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A New Model for Qualitative Research: Connecting Triangulation, Crystallization, and Artificial Intelligence

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A B S T R A C T

This study examines the methodological transition from triangulation to crystallization and investigates the emerging role of artificial intelligence (AI) in qualitative research. The central research question addressed whether traditional approaches such as triangulation and crystallization are sufficient to capture the complexity of meaning making in the digital era. Findings suggest that, while triangulation enhances data validity, it tends to favor convergence and may overlook the polyphony of data. Crystallization embraces diversity and contradictions, providing a richer portrayal of phenomena, yet faces challenges when confronted with the vast volume of digital data. To address these limitations, this research proposes an innovative model that incorporates AI as an "algorithmic co-analyst" within the qualitative research process. The model creatively integrates triangulation, crystallization, and algorithmic analysis, enabling the detection of hidden patterns, amplification of contradictions, and improved scalability of qualitative inquiry. The primary contribution of this study lies in presenting a multi-paradigmatic framework that preserves methodological rigor, deepens interpretive richness, and leverages technological capacities to better grasp the complexity of the digital world. This approach opens a new horizon for the future of qualitative research, demonstrating that the integration of humans, data, and algorithms provides an effective pathway for studying multilayered and dynamic social phenomena.

Keywords: *Triangulation, Crystallization, Artificial Intelligence, Qualitative Methodology, Human Complexity, Network Society, Post-Triangulation.*

1. Introduction

In the study of human phenomena, complexity represents one of the most fundamental challenges for methodological paradigms (Sanbonmatsu et al., 2021). As Biggiero (2001) highlights, human systems are characterized by logical complexity (such as self-reference and Gödel's incompleteness theorems), relational dynamics (e.g., the Hawthorne effect), infinite epistemological and semiotic dimensions, and computational unpredictability. These multilayered and nonlinear characteristics render any reductionist approach or search for a single "truth" epistemologically impossible, pushing qualitative research toward multidimensional, interpretive, and exploratory frameworks (Ahmadi et al., 2019).

Within this context, methodological debates in qualitative research have continuously oscillated between the poles of validity and the representation of reality (Tayebi Abolhasani, 2019). Triangulation, as a classical metaphor, seeks epistemic assurance by overlapping data,

methods, or theoretical perspectives (Abbaszadeh & Hoseinpour, 2011; Pashaie et al., 2023; Tabatabaee et al., 2013). Rooted in the post-positivist paradigm, triangulation emphasizes convergence and confirmation of a more "objective" reality (Morgan, 2024; Tayebi Abolhasani, 2019). However, critics argue that this focus on convergence risks silencing polyphony, contradictions, and the richness of data (Rouse, 1994). From a Foucauldian perspective, triangulation ultimately reproduces power/knowledge relations by concealing multiplicity of meaning behind the illusion of a single truth (Foucault, 2020).

Post-structuralist scholarship suggests that artificial intelligence (AI) should be understood as a discursive object, embedded within networks of meaning and relations of power. AI is not merely a neutral tool but an "algorithmic subject" that actively participates in processes of meaning-making and truth-construction. In Foucauldian terms, this algorithmic subject is shaped within power/knowledge regimes and simultaneously contributes to their reproduction.

In response to the limitations of triangulation, crystallization has been proposed as a more interpretive and reflexive paradigm. Crystallization posits that each method or perspective, like a facet of a crystal, reveals only part of the phenomenon (Abbaszadeh & Soltani Bahram, 2016; Ellingson, 2009). Unlike triangulation, crystallization does not seek confirmation but embraces contradiction, diversity, and multiplicity as signs of richness (Morgan, 2024). In this sense, crystallization aligns with interpretive and postmodern paradigms, emphasizing reflexivity and engagement with complexity.

As Castells (2004) argues, the emergence of the network society has transformed the conditions under which meaning is represented. Data are no longer merely produced through human observation or dialogue but are increasingly generated within digital architectures and algorithmic processes (Abbaszadeh & Pashaie, 2025; Anttiroiko, 2015). In this environment, even crystallization appears insufficient to capture the dynamic and networked multiplicity of meaning (Cherkasova et al., 2021).

AI thus emerges not only as a tool but as a methodological paradigm in its own right (Xu et al., 2021). Beyond assisting with coding and analysis, AI can actively participate in knowledge production, acting as an algorithmic interviewer, data interpreter, and even a social actor (Abbaszadeh et al., 2025). Its capacity to process massive volumes of data characterized by the five "V"s of big data (volume, velocity, variety, veracity, and value) challenges the traditional foundations of research (Abbaszadeh et al., 2025; Cremin et al., 2022; Nageye et al., 2024; Pashaie et al., 2025). This reconfiguration of boundaries between researcher, data, and text leads, in Foucauldian terms, to a reorganization of power/knowledge regimes.

As Beck (1998) reminds us in his risk society theory, every innovation introduces not only opportunities but also new risks. In the field of AI, such risks include algorithmic bias and the reproduction of epistemic inequalities (Baş, 2025; Beck, 1998; Vulpe et al., 2024). Adopting AI as a methodological paradigm therefore requires critical awareness of both its potential and its risks. As scholars note, methodological innovation often emerges not from creating something entirely new but from creatively recombining existing frameworks (LaMarre & Chamberlain, 2022). From this perspective, integrating the multifaceted lens of crystallization with the computational power of AI may offer a richer and more layered approach to qualitative inquiry.

Thus, the movement from triangulation to crystallization and beyond toward AI represents not merely a technical shift but a paradigmatic transformation in knowledge production. In this transition, human complexity is no longer understood as a fixed truth but as a series of multifaceted, networked, and algorithmic reflections and refractions. Methodology becomes, therefore, a critical arena for rethinking the relationships among data, meaning, and technology in the digital age.

Nevertheless, in an era where human data and meanings are reproduced through digital networks, algorithms, and machine learning, a fundamental question arises: Is crystallization alone sufficient for understanding these new complexities? The emergence of AI conceived not simply as a data analysis tool but as a methodological paradigm opens possibilities for rethinking the foundations of qualitative knowledge production. Acting as an algorithmic interviewer, interpreter, and co-participant in the field, AI disrupts traditional boundaries between researcher, data, and text. This disruption not only redefines the relationship between objectivity and subjectivity but also raises new questions about power, knowledge, and representation.

This study therefore seeks to move beyond triangulation and crystallization by positioning AI as a novel paradigm, opening a new horizon for understanding human complexity in the digital era. In this framework, methodology is not merely a technical instrument but a

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theoretical and critical space for rethinking the interplay between data, meaning, and technology.

2. Conceptual Framework

2.1. *From Triangulation to Crystallization*

One of the most common critiques of qualitative research concerns its perceived subjectivity and lack of rigor and validity (Tayebi Abolhasani, 2019). However, the history of qualitative methodology shows that researchers have continually sought to enhance the credibility and richness of their findings through appropriate strategies, including triangulation and crystallization. Although these two approaches share some surface-level similarities, they differ significantly at the philosophical and epistemological levels (Abbaszadeh & Soltani Bahram, 2016).

Triangulation refers to the simultaneous use of multiple data sources, research methods, theories, or investigators to study a single phenomenon (Tabatabaee et al., 2013). Its four main types include data triangulation, investigator triangulation, theory triangulation, and methodological triangulation. By comparing and integrating information obtained from different routes, triangulation seeks to enhance the credibility and trustworthiness of findings. From this perspective, the more the data overlap, the more valid the results are considered to be. Nevertheless, because triangulation is rooted in the post-positivist paradigm and aims to approximate a single, objective reality, it is not fully aligned with interpretivist paradigms that emphasize the multidimensional and socially constructed nature of reality (Morgan, 2024).

In contrast, crystallization has been proposed as an alternative approach that is more compatible with interpretive and postmodern paradigms (Stewart et al., 2017). Rather than seeking convergence and mutual confirmation of data, crystallization focuses on the multidimensional reflection of phenomena. The metaphor of the crystal is important here: just as the different facets of a crystal refract light in different ways, research can explore a phenomenon from multiple perspectives, narratives, and even artistic forms. Consequently, in the crystallization approach, contradictions and inconsistencies are not treated as weaknesses but as valuable indicators of the inherent complexity of phenomena.

Crystallization allows the researcher to combine scientific and artistic modes of inquiry (Ellingson, 2009). For example, researchers may present poetic narratives based on interview data, ethnographic representations of participants' lived experiences, or use artistic media such as painting and film alongside classical methods of analysis. This diversity not only enriches description and deepens analysis but also enables a more multidimensional representation of human experience. Nevertheless, some limitations exist: not all researchers possess the skills to work with creative genres, and academic reviewers may at times view such approaches as unconventional. Furthermore, a deep focus on a single topic may restrict the overall breadth of coverage.

2.2. *Comparison and Integration of Approaches*

A comparison of these two approaches reveals that, although triangulation and crystallization can be used complementarily in practice, they differ in their philosophical orientations. Triangulation primarily seeks to validate data through convergence and, within the framework of post-positivism, aims to represent reality with greater accuracy. In contrast, crystallization is rooted in an interpretivist understanding of reality, emphasizing polyphony, diversity, and even contradictions within the data. Within this framework, the subjectivity and positionality of the researcher are not seen as obstacles but as integral components of the research process (Abbaszadeh & Soltani Bahram, 2016).

Moreover, crystallization offers greater flexibility in presenting research findings. Rather than strictly adhering to traditional academic formats, it allows the use of literary narratives, visual forms, or multimedia alongside conventional scientific reports. This feature enables findings to be communicated to audiences in a more tangible, multidimensional, and engaging way.

2.3. *The Role of Artificial Intelligence in Bridging the Two Approaches*

The rapid development of AI, fueled by advances in natural language processing (NLP) models and growing public adoption, is accelerating at an unprecedented pace (Pashaie et al., 2025; Wibawa & Kurniawan, 2024). AI technologies, which rely on statistical analysis of linguistic structures to process and generate human language, treat text and speech as raw material for analysis (Hitch, 2024). The entry of AI and data science into the domain of human research has created a novel approach for integrating these two fields. Using big data technologies characterized by their distinctive features of volume, velocity, variety, veracity, and value AI is capable of processing massive and

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complex datasets in very short periods of time (Cremin et al., 2022; Nageye et al., 2024).

These technologies not only increase processing speed but also connect structured and unstructured data, enabling the discovery of nonlinear and complex relationships that were previously difficult or impossible to detect using traditional methods. As a result, AI has contributed to the emergence of a new paradigm in research methodology. In addition, advanced tools such as natural language processing for automated thematic analysis and machine learning significantly enhance the ability to uncover hidden patterns and latent narratives within qualitative data. They also improve the precision of cross-cultural analyses by incorporating contextual understanding and cultural nuances.

Within this framework, triangulation can benefit from AI's capacity to enhance the accuracy and reliability of analyses (Niloy et al., 2024), while crystallization can leverage the same technologies to deepen multidimensionality, reflexivity, and richness of interpretation (Saini, 2014). In other words, AI can serve both the goal of strengthening validity and scalability of data (aligned with the logic of triangulation) and the goal of amplifying polyphony and revealing hidden complexity (aligned with the philosophy of crystallization).

The transformative power of these technologies has made it possible to process unprecedented volumes of complex data within short timeframes (Abbaszadeh et al., 2025). For instance, in healthcare, AI is used to process large and diverse datasets to predict disease progression and personalize treatment; in finance, it enables fraud detection and risk management; and in environmental science, it is employed for climate modeling and pollution tracking with validated accuracy.

Nevertheless, integrating AI and big data into research requires careful methodological guidance to direct data analysis, validate models, and ensure the accuracy and trustworthiness of predictions. This highlights the dynamic interplay between technological advancement and methodological foundations, underscoring the need for new methodological frameworks to guarantee the validity, transparency, and value of AI-generated analytical outputs (Pal, 2023).

2.4. Implications for Qualitative Research

The concern for the credibility and trustworthiness of findings has been one of the most persistent issues in qualitative research. In response to this challenge, the concept of triangulation emerged as a classical methodological strategy in the mid-twentieth century. Its central premise was that if a researcher could reach convergent and consistent findings through multiple pathways, sources, or perspectives such as different types of data, diverse data collection methods, various theoretical lenses, or even multiple researchers then the results would possess greater validity and reliability. In other words, triangulation was primarily considered a technical tool for improving accuracy, reducing bias, and strengthening objectivity in qualitative inquiry (Flick, 2013).

However, deeper epistemological analysis reveals that triangulation, despite its widespread use, is more closely aligned with a post-positivist worldview than with an interpretive paradigm. Post-positivism acknowledges that absolute truth is unattainable but assumes the existence of a single, external reality that can be known with increasing precision through the use of multiple methods and tools. By contrast, interpretivist and critical paradigms conceive of social reality not as a singular, objective entity but as a multiple, constructed, and context-dependent phenomenon shaped by human interpretation. From this perspective, expecting data from different sources or methods to converge may reproduce a positivistic mindset and oversimplify the inherent complexity of the social world (Abbaszadeh & Hoseinpour, 2011).

This epistemological tension has led to the development of diverse approaches to defining and achieving quality in qualitative research. The post-positivist approach emphasizes the possibility of approximating objective reality and advocates criteria such as triangulation and replicability (Park et al., 2020). By contrast, interpretive or constructivist approaches view quality in terms of interpretive richness, transparency in the research process, reflexivity, and amplification of participants' voices. Critical and postmodern approaches go even further, rejecting fixed criteria altogether and emphasizing polyphony, alternative representations, and sensitivity to power dynamics and social context. To achieve these diverse aims, researchers employ various tools and techniques, including data, theory, and methodological triangulation, member checks, thorough documentation of the research process, transparent coding and analysis procedures, and ongoing reflexivity. Ultimately, the quality of qualitative analysis depends on the researcher's ability to balance methodological rigor with interpretive sensitivity (Flick, 2013).

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Considering this theoretical framework and the need for approaches that can engage with multiple paradigms simultaneously, an intelligent combination of triangulation, crystallization, and AI may open new horizons for qualitative research. In this integrated model, triangulation addresses the concern for credibility and dependability rooted in the post-positivist tradition, whereas crystallization by emphasizing the representation of multiple dimensions of a phenomenon without expecting convergence enhances interpretive depth and multiplicity in line with interpretivist and critical paradigms. AI serves as a bridge between these two seemingly distinct approaches by enabling the processing of massive, multidimensional datasets and supporting scalable, in-depth, and creative analyses (Morgan, 2024).

Moreover, the entry of AI into qualitative research should be seen not as a replacement but as a complement to existing approaches, creating an opportunity to rethink established methodologies. This co-presence liberates the researcher from traditional limitations and facilitates a creative dialogue between data, interpretation, and technology. The future of qualitative inquiry will depend on researchers' ability to strike a balance between methodological rigor, interpretive sensitivity, and technological capacity a balance that can make qualitative research more capable of addressing the complex, multilayered challenges of the contemporary world (Abbaszadeh & Pashaie, 2025; Pashaie et al., 2025).

Table 1

Paradigmatic Differences Between Triangulation and Crystallization

Interpretive Paradigm	Post-Positivist Paradigm
The external world cannot be fully known independent of the human mind.	The natural world can be measured with reasonable accuracy.
Emphasis is placed on understanding human behavior and experience.	Emphasis is placed on constructing meaning through measurement and testing.
Focus is on interpreting individuals' perceptions of the world.	Data are often reduced to numbers.
Subjectivity is considered a valuable part of the research process.	Objectivity is considered a core value.
Emphasis is on the social construction of reality and how meanings are co-created.	Research follows a deductive approach, focusing on theory testing.

In the research methodology literature, the concept of triangulation has been extensively discussed and classified into several types. These classifications help researchers systematically strengthen the credibility and trustworthiness of their findings by considering multiple dimensions of the research process. The most widely accepted and classic framework is Denzin's (1978) fourfold typology (Decrop, 1999). This model categorizes triangulation based on the sources that can provide multiple perspectives for investigating a phenomenon (Tabatabaee et al., 2013):

1. ***Data Triangulation***: This involves collecting data from different sources, at different times, or in different settings. The underlying idea is that using diverse types of data can provide a more balanced and comprehensive understanding of the phenomenon. For example, a researcher might conduct interviews with various participants, at multiple points in time, and across different contexts to ensure that findings are not biased by specific conditions (Pashaie et al., 2023).
2. ***Investigator Triangulation***: This refers to using multiple researchers or observers during data collection, analysis, and interpretation. This approach reduces individual subjectivity and allows the data to be examined from multiple viewpoints. When several independent researchers arrive at similar conclusions, the internal validity of the study is strengthened.
3. ***Theory Triangulation***: Here, the researcher applies different theoretical frameworks to interpret the same dataset. This enables a more layered and multidimensional understanding of the phenomenon. For instance, a single dataset might be analyzed using theories from social psychology, sociology, and anthropology.
4. ***Methodological Triangulation***: This type involves using multiple methods to study the same research problem. It may include combining several qualitative techniques (e.g., interviews, observation, document analysis) or even integrating quantitative and qualitative approaches

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(mixed methods). The goal is to exploit the strengths of each method to compensate for the weaknesses of others, thereby achieving a more comprehensive understanding of the subject (Tabatabaee et al., 2013).

These four forms of triangulation can be used individually or in combination, and each contributes significantly to enhancing the credibility and dependability of qualitative research. However, the choice and application of each type should be aligned with the research objectives, questions, and context to maximize their contribution to research richness. Importantly, despite their focus on diversity, these approaches ultimately aim for convergence and the production of a single coherent narrative an assumption that has been questioned by interpretivist and critical paradigms.

Table 2

Comparison Between Triangulation and Crystallization

Key Feature	Triangulation	Crystallization
Primary Goal	Seeks to enhance accuracy, validity, and reliability by cross-verifying findings through different methods.	Seeks to achieve a deep, rich, and multidimensional understanding of a phenomenon by embracing multiple perspectives and meanings.
Dominant Paradigm	Rooted in post-positivism (searching for objective reality, albeit cautiously).	Rooted in the interpretive and social constructivist paradigms.
Expected Outcome	The more data from different methods converge, the more valid the findings are considered.	Inconsistencies and contradictions are considered as meaningful and valuable as consistencies, as they reveal the depth and complexity of the phenomenon.
Form of Presentation	Typically presented in conventional academic formats (reports, articles).	Encourages the use of creative and artistic forms alongside traditional formats (e.g., poetry, ethnographic narratives, plays, paintings, video).
Role of the Researcher	Seeks to minimize researcher bias as much as possible.	Accepts the researcher's subjectivity as an integral part of the process and emphasizes reflexivity.

2.5. Human Complexity

Human systems are inherently complex and irreducible, arising from an interplay of logical, relational, infinite, and computational intricacies. Traditional analytical paradigms often face significant limitations when attempting to capture such complexity. Within this context, two emergent paradigms crystallization in qualitative methodology and AI in technological domains do not serve as ultimate solutions but rather as powerful frameworks for approximating and navigating this complexity (Biggiero, 2001).

Crystallization, employing the metaphor of a crystal, acknowledges the multidimensional, structural, and interpretive nature of social reality. This methodological approach is inherently open to the sources of complexity that shape human systems. Rather than seeking a singular truth, researchers gather data from diverse sources, such as interviews, observations, and documents, thereby engaging with semiotic complexity, where meaning is inherently ambiguous and context-dependent. When contradictions and inconsistencies within the data are embraced not as errors but as valuable information for exploration, the epistemological dimension of complexity is respected, highlighting how diverse perceptions construct different realities. Active acknowledgment of the researcher's role in the investigative process validating relational complexity and observer effects positions the researcher not as an external observer but as an integral component of the studied system, simultaneously influencing and being influenced by it. Ultimately, the goal of crystallization is to generate layered, rich knowledge that weaves together multiple narratives, offering a more comprehensive understanding of the intrinsic complexity of human systems.

In the technological realm, AI particularly advanced approaches such as deep learning and neural networks offers another paradigm for engaging with complexity. These systems are designed to detect patterns in data characterized by high dimensionality, nonlinear relationships, and computational intricacy, features directly aligned with the complexity of human systems. AI models can process thousands of variables simultaneously to uncover hidden connections that are beyond the capacity of linear human cognition. This capacity represents a means to address computational complexity and infinite-dimensionality. By analyzing massive datasets of behavioral, linguistic, and social information, AI can facilitate deeper insight into semiotic complexity (e.g., sentiment analysis, theme identification in texts) and even probabilistic forecasting in chaotic systems (e.g., financial market modeling). AI, however, is not without limitations. There is a risk of reductionism, whereby rich human

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complexity is simplified into binary or statistical patterns. Moreover, the "black box" problem in many advanced models where the exact process of arriving at a result is opaque reflects logical complexity and incompleteness, meaning that a system can provide correct outputs without a fully interpretable or objective rationale.

Consequently, crystallization and AI one grounded in human interpretation and the other in computational analysis offer complementary, though sometimes contrasting, tools for navigating the ocean of human complexity. Crystallization emphasizes perceptual richness, multiplicity, and acceptance of contradiction, while AI focuses on pattern detection, large-scale data processing, and probabilistic forecasting. A new realist paradigm may not lie in selecting one approach over the other but in their intelligent integration: leveraging the computational power of AI to process vast layers of data and detect hidden patterns, while simultaneously applying the interpretive insights of crystallization to provide human contextualization, meaning-making, and nuanced interpretation, without losing the complexity, multidimensionality, and socially constructed nature of human reality. Such an integration can provide a practical response to calls for exploratory, multi-criteria, and contextually sensitive approaches in research (Biggiero, 2001).

3. Post-Triangulation Methodology

The present methodological framework, inspired by post-triangulation and adopting a multi-paradigmatic approach, integrates elements of social constructivism and critical realism. This framework emphasizes the construction of meaning through lived experiences while simultaneously acknowledging the objective and structural dimensions influencing the studied phenomena. The overall research strategy follows a mixed-methods design guided by a crystallization approach, implemented across three sequential and interactive phases:

1. **Qualitative Phase:** Semi-structured interviews are conducted with 20–30 young individuals from Tehran, Tabriz, Isfahan, and Sanandaj to explore lived experiences and identify preliminary themes.
2. **Quantitative Phase:** The insights obtained from the qualitative phase are tested through a larger-scale online survey.
3. **Integration Phase (Crystallization):** Findings from both prior phases, together with a vast corpus of digital data, are deeply integrated and interpreted.

***Data Collection*:** Data are gathered multi-dimensionally using complementary tools, including semi-structured interviews, online questionnaires, digital data (approximately 100,000 posts extracted from social media platforms), and optional observations.

***Data Analysis*:** Analyses are conducted in an integrated manner with the support of AI, encompassing:

- Thematic analysis of qualitative data
- Statistical analysis of quantitative data
- Natural language processing (NLP) of digital data
- Comprehensive integration of all findings through crystallization

AI functions as a co-analyst, enabling the processing of massive datasets, identification of hidden patterns, and automation of repetitive analyses, thereby deepening insights.

Validity and Reliability: Research validity is ensured through member checks, transferability, and confirmability, while reliability is maintained via complete documentation of coding schemes and AI algorithm parameters.

Ethical Considerations: Participants provide informed consent, personal data are fully anonymized, AI limitations and biases are transparently disclosed, and user privacy is strictly maintained.

Results Representation: Findings are presented multi-dimensionally through an interactive dashboard, offering a comprehensive view of the cultural identity complexities of Iranian youth in the digital era.

This framework is grounded in the principle that advances in navigating human complexity emerge through intelligent integration, contextual adaptation, and critical evaluation of existing paradigms and tools. Although the number of publications and specialized institutions in qualitative research has increased significantly, analyses of claims regarding methodological innovation indicate that many purported innovations do not involve entirely new methods but rather the adaptation, integration, or transfer of existing approaches from other fields, particularly arts and humanities. Excessive claims portraying adaptation as pure invention can generate unrealistic expectations and undermine the credibility of the field. Hence, true innovation in qualitative research typically lies not in inventing unprecedented methods but in creatively and adaptively applying existing frameworks to novel contexts (LaMarre & Chamberlain, 2022).

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Figure 1

Methodological Transition from Triangulation to Crystallization

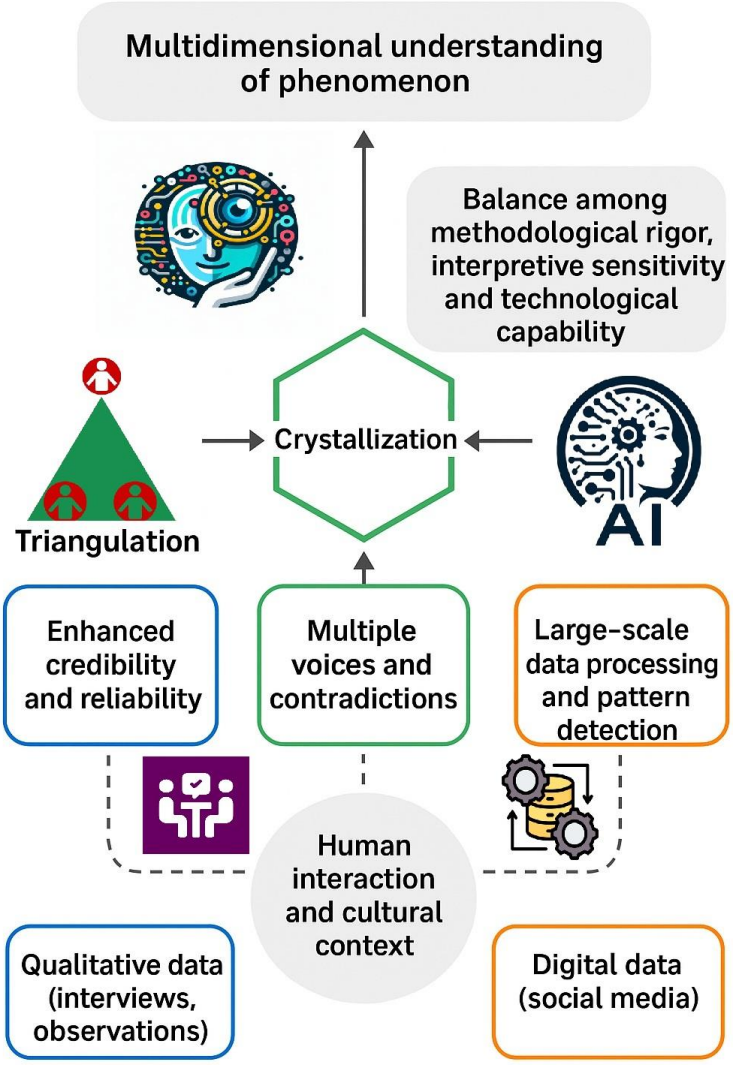

Figure 1 illustrates the methodological evolution from triangulation to crystallization. In the first stage, triangulation, with its focus on convergence of data and methods, aims to enhance the credibility and reliability of findings, yet it often overlooks the multiplicity and interpretive richness inherent in the data. In the second stage, crystallization embraces diversity, contradictions, and multidimensionality, enabling a deeper and more nuanced reflection of human phenomena. This transition represents a shift from post-positivist approaches toward interpretive and reflexive paradigms, which, rather than seeking a single objective truth, aim to capture a layered and pluralistic understanding of social reality. The figure also highlights that this evolution is not merely a technical adjustment but reflects a broader paradigmatic transformation in how reality is understood, interpreted, and represented.

4. Discussion and Conclusion

The findings of this study indicate that the transition from triangulation to crystallization, and subsequently to the integration of AI, represents more than a technical adjustment it embodies a paradigmatic shift in the understanding and production of qualitative knowledge. This aligns with prior analyses emphasizing that human

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systems are inherently complex, multilayered, and irreducible, and that any approach seeking a single truth inevitably overlooks part of this complexity (Biggiero, 2001; Sanbonmatsu et al., 2021).

From an epistemological perspective, the results confirm that while triangulation is valuable for enhancing data credibility, its roots in post-positivism tend to steer the diversity and multiplicity of data toward convergence (Abbaszadeh & Hoseinpour, 2011; Morgan, 2024). This tendency reflects what critics such as Foucault describe as the reproduction of power/knowledge relations, in which the richness of meanings is hidden behind a single truth (Foucault, 2020). The present study further demonstrates that data even when contradictory can be analytically valuable and should not be forcibly assimilated into a convergent narrative.

Crystallization, as employed in this study, allows for the reflection of multidimensionality and the acceptance of contradictions. This finding is consistent with Ellingson (2009) and Stewart et al. (2017), who describe crystallization as a methodology that enables researchers to recognize multiple narratives, creative forms, and even contradictions as part of the richness of phenomena. The study showed that integrating qualitative data (interviews and observations), quantitative data (surveys), and digital data (social media posts) through a crystallized approach produced a more nuanced and multidimensional understanding of Iranian youth cultural identity.

However, the findings also reveal that even crystallization has limitations when confronted with large-scale, dynamic data generated in digital environments. As Castells (2004) emphasizes, the networked society has transformed the conditions for meaning-making; meaning is now constructed at the intersection of human and algorithmic data (Anttiroiko, 2015). In this context, the present study demonstrates that AI, acting as a co-analyst, can uncover hidden patterns and support researchers in integrating multi-source data. This aligns with Xu et al. (2021) and Abbaszadeh and Pashaie (2025), who position AI not merely as an analytic tool but as a new methodological paradigm.

Nevertheless, our findings indicate that using AI without a critical perspective may introduce bias and reproduce epistemic inequalities. This observation corresponds with Beck (1998) and Baş (2025), who frame emerging technologies within the risk society, highlighting potential hazards. Moreover, the "black box" nature of advanced algorithms can reduce the transparency of qualitative analyses (Hitch, 2024). The study emphasizes that researchers must mitigate these risks through full documentation of AI codes and reflective consideration of algorithmic roles.

Practically, the study suggests that combining triangulation for credibility (Flick, 2013; Tabatabaee et al., 2013), crystallization for interpretive richness (Abbaszadeh & Soltani Bahram, 2016; Ellingson, 2009), and AI for processing large-scale data (Cremin et al., 2022; Nageye et al., 2024) can offer a comprehensive and multifaceted framework for addressing human complexity. In the Iranian context, this integrated approach enhanced both interpretive sensitivity and analytic reliability.

Overall, the findings underscore that the future of qualitative research does not lie in excluding any of these paradigms but in their critical and creative integration. AI should be viewed as a complement to, rather than a replacement for, qualitative approaches. Meaning continues to emerge through human interactions and cultural contexts (Ahmadi et al., 2019) while AI facilitates the discovery of hidden patterns and scalability (Pal, 2023). This methodological synergy enables researchers to balance methodological rigor, interpretive sensitivity, and technological capacity—an equilibrium that strengthens qualitative research in the face of contemporary complex challenges.

In conclusion, the shift from triangulation to crystallization and the subsequent integration of AI is not merely a technical choice but represents a paradigmatic transformation in understanding truth, knowledge, and researcher agency. Triangulation emphasizes credibility through convergence, whereas crystallization focuses on the reflection of multiplicity and the multilayered nature of human experience. AI introduces algorithmic capacity, creating a new horizon where these approaches can coexist not solely affirming a single truth nor merely reflecting multiple voices, but dynamically combining both.

This methodological evolution also redefines the researcher's role. In traditional paradigms, the researcher functioned as an objective observer; in interpretive paradigms, as an active interpreter; and in AI-integrated paradigms, as a co-analyst collaborating with algorithms. This redefinition reshapes the relationship between data, interpretation, and the human subject, opening new opportunities for pattern discovery while demanding heightened critical sensitivity.

Moreover, the integration of triangulation, crystallization, and AI is not simply a tool for enhancing

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research efficiency it reflects deeper epistemological transformations in qualitative inquiry. In a world where data is rapidly generated and redistributed through digital networks, qualitative research must redefine its boundaries. AI offers a means to align qualitative research with contemporary social and technological conditions while simultaneously highlighting risks of over-reliance on algorithmic logic.

The significance of these findings lies in demonstrating that qualitative research in the digital era requires a serious rethinking of its epistemological and methodological foundations. AI is a complement, not a replacement, for qualitative approaches enhancing data processing while meaning continues to be constructed through human interaction, cultural context, and critical reflection. This multiparadigmatic integration empowers researchers to navigate the complex, multilayered realities of the contemporary world.

Nonetheless, this study has limitations. First, deploying AI as a co-analyst raises ethical concerns, potential algorithmic bias, and transparency challenges. Second, while the post-triangulation framework with crystallization and AI is innovative, it has inherent limitations: AI models (e.g., natural language processing) may amplify or suppress certain patterns, and crystallization's interpretive nature heavily depends on researcher sensitivity and creativity, which may introduce unintentional bias. Third, although combining qualitative, quantitative, and digital data enhances explanatory power, aligning these three data streams with AI still faces challenges; patterns extracted from digital data may be misinterpreted without precise cultural contextualization.

Future research is encouraged to explore new data analysis methods, such as deep learning, social network analysis, or computational modeling of complexity, to uncover unexplored dimensions of human-data-algorithm interactions. Developing new theoretical frameworks—such as algorithmic crystallization or cyberstructural triangulation may improve understanding of technology's role in representing multiplicity. Additionally, future studies should address ethical and social dimensions of AI in qualitative research, including algorithmic bias, transparency, and the impact of digital data on participants' rights and privacy.

Ultimately, this study highlights that the future of qualitative research depends on the researcher's ability to balance methodological rigor, interpretive multiplicity, and technological capacity. This path not only addresses the increasing complexity of social realities but also opens new horizons for methodological innovation and knowledge production.

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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Declaration of Interest

The authors report no conflict of interest.

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Ethics Considerations

The study protocol adhered to the principles outlined in the Helsinki Declaration, which provides guidelines for ethical research involving human participants.

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