Cultural Influence on Building Trust in Human-Computer Interactions

Edilson Osorio Junior
Under the supervision of Dr Sonia Sousa and Professor David Lamas
osoriojr@gmail.com

Tallinn University
School of Digital technologies
Narva Rd 25, 10120 Tallinn
Estonia

Abstract

The purpose of this research is to connect cultural dimensions mentioned by Hofstede with research on measuring Trust, along with Kahneman's Loss aversion theory. Understand how they have a profound influence on how humans take their decisions and how they build Trust during the process of human-computer interaction. The research plan proposes to focus in the gap between the levels of technology adopters, referred in Rogers' theory as early adopters and early majority adopters.

Keywords

trust, human-computer interactions, blockchain, cultural influence, behavioural economic principles

Introduction

Since we have new technologies designed to provide different levels of user experience, the acceptance and Trust may differ accordingly if the user perceives an objective or indirect reward that can cause some momentaneously or future benefit. However, it seems that latest technologies had raised concerns on transparency, data privacy, security and ethical uses of data. Especially on those who rely on data to support our daily decision making activities (e.g Artificial intelligence or machine learning). Within it we see the need to further understand and study it cultural effects in users feelings of Trust towards technological artefacts. This understanding the cultural dimensions of Trust in technology will help to support the establishment of new norms of ethical behaviour with digital technology and eventually leverage higher levels of Trust in critical digital innovations.

Rationale

Promote a study on how to use Trust to influence the adoption of disruptive technologies by the early majority adopters. Applications and platforms that relies on disruptive technologies such as artificial intelligence and blockchain, have been adopted by early adopter users [39][40][41] and they seem to have much resistance by early majority users and institutions.

Blockchain is an example of deep technology which can generate value and digital transformation on any public and private organisations, as also to the whole society. It has the potential to bring disruption on all levels of relationship that relies on a third-party to provide Trust and who authenticates some transaction.

The impact of the digital transformation by digitalisation and/or by the elimination (or reduction) of the non-functional bureaucracy caused by third-parties, can make positive contributions to improve Trust in the digital economy, as long it has the capacity to cross the chasm between early-adopters and early-majority adopters.

Because of the problem mentioned above, this research proposal has three main objectives:

Objective 1: First using Gulati's (2019) human-computer trust as lenses to observe user's behaviours towards Trust in a different cultural context.

Objective 2: Second, explore Kahneman and Green [37] Loss Aversion as lenses to observe user's behaviours towards Trust in a different cultural context.

Objective 3: Third and last, to describe, analise and sintetise how to establish a pattern library for designing interaction behaviours, that improve adoption into early majority adopters, by leveraging trustworthiness.

The results of objectives 1 and 2 will help to design the strategy to be defined on objective 3.

Rationale assumptions

Assumption 1: As Sousa, (et al., 2014) [22], argues user's Trust in technology has been studied to create Trust patterns on users of disruptive technologies.

As described by Bower and Christensen [42], a disruptive technology introduces a very different package of attributes from the one mainstream users historically value, and they often perform a far worse along one or two dimensions that are particularly important to those customers. As a rule, mainstream customers are unwilling to use a disruptive product in an application they already know and understand. At first, then, disruptive technologies tend to be used only in new markets and new applications; in fact, they generally make it possible for the emergence of new markets.

Assumption 2: As Kahneman and Green [29] explored on their extensive research, the slow and fast thinking models to understand human judgment based on which level of the thinking was better activated. Their research is a step to develop a theory of human-computer Trust further to perceive if different cultures have different reactions to loss aversion or risk situations (e.g. losing personal information, information use threats).

Accordingly to Kahneman (et al., 1991) [37], there are two systems of thinking:

- System 1 operates automatically and quickly, with little or no effort and no sense of voluntary control
- System 2 allocates attention to the effortful mental activities that demand it, including complex computations. The operations of System 2 are often associated with the subjective experience of agency, choice, and concentration.

Assumption 3: It is possible to make the technology move towards to early majority adoption on a country like Brazil, where the population, the justice and government seem to have a better understand about the technology and are keen to adopt.

Theoretical background

Blockchain

The book "Blueprint for a new economy" [24] explains that Blockchain is the infrastructure created to support the cryptocurrency named Bitcoin, and its primary role is to be a ledger where it is registered, sequentially, all the transactions using the cryptocurrency. Later, the concept became more comprehensive to register transactions containing not just the transfer of cryptocurrencies, but for registering data and making some computation on decentralized Turing complete applications, generally called smart-contracts.

All blockchains have no blind spots or black boxes, and all of them have the concept of absolute transparency, immutability (tamperproof), auditability and the rewarding of users who help in the verification of transactions and data. Blockchain technologies are broadly studied because of the potential for improving Trust in all governance models since the tracking of supply distribution to e-voting systems. However, by far the end user does not know how to verify the information recorded, even if it is critical like a signature on a contract or a judge that need to decide some case, and the authenticity of the proofs are authenticated on a blockchain. The interface human-computer can influence the quantity of Trust on the system, even if the system is considered secure.

Cultural bias

Cultural bias is the interpretation and decision-making based on the environment and culture that people were being exposed and experienced. Different cultures can impact on the acceptability of evidence, even if it is registered on conventional technology.

Studies like "Consumer Trust in an Internet Store: a Cross-Cultural Validation" [28] already shows that consumers in different cultures have different expectations of what makes a web-store more or less trustworthy.

Loss aversion theory

Kahneman [37] defines loss aversion as the disutility of giving up an object is more significant than the utility associated with acquiring it.

Trust

Sousa (et al.,2014) [22], separates the approach to define Trust, in two-distinct domain definitions: operational and internal. The operational domain observes Trust from rational choices versus measurable risks. The internal domain reflects the individual's state of belief in the motivation of others, associated with notions of willingness, motivation and cooperation. Her approach to an operational perspective enables to leverage Trust, measuring, ex., the willingness to risk like the willingness to share or not to share some information.

Diffusion of innovation

According to Rogers' [32], five factors influence the adoption of an innovation, and each of these factors is at play to a different extent in the five adopter categories:

1. Relative advantage - The degree to which an innovation is seen as better than the idea, program, or product it replaces.
2. Compatibility - How is the consistency of an innovation with the values, experiences, and what are the needs of the potential adopters.
3. Complexity - How difficult innovation is to understand and use.
4. Traceability - The extent to which the innovation can be tested or experimented with before a commitment to adopt is made.
5. Observability - The extent to which the innovation provides tangible results.

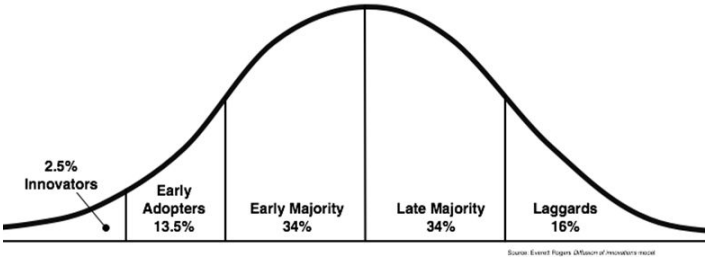

Fig. 1 Diffusion of Innovation
Source: http://blog.leanmonitor.com/early-adopters-allies-launching-product/

Motivation

Analysing Rogers' [32] model, Geoffrey Moore [34] concluded that there is a chasm between two distinct marketplaces for technology products:

- Early market: dominated by early adopters and insiders. They are people who understand and appreciate the benefits of technology and do not rely

on well-based references to make their buying decisions. They prefer to make decisions based on their vision and intuition.
- Mainstream market: people who want the benefits of the new technology, but are driven by a strong sense of practicality. They expect to see well-established references before investing. They wait and see how people are relating to the new technology, before deciding on getting it to themselves.

The transition between the two markets depends on a radical transformation to serve the mainstream market, and Trust can be the key to have a successful and smooth transition.

Trust is recognized as a way to facilitate human mediation in technology. As technologies are becoming complex, and the acceptance of them relies on Trust, where even the most disruptive innovation needs to improve the Trust layer to reach out to their customers. However, it seems the Trust impacts the acceptance and the decision-making judgement directly and potentialized by the cultural influence of the user.

Furthermore, because blockchain is a very new and disruptive technology and industry, which did not achieve the mainstream, and the use and adoption seem to be driven by Trust, it can be a great candidate to drive the research and, as well, generating benefits directly to both industry and technology.

At this moment, the European Commission is studying ways of enhancing the leadership on the global digital economy. It is even promoting the development and research on topics focused on social impact and how to improve digital opportunities to people and businesses.

One of their topics involves the strengthening of online Trust, security and inclusion, where they consider Trust and security the core of the Digital Single Market Strategy through the electronic Trust Services (eTS) and electronic Identification (eID) to enable the cross-border electronic transactions.

The timing is even favourable since Horizon2020 is enabled to fund Blockchain projects inside the Digital Single Market initiative. The fund has allocated up to EUR 340 million for incentivizing the research and development of blockchain projects for social good.

The proposed research can impact the European market, presenting a methodology for better development and acceptance of blockchain applications by the mainstream public, resulting in a direct social impact on the entire region.

Research problem

Many of the references found on the preliminary research showed how to build Trust between different systems, where they need to validate and trust in messages automatically sent between them. One example was the use of blockchain for building Trust in the communication on vehicular networks [2].

Another approach is about the evaluation of the trustworthiness of the participating entities on a network, to assist the detection of malicious nodes and mitigate the risk attacks.

Found HCI blockchain related theories on Trust, were based on identifying the main characteristics of a sort of blockchain (based on cryptocurrencies/Bitcoin) and their impact on Trust, listing specific characteristics like decentralisation, transactions transparency, and reputation. Anything based on leverage Trust between the human and computer interaction, but showing the aspects that shall be present to show there is some level of Trust.

There are not enough resources available, by empirical or limited by the scope, with attempts to quantify how much Trust is being placed during the adoption of blockchain, as also during the transition between the two adopter categories where the chasm takes place: between the early adopters and early majority adopters.

Also, as described in the motivation, blockchain is a very new technology who did not achieve the mainstream industry, and there are not enough resources available about the field.

Research goal

Those both levels of thinking (system 1 and system 2) have a profound influence on how humans take their decisions, and how they build Trust during the process of human-computer interaction. We will approach that process to improve the understanding of how to access, monitor and manipulate the human-computer Trust with an emphasis on blockchain technologies, considering the cultural influence of people in the different countries from Latin America, USA, Europe, Africa, and also countries like India and China.

Research questions or challenges

PhD studies will concentrate on the research embracing:

- Applying behavioural economic principles to the domain of human-computer interaction
- Mapping the divergences that cultural influence can impact on Trust in the domain of human-computer interaction

Social-technical interaction - Decision making - Trust

- RQ1: Can the Human-Computer Trust model (Gulati et.al, 2019) be applied to different cultures?
- RQ2: To what extent does Trust leverage technology acceptance?
- RQ3: To what extent does Trust support diffusion of innovation?
- RQ4: To what extent does Trust influences user's decisions towards technology use?

Methodology

We will approach that process to improve the understanding of how to access, monitor and manipulate the human-computer Trust on the two selected adopters categories (early adopters and early majority adopters) with an emphasis on blockchain technologies, considering the cultural influence of people in the different countries from Latin America, USA, Europe, Africa, and also countries like India and China.

This research will start by evaluating the relationship between Trust and its influence on users behaviours through a literature review. Then proceed with a field study through a survey that uses the Human-Computer Trust model of Trust (Gulati et al., 2019) as research lenses to design a confirmatory factor analysis to test the reliability of its constructs the role of Trust in decision making using distinctive cultures.

This will be achieved by carrying out several mixed method studies, combining ethnographic-interpretive approaches with surveys and large-scale data mining. The data will be used to inform and mapping the divergences that cultural influence can impact on Trust in the domain of human-computer interaction.

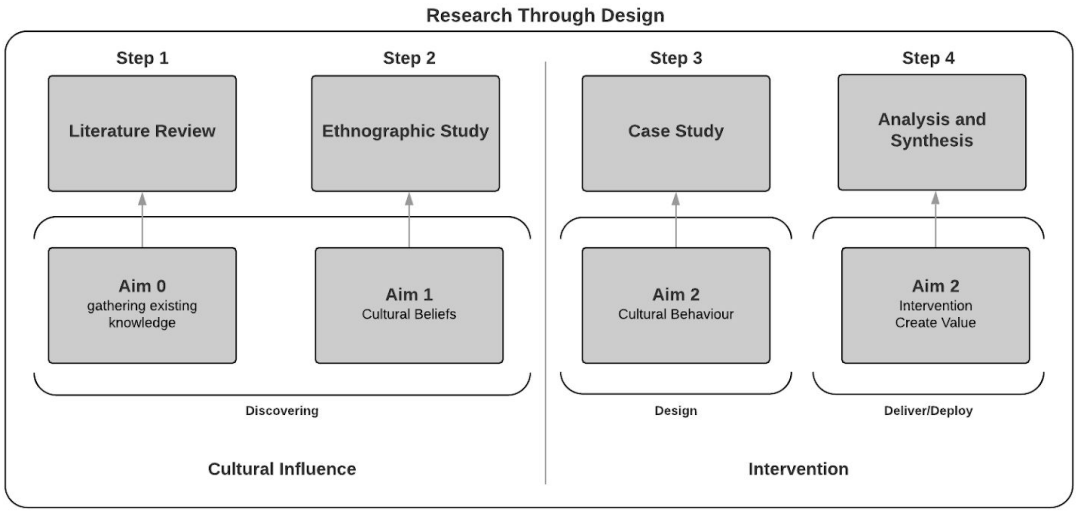

Fig 2: Research Through Design

The research aim is to connect cultural dimensions (Hofstede [30]) with research on measuring Trust along with Kahneman's [37][29] Loss aversion theory, applying both levels of thinking (system 1 and system 2) to the domain of Blockchain Technologies, focused on the two categories of adopters (early adopters and early majority adopters). The objective of the research is to develop guidelines for the diffusion of technology based on Trust.

It aims to highlight potential cultural bias and effects when deciding to accept and use disruptive technologies. Pearson's [36] correlation and multiple regression analysis will be conducted to find possible common behaviours patterns. Then to further design a behavioural user model that specific accounts for both 1) users user properties (e.g. preferences, attitudes, personality traits, which are stable over more extended periods); and 2) trust decisions attitudes drive the acceptance of the technology.

It will help to design a personalised system that adjusts to user Trust beliefs and preferences, proceeding during a case study.

Enhancing user/learner models considering user cultural bias towards Trust.

- Verify and assure the validity of the Trust scale on a global level
- Use the scale to develop strategies of Trust building
- Design and apply prototype to early majority adopters
- To analyse and synthesise patterns of Trust building.

Research Design Strategy and Instrumentation

Work Plan

The next section shows the initial plan for the research activities proposed during the PhD study period.

WP1 Preparation

T1.1 Literature review, gathering existing knowledge

WP1 involves taking classes on specific topics and reviewing the literature

WP2 Design the study and start Data Collection

T2.1 Reviewing cultural behavior patterns

T2.2 After the study designing, review the leverage of Trust on technology acceptance

WP2 will focus on general and common cultures like Brazil to gather data.

WP3 Propose design patterns to create Trust reinsurance mechanisms towards blockchain technology

T3.1 Design the patterns to support the diffusion of innovation between early adopters and early majority adopters.

T3.2 Design the case study to understand user's decisions towards technology use.

WP3 will apply the information gathered on questions 1 and 2 to be applied on a use case that will answer the questions 3 and 4.

WP4 Analysis and Synthesis

T4.1 Analysing and Synthesising

WP4 allows validating if the acceptance of the technology is subject by cultural influence and if you can insure Trust mechanisms through patterns.

Annual planning

Activity	1st year		2nd year		3rd year		4th year	
	I semester	II semester	I semester	II semester	I semester	II semester	I semester	II semester
Ethnographic studies								
Literature Review								
Research through design								
Publications								
- Conference - Step 2 paper								
- Conference - Step 1 paper								
- Journal - Step 3 paper								
- Journal - Step 4 paper								
Thesis compilation								

Impact and Outcomes

The proposed research aims to deliver four primary outcomes and an in-depth and insightful comparison between different cultural realities, between Latin America, USA, Europe, Africa, India and China.

Also, it expects to impact the science community, as technology and the industry by providing resources that will help to show how to deliver a technology which will have acceptance and Trust by the mainstream population.

To achieve the expected goals, it is crucial the participation of governments, regulators, institutions and companies during the development of the research, because of the global characteristics of it and the potential use of the outcomes delivered by the entities mentioned before.

- Model to measure Trust in human-computer interfaces on blockchain technologies
- Documented techniques and practices
- Prototypes
- Reports and publications

List of target conferences

NordiCHI a biennial conference functioning as the main Nordic forum for human-computer interaction research. In 2020 is going to be held in Tallinn, the author hopes to present here initial findings and validate his research proposal plan among HCI community.

INTERACT this conference addresses both the technical and social aspects of HCI. Within the broad umbrella of HCI, we will see to bring the cultural

differences of trusting technology and the need for Trust to tackle present digital transformation.

List of target journals

ACM Transactions on Computer Human Interaction (TOCHI) covers the software, hardware and human aspects of interaction with computers. The author aims at presenting a literature review on how humans take their decisions to adopt disruptive technologies and how building Trust can be a key to support those decisions.

ACM Interactions is a magazine aiming to connections people, experiences and technology. Here we aim at providing an overview of the achieved results.

References

[1] Hawlitschek, Florian & Notheisen, Benedikt & Teubner, Timm. (2018). The limits of trust-free systems: A literature review on blockchain technology and trust in the sharing economy. Electronic Commerce Research and Applications. 29. 10.1016/j.elerap.2018.03.005.

[2] Z. Yang, K. Yang, L. Lei, K. Zheng and V. C. M. Leung, "Blockchain-Based Decentralized Trust Management in Vehicular Networks," in *IEEE Internet of Things Journal*, vol. 6, no. 2, pp. 1495-1505, April 2019. doi: 10.1109/JIOT.2018.2836144

[3] Berg, Chris and Davidson, Sinclair and Potts, Jason, Blockchains Industrialise Trust (November 19, 2017).

[4] Risius, M. & Spohrer, K. Bus Inf Syst Eng (2017) 59: 385. A Blockchain Research Framework https://doi.org/10.1007/s12599-017-0506-0

[5] Beck, Roman; Stenum Czepluch, Jacob; Lollike, Nikolaj; and Malone, Simon, "BLOCKCHAIN – THE GATEWAY TO TRUST-FREE CRYPTOGRAPHIC TRANSACTIONS" (2016). Research Papers. 153.

[6] Scott J. Shackelford & Steve Myers, Block-by-Block: Leveraging the Power of Blockchain Technology to Build Trust and Promote Cyber Peace, 19 Yale J.L. & Tech (2018).

[7] Z. Lu, W. Liu, Q. Wang, G. Qu and Z. Liu, "A Privacy-Preserving Trust Model Based on Blockchain for VANETs," in IEEE Access, vol. 6, pp. 45655-45664, 2018.

[8] G. Zyskind, O. Nathan and A. '. Pentland, "Decentralizing Privacy: Using Blockchain to Protect Personal Data," 2015 IEEE Security and Privacy Workshops, San Jose, CA, 2015, pp. 180-184.

[9] Q. Xia, E. B. Sifah, K. O. Asamoah, J. Gao, X. Du and M. Guizani, "MeDShare: Trust-Less Medical Data Sharing Among Cloud Service Providers via Blockchain," in IEEE Access, vol. 5, pp. 14757-14767, 2017.

[10] Moinet, Axel, Benoît Darties, and Jean-Luc Baril. "Blockchain based trust & authentication for decentralized sensor networks." *arXiv preprint arXiv:1706.01730* (2017).

[11] Sun, Y.L., Han, Z., Yu, W., & Liu, K.J. (2006). A trust evaluation framework in distributed networks: Vulnerability analysis and defense against attacks. Proceedings IEEE INFOCOM 2006. 25TH IEEE International Conference on Computer Communications, 1-13.

[12] Hammi, Mohamed Tahar, et al. "Bubbles of Trust: A decentralized blockchain-based authentication system for IoT." *Computers & Security* 78 (2018): 126-142.

[13] Corina Sas and Irni Eliana Khairuddin. 2017. Design for Trust: An Exploration of the Challenges and Opportunities of Bitcoin Users. In Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems (CHI '17). ACM, New York, NY, USA, 6499-6510.

[14] Mathews, Malachy, Dan Robles, and Brian Bowe. "BIM+ blockchain: A solution to the trust problem in collaboration?." (2017).

[15] Jun Lin, Zhiqi Shen, and Chunyan Miao. 2017. Using Blockchain Technology to Build Trust in Sharing LoRaWAN IoT. In Proceedings of the 2nd International Conference on Crowd Science and Engineering (ICCSE'17). ACM, New York, NY, USA, 38-43.

[16] Otte, Pim, Martijn de Vos, and Johan Pouwelse. "TrustChain: A Sybil-resistant scalable blockchain." *Future Generation Computer Systems* (2017).

[17] Ali, Muneeb, et al. "Bootstrapping trust in distributed systems with blockchains." *login: USENIX Mag.* 41.3 (2016).

[18] N. Alexopoulos, J. Daubert, M. Mühlhäuser and S. M. Habib, "Beyond the Hype: On Using Blockchains in Trust Management for Authentication," 2017 IEEE Trustcom/BigDataSE/ICESS, Sydney, NSW, 2017, pp. 546-553.

[19] Seppälä, Jane. "The role of trust in understanding the effects of blockchain on business models." (2016).

[20] Auinger, Andreas, and RenÃ Riedl. "Blockchain and trust: Refuting some widely-held misconceptions." (2018).

[21] Hawlitschek, Florian, Benedikt Notheisen, and Timm Teubner. "The limits of trust-free systems: A literature review on blockchain technology and trust in the sharing economy." *Electronic commerce research and applications* 29 (2018): 50-63.

[22] Sousa, Sonia C., et al. "A Design Space for Trust-enabling Interaction Design." *MIDI*. 2014.

[23] S. Sousa, P. Dias and D. Lamas, "A model for Human-computer trust: A key contribution for leveraging trustful interactions," *2014 9th Iberian Conference on Information Systems and Technologies (CISTI)*, Barcelona, 2014, pp. 1-6.

[24] Swan, Melanie. *Blockchain: Blueprint for a new economy*. " O'Reilly Media, Inc.", 2015.

[25] Marris, Claire, Ian H. Langford, and Timothy O'Riordan. "A quantitative test of the cultural theory of risk perceptions: Comparison with the psychometric paradigm." *Risk analysis* 18.5 (1998): 635-647.

[26] Huff, Lenard, and Lane Kelley. "Levels of organizational trust in individualist versus collectivist societies: A seven-nation study." *Organization Science* 14.1 (2003): 81-90.

[27] Pinotti, Paolo. "Trust, regulation and market failures." *Review of Economics and Statistics* 94.3 (2012): 650-658.

[28] Jarvenpaa, Sirkka L., Noam Tractinsky, and Lauri Saarinen. "Consumer trust in an Internet store: A cross-cultural validation." *Journal of Computer-Mediated Communication* 5.2 (1999): JCMC526.

[29] Kahneman, Daniel. *Thinking, fast and slow*. Macmillan, 2011.

[30] Hofstede, Geert. "Geert Hofstede cultural dimensions." (2009).

[31] Sahin, Ismail. "Detailed review of Rogers' diffusion of innovations theory and educational technology-related studies based on Rogers' theory." *Turkish Online Journal of Educational Technology-TOJET*5.2 (2006): 14-23.

[32] Rogers, Everett M. *Diffusion of innovations*. Simon and Schuster, 2010.

[33] Robertson, Thomas S. "The process of innovation and the diffusion of innovation." *Journal of marketing* 31.1 (1967): 14-19.

[34] Moore, Geoffrey A., and Regis McKenna. "Crossing the chasm." (1999).

[35] Benesty, Jacob, et al. "Pearson correlation coefficient." *Noise reduction in speech processing*. Springer, Berlin, Heidelberg, 2009. 1-4.

[36] Pearson, Karl. "VII. Note on regression and inheritance in the case of two parents." *proceedings of the royal society of London* 58.347-352 (1895): 240-242.

[37] Kahneman, Daniel, Jack L. Knetsch, and Richard H. Thaler. "Anomalies: The endowment effect, loss aversion, and status quo bias." *Journal of Economic perspectives* 5.1 (1991): 193-206.

[38] Hofstede, Geert, and Michael H. Bond. "Hofstede's culture dimensions: An independent validation using Rokeach's value survey." *Journal of cross-cultural psychology* 15.4 (1984): 417-433.

[39] Luu, L. "Blockchain Adoption: How Close Are We Really?." (2018). https://www.forbes.com/sites/luuloi/2018/01/26/blockchain-adoption-how-close-are-we-really/#6346c736d9dc

[40] Coin Crunch, "Don't kid yourself, this is still the early adoption phase" (2018). https://hackernoon.com/dont-kid-yourself-this-is-still-the-early-adoption-phase-3463573b4bab

[41] Mejia, D. "Early adopters show blockchain's big potential for Latin America" (2019). https://venturebeat.com/2019/01/20/early-adopters-show-blockchains-big-potential-for-latin-america/

[42] Bower, Joseph L., and Clayton M. Christensen. "Disruptive technologies: catching the wave." (1995): 43-53.