Use of distributed ledger technologies to formalize Ostroms governance properties

Research plan

By Jarno Marttila

Outline

My research explores the use and applicability of decentralized ledger technologies on creating socio-technical systems to alleviate commons-related governance challenges. I am particularly interested in investigating how Ostrom's design principles (Ostrom 1990, 2010) for sustainable self-governing systems can be applied to designing scalable governance systems in the distributed ledger technology (DLT) space.

Research motivation and objectives

Exploitation is in human nature. We are biologically programmed to compete against each other, which can be beneficial for individuals but also detrimental for the ecosystem we live in. In economics we study the behavior of humans and how incentives and disincentives can guide them towards the wanted system goal (Fehr & Falk, 2002). Given this premise with the right tools and economic incentives systems can be made fairer and more equitable.

A commonly known challenge with any commons is the tragedy of the commons. It occurs when people who have access to common pool resources act independently on their self-interest against the common good of all users of the resource and cause the depletion of the resource due to their uncoordinated activities (Hardin 1968, Ostrom 1990, Ostrom 2008). Tragedy of the commons is mostly associated with the natural resources, such as fisheries, water and forests, but it can also occur for information and knowledge commons (Hakanen et al. 2022, Grego & Floridi 2004, de Rosnay & Stalder, 2020).

Distributed Ledger Technologies (DLT) and especially blockchain applications are still seen as solutions searching for a problem despite its many promises such as immutability, transparency and decentralization of trust and governance (Filippi et al. 2020). Some success stories exist in the blockchain space in regards to applications, such as Maersk and IBMs Tradelens, a private blockchain based solution for tracking supply chain information in multi-stakeholder environment (Jensen et al. 2019), but in the wider picture the blockchain space is littered with hype and unreasonable expectations.

DLT systems provide novel technical frameworks such as programmable smart contracts that can be utilized to rapidly develop and test new types of tokenized solutions that would be

arduous to replicate in an analogue world such as anti-rival accounting methods. DLTs have garnered criticism associated with the DLT applications and their perceived utility (Filippi et al. 2020, Nordgren et al. 2019, Kosmarski 2020). Despite the critique they drive a paradigm shift from centralized systems towards distributed and decentralized systems.

There is no comprehensive understanding on how Ostroms (1990, 2010) design principles for sustainable self-governing systems can be applied for designing scalable governance systems in the distributed ledger technology space.

My plan is to investigate how Ostroms governance principles have been applied in the blockchain space, with a special interest in the application of them for information and knowledge commons governance and commons-based peer production such as open source software projects. In the process, I will contribute to the emergent literature on the governance of polycentric information commons.

In my doctoral thesis I will combine different sources of information in order to construct a holistic understanding on how commons-related governance mechanisms can be formalized with DLTs.

Theoretical perspectives

The institutional building of governance systems for common pool resources has been studied extensively (Laerhoven & Ostrom 2007, Ostrom 1990, Ostrom 2010, Cox 2010, Cila et al. 2020, Davidson et al. 2016). Ostrom has observed that people who are close to the commons i.e. users of the commons, are able to create stable self-governing systems without external top-down centralized governance models and signaling from 'the market' or from 'the state' (Ostrom 1990, Davidson et al.2016). Ostrom identified eight different design principles that guide towards creation of an institution that can manage a common pool resource - work that resulted in a nobel prize in economics.

Ostrom's original work has been influenced by the phenomenon of the tragedy of the commons and limited by the observations of governance systems and institutions built around the use of the natural resources, or so called commons 1.0 (Davidson et al. 2016).

Now moving on from natural resource commons towards information and knowledge resource commons, or commons 2.0, the issue of tragedy of the commons persists. Though the information and knowledge commons do not suffer from the overuse of the resources in similar way as natural resources, they do suffer from underprovisioning back to the commons and the challenges of building self-governing systems persist as well.

Research in the use of blockchain-based technology is relatively novel in relation to designing and creating commons based governance systems (Rozas et al. 2021, Cila et al. 2002, Davidson et al. 2016). There are indications that the qualities and principles of blockchain-based

technologies have potential to facilitate coordination and to help scaling up commons governance (Rozas et al. 2021) and that the structure of Ostroms rules may be relatively same to the Ostroms identified design rules in the blockchain-based technology space (Cox et al 2010).

While the affordances and principles of blockchain based technologies seem to match the Ostroms principles (Rozas et al. 2021), there are studies that have identified that the lack of design principles for DLT-based platforms are a hindering factor in their development and adoption (Cila et al. 2020). Thus, DLTs and more specifically blockchains seem to be a suitable technology to answer to the call of governing commons, but there seems to be a lack of suitable tools, frameworks and research publications to facilitate greater adoption.

There may also be other limitations that hinder the development and adoption of DLT-based technologies for creating self-governance systems for commons which should be uncovered to fully understand the complexities involved in adoption of such systems.

Funding

Publications to date

Examination on how alumni studies and visualizations of their career paths shared on university specific social media service motivate and commit students to their studies.
Kailanto, M., Silius, K., Tervakari, A. M., Marttila, J., Tebest, T., & Huhtamäki, J. (2012, April). Alumni stories and students' commitment to studies. In Proceedings of the 2012 IEEE Global Engineering Education Conference (EDUCON) (pp. 1-8). IEEE.

Computational modeling of electromagnetic field of contact failure in a coaxial high-frequency signal transmission line to further discussion on contact conditions and EM-fields around transmission lines.
Marttila, J., Hayashi, Y. I., Kayano, Y., SONE, H., & INOUE, H. (2008). Computation of Electromagnetic Field Distribution in a Cross-Section of Connector with Contact Failure. 電子情報通信学会技術研究報告. EMD, 機構デバイス, 108(296), 77-80.

Whitepaper publication on how first-mile traceability data of seafood can be collected and how its production can be incentivized with a mobile decentralized application.
Marttila, J and Nousiainen, M and Sheppard, B and Malka, M and Karjalainen, R. (2019) Tracey - your trade and traceability companion.
https://tx.company/wp-content/uploads/2020/10/Tracey-Whitepaper-2019.pdf

A case study on how interdisciplinary cross university course motivated students to learn and to develop their professional competencies and collaboration skills.

Silius, K., Tervakari, A. M., Kailanto, M., Huhtamäki, J., Marttila, J., Tebest, T., & Miilumäki, T. (2012). Developing an online publication collaborating among students in different disciplines. In Proceedings of the 2011 2nd International Congress on Computer Applications and Computational Science (pp. 361-367). Springer, Berlin, Heidelberg.

Research paper on evaluating pedagogical use of social media enabled learning platform on learning programming and evaluation of peer learning in the pilot case platform.
Silius, K., Tervakari, A. M., Huhtamäki, J., Tebest, T., Marttila, J., Kailanto, M., & Miilumäki, T. (2012). Programming of Hypermedia. In Proceedings of the 2011 2nd International Congress on Computer Applications and Computational Science (pp. 369-376). Springer, Berlin, Heidelberg.

Introductory paper to learning analytics on an instance of a social media enabled learning platform and evaluation of use of learning analytics on three case studies.
Tervakari, A. M., Marttila, J., Kailanto, M., Huhtamäki, J., Koro, J., & Silius, K. (2012, July). Developing learning analytics for TUT Circle. In IFIP WG 3.4 International Conference on Open and Social Technologies for Networked Learning (pp. 101-110). Springer, Berlin, Heidelberg.

A study on the use of bespoke social media enhanced learning environment to enhance students' collaboration, communication and networking skills.
Tervakari, A. M., Silius, K., Tebest, T., Marttila, J., Kailanto, M., & Huhtamäki, J. (2012, April). Peer learning in social media enhanced learning environment. In Proceedings of the 2012 IEEE Global Engineering Education Conference (EDUCON) (pp. 1-9). IEEE.

Publication plan

I've taken part in the following publications, which are relevant to the topic.

In progress:
Elo, Marttila, Cutillas, Hakanen. Elements of Anti-rival Accounting with Shareable Non-Fungible Tokens. (ICCS, in review)

Hakanen, Eloranta, Marttila, Amadae. Digital protocols as accounting and incentivization mechanisms in anti-rival systems – Developing a shareable non-fungible token (sNFT) (ETLA, in review).

Shamsuzzoha, A., Marttila, J. Application of blockchain technology in the seafood supply chain traceability systems: a case study (in review)

Shamsuzzoha, A., Marttila, J., Helo, P. Blockchain-based supply chain traceability system for the sustainable seafood industry (in review)

Planned:
Governing collective action in polycentric information commons

Design principles for DLT platforms

Use of sNFT as an incentive in a web3 community

Towards sustainable web3 community governance

Potential academic journals for publications:
Journal of Operations Management
Journal of Experimental Innovation
IEEE Access
Journal of Economic Theory
Academy of Management Review

The research study and papers are expected to be done on the basis of work done in the ATARCA research project[1] (2021-2023), the upcoming continuation for the ATARCA research project and on the basis of day-to-day research and development work done in blockchain space.

Plan for international mobility

No current plans in relation to international mobility.

Expected duration of studies

Considering that the personal research journey started in 2008 and restarted in 2021 the duration of studies should take no longer than five years with expected graduation by 2028.

Expected outcomes

Increasing the understanding of applicability of DLTs and especially blockchain based technologies for commons governance while also furthering and developing the associated tooling for it such as frameworks, models, design patterns and IT artifacts.

Personal motivation

Given my background working as a software engineer in DLT projects and my academic background both in computer science and in economics I am also interested in investigating development and application of design tools and frameworks for token economics which could be applied to support formalization of Ostrom's design principles in real world use cases.

---

[1] https://atarca.eu/

References:

Cila, N., Ferri, G., De Waal, M., Gloerich, I., & Karpinski, T. (2020, April). The blockchain and the commons: Dilemmas in the design of local platforms. In Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems (pp. 1-14).

Cox, M., Arnold, G., & Tomás, S. V. (2010). A review of design principles for community-based natural resource management. Ecology and Society, 15(4).

Davidson, S., De Filippi, P., & Potts, J. (2016). Economics of blockchain. Available at SSRN 2744751.

De Filippi, P., Mannan, M., & Reijers, W. (2020). Blockchain as a confidence machine: The problem of trust & challenges of governance. Technology in Society, 62, 101284.

Dulong de Rosnay, M., & Stalder, F. (2020). Digital commons. Internet Policy Review, 9(4), 1-22.

Fehr, E., & Falk, A. (2002). Psychological foundations of incentives. European economic review, 46(4-5), 687-724.

Greco, G. M., & Floridi, L. (2004). The tragedy of the digital commons. Ethics and Information Technology, 6(2), 73-81.

Hakanen, E., Eloranta, V., & Shaw, C. (2022). Forming digital commons: The role of signaling and sociology of translation in decentralized systems. Academy of Management Proceedings 2022, 11067.

Hardin, G. (1968). The tragedy of the commons: the population problem has no technical solution; it requires a fundamental extension in morality. science, 162(3859), 1243-1248.

Jensen, T., Hedman, J., & Henningsson, S. (2019). How tradelens delivers business value with blockchain technology. MIS Quarterly Executive, 18(4).

Kosmarski, A. (2020). Blockchain adoption in academia: Promises and challenges. Journal of Open Innovation: Technology, Market, and Complexity, 6(4), 117.

Mindel, V., Mathiassen, L., & Rai, A. (2018). The sustainability of polycentric information commons. MIS Quarterly, 42(2), 607-632.

Nordgren, A. I. N. O., Weckström, E. L. L. E. N., Martikainen, M. I. N. N. A., & Lehner, O. M. (2019). Blockchain in the fields of finance and accounting: a disruptive technology or an overhyped phenomenon. ACRN Journal of Finance and Risk Perspectives, 8, 47-58.

Ostrom, E. (1990). Governing the commons: The evolution of institutions for collective action. Cambridge university press.

Ostrom, E. (2008). Tragedy of the commons. The new palgrave dictionary of economics, 2.

Ostrom, E. (2010). Beyond markets and states: polycentric governance of complex economic systems. American economic review, 100(3), 641-72.

Rozas, D., Tenorio-Fornés, A., Díaz-Molina, S., & Hassan, S. (2021). When ostrom meets blockchain: exploring the potentials of blockchain for commons governance. Sage Open, 11(1), 21582440211002526.

Van Laerhoven, F., & Ostrom, E. (2007). Traditions and Trends in the Study of the Commons. International Journal of the Commons, 1(1), 3-28.