person as long as you grant them access and like everything like that, and that the info isn’t tampered with” (Accountant #12)	The blockchain system shall grant a copy of the ledger to authorized users.
Availability of information	“[About blockchain data].. like I can download it, see it online, cross references it with other accountancy data... that would be perfect, amazing there eh shouldn’t be errors” (Accountant #12) “We will be able to obtain economic information in real time and in an ultra reliable way.” (Accountant #1)	The blockchain system shall allow live queries of the ledger.

Continued on next page

Table 6 – continued from previous page

Goal	Verbatim	Requirement
Availability and traceability of information	"[About blockchain] All that chain of data, you have the data of one section of a company to another one, like providers, seller, and the info will be available if the blockchain allows for that information to be saved and written in an way that is compatible and integral to accountancy practice" (Accountant #12)	The blockchain system shall allow accountant to write data on the ledger.
Availability and traceability of information	"[About blockchain] All that chain of data, you have the data of one section of a company to another one, like providers, seller, and the info will be available if the blockchain allows for that information to be saved and written in an way that is compatible and integral to accountancy practice" (Accountant #12)	The system shall allow to write different types of accountancy data.
Traceability	"... try not to modify the stuff on the system as to ... as to show better results, better information that was not there [...] So, if this information is on the blockchain, this affect that it is more difficult to modify, so I assume that it is also easier to trace..." (accountant #11) "I understand that the data in blockchain is very difficult to modify so ... so if something happens, another user can see it, so it is difficult to modify something" (Accountant #12) "Blockchain is [..] if you cannot erase what you do, you can (use it for better?) for sure, because people will know what you do and what you did.." (Accountant #2) "[Impact of blockchain in accounting] But in accounting from what I understand, could be for example, we are sure that the transaction has been done, recorded and no one could run the, make disappear these things, its something which could maybe increase our, yes we can say the trust we have in the financial statement," (Accountant #4)	The blockchain system information shall be tamper-proof.
Trust in information	"Well I don't know about blockchain but what I can tell you about technology is that ehh well it is important that these new technologies or technologies take into consideration the different finance regimes, like um understand that Chilean finances is different from Argentinian. For example when doing finance accounting in Argentina or Brazil you pay taxes for everything but in Chile no ahaha so um when we bought this new ERP system for management, they didn't know that." (Accountant #9)	The blockchain system data shall be compliant with national accountancy standards.
Availability of information	"Blockchain will be the future of trust as long as the format of the information is good and it deliver the necessary requirements to trust this information" (Accountant #2)	the blockchain system data should follow standard formatting for accounting data.
Traceability	"So, if this information is on the blockchain, this affects it that it is more difficult to modify, so I assume that it is also easier to trace... like, at the end, if someone wants to modify it would be difficult and the system would know..." (Accountant#13) "But I can see behind the backlog, at what time the stuff was done, who did it, who wrote the info. Why is this important? Because then I can trace the information. Who did what is key. Did he have right? Was his obligation?" (Accountant #2)	When an accountant request a copy of the ledger, the blockchain system shall include the metadata.
Availability of information	"[About accountancy] Yeah you don't share [that information], and with blockchain of course this is the basis you share, so how can we be sure that someone could have access to all information, so this is something that could maybe delay" (Accountant #4)	When an accountant requests for access right, the blockchain system shall ask the organization in charge for the proper access rights.
Traceability information	"Today there is undeclared work. Obviously undeclared work does not go into the [accounting] pipes. Yet, this will certainly consume company resources at some point. If we could link these resources to that work, maybe the blockchain could be help to make this part more reliable?" (Accountants #7 and #8)	If the blockchain software detects that some data is missing, then the software shall alarm blockchain network.
Traceability of information	"But I can see behind the backlog, at what time the stuff was done, who did it, who wrote the info. Why is this important? Because then I can trace the information. Who did what is key. Did he have right? Was his obligation?" (Accountant #2)	While the accountant is querying information in the blockchain software, the system shall include the metadata.

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Table 6 – continued from previous page

Goal	Verbatim	Requirement
Availability and traceability of information	"The only thing that will affect [its adoption] is the parametrization of the information in the systems, so that it give the eh... information, the good information and that users eh... can enter the data in the correct format for each operation" (Accountant #2)	Where a balance sheet information is available for writing, the blockchain system shall also allow to write information for post-balance and explanatory sheets.

One issue we have identified while doing the identification of goals and high level requirements, is that there might be problems with creating a generic blockchain based software for accountancy, as it might not satisfy all the requirements for every accountancy branch. Firstly, this arises as a consequence that accountancy regulations vary between different countries and thus, the requirements (or constrains to be more precise) are different. Secondly, although our i* modeling was for balance sheet (financial accounting), accountancy has other branches, such as forensic, auditing, tax accounting or political campaigns accounting. These activities requirement's might not be fulfilled with a generic accountancy blockchain based system and might have different requirements. In addition, this is can further complicate things, as these different branches might be regulated differently depending on the country.

6 Threats to validity

From our interviews and transcripts, we have reached high levels of saturation from both interviewed groups, as we went on interviewing accountants and developers, fewer new points of information were reached each time. As a matter of fact, very few new points were brought up by the last two interviewees. However, because blockchain developer is not yet a widely exercised job, we had to somewhat enlarge our search, and also interviewed blockchain projects managers. Despite the good saturation rate, a larger sample size would yield more robust conclusions.

Furthermore, because we aimed at doing preliminary research, our results must also be interpreted as preliminary as well. For more research on the topic, possible paths of improving the results presented here would be to gather more data and apply quantitative methods, notably to limit and quantify the bias in the answers. A more detailed analysis of the interviewees variables (level of expertise, education details...) could also bring further hindsight on the topic.

It might also be of interest to carry this research with other sources, such as meta-studies of real-world projects to better carry observations and draw conclusions.

Furthermore, future studies should aim at how the transparency and trust requirements of accountant's in blockchain system and propose prototypes or design of blockchain based accounting systems. Finally, we tried modelling an initial round of goals and requirements from the accountant's intention. Further research should be done to identify goals and requirements from the other actors. In addition, given the lack of knowledge on the domain of blockchain, some of the identified goals and requirements should be further refined and worked upon.

7 Conclusion

Even though our paper aims to give preliminary results, we can already observe a clear difference between developers and accountants mental models about trust and transparency, and their opinion on the impact of blockchain on accounting. Even though the mental models are different, our analysis also seem

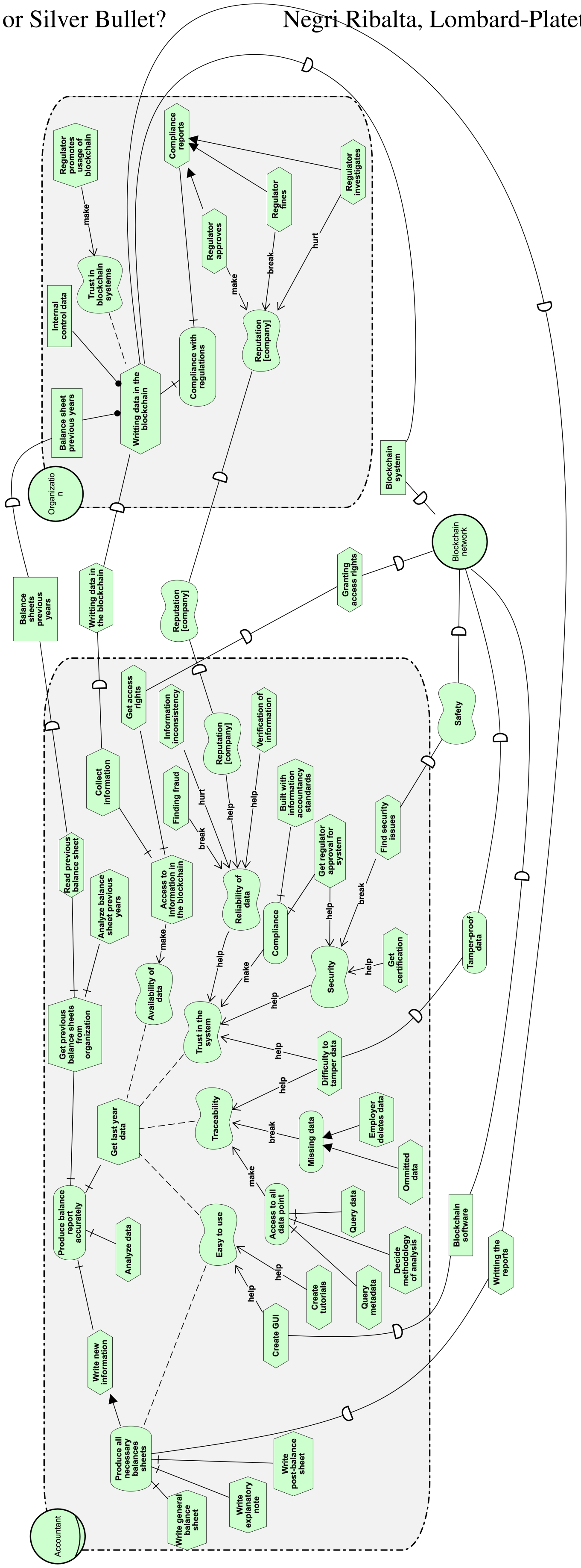

Figure 2: SD/SR model

to indicate that the concepts of trust and transparency in accounting are not going to be significantly modified by the arrival of blockchain: some specific areas might evolve, but the core of their definition should remain untouched.

An interesting point we observed and did not anticipate is that, during the interviews when talking about blockchain systems, accountants were mostly concerned about minimizing the issue of entering new data on the blockchain: is the data correct, who wrote it under which pretenses, does it follow accountancy standards, regulations, the metadata data, the traceable of such data, among others.

Furthermore, from our interviews, we were able to derive a simplified mental model map of both developers and accountants, and establish some of the goals for developing a blockchain-based accounting system.

Even though further research should be carried on blockchain implementation, accountancy and software engineering, we believe that we have already a good idea of the conceptions of trust and transparency of each party, and an understanding of the goals of accountants. A more precise view on the topic might be gained by researching on the following questions: can different mental models agree on the expectancy of software? What have been the key variables for the adoption of new technologies in accountancy? Moreover, one could start from the goals identified in this paper and carry on a design pattern for accounting solutions on blockchain.

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