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Application of Cyber-Constructive Triangulation in Qualitative Research: Simultaneous Analysis of Human, Machine, and Data Interactions

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A B S T R A C T

The refinement of artificial intelligence (AI) systems has significantly impacted the field of qualitative research. Within this space, the interaction of human researchers, algorithmic agents, and data architectures is complex and requires new methodological frameworks which are adaptive and responsive. This article presents a new mixed-method framework called Cyber-Constructive Triangulation (CCT) which seeks to provide solutions to the epistemic, ethical, and methodological dilemmas posed by the intersection of qualitative research and AI technologies in the age of big data. The framework aims to examine the simultaneous and critical interplay of three elements: humans (the researchers and the participants), machines (algorithms and automated systems), and data (the digital and social systems). Unlike other approaches which CCT as a qualitative methhod attributes meaning construction solely to human activity or technology, CCT illustrates that in digital research, meaning and knowledge emerge from interplay of distributed processes involving human and non-human actors. These are informed by three main theories which are Foucault power/knowledge theory, Castells' network society theory, and Beck risk society theory. They assist in the examination of algorithmic power, digital agency, and ethical risks posed by modern technologies. The model comprises of three primary stages: design, creation of mixed data set and perform a three-tiered analysis composed of interpretive, algorithmic, and contextual layers. This enhances the level of analysis, promotes ethical sensitivity, and allows researchers to become more self-aware and responsible. This paper demonstrates through case studies the different applications of CCT in various disciplines as a general, reusable, and locally flexible instrument for qualitative data analysis. In this sense, CCT presents a new opportunity for qualitative researchers working in digital spaces to integrate precision, reasoning, and theoretical coherence.

Keywords: *Cyber-Constructive Triangulation, Qualitative Methodology, Foucault's Power/Knowledge, Castells' Network Society, Beck's Risk Society, AI Ethics.*

1. Introduction

The expansion of digital technologies and artificial intelligence has fundamentally transformed the epistemological foundations and methodological approaches of qualitative research in the fields of humanities and social sciences (AlDajani & Bocanegra Barbecho, 2024; Meyer & Schroeder, 2023; Qin, 2024). Tools such as Computer-Assisted Qualitative Data Analysis Software (CAQDAS), including NVivo, Atlas.ti, webQDA, and MAXQDA, enable researchers to code and structurally analyze complex, multimedia, and large-volume data. At the same time, big data, machine learning, and sentiment analysis on social platforms have introduced new capacities for uncovering hidden patterns and insights (Bryda & Costa, 2023; Yeasmin, 2024). However, these technological developments have raised new questions regarding agency, bias, and ethics in the process of knowledge production. Classical qualitative frameworks are not fully equipped to address these challenges (Rowe, 2018).

Data triangulation in qualitative research refers to approaching a question from multiple perspectives. This process involves using several data sources or methods to analyze a theory or validate a finding (Pashaie et al., 2023). By embracing diverse perspectives and methods, researchers are able to validate their findings, leading to more comprehensive and reliable results while enhancing their ability to navigate cultural dynamics. Findings can also become more culturally sensitive and accurate. Beyond methodological aspects, triangulation allows researchers to capture varied viewpoints and enrich their analysis. This approach plays a significant role in enhancing the credibility, validity, and depth of research findings and is also applicable in mixed-method research designs, contributing to a better understanding of research issues. Ultimately, triangulation serves as a foundation for advancing knowledge and understanding in multicultural research contexts and adds to the richness of the academic literature in this field (Meydan & Akkaş, 2024).

In this regard, research methods have been recognized as an inevitable priority in the development process (Fooladi, 2014). The introduction of intelligent algorithms, language models, recommender systems, and big data into academic fields has fundamentally redefined the traditional structure of research (Abbaszadeh & Pashaie, 2025). As Costa and Costa (2017) suggested, conducting research in digital environments can offer new perspectives on traditional research methods (Costa & Costa, 2017). One of the recent efforts in this field is the proposal of a framework called Cyber-Constructive Triangulation (CCT), which analyzes the interaction of humans, machines, and data as the three main components of research reality in the digital age. In qualitative research, CCT refers to the use of multiple methods or data sources even within a digital or virtual environment to enhance the validity and reliability of research findings. Essentially, it is a strategy to ensure that research results are robust and trustworthy by cross-verifying information from different perspectives. This can include using multiple data sources such as online surveys, virtual focus groups, document analysis, various research methods including qualitative and quantitative approaches, or involving multiple researchers in the analysis process.

Unlike previous traditions in qualitative methodology that focused on the human narrator, lived experience, and text analysis (Griffin & May, 2012; Riessman, 2008). This process has simplified data analysis and ensures that qualitative researchers can easily work with large and complex datasets. The digital world offers innovative tools and methods that fundamentally change the qualitative research landscape. From virtual interviews to AI-assisted transcription and beyond, the range of possibilities in research has significantly expanded and led to richer and more precise insights. One of the deepest changes that the digital age has brought is the transformation in research collaborations. Digital platforms have enabled global and real-time collaboration. This mutual interaction strengthens a more comprehensive and multidisciplinary approach to research, where different perspectives come together and produce better results (Bryda & Costa, 2023).

Methodological innovations (such as CCT) in research allow researchers to enter unknown territories and produce more comprehensive and thought-provoking findings (Bryda & Costa, 2023). Actor-Network Theory (ANT), as an innovative approach, redefines actors and introduces them not as intentional or willful agents, but as any entity, whether human or non-human, that in some way affects the functioning or disruption of socio-technical systems (Crawford, 2020). In this context, the qualitative researcher is no longer merely a data collector and analyst, but operates within a network of human and non-human actors, including algorithms, data, and digital platforms (Tayebi Abolhasani, 2019; Wilkie, 2010). Despite the expansion of traditional qualitative triangulation as a method to increase validity through diversity of data and methods) Denzin, 2012(), this approach largely lacks analytical tools to

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simultaneously examine the interaction between human, machine, and data in digital contexts. In particular, the dimensions of power, technological agency, and ethical and social risks are not systematically considered.

In traditional qualitative research, the human (whether the researcher or the participant) is often considered the only meaning-making actor (Daher et al., 2017), while in contemporary digital contexts, machines (such as algorithms, artificial intelligence, and platforms) (Abbaszadeh & Pashaie, 2025) and data (as both the product and reflection of social and technological contexts) also play an active role in meaning production (Lim, 2025). As provided by the latest technologies, datasets have become more complex, diverse, and, voluminous, thanks to more profound AI tools, such as computer-assisted qualitative data analysis software (CAQDAS) and big data analytics. This, however, poses more interdisciplinary and ethical concerns than qualitative approaches are ready to handle. Current unfavorable adaptations do not embrace the value that multicentric methodologies bring to qualitative research, which, as we know, relies fundamentally on the sense-making capacity of people and ignores the intricate organizational ecosystem of machine, human, and data actors. With the rise of the digital epoch, we now have more data and information, and our ability to process them through existing technologies is still limited. Where algorithm-based epistemological actors, algorithms as epistemic agents, are now the ones generating data, the actual integration of the dynamic of meaning making alongside algorithm control within a powerful yet delicate structure lacking pre-existing frameworks remains incomplete.

The lack of such a framework constrains the qualitative researcher's ability to interrogate the intertwined processes of meaning making in the context of AI systems. There is a gap in the qualitative research framework where the socially embedded aspects of the technologically mediated world are neglected, including: the role of algorithmic knowledge as a gatekeeper, the redistribution of agency in networked worlds involving humans and non-humans, and the socially infrastructural forms of risk and ethics technology provides. In light of these gaps, this research seeks to answer: In what ways qualitative research in the digital context can achieve a layered simultaneous analysis in the processes of meaning making, in relation to the roles human, machine, and data play and the dimensions of power, distributed agency, and ethical risk involved? In answering the above question, the researchers formulated a framework which they termed Cyber-Constructive Triangulation (CCT), which is both theoretically founded and practically useful in integrating the perspectives of Foucault's power/knowledge theory, Castells' network society theory and Beck's risk society theory. Through the application of interpretive, algorithmic, and contextual analyses, CCT provides a critical and flexible interdisciplinary framework for the study of digital phenomena.

The remainder of this article first outlines the conceptual foundations of CCT, then describes its methodological structure, and finally illustrates its application through examples from digital research contexts.

2. Conceptual Framework

Qualitative methodology is an interactive and iterative process in which the researcher seeks a deep and comprehensive understanding of phenomena within their natural context and from the perspective of key actors (Tayebi Abolhasani, 2019). This approach emphasizes that the researcher must always reflect on their assumptions and role in the knowledge production process and analyze data with sensitivity to cultural and social contexts (Farasetkhah, 2024). In the field of digital research, the necessity for multilayered reflection and analysis becomes increasingly important due to the presence of diverse human and non-human actors such as machines and data. The CCT model addresses this complexity by integrating the three main actors of digital qualitative research, human, machine, and data, within a multilayered and interactive framework. From a methodological perspective, this model, by employing triangulation in data collection and analysis, enhances the validity and richness of findings and enables simultaneous multifaceted data analysis (Pashaie et al., 2023).

2.1. Foucault's Power/Knowledge Theory: Algorithms as Symbolic Power

Michel Foucault, through the concept of power/knowledge, demonstrated that knowledge is never neutral or impartial but is always intertwined with structures of power (Foucault, 1972). From Foucault's perspective, the production of knowledge is a social, political, and historical process through which power is exercised and, at the same time, legitimized (Foucault, 2020; Willcocks, 2004). This perspective acquires new dimensions in the age of artificial intelligence, particularly

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in qualitative research based on algorithms, because algorithms now act as epistemic actors that not only analyze data but also play an active role in determining what is recognized as valid knowledge.

In the context of digital qualitative research, algorithms are not passive tools but power-oriented entities that, through design, training, and technical policymaking, intervene in processes of meaning-making, the elimination of seemingly irrelevant data, and the reinforcement of specific discourses (Bonami et al., 2020; Seaver, 2017). More precisely, Foucault teaches us to pay attention to how systems of knowledge operate, systems in which some voices are heard while others are marginalized. Machine learning algorithms, particularly in processes such as semantic clustering, sentiment analysis, or automated data selection, can effectively act as gatekeepers of knowledge. This gatekeeping, as Foucault explained in his analysis of medical or madness discourse, is not accidental but follows specific regimes of truth (Foucault, 1972).

Therefore, the qualitative researcher, in interaction with algorithms, faces structures that specifically make data visible, interpretable, and acceptable. These structures may include hidden assumptions in statistical models, the optimization logic of the algorithm, or predefined definitions for data classification (ContentSquare, 2023). In such a context, one must ask: What kind of knowledge is produced within the framework of artificial intelligence? Which discourses are amplified and which are silenced? And how does the power of this knowledge operate in shaping research outcomes?

Based on this analysis, Foucault's power/knowledge theory within the framework of CCT not only serves as a critical tool for identifying unequal relations in digital knowledge production but also enables the qualitative researcher to be aware of their own role in knowledge creation. The researcher is no longer merely an observer but part of a power mechanism that shapes knowledge through interaction with machines and data. This awareness places an added responsibility on the researcher to be sensitive and critical toward the hidden processes of control, classification, and exclusion in interaction with artificial intelligence (Abbaszadeh & Pashaie, 2025; Rowe, 2018).

Finally, Foucault's theory warns us that relying on algorithms without critically analyzing their position within power structures may lead to the reproduction of biases, elimination of epistemic diversity, and reinforcement of systems of domination disguised as science. In algorithm-based qualitative research, no data is merely a representation of reality but rather the product of a powerful process of filtering, interpretation, and translation. Therefore, the power/knowledge theory remains an essential tool for reconsidering knowledge production policies in the digital age.

2.2. The Network Society Theory of Castells: Distributed Agency in Digital Networks

Manuel Castells, in his theory of the network society, adopts a structural-processual perspective to explain the transformations of systems of power and meaning in the digital age (Castells, 2003). He argues that modern societies are no longer defined by hierarchical and centralized structures, but rather operate within decentralized, fluid, and interactive networks in which information, power, and action flow in a non-linear and dispersed manne (Castells, 2011). In such a context, agency is neither exclusively human nor merely a function of structure; rather, it is redefined in a distributed and dynamic manner through the interaction of humans, machines, and data.

In AI-based qualitative research, Castells' perspective helps researchers move beyond the traditional human/technological tool dichotomy, replacing it with a networked understanding of agency. In other words, the researcher, content analysis software, data infrastructures, digital platforms, and even end-users are regarded as active agents within an interaction-oriented network, all participating in the production of meaning, knowledge, and social reality (Bryda & Costa, 2023). Each of these actors possesses a form of relative power and specific limitations that, depending on their position within the network, can either facilitate or control the flow of information.

In this framework, data is no longer merely passive raw material; rather, data (through algorithms) has the capacity to react and shape the researcher's behavior, just as the researcher's choices influence the output of the data. This reciprocal dynamic signifies the emergence of "hybrid agency," a concept in which the boundary between human and technology in the process of meaning-making becomes blurred (Wilkie, 2010). For example, in a study that utilizes tools such as ChatGPT for textual data analysis, the results are a function of the algorithm's settings, the researcher's theoretical framework, and the structure of the data-driven platform. In this way, meaning is produced not only by the researcher's mind but also through interaction with intelligent tools and digital infrastructures. Castells also

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emphasizes the concept of networked power, a type of power that, unlike traditional forms of power, does not reside in centralized institutions but lies in the ability to create or remove connections within the network (Castells, 2011). In this regard, the deletion or amplification of data by algorithms, the prioritization of specific sources, or the inaccessibility of certain information are examples of the exercise of power within the network that influence the orientation of research.

Therefore, from the perspective of network society theory, qualitative research in the digital age should be regarded as a multi-agent and interaction-oriented field in which humans, machines, and data, through complex and fluid interconnections, shape the processes of cognition and knowledge production. The CCT framework, by drawing on Castells' perspective, provides an opportunity to critically and analytically examine this complex dynamic of agency within digital networks and to contribute to the production of multilayered, flexible, and localized knowledge.

Ultimately, Castells believes that power in contemporary societies has shifted from hierarchical structures toward networked forms. Qualitative research conducted in digital environments and with artificial intelligence tools exists within networks of humans, machines, and data. In this framework, agency can no longer be considered solely human; rather, agency is distributed among human and non-human actors, and the responsibility for knowledge production has also become multi-actor.

2.3. Beck's Risk Society Theory: Ethical and Technological Risks in Qualitative Research

The risk society theory, as one of the influential theories in contemporary sociology, has served as the foundation for numerous scientific explanations, models, and analyses in various fields, including environmental and ecological issues, as well as social, cultural, and political transformations over the past two decades. Although this theory initially resembled an environmental manifesto, due to its alignment with other concepts and theories such as globalization, late or reflexive modernity, and modernity as an unfinished project, it gradually attracted the attention of researchers and scholars in various fields, including political science, the humanities, sociology, ecology, economics, and science and technology studies (Tosuli & Vadehiri, 2009).

The risk society theory, proposed by Ulrich Beck, refers to a fundamental transformation in the social structure of modern societies; a transformation in which the production and distribution of risks, rather than goods and resources, become the core of social organization (Beck, 2014). Beck argues that contemporary society is confronted less with the absence or scarcity of resources and more with an abundance of technologies that themselves are sources of hazards and unpredictable consequences (Beck, 2009). These risks, unlike traditional threats, are often the products of scientific knowledge and modern technologies, ranging from climate change to biological hazards and from global financial systems to digital infrastructures.

In the context of qualitative research based on artificial intelligence, this perspective gains a deeper meaning. The use of data analysis algorithms, intelligent systems, data collection platforms, and large language models, despite their numerous analytical advantages, carries risks of technological, ethical, and social nature. These risks are often invisible, multifaceted, and dispersed, and because they are embedded within research tools, they easily remain hidden from the researcher's view (Rowe, 2018). The risk society theory enables conceptualizing these hazards beyond technical or security frameworks, viewing them as social, cultural, and epistemological phenomena (Tavasoli & Vadadhir, 2010).

One of the main risks in this field is algorithmic bias, a phenomenon in which machine learning models, due to incomplete or biased training data, reproduce social and cultural inequalities. In addition, the risk of erasing the cultural and contextual environment in data interpretation is another serious challenge in qualitative research within digital contexts because algorithms lack contextual sensitivity and their analyses are mainly based on statistical patterns rather than interpretive understanding (Abbaszadeh & Pashaie, 2025).

Furthermore, in the risk society, the concept of organized distrust is introduced, a condition in which even knowledge-producing institutions, including universities and research centers, may themselves be carriers or generators of risk (Ahmadi & Dehghani, 2016). This concept encourages researchers, especially in AI-driven research, to reflect on mechanisms of validation, transparency, and accountability of researchers and technological platforms. According to Beck, researchers no longer face external risks; rather, the dangers arise from within the very tools they use to understand and solve problems (Beck, 2014).

The CCT framework, by drawing on this theory, elevates the researcher to the position of an ethical critic; a

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position in which attention must be paid not only to the accuracy of the data but also to the political, cultural, and technological contexts in which it is formed. From this perspective, the researcher is not in a neutral position but in an ethical one, where the social and cultural consequences of the technologies they use must also be considered. Their responsibility is not merely the production of knowledge but also the care for its quality and epistemic justice. Table 1 shows theorists and theoretical applications in artificial intelligence within the cyber-constructivist context.

Table 1

Theorists and Theoretical Applications in AI

Additional Points	Explanation with Application in AI	Theory	Theorists
Analysis of the relationship between power, knowledge, and social control	Foucault emphasizes the role of knowledge and power in modern societies. In AI-based qualitative research, knowledge produced by algorithms can be used as a tool for controlling and shaping behaviors in society.	Power/Knowledge Theory	Michel Foucault
The impact of digital networks on social structures	Castells refers to the impact of digital networks on social structures. In AI-based qualitative research, the development of machine learning mostly takes place in virtual spaces and digital networks.	Network Society Theory	Manuel Castells
Analysis of global risks caused by technology	Beck refers to the global risks caused by technology. In CCT, the risks of algorithmic decision-making and ethics in artificial intelligence are important.	Risk Society Theory	Ulrich Beck

3. Methodology

This study employs a theoretical conceptual design with a critical interpretive orientation (Morgan, 2024) to develop and operationalize the CCT framework for qualitative research in digital contexts. The approach consists of three interconnected stages: question design, mixed data collection, and three-layered analysis, with procedures described in sufficient detail to enable replication. The proposed framework, CCT, is based on the simultaneous and critical analysis of three main actors: humans (researchers and participants) (Abbaszadeh, 2012), machines (algorithms and artificial intelligence tools) (Fast, 2019), and data (digital structures and contextual or environmental factors) (Bans-Akutey & Tiimub, 2021). The theoretical foundation of this framework integrates three theories: Foucault's power/knowledge, Castells' network society, and Beck's risk society, which respectively address dimensions of power, distributed agency, and ethical risks (Beck, 2009; Castells, 2003; Foucault, 1972). The operational model of CCT consists of three stages: designing three-dimensional research questions; collecting mixed data from human, machine, and contextual sources; and conducting a three-layered analysis involving human interpretation, algorithmic processing, and environmental analysis. To evaluate the validity and reliability of the CCT framework, a combination of theoretical and operational indicators has been employed (Moon, 2019).

Theoretical validity was ensured through the coherence of the theoretical triad, while data validity was strengthened via source triangulation and the convergence of human and algorithmic analyses. Reliability was established through documentation of algorithmic parameters, peer analytical review, and control of research implementation conditions.

This framework moves the researcher from a passive analyst to a conscious, ethical, and multifaceted activist. The CCT model is highly flexible and can be localized in various fields such as education, marketing, and cultural studies.

4. CCT Method: Human, Machine, and Data Interaction

As can be seen in Table 2, within the framework of the CCT methodology, research proceeds based on the simultaneous and dynamic interaction between three key components: humans, machines, and data, each of which has a specific role and function.

***Human*:** This process involves the collaboration of multiple researchers or analysts in collecting, analyzing, and interpreting data in a virtual space, such as using collaborative coding platforms. Researchers and participants are not only responsible for interpreting the data, but also for ethical analysis, critical evaluation, and epistemic guidance of the research. This section refers to human behaviors, needs, and capabilities (Bhandari, 2022). In the digital age, humans act as consumers, producers, and

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analysts of data. Human understanding and the ability to interact with machines play a fundamental role in analytics and decision-making.

Machine: includes hardware and software that collect, process, and analyze data or refers to intelligent systems, algorithms, and analytical tools that collect, process, and classify data; these processes are usually performed using machine learning, natural language processing, or clustering (Lulka, 2025).

Data: refers to the use of diverse online sources such as online forums, social media, and existing datasets to cross-validate findings and gain a comprehensive understanding of phenomena. This concept includes big data, digital infrastructure, social networking platforms, and digital footprints of participants, which are used as raw materials for research (Naghibulsadat, 2022). A distinctive feature of this model is the nonlinear and reciprocal interaction among its three components: human, machine, and data. These elements not only complement one another but also continuously redefine each other through their interactions, simultaneously co-producing the research reality. This model also possesses high educational value, as it teaches researchers how roles, power relations, and cognitive processes are reconfigured in AI-based qualitative research.

Table 2

The concept of cyber-structural triangulation

Row	Actor	Role in the research process
1	Human (researcher and contributor)	Question design, data interpretation, ethical judgment
2	Machine (AI algorithm)	Data collection, preliminary analysis, semantic classification
3	Data (platform, metadata, networks)	Knowledge production context, interaction context, source of risk

For example, platforms like Digikala and SnappFood are dynamic interaction scenes of the three elements: human, machine, and data. The choices of Iranian consumers, rooted in consumption culture and social occasions, are influenced by product recommendation systems that operate based on users' purchase history and searches. At the same time, intelligent credit validation systems, based on users' financial data, regulate the possibility of installment purchases. In this space, the meaning and value of goods are shaped not only by producers or consumers but through the interaction of these three elements. Researchers analyzing this phenomenon need methods that can consider consumer mentality, algorithm logic, and data patterns simultaneously.

Similarly, in the field of digital health in Iran, these three-way interactions are clearly observable. Iranian health-focused applications such as "Sina" or "Payesh" interact on one hand with human users, on the other hand use early detection algorithms, and at the same time operate based on big health data. Here, the understanding of disease and health is no longer shaped solely by doctors or patients but is the product of a complex interaction in which algorithmic recommendations, biometric data, and user interpretations intertwine.

4.1. A Research Example of Cyber-Constructivist Triangulation (CCT)

A Hypothetical Empirical Case from Iran: Analyzing the Impact of social media on the Lifestyle of Tehran Youth Using the CCT Approach

1. Research Design Stage

An Iranian researcher at the University of Tehran, aiming to examine the impact of Instagram on lifestyle, designed the following questions:

- **Human question:** How do young people in Tehran describe their experience of using Instagram?
- **Machine question:** What patterns in the behavior of Iranian users are identified by Instagram's content recommendation algorithm?
- **Contextual question:** How are Instagram's content policies applied to Iranian users?

2. Data Collection

a) Human data

- 20 in-depth interviews with 18–35-year-old youth in Tehran
- Interview locations: Cafés in districts 1, 3, and 12 of Tehran
- Purposive sampling based on the criterion of daily Instagram use

b) Machine data

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- Collection of 1,000 Instagram posts with popular hashtags (#Iranian_Lifestyle #Tehran_Fashion)
- Use of Instagram API for metadata analysis
- Execution of clustering algorithms on the content

c) Contextual data

- Review of Instagram's content policies in Iran
- Analysis of filtering reports from 2023 (1402 in the Iranian calendar)
- Interviews with two Iranian cyberspace experts

3 Data Analysis

Human analysis

Identification of five main themes from interviews:

- Displaying an ideal life
- Social pressure to conform
- Reality/virtual duality
- Consumerism
- Self-censorship

Machine analysis

The LDA algorithm identified three main topics:

- Fashion and clothing 42%
- Food and café-hopping 35%
- Travel 23%

Contextual analysis

Identification of three key constraints:

- Filtering of political content
- Removal of posts with unconventional hijab
- Delay in content loading

4.. Integration of Findings

The intersection matrix showed:

- A contradiction between displaying an ideal life in interviews (human) and technical restrictions (contextual)
- Overlap between the consumerism theme (human) and the fashion/clothing topic (machine)

5. Validation

- Review by communication science professors at Allameh University
- Verification of results by 5 participants
- Cohen's kappa coefficient of 0.82 between coders

6. Managing Challenges

Algorithmic bias

- Identified algorithm focus on northern districts of Tehran
- Compensation through purposive sampling from disadvantaged areas

Technical limitations

- Use of VPN to access the API
- Replacement of filtered content with similar data

Ethical considerations

- Obtaining approval from the university ethics committee
- Use of pseudonyms
- Removal of user identifiers

Key Findings

- Algorithms reinforce the lifestyle of the upper-middle class
- Iranian users develop creative strategies to bypass restrictions
- The gap between virtual display and reality in Tehran is widening

Policy Recommendations

- Designing local algorithms that consider Iranian values
- Increasing media literacy in schools
- Developing domestic platforms with transparent architecture

This study demonstrated how CCT can analyze the complexities of Iran's virtual space by simultaneously considering human, technological, and socio-political dimensions.

4.2. Stages of Implementing CCT

The conceptual model of CCT provides a comprehensive framework for understanding the dynamics of the contemporary digital space (Figure 1). At the center of this model lies the dynamic and interwoven interaction of three key elements: human actors, machine systems, and data flows. These elements do not function in isolation, but within a complex and interdependent network. Analyzing this network is only possible through a multidimensional approach.

Foucault's theory of power is redefined in this framework considering the unique characteristics of the digital space. Today, we witness the emergence of new forms of power exercised through recommendation algorithms, social scoring systems, and digital surveillance mechanisms. These mechanisms enforce discipline not through direct force but by shaping users' choices and preferences. In this space, researchers must carefully examine the biases embedded in training datasets and the decision-making logic of algorithms.

On the other hand, Castells' network society theory has gained new dimensions in response to recent advancements in artificial intelligence. AI is no longer merely a tool in

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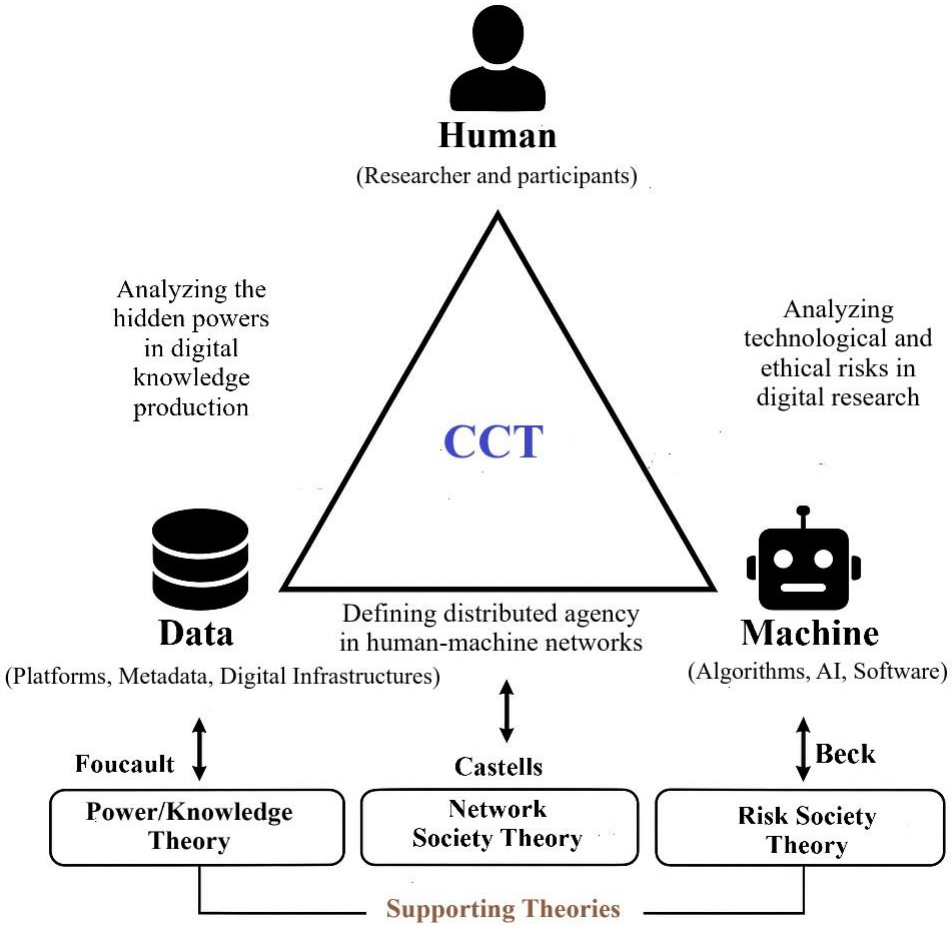
human hands but has become an independent actor capable of influencing social structures. Digital platforms have turned into arenas for cultural and political competition, where data functions as a strategic asset. These developments call for a reconsideration of traditional concepts of agency and power.

Beck's risk society theory has also been expanded in this model to address the challenges of the digital age. Today, we face emerging risks such as pervasive surveillance, algorithmic manipulation of public opinion, and cyber vulnerabilities. The digital divide has become a new source of social inequalities, and ethical issues surrounding data ownership and privacy have created unprecedented challenges.

Finally, this developed model, by combining insights from various theories, enables a deeper and more comprehensive analysis of digital phenomena. Such an approach is valuable not only for academic research but also for policymaking in technology and the design of responsible digital systems. Ultimately, this framework helps us adopt a more active and informed stance in the face of digital transformations.

Figure 1

Steps of Implementing Cyber-Constructive Triangulation



What distinguishes this approach is its emphasis on relative equivalence and critical interaction between humans and machines. In this model, neither human interpretation is considered absolute and final nor is algorithmic output accepted as the ultimate truth. Rather, the goal is to reach a deep and multidimensional understanding of data that considers various factors such as power, cultural contexts, and technological impacts. Such an approach moves the researcher out of a passive analyst position and turns them into an aware actor who creates a critical balance between empowerment by technology and vulnerability to it. Therefore, the theoretical linkage of these stages with the three theories of Foucault (power/knowledge), Castells (network society), and Beck

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(risk society) provides a ground for simultaneous analysis of agency, meaning, and risk in digital qualitative research and transforms the researcher into a critical actor in the cyber-constructivist space.

4.3. Applied research example

For example, a study was conducted on the representation of gender identity in algorithmic responses. ChatGPT was used to answer semi-structured questions. Then, the researcher applied open coding to interpret the responses and compared them with codes extracted from the BERT model. Finally, contextual data related to the platform's structure and policies were also included in the analysis to examine the contextual influences on the formation of the responses.

4.4. Advantages of CCT

- **Increased validity and reliability:** By utilizing multiple sources, methods, or perspectives, CCT triangulation helps strengthen the validity and trustworthiness of research findings (Abbaszadeh, 2012). For example, analyzing posts, comments, and interactions on social media related to a specific topic or event can collect user perspectives and validate findings through other data sources.
- **Overcoming geographical barriers:** This approach allows researchers to access participants from diverse locations and backgrounds, expanding the scope of the study (Fusch et al., 2018; Meydan & Akkaş, 2024). For instance, comparing discussions and interactions across different online forums related to the research topic can help identify similarities and differences in user experiences.
- **Increased depth and nuance:** By incorporating multiple viewpoints and interpretations, CCT offers a more comprehensive and detailed understanding of the research topic (Dootson, 1995).
- **Reduction of bias:** Including diverse perspectives and interpretations helps minimize the influence of individual researcher bias (Bans-Akutey & Tiimub, 2021). For example, using online platforms that allow multiple researchers to simultaneously code and analyze qualitative data ensures consistency and reduces individual bias.
- **Cost-effectiveness:** This method can be more economical compared to traditional approaches, especially when participants are from different geographical locations (Nakkash et al., 2003; Yeung, 1995). For example, interviews and focus groups can be conducted via video conferencing tools, and the resulting transcripts can be collaboratively analyzed by several researchers to identify patterns and themes.
- **Simultaneous three-layer analysis:** Enables data analysis from three perspectives — human (interpretive), machine (algorithmic), and contextual (socio-cultural).
- **High adaptability and localization capability:** The framework can be tailored to various contexts such as education, social sciences, marketing, health, media, and more.
- **Suitable for complex digital data:** Unlike traditional methods, CCT is designed for analyzing big data, social media, and interactions on intelligent platforms (Hussein, 2009).
- **Facilitation of interdisciplinary knowledge production:** Allows the integration of social theories, algorithmic analysis, and cultural data within a single framework.

5. Discussion and Conclusion

The emergence of new technologies, especially intelligent algorithms and large language models, in the field of qualitative research has not only transformed the tools for data collection and analysis but has also fundamentally redefined epistemological, power, and ethical structures (Sposato, 2025). The convergence of artificial intelligence and qualitative methods presents opportunities and challenges that lead to the reassessment of research paradigms and the posing of epistemological questions. In such an environment, the cyber-constructivist triangulation (CCT) framework is not merely an analytical model but a critical approach for rethinking the position of the researcher, the machine, and the data in knowledge production. Unlike classical triangulation models that primarily focused on the diversity of sources to strengthen validity (Denzin, 2012), CCT, by emphasizing the simultaneous and asymmetric interaction between humans, machines, and data, addresses the hidden mechanisms of power, algorithmic bias, and the exclusion of discourses.

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The core innovation of CCT lies in its conceptualization of data analysis not as a linear process, but as a networked and multi-agent domain, where the researcher, the algorithm, and the data dynamically and interactively produce and reproduce meanings. Within this framework, algorithms are not merely processing tools but knowledge-producing actors that, through their internal logic, data prioritization, and predefined assumptions, exert a structural influence on research outcomes (Seaver, 2017). Conversely, the qualitative researcher does not remain a passive observer but, as a conscious, responsible, and ethically oriented actor, monitors data-driven interactions, questions technological assumptions, and resists structural biases (Rowe, 2018).

Another advantage of the CCT framework is its reproducibility and localizability. Hybrid analysis, combining intelligent tools with human coding, not only leads to more precise and multilayered results but also enables step-by-step reconstruction of research across various contexts. Documenting algorithmic settings, environmental analyses, and human interpretation processes enhances methodological transparency and supports research replicability. Moreover, CCT facilitates the integration of textual, visual, audio, and structured data, thereby providing an effective tool for multimedia, cultural, and digital research.

From a theoretical perspective, CCT, by integrating the three foundational theories of Foucault, Castells, and Beck, has been able to incorporate the layers of power, agency, and risk into qualitative analysis in a unified way. Such a combination not only helps achieve a deeper understanding of the process of knowledge production in the digital space, but also calls the researcher to reflect on their own epistemic position. In fact, CCT is a link between content analysis and structural critique, a method that focuses not only on "what" but also on “how” knowledge is produced, filtered, and legitimized.

Ultimately, the importance of CCT lies in its ability to move beyond the classic dichotomies of “tool/actor,” “qualitative/quantitative,” and “analysis/technology,” opening a path toward post-technological and critical approaches. In a world where technology is not only the context of research but also one of its actors, qualitative researchers need frameworks like CCT to confront the complexities of power, meaning, and ethics in the data age. This framework elevates qualitative research from the level of description to the level of conceptual and ethical transformation.

The present article, aiming to address emerging methodological challenges in the digital era, introduces the CCT framework as a new paradigm. This model, through simultaneous and critical analysis of three elements: human (researcher and participant), machine (algorithms and intelligent systems), and data (digital structures and socio-cultural contexts), enables the exploration of epistemic complexities in qualitative research within technological spaces. Unlike traditional triangulation approaches that focus solely on the diversity of data sources, CCT, by integrating three foundational theories: Foucault’s power/knowledge (explaining relations of domination in knowledge production), Castells’ network society (defining distributed agency), and Beck’s risk society (analyzing ethical hazards), addresses the identification of hidden mechanisms of power, algorithmic biases, and the exclusion of marginal discourses.

The CCT implementation model operates in three structured steps: first, designing triadic questions focusing on human (subjective experiences), machine (algorithmic patterns), and contextual (macro policies) dimensions; second, collecting mixed data from human sources (in-depth interviews), machine sources (AI), and contextual sources (policy documents and regulations); third, conducting a three-layered analysis including human interpretation (qualitative coding), machine processing (algorithmic clustering), and environmental examination (discourse or structural analysis). This process not only deepens analytical insight but also elevates the researcher from a passive observer to an ethical agent responsible for monitoring technological biases, data privacy, and epistemic justice.

The applicability of CCT in non-Western contexts, such as the Iranian case study analyzing the lifestyle of young Tehranis on Instagram, demonstrated that algorithms unintentionally reinforce the lifestyle of the upper middle class, users overcome technical limitations with creative strategies like using VPNs, and content filtering exacerbates the gap between virtual and actual realities. However, implementing this framework faces limitations: the need for broader empirical validation through field projects, especially in sensitive areas like digital health; technical barriers to accessing big data processing tools; and methodological complexities in integrating philosophical theories with practical analysis.

Future research horizons include the development of localized software tools to simplify CCT processes, the localization of algorithms in accordance with cultural

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values (such as designing recommendation systems sensitive to Iranian identity), and the formulation of digital ethics frameworks to monitor bias in AI research. Overall, CCT is not merely an analytical technique, but a paradigm that, by breaking traditional human/machine and qualitative/quantitative binaries, leads to the production of multidimensional, flexible knowledge committed to epistemic justice and provides a springboard for post-technological methodologies in the coming decade.

Ultimately, it can be said that the CCT framework is not merely a technical or analytical tool, but rather represents a dynamic and ontological interaction between human and machine. An interaction in which at every step a question arises about the boundaries of our cognition and understanding. We live in an era where machines are no longer just reflections of the human mind, but in a way also play a role in shaping thoughts and ideas; as if they shape our unconscious as well. CCT acts like a mirror reflecting the complex and multilayered relationship between humans, algorithms, and the cultural and social contexts in which both are formed. From this perspective, every piece of data is not just a number or code, but a narrative of human effort to make sense of the digital world. This framework reminds us that truth is never singular, but rather a combination of diverse voices: the voice of humans, the voice of machines, and the voice of the cultural context in which both are shaped.

However, the present research also faces limitations. First, due to the theoretical-conceptual nature of the proposed model, its empirical validation will only be possible in future studies through field projects. Second, this framework requires specific analytical and technical infrastructures that may not be accessible to some researchers or in certain research contexts. Additionally, a full understanding and effective application of it necessitate deep familiarity with postcritical theories and qualitative data analysis technologies.

In the future horizon, several notable research directions emerge: first, the empirical expansion of the CCT framework across various thematic fields and testing its effectiveness in field studies with real data; second, the development of localized educational and software tools to facilitate the use of this framework within research communities; third, the elucidation of the role of algorithms not only as analytical tools but also as actors possessing symbolic power in the reproduction or resistance of dominant discourses.

Authors' Contributions

All authors equally contributed to this study.

Declaration

In order to correct and improve the academic writing of our paper, we have used the language model ChatGPT.

Transparency Statement

Data are available for research purposes upon reasonable request to the corresponding author.

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Ethics Considerations

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