EXPLORING VALUE SENSITIVE DESIGN FOR BLOCKCHAIN DEVELOPMENT

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ABSTRACT

The potential impact that blockchain technologies might have in our society makes it paramount to consider human values during their design and development. Though the blockchain community has been moved from the beginning by a set of values that are favored by the underlying technologies, it is necessary to explore how these values play among the diverse set of stakeholders and the potential conflicts that might arise. The final aim is to motivate the establishment of a set of guidelines that make blockchains better support human values, despite the initial bias these technologies might impose.

KEYWORDS: blockchain, smart contract, human values, value sensitive design.

1. INTRODUCTION

Blockchains have their roots in Bitcoin. After many attempts to create digital money, Nakamoto (2008) made a revolutionary proposal that resulted in the first cryptocurrency. The main breakthrough was that Bitcoin was completely decentralized, not requiring a central control responsible for keeping track of who owned every Bitcoin and, thus, putting too much power on it.

This is attained by implementing a distributed ledger, where all nodes participating in running the blockchain hold a copy of the ledger with all the Bitcoin transactions to date. This way, all blockchain nodes are responsible for controlling that no-one cheats, which is discouraged with an incentives system for those behaving properly, called mining rewards.

Second generation blockchains, like Ethereum (Buterin, 2014), move things one step further to create distributed ledgers that are not just capable of keeping track of currency payments, but also the transactions and current state of a shared computer. This shared computer is in fact replicated and run in every blockchain node to guarantee that it produces the same computations for everyone.

In this case, there are also application developers that can program this shared computer contributing pieces of code called smart contracts. They are contracts in the sense that it can be trusted that their code will execute as programmed. For instance, it is possible to develop an escrow payment application that does not require a trusted third party. There is guaranteed that the corresponding smart contract will make the payment if the escrow conditions are met.

Overall, the blockchain has the potential to change the ways that people and organizations trust each other, establishing a shared and tamper-proof registry of events that aims to be decentralized and neutral. This means a potential shift in money, law and government that those traditionally intermediating might perceive as a menace. Thinking even longer term, developing your own blockchain-based application you are not just making another application, it might evolve into a new form of society where humans and even machines can autonomously interact. For instance, self-driving cars that get paid and use the income to pay their energy consumption or repairs.

2. OBJECTIVES

To date, the core values that inspired blockchains design have been decentralization, transparency and neutrality. However, these values and intentions cannot be guaranteed just by the technical infrastructure alone and must be considered for each application built on top of existing blockchains. A decentralized computer network does not guarantee decentralized power, transparency does not guarantee legibility and finally, code and cryptography do not guarantee neutrality. Finally, it is important to assure that the use of blockchain technologies does not go against other values that, though no favored by the technology, should not be limited by them. For instance, transparency versus privacy.

Consequently, considering the big bias towards some specific human values, and against others conflicting, plus the enormous impact that blockchain technologies might have on our society (Tapscott & Tapscott, 2018), it is paramount to consider human values throughout the design process of blockchains and blockchain applications.

The objective of this work is to start exploring the application of Value Sensitive Design (VSD) as a way to ensure that human values are taken into account in these cases (Friedman & Hendry, 2019; Spiekermann, 2015). VSD builds on an iterative methodology that integrates conceptual, empirical, and technical investigations, which can be aligned with the development processes of information systems.

3. BLOCKCHAIN STAKEHOLDERS

Following VSD, conceptual investigations first identify the direct and indirect stakeholders affected by the considered technology. In the case of blockchain, we have made a literature review (e.g. the report by GetSmarter (2018) or the study by Nanayakkara et al. (2019) and compiled a list of stakeholders. Most of them are targeted and direct (as indicated next):

- **Miners (direct)**: run nodes looking for rewards for those that do not try to cheat. The way of proving their commitment might involve a costly task (proof of work) or require the deposit of an economic amount as a guarantee (proof of stake), among other approaches.
- **Core Developers (direct)**: create and define the evolution of the blockchains they are involved in by contributing to its codebase. For instance, they can change the rewards that miners receive or the costs of transactions that users should satisfy.
- **Entrepreneurs (direct)**: create applications on top of blockchains that benefit from its features, especially the trust mechanisms. Trust makes it possible to develop smart contracts, pieces of code that, once deployed, guarantee their execution. These

applications usually employ incentives like cryptocurrencies or tokens, which might also have economic value.

- **Investors (direct)**: buy cryptocurrencies and other tokens as an investment. They try to forecast the success of the associated blockchain or application, which might increase their demand and consequently their value.
- **Users (direct)**: employ blockchains to make cryptocurrency transactions or to use applications developed on top of blockchains, which might also include direct or indirect economic transactions but also other kinds of uses as registering agreements or voting.
- **Exchanges (direct)**: provide mechanisms to convert fiat currencies to the cryptocurrencies they have listed. Most of them are centralized and require that users move their holdings to accounts in the exchange. More recently and thanks to smart contracts, decentralized exchanges have also become available.
- **Key personalities and celebrities (indirect)**: are people that have influence in a particular blockchain community, or its associate cryptocurrency. This includes outstanding developers like the creators of some blockchains or celebrities from media that advocate in favor of particular cryptocurrencies or blockchain applications (Business Insider, 2019).
- **Regulators (indirect)**: are different kinds of organizations, public and private, that survey or regulate different kinds of economic and social systems which might be impacted by blockchain technologies. Examples of such organizations are those regulating financial systems, energy or taxes at different levels of granularity, from local to international level.

Finally, it is also possible to identify non-targeted stakeholders. Technologies are not always used in ways that the designers intended. Non-targeted stakeholders include those who might use the system for unplanned or malicious purposes. In this case, the most relevant ones are malicious hackers trying to steal assets managed using blockchain technologies, specially cryptocurrencies. Another kind of non-targeted stakeholder also very relevant and with high impact in the evolution of blockchain technologies are those using them for money laundering, including not just individuals but also organizations, for instance countries trying to circumvent trade restrictions.

4. BENEFITS, HARMS AND VALUES

Continuing with the VSD approach, we analyze the benefits and harms for the targeted stakeholders and then map them to the corresponding values using a deductive approach: human welfare, ownership and property, privacy, universal usability, trust, autonomy, informed consent, accountability or environmental sustainability (Friedman et al., 2013). The output of stakeholders analysis plus the identified benefits, harms and values are listed in Table 1.

Table 1 Mapping Blockchain Stakeholders' Benefits and Harms to Values.

Stakeholder	Benefits	Harms	Values
Miners (direct)	- Economic rewards. - Participating in the decentralization movement. - Enjoying additional privacy by interacting with the blockchain through an own node.	- Changes in rewards or costs (like electricity) might make mining not profitable. - Entry barriers, and risk of losing opportunities to earn rewards, due to the increasing investments required in computational resources or staked value because the chance of earning rewards is proportional to the commitment. - Environmental impact of mining when it is based on the intensive use of computational resources	- Human Welfare - Ownership and property - Privacy - Trust - Autonomy - Accountability - Environmental Sustainability
Core Developers (direct)	- Participating in the decentralization movement. - Public acknowledgement from the developer community, usually blockchains are open source projects to facilitate accountability and trust - Influencing the evolution of the blockchain or cryptocurrency ecosystem.	- Risk of losing the interest of miners or users that might abandon a blockchain and make it useless - Pressures from other stakeholders (including exchanges or key personalities and celebrities)	- Human Welfare - Ownership and property - Trust - Autonomy - Accountability
Entrepreneurs (direct)	- Participating in the decentralization movement. - Economic rewards from investors, including token offerings, or from users through utility tokens.	- High costs and risks of developing projects on top of a nascent technology with a lot of uncertainties - Complex technology imposes high entry barriers to potential users	- Human Welfare - Ownership and property - Universal usability - Trust - Autonomy - Accountability
Investors (direct)	- Participating in the decentralization movement, operating outside traditional and more restricted investment ecosystems - Investment returns are usually higher than other more mature markets.	- Higher risks than other more mature markets, including legal voids and potential scams	- Human Welfare - Ownership and property - Autonomy
Users (direct)	- Participating in the decentralization movement. - Economic incentives derived from cryptocurrencies and tokens earned as a reward for contributing to the application being used.	- Additional complexities introduced by an immature technology might produce economic harms - Risk of losing collected rewards if the economic volatility associated with the blockchain ecosystem makes them less valuable	- Human Welfare - Ownership and property - Privacy - Trust - Autonomy - Accountability - Informed Consent

Exchanges (direct)	- Economic profit from transaction fees. - Influencing the evolution of the cryptocurrency ecosystem, for instance choosing the currencies to be listed in the exchange. - Potential to reach a more diverse user base and reduced costs of operation	- Higher risks than other more mature markets, including legal voids and potential scams - Accumulation of value makes them very attractive to malicious hackers	- Ownership and property - Trust - Autonomy - Accountability
Key personalities and celebrities (indirect)	- Participating in the decentralization movement. - Participation in investments and other economic rewards related to cryptocurrencies and tokens.	- Higher risks than other more mature markets - Potential popularity harms due to legal or other kinds of issues associated to the blockchain or application being supported	- Human Welfare - Ownership and property
Regulators, financial systems, energy, etc. (indirect)	- Alternative mechanisms to regulate through incentives - Costs reductions - Facilitate the availability of banking and financial services	- Lack of control and enforcement measures over blockchain actors, pseudo-anonymous or outside jurisdiction - Higher risks than other more mature markets, volatility - Legal uncertainties	- Human Welfare - Ownership and property - Accountability

5. CASE STUDY

Following the previous analysis of Benefits, Harms and Values, we have studied a particular blockchain application based on smart contracts. The application is conveniently called EthicHub and geared towards becoming an ethical bridge of inclusion, as described in Figure 1.

Users can make investments that go directly, without intermediaries, straight to the involved farmers in developing countries, where access to credit to finance their farming activities is unavailable or at unaffordable rates. In many cases, these communities are not even banked.

The contributions support their farming activities, as detailed in the platform, and allow their funding with a fair interest rate. There are EthicHub local nodes, persons that are in direct contact with the farming communities. They help communities define projects looking for funding, converting contributions made using blockchain assets into local currency, contacting direct buyers to guarantee purchase before the harvest to ensure farmers can repay the loans and, finally, returning the invested quantity including a 15% annual interest rate plus a 8% that goes to the platform and the local node.

The stakeholders in this particular case are:

- **Entrepreneurs**: they include all the EthicHub staff running the platform, which gets 4% of the investments, plus the local nodes, which also get another 4%. The values into play in this case are mainly Human Welfare, especially regarding wealth redistribution, plus Ownership and property.
- **Investors**: these are the users willing to invest in farming projects and looking for a 15% annual interest on the invested quantity, starting from just 20€. For investors the most relevant values are also Human Welfare plus Ownership and property, though they can also appreciate the Privacy that blockchain technologies provide them.

- **Users**: the farmers looking for funding for they farming projects at a very competitive interest rate compared to local options. In most cases, farmers are unbanked and cannot apply to commercial banks loans. Consequently, compared to the local alternatives that farmers have that can be of a 20% interest rate but monthly, it is a very convenient option that allow them to look for bigger and much longer-term project. For farmers, the target values are Human Welfare and Ownership and property. However, in this case, Autonomy is also very important.
- **Regulators**: this category of stakeholders includes the entities participating in the markets where the farmers operate, especially buyers of their harvest. Additionally, other entities like the local financial system should be also considered as EthicHub can be perceived as a competitor on the longer term. Finally, there are also the entities responsible for collecting taxes for the investors using EthicHub. As for other kinds of investments, it is likely that they will be willing to collect the corresponding taxes on the returns. This might impose the biggest value tension between the Privacy that investors through blockchain technologies and the Accountability requested by the regulators involved in this case. Currently, there is little regulation to this can of investments that occur outside traditional channels. On the longer term, is seems evident that EthicHub will need to provide mechanism to regulators to collect investments data while maintaining investors Privacy to the maximum extent possible, which in any case should not enable taxes evasion.

Figure 1. How does EthicHub Work?

Source: EthicHub, https://ethichub.com (2020)

6. CONCLUSIONS AND FUTURE WORK

The previous study of stakeholders and values following the VSD approach highlights potential conflicts like accountability vs. privacy or trust vs. environmental sustainability. These are trade-offs among competing values in the design, implementation, and use of blockchain-based systems. For instance, blockchain technologies due to their immutability imply serious risks for privacy. From a VSD perspective, this issue is addressed during the whole blockchain application development process so it implements measures than ensure user privacy. For instance, store personal data on chain once encrypted or just a hash of it.

Remains future work to conduct further empirical investigations that help clarify the outcomes of different blockchains and applications regarding the identified values by exploring the corresponding white papers. The final target is to be able to characterize the properties and underlying mechanisms of blockchain technologies to generate a set of recommendations that make them and applications build on top of them better support human values, despite the initial bias the technology might impose.

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