The University Journal: A Doctoral Association of Eastern Africa (DAEA) Publication
Vol 8(2 Sup. Issue II)

ISSN: 2519-0997 (Print)

Towards a Critical Realist Epistemology for Blockchain Research

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Cite: Nooseli, M., Okello, G., & Okanda, P. (2026). Towards a Critical Realist Epistemology for Blockchain Research. *The University Journal, 8*(2 Sup. Issue II), 14-21.

Abstract

Although the transformative power of blockchain technology in the context of various global governance frameworks has been widely noted, the emergence of blockchain as an Information System (IS) artifact remains poorly supported by the consolidated and robust epistemological framework. This paper fills the gap by critically evaluating the blockchain technology using the lenses of the three main IS research paradigms: positivism, interpretivism, and critical theory. This paper suggests that while the former paradigm provides a great opportunity to model the deterministic and immutable aspects of blockchain as an object, and the latter – to explore the subjective views of human actors, neither of them independently takes into consideration the complex interaction of the sociotechnical processes that accompany blockchain implementation. Therefore, it is proposed to adopt the philosophical approach of Critical Realism (CR), combining the epistemological perspectives of CR and the process-based research approach outlined by J.D. Roode.

Keywords: Blockchain, Critical realism, Interpretivism, Positivism, Information Systems, Research Methodology.

Introduction

Information System (IS) has long remained difficult to define as an academic domain. The foundational research in IS conducted by Mason and Mitroff (1973) stressed the importance of identifying the problematics of creating a unified approach for the management information systems research. Embedded deeply in the formal research of the technical and social aspects of the information technology, IS represents a multidisciplinary field at the intersection of technical architecture and human behavior.

The first step in every academic study of IS begins with the definition of the studied information system. According to Turban (1996), the IS could be defined as a set of integrated components which aim at collecting, processing, storing, analyzing, and delivering the information for the achievement of the predetermined objectives. At the same time, Preston (1991) called the academic community to reflect on the underlying assumptions and theoretical constructs, as well as contextual factors that determine the understanding of IS practice. This reflection is important because the field of IS research goes far beyond the purely technical aspects. As Checkland and Holwell (1998) noted, the

main issue for the field is to provide the ordered access to the information for people acting purposefully in the organizational context.

This notion highlights the sociotechnical complexity of both "information" and "organization". Being a cross-disciplinary domain, the research in IS is based on the exact sciences (e.g., system theory, control theory, and decision sciences), technology (e.g., computer science and information theory), and social behavioral sciences (e.g., sociology, cognitive psychology, and economics) (Ahituv & Neumann, 1982; Benbasat & Zmud, 1999). Such intersection makes researchers choose the epistemological frameworks which would be able to unite technical determinism with social constructivism.

Sociotechnical Complexity of Blockchain

Being the new stage in development of the distributed ledger technology (DLT), blockchain could be regarded as a peer-to-peer, secure, transparent, and tamper-proof network that performs transactions without intermediaries (Nidhieaswar, 2023). The core characteristics of blockchain include decentralized decision-making, distributed processing, cryptographic immutability, consensus-driven automaticity, low transaction latency, and non-repudiability. Thus, blockchain has been often considered as a trust-building machine (Bahga & Madisetti, 2017; Iansiti & Lakhani, 2017; Nakamoto, 2018; Narayanan et al., 2016).

At the same time, empirical evidence shows that just the technical architecture cannot ensure the success of the implementation of blockchain solutions, and their performance is dependent on political, social, and institutional aspects (Bhutta et al., 2021). For instance, the comparative analysis of the blockchain solutions in the public sector shows that the 60% of the political support of the country limits the implementation of the smart contracts in the case of Armenia, whereas the 94% of the political support is required to perform the successful digital governance in the case of Estonia (Vardan & Hovik, 2025). Similarly, the failure of e-Zwich project in Ghana is explained by the lack of the necessary political and institutional support (Monethi, 2023), and the successful experience of Georgia with the land registry modernization is explained by the appropriate legislative reforms (Reyan & Twinomurinzi, 2023).

Thus, in order to study these processes, IS researchers have been using behavioral frameworks such as the Technology Acceptance Model (TAM). Based on the Theory of Reasoned Action (TRA) (Ajzen & Fishbein, 1975; Fishbein et al., 1975), TAM states that the decision to accept a particular system is defined by two main beliefs which are formed under the intentions of the user: Perceived Usefulness (PU) and Perceived Ease of Use (PEOU) (Davis, 1989; Davis et al., 1989). Although the validity of TAM to predict the IT acceptance is confirmed by Adams et al. (1992), Doll et al. (1998), etc., the constructs of TAM do not take into consideration the complex trust dynamics, regulatory restrictions, and other structural aspects of the decentralized systems. In order to do so, researchers have been supplementing TAM with such social constructs as Trust and Trustworthiness (Gefen et al., 2003; Carter & Bélanger, 2005), Perceived Credibility (Wang, 2003), and System Compatibility and Resources (Mathieson et al., 2001; Chen et al., 2002).

This combination of constructs shows that blockchain is not simply a technically deterministic software (positivist approach) or a socially created projection of its users (interpretive approach). Blockchain is a sociotechnical system, and to properly research it,

we need to find the epistemological paradigm which will be able to incorporate its immutable architectural aspect with its highly variable social and political contexts.

Evaluation of Competing Philosophical Foundations

In order to develop a research design, we have to evaluate the ontological and epistemological assumptions which guide our research. The ontological assumptions represent our beliefs about the nature of reality, especially whether it exists independently of our perception (objectivism), or whether it is socially constructed (constructionism) (Bryman & Bell, 2001; Cresswell, 2003). The epistemological assumptions dictate the way in which we gain valid knowledge about this reality. Table 1 shows the philosophical dimension of the IS research paradigms.

Table 1

Philosophical dimension of the IS research paradigms

Philosophical Dimension	Positivism	Interpretivism	Critical Realism
Ontological Stance	Objectivism: Reality is singular, objective, and independent.	Constructionism: Reality is socially constructed, multiple, and local.	Stratified Realism: An independent reality structured into Real, Actual, and Empirical.
Epistemological Stance	Dualist/Objective: Derived from direct empirical observation and measurement.	Subjectivist: Co-created through human experience and interpretation.	Modified Objectivist: Reality is independent but knowledge is socially conditioned.
Common Methodologies	Quantitative, deductive, experiments, statistical modeling.	Qualitative, inductive, ethnography, phenomenology.	Mixed methods, retrodictive analysis, case studies.
Application to Blockchain	Measures transaction speeds, consensus efficiency, and TAM correlations.	Explores user trust, institutional resistance, and cultural perceptions.	Evaluates how objective properties interact with social structures.

Positivism

Historically, the early IS research has been based on the positivist epistemology (Mingers, 2004). Positivism assumes that all phenomena in the physical and social worlds follow some laws, and can be objectively measured and analyzed (Hussey & Hussey, 1997).

Scientific progress under positivism is made through hypotheses testing and identification of empirical regularities.

Applied to blockchain, the positivist approach is very useful to explore its objective aspects (Piccardo et al., 2024). For instance, it is possible to measure objectively transaction latencies, cryptographic security aspects, database throughput, and TAM-related correlations.

However, positivism has its drawbacks in application to social systems. Since it focuses only on the measurable aspects, it is unable to explain why the same technologies perform successfully in one organizational context (such as Georgia's land registry), but unsuccessfully in another (such as Ghana's e-Zwich project) (Phillips & Burbules, 2000; Bryman & Bell, 2001).

Interpretivism

As the alternative to positivism, interpretivism became a paradigm of IS research in 1980s and 1990s (Mingers, 2004). Based on the ideas of social constructivism, interpretivism states that the worlds in the physical and social contexts differ (Benton & Craib, 2001). The social reality is created through the process of interpreting human experience (Berger & Luckmann, 1967; Mannheim, 1997; Guba & Lincoln, 1985).

An interpretive approach helps IS researchers to investigate how the different stakeholders interpret decentralized systems. It allows to examine such issues as development of trust, redistribution of power, and adaptation of the organizational culture in the new circumstances. However, interpretivism has its own drawbacks. First, since it is focused on interpreting the experience, it may easily become relativist, leaving researchers with no objective criteria for evaluation of the actual performance of blockchain systems (Bryman & Bell, 2001; Weber, 2004). Second, it is incapable of taking into account the deterministic, objective aspects of blockchain technology. The cryptographic laws, consensus rules, and immutable ledgers of the blockchain work independently of the human perception and interpretation.

The Case for Critical Realism in Blockchain Research

Resolving the Paradigm Conflict

In order to overcome the drawbacks of positivism and interpretivism, this paper argues that the adoption of Critical Realism (CR) as an underlying philosophical approach is needed. Unlike positivism and interpretivism, which represent mutually exclusive paradigms, CR implies a pluralistic approach (Fitzgerald & Howcroft, 1998; Mingers, 2001). It unites realism and epistemology of social conditioning (Mingers, 2004). Critical realism, as stated by Bhaskar (2024), stratifies reality into three distinct domains:

1. **The Real:** The deepest domain, which contains the generative mechanisms, causal structures, and physical properties (cryptographic protocols, smart contract source code, consensus algorithms, etc.) which exist independently of our observation.

2. **The Actual:** The domain where the generative mechanisms are activated, producing some events that may or may not be observed (execution of the smart contract, validation of a block, or failure of the system).

3. The Empirical: The shallowest domain, which consists of the observations, experience, and perceptions of the actual events by the humans (transaction speed, user perception, the manager's trust in the ledger, political resistance, etc.).

With the help of this stratification, we are able to consider blockchain architecture as a part of the Real domain. These properties have their own causality and powers. However, when these powers are activated in the Actual domain, they are mediated by the human agency, politics, and organizational structures. The resulting experience and perceptions form the Empirical domain (Monod, 2004; Phillips & Burbules, 2000).

Methodological Integration via Roode's Process-Based Model

In order to apply critical realism in the empirical research on blockchain, it is possible to map our philosophical approach to J.D. Roode's (1993) process-based research model shown in Figure 1. It is aimed at the exploration of sociotechnical phenomenon through dynamic questioning.

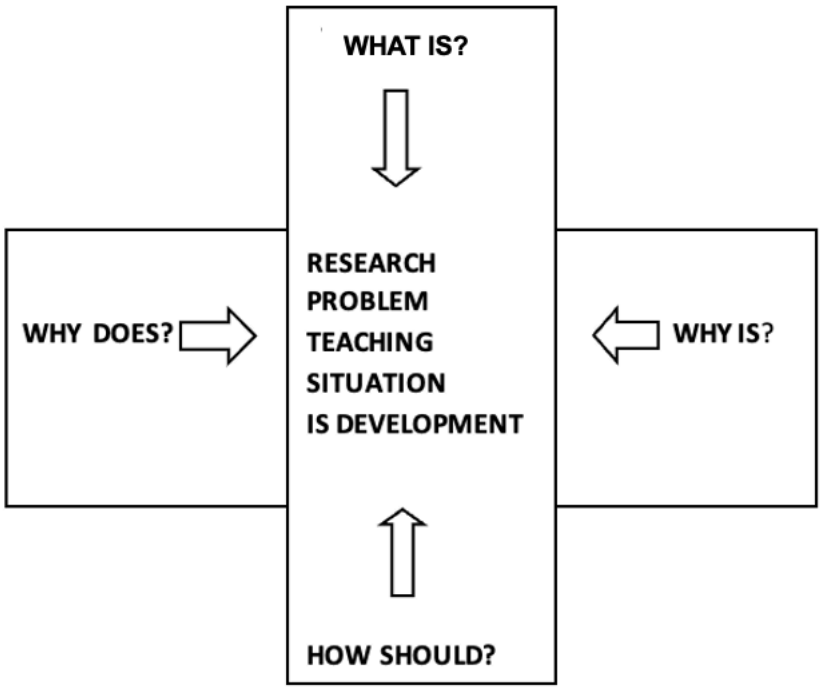

Figure 1: Generic Research Questions by Roode, (1993)

Applying this model, we are able to structure our research of the blockchain opportunities, problems, and practical implementation around the four core ontological questions:

a) **What are the challenges which hinder the success of blockchain?** This question is aimed not only at describing the human complaints, but at identifying the structural contradictions, regulatory restrictions, and technical difficulties (located in the Real) which prevent the proper implementation of the blockchain in the Actual domain.

b) **How do citizens benefit from blockchain?** This question is aimed at assessing the actual impact of the decentralized systems on their users. On the one hand, it should include the objective measures (such as reduced transaction fees or increased speed of processing). On the other hand, it should include the subjective assessment of the benefits and empowerment of the stakeholders.
c) **How does blockchain help to improve service provision?** This question concerns the influence of the blockchain properties (immutable, traceable, and automated) on the organizational processes and the service provision.
d) **How should blockchain be implemented?** Going beyond the descriptive aspect, this question focuses on finding out the best implementation strategies (considering that while the core of the technology is constant, implementation approaches are variable).

Making the decisions on the research of blockchain requires the consideration of many factors, since our philosophical framework affects the research questions, design, and data interpretation. The positivist paradigms are useful for the analysis of the objective, highly structured phenomena which are minimally affected by the human perception. The interpretive paradigms are suitable for the examination of the socially shared realities, user perceptions, and cultural dynamics. At the same time, since blockchain is a sociotechnical system, we require the paradigm which will allow to unite both dimensions. Critical Realism is the one.

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