State of the art of Blockchain for Real Estate and Land Registration

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Abstract. Research has shown that Blockchain has been studied to be introduced to support transformation over the real estate realm and the land registry system particularly. This research aims to analyze the po-tential of this technology on these applications. It was conducted using the Systematic Literature Review (SLR) methodology, which is a means to identify, evaluate and interpret the available research; andthe case study protocol by conducting a multiple case research and combining it with a psychological framework named Theory of Planned Behavior (TPB). With the help of these, four case analyses were built, each one containing quotes from the interviewees conducted and previous knowledge, intending to give an overview of the studied problem and also to enrich the reader's perception.As for results, we present the advantages and disadvantages of the use of Blockchain in the land registry system and the countries which already have implemented Blockchain in the mentioned system and cases analysis regarding four different countries that are in four different continents and context about how this technology is already ingrained in them. For these two, there is a discussion in which topics are built up.These artifacts can help when evaluating the need to adopt the technology and they show that in previous literature Blockchain isn't agreed upon by researchers, governments, and other parties. This Is emphasized by the heterogeneity of the countries which already have implemented the tech and the prospect of the growing use of it.

Keywords: Blockchain, Real Estate, Case Study.

1. Introduction

The first objectives of this master thesis were to include a proposal and a software tool for supporting a real estate (housing) business transaction using blockchain and the supposed tool would be evaluated with simulations in a lab and interviews with experts.

However, the path chosen was a Systematic Literature Review (SLR) followed by a multiple case study. This was made to provide an abstract and a qualitative overview of how Blockchain is, was, orwill be thought to integrate with the real estate domain in a general sense, but we came across mostly about one area of it which was the land registry. Hence, the objective for the first research was to seize all advantages and challenges, from the previous literature, of this technology in the land registry system. With this in mind, the objective of the latter research was to deepen the scope and to know which challenges, benefits, and how this technology was perceived by governments, banks, and other parties in four different continents of the world.

Before instantiating the research methodologies, real estate, and blockchain, the SLR and the case study concepts are described. Succeeding, and in a detailed way, the first research, that is represented in the Systematic Literature Review section, intends to: explain how it was carried out by describing how the SLR was done and its steps - Planning, Conducting, and Reporting; the latter step presents the results which consist in various tables showing the advantages and disadvantages of Blockchain when addressed to the real estate realm, particularly land registry, and also show that there are no successful examples of countries that already have or are developing pilot projects. In the end, a Discussion section builds up the results.

The second research presents how the case study protocol was guided, the analysis framework adopted to examine the responses of the four interviews made, each case analysis, and finally a Discussion section to introduce a social perspective that may influence the general adoption and impact of the application of the technology for the real estate realm.To terminate, it is the main contributions of the research, research limitations, and future work, along with the bibliography.

2 Theoretical Background

2.1 Real Estate

"Real estate conveyance is a heterogeneous phenomenon in which several intermediaries and public services might be involved, depending on the type of transaction, on the step being taken as well as on the country." (Garcia-Teruel, 2020). The real estate market involves multiple untrusted actors with contrasting objectives and it is a complex subject with many facets (Avantaggiato & Gallo, 2019), and although highly regulated, is known for its resistance to change (Tilbury et al., 2019), being an example in 2015 the European Parliament was worried that EU (European Union) member state citizens' difficulties in acquiring real estate (homes in particular) in another member state, which is against the creation of a true cross-border land-acquisition internal market (Nasarre-Aznar, 2018).

2.2 Blockchain

Blockchain, although originally created to bypass the traditional intermediaries in currency issuance, academics, governments and stakeholders envisaged the potential opportunities that this technology offers for their own activities and even the financial sector, which was the one most directly affected by the creation of the bitcoin currency and therefore the blockchain systems, considered this technology as an opportunity for improving their processes as well as lowering their expenses (Garcia-Teruel, 2020).
Blockchain technology can be described as:

"A blockchain contains a secure history of data exchanges, utilizes peer to peer timestamp and verifies the exchanges, and can be managed without the interference of a third party. The verification happens with the help of other peers in the network (through a consensus) and every transaction is saved in the block. Every user connected to the blockchain is entangled by two kinds of keys, private keys and public keys linked to a wallet using which a user can perform transactions. A user can access his wallet using private keys and the public key (wallet address) is the one which is available for other peers in the network to perform transactions. Private keys gives an user the power to digitally sign and validate every action initiated with his public key. Since the wallet address is a key that comes out of an encryption algorithm, it is a string of random characters for an unintended user. This makes a wallet owner anonymous to the outside world. The copy of the blockchain is kept in every machine connected to the network and hence there is no concept of centralized access. In addition, because of these multiple copies it is unable for anyone to tamper the contents of a chain. Anonymity and decentralization are the major backbones of blockchain technology." (E et al., 2019)

3 Research Methodologies

3.1 Systematic Literature Review

A SLR, or a systematic review, is a means of identifying, evaluating, and interpreting all available research relevant to a particular research question, or topic area, or phenomenon of interest (Kitchenham & Charters, 2007). The guidelines to make a SLR are different according to each source.

2.1.1 Research Questions

Although there are several studies on blockchain applied to real estate, to our knowledge, it doesn't exist one which comprises so many advantages and challenges and specifies in which countries blockchain is already implemented. For this reason, we developed three guiding research questions:

• RQ1. What are the advantages associated with the implementation of blockchain in the process of land registry?

• RQ2. What are the challenges associated with the implementation of blockchain in the process of land registry?

• RQ3. Which examples of pilot projects of blockchain already exist for land registry?

3.2 Case Study

3.2.1 Research Questions

The research questions of this study have the purpose of requesting an overview of how this particular technology fits in and if it's being recognized or not as applicable in the real estate realm of certain countries. With this aim, we presented the above questions to the interviewees:

1. Why is Blockchain being adopted in this case study, i.e., for supporting real estate in your country?
2. How is Blockchain being adopted in this case study (only in land registration or another part of the real estate domain)?
3. What are the major challenges of Blockchain in this case study?
4. What are the major benefits of Blockchain in this case study?
5. What are the major disadvantages of Blockchain in this case study?
6. How is this case study perceived by:

6.1 government/politicians
6.2 enterprises
6.3 middlemen (e.g., notaries)
6.4 banks
6.5 other entities (e.g., researchers)
7. How do you assess the maturity level of this case study?
8. What is your prediction for this case study in the near future?

3.2.2 Analysis framework - Theory of planned behavior (TPB)

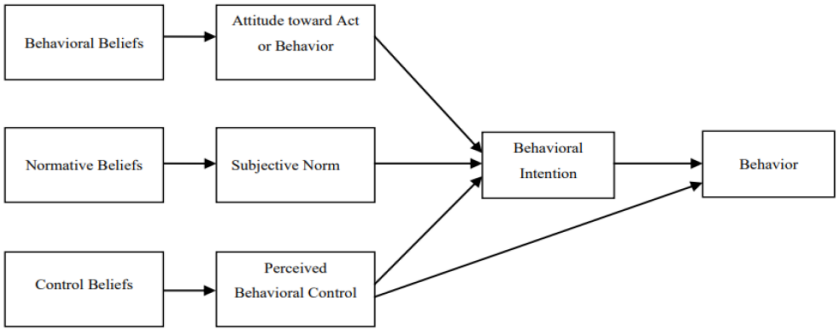

Figure 1. **The TPB model**

The TPB postulates three conceptually independent determinants of intention: the first is the *attitude toward the act or behavior* and refers to the degree to which a person has a favorable or unfavorable evaluation or appraisal of the behavior in question; the second predictor is a social factor termed *subjective norm* and it refers to the perceived social pressure to perform or not to perform the behavior; and the third antecedent of intention is the degree of *perceived behavioral control* which refers to the perceived ease or difficulty of performing the behavior and it is assumed to reflect past experience as well as anticipated impediments and obstacles (Ajzen, 1991).

4 Case Analysis

We will now present each case and its respective analysis. The analysis is composed by a table that associates each belief described above with quotes from the interviewees, and a brief context about the integration of Blockchain in each country.

4.1 Canada

Category	Quotes from interviewees
Behavioral beliefs	• "I expect that, in time, they (land title authority) will adopt a blockchain solution of some sort."
Normative beliefs	• "The land title authority has recently expressed interest in exploring new cases for the application of blockchain."
Control beliefs	• "In 2018, the province of British Columbia in Canada wished to explore the possibility of using blockchain in land titles administration and real estate transactions. As a first experiment with the possible future adoption of blockchain, so interesting but not critical." • "The case study was undertaken in 2018, and so the technology and the land titles authorities' understanding of blockchain was very limited."

Table 1. Canada' interviewee quotes related to a certain belief.

4.2 Dubai

Category	Quotes from interviewees
Behavioral beliefs	• "It's very promising, it's very promising but I think at the moment there are still the bottlenecks."

Normative beliefs	• "...other people in Dubai are amazingly pro-innovative..." • "But my experience has been in Dubai. It's quite crazy actually how eager they are to just have the best innovations in capacitance, the best tech and everything they have the money and they have the mentality..." • "Dubai's full of blockchain startups." • "Many blockchain companies don't have any tax issues, the legal environment is amazing and there are tons of investors."
Control beliefs	• "I must say I'm not aware that blockchain is in fact used at this point..." • "...they have the money and also the laws are in place to allow for this innovation."

Table 2. Dubai' interviewee quotes related to a certain belief.

4.3 Georgia

Category	Quotes from interviewees
Behavioral beliefs	• " I'm sceptical I'm because of the number of laws and the mindset of the people... you can hope that at least you can track people along with all this technology." • "In Georgia, this has only been possible recently to develop and they still have a lot of legacy to overcome." • "But that is not using the opportunity of the blockchain technology to change any processes or anything so that option is really very very shallow at least in this case and shows an enormous amount of resistance to structural change."
Normative beliefs	• "In Georgia, they know corruption is a much bigger problem in the country".

Control beliefs	• "In Georgia, you have established structures that are entrenched and embedded or middlemen and all this stuff you know also enforced by the law which does not change so quickly. The jurisdiction in Georgia does not allow for a high degree of innovation and getting rid of middlemen and so on is more of a challenge because it's backed by the law."

Table 3. Georgia' interviewee quotes related to a certain belief.

4.4 Ghana

Category	Quotes from interviewees
Behavioral beliefs	• "I believe western academics are looking to justify neo-colonialism and are just attempting to validate that African governments have created a safer environment for exploitative business practices from the west." • "It is interesting to see how western academia has really only been interested in attempting to exploit African real-estate through blockchain rather than study how land-right protection could advance the female population."
Normative beliefs	• "Politicians either see it as a potential bane against their opacity or a means to gather support to make the government more transparent. Nowhere in between." • "Banks see crypto and blockchain as a general threat."
Control beliefs	• "The technology is too nascent and UI/UX is not developed enough to be useful in the real world." • "Blockchain technology is currently not scalable, not user-friendly, not easily deployable, not easily understood."

Table 4. Ghana' interviewee quotes related to a certain belief.

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