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Digital Transformation of Cooperatives in Indonesia: A Descriptive Qualitative Study of Cooperatives in Lampung Province

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Abstract

Objective: This study aims to analyze the current state, driving and inhibiting factors, impacts, and patterns of digital transformation among cooperatives in Lampung Province, Indonesia, as part of the broader effort to modernize cooperative institutions in the digital economy.
Method: A descriptive qualitative approach was employed to capture the complexity of digital transformation within cooperatives. Data were collected from seven cooperatives through in-depth interviews with 21 key informants, participatory observation, and document analysis. The data were analyzed using the Miles and Huberman interactive model, including data reduction, data display, and conclusion drawing.
Results: The findings reveal that digital adoption among cooperatives remains uneven, with an average digitalization index of 51.8%, indicating an early transition toward digital cooperative models. Digital member management systems showed the highest adoption rate, while digital annual meetings and e-commerce platforms remained limited. The main drivers of digital transformation include government support programs, competitive pressure from fintech institutions, and visionary leadership. Conversely, barriers consist of limited digital human resources, inadequate technological infrastructure, organizational resistance to change, and low digital literacy among members. The study also identifies four distinct patterns of cooperative digital transformation: Digital Pioneers, Selective Adopters, Reluctant Followers, and Passive Resistance. Furthermore, digitalization improves operational efficiency and service reach but may reduce social interaction and cooperative solidarity if not managed carefully.
Implications: The findings suggest the need for differentiated digitalization policies, continuous digital capacity building, and inclusive transformation strategies that preserve cooperative values while enhancing technological competitiveness
Novelty: This study contributes to the literature by proposing a contextual typology of cooperative digital transformation grounded in empirical evidence from Indonesian cooperatives and by highlighting the tension between digital efficiency and the preservation of cooperative social values, an aspect underexplored in prior research.

Introduction

Cooperative, as one of the pillars of the economy, the Indonesian people face a serious challenge in the era of digital disruption. Based on data from the Ministry of Cooperatives and SMEs of the Republic of Indonesia (2025), there are 130,354 cooperatives. active throughout Indonesia, with a total of 22.46 million members and a business volume of Rp188.02 trillion. However, the contribution of cooperatives to the National Gross Domestic Product (GDP) remains relatively small, at only around 5.1%, far below their potential.

The emergence of institution-finance-based technology (financial technology/fintech) and online lending platforms (peer-to-peer lending) has become a real threat to the sustainability of conventional cooperatives. Survey: In 2025, the Financial Services Authority (OJK) reported that as many as 27.3% of members of cooperative savings loans who switched to the fintech platform cited convenient access and speed of service as the main reasons. Condition: This heightens the urgency for digital transformation of cooperatives as an adaptive strategy to maintain relevance and power in the changing ecosystem of national finance.

The Indonesian government has responded to this challenge by issuing various regulations and strategic programs. Regulation of the Minister of Cooperatives and SMEs Number 9 of 2020 concerning Supervision of Cooperatives provides a legal framework for the organization of digital-based service cooperatives. Furthermore, the 2026 Modern Cooperatives program launched by the Ministry of Cooperatives and SMEs sets a digital transformation target for 10,000 cooperatives. In a way, gradually until the end of 2026. This program covers the facilitation of adoption systems and information management cooperatives, training in digital literacy for administrators and members, and mentoring in the technical development of digital services (Asmini et al., 2018).

Lampung Province, as one of the areas with the largest number of cooperatives in Sumatra, has become a locus for relevant research. Data from the Lampung Province Cooperatives and SMEs Service (2025) recorded 4,892 active cooperatives, with the majority operating in the savings-loan (42%), agriculture (28%), and consumer (18%) sectors. However, preliminary survey work conducted by researchers in October 2025 indicated that only around 34% of cooperatives in Lampung have implemented at least one digitally based service. This number is far below the national average of 43%.

Digital transformation is defined as a process of change, fundamental to organizational methods, that creates value, addresses stakeholders' interests, and carries

out operations through the integrated use of digital technology. (Westerman et al., 2015). Unlike digitization, which refers to the conversion of information from analog to digital, and digitalization, which involves the use of digital technology to automate existing processes, digital transformation entails more comprehensive changes in business models, culture, organization, and propositions. (Akhter et al., 2022; Hess, 2016; Westerman et al., 2015).

The framework states that digital transformation is a process driven by innovative technologies and information, producing change in the entity that creates value and giving rise to a strategic framework within the organization. (Akhter et al., 2022; Arrabal et al., 2022). For road changes, they create markings while managing the associated structures and barriers. (Vial, 2019). Framework: This confirms that digital transformation is not merely a technological phenomenon but a sociotechnical one, involving complex interactions among humans, organizations, and technology.

Cooperative, as an organizational economy based on family and cooperation, has unique characteristics that distinguish it from conventional business entities. Principles cooperatives established by the International Co-operative Alliance (ICA), namely membership voluntary and open, control democratic by members, participation of members in the economy, autonomy and independence, education and training, cooperation inter-cooperative, as well as concern for the community, creating a unique dynamic organization in the context of digital transformation (Hendrikse & Feng, 2023; MM, 2023; Savga et al., 2023).

Research by (Hendrikse & Feng, 2023) In Europe, we find that successful cooperatives in digital transformation generally maintain cooperative principles as a compass for every technology decision. They do not adopt technology solely for efficiency, but also to ensure that it strengthens participation, members, transparency, and values democracy, which becomes a runway movement, a cooperative approach. This is fundamentally different from digital transformation in companies, more conventional, maximization-oriented profit. (Khachaturyan & Klicheva, 2022).

In the Indonesian context, (Anggraeni and Martoyo, 2025) stated that digitalization cooperatives need to consider three main dimensions: (1) technological dimensions, including digital infrastructure and systems information; (2) human dimensions, including human resource capacity and digital literacy; and (3) institutional dimensions, which include regulation, governance, and organizational culture. Failure to pay attention

to a single dimension often hampers digital transformation processes in Indonesian cooperatives.

Various studies have previously studied digitalization cooperatives from diverse perspectives. (Dukalang Moh Agus Nurgoho et al., 2022) analyzed readiness cooperative save borrow in facing the digital era using the Technology Acceptance Model (TAM) and found that perceived usefulness, perceived convenience, and perceived ease of use are significant predictors of intention to adopt technology. Meanwhile, (Wijayanto, 2024) reviewed the impact of implementing the System Information Management Cooperative (SIMKoop) on operational efficiency. They found a 38% improvement in administrative productivity in cooperatives that have fully implemented the system.

Thus, research is generally conducted using a quantitative approach and is limited to aspects of technology adoption. There is still a significant research gap in understanding, in depth, the process, social dynamics, and the meanings constructed by the actors cooperating to undergo digital transformation. An approach that requires a qualitative approach to catch complexity, nuance, and local context that cannot be covered by the measurement alone.

Study This: develop a conceptual framework based on a synthesis of the Technology Adoption Model. (Davis, 1989), Innovation Diffusion Theory (Spear, 2004), and the Digital Maturity Model (Hess, 2016). The framework identifies three main components that mutually interact in the digitalization process of cooperatives: (1) factors driver external (market pressure, policy, government and development technology); (2) internal capacity of cooperatives (human resources, capital, infrastructure, and culture organization); and (3) the adoption process technology that includes awareness, interest, evaluation, trial, and adoption full.

The interaction between the third component produces different digital transformation patterns in each cooperative. Framework: This guides the data collection and analysis in this study while still allowing for potential empirical findings. No anticipated previously a consistent approach within the paradigm of qualitative study, which emphasizes openness to the field's complexity.

Based on the background, research aims to: (1) describe the latest patterns of digital transformation of cooperatives in Lampung Province; (2) identify the factors, drivers, and inhibitors of digitalization of cooperatives; (3) explore the impact of digital transformation on the performance and sustainability of cooperatives; and (4) formulate a digitalization model for contextual and sustainable cooperatives. Research results, as

expected, can contribute theoretically to the development literature on the digital transformation of cooperatives in Indonesia and provide practical recommendations for stakeholders' interests.

Research Methodology

Study This uses a qualitative approach with a descriptive design. Selection approach: This is based on the consideration that the digital transformation of cooperatives is a complex, contextual social phenomenon that cannot be adequately understood through quantitative measurement alone. Approaches to qualitative research allow researchers to understand the meanings, processes, and subjective experiences of perpetrators who are cooperative in undergoing digital change, as (Creswell J.W, 2014) Note that qualitative research is used when researchers want to understand the context and processes of a phenomenon in depth.

Descriptive design chosen because of the study's aim: to describe existing conditions (what is) in a systematic, factual, and accurate manner, not to prove the connection between cause and effect or test a hypothesis. (Lincoln and Guba, 1985) asserted that descriptive qualitative studies seek to describe and interpret phenomena in context in a natural way, with researchers as the key instruments for data collection and analysis.

The study was implemented in Lampung Province from October 2025 to January 2026. Election location. This is based on the following considerations: (1) Lampung is a province with the largest number of cooperatives on the third largest island in Sumatra; (2) there is a diverse range of adequate cooperatives for comparative needs analysis; and (3) accessibility and familiarity of researchers with the local socio-cultural context.

Informant study chosen uses a purposive sampling technique with the following criteria: (1) is an administrator, manager, or member of active cooperatives who knows the operational conditions of cooperatives; (2) cooperatives represented have been operating for at least five years; and (3) willingness to participate in the study is voluntary. As many as seven cooperatives were selected for the location study, with 21 informants from various positions (chairpersons, managers, treasurers, and members). The profiles of the informants and cooperatives studied are presented in Table 1.

Table 1. Profile Cooperatives and Informants Study

Code	Types of Cooperatives	Location	Position Informant	Year Stand
KP-01	Cooperative Save Borrow	Bandar Lampung	Chairman Cooperative	2005
KP-02	Cooperative Consumer	Pringsewu, Lampung	Manager Operational	2010

KP-03	Multipurpose Cooperative	Metro, Lampung	Secretary	2008
KP-04	Cooperative Employee	Bandar Lampung	Treasurer	2012
KP-05	Cooperative Agriculture	Pesawaran, Lampung	Chairman Cooperative	2003
KP-06	Cooperative Save Borrow	Central Lampung	Manager Finance	2015
KP-07	Cooperative Consumer	Tanggamus, Lampung	Member Active	2009

Source: Field Data, 2025-2026

Data collected through three techniques: main, mutual, and complete. First, in-depth interviews were conducted with 21 informants using semi-structured questions covering the following topics: conditions of digitalization, cooperative moments, the adoption process and technology strategy, obstacles and challenges faced, and the impact experienced. Each session interview lasted between 60 and 120 minutes and was recorded with the informant's agreement.

Second, participatory observation was conducted for two weeks at each cooperative to directly observe how technology was used in daily operational interactions between officers and members during digital transactions, as well as the dynamics of meetings and technology-driven decision-making. Notes field notes are created systematically after every session observation.

Third, a study was conducted on various documents relevant to cooperatives, including financial reports, meeting minutes, member annual meeting (RAT) minutes, internal technology policies, and records of the cooperative's digitalization journey. Documents, regulations, government reports, and reports from the Cooperatives and SMEs Service of Lampung Province were also analyzed as secondary data.

Data analysis using the interactive model of (Miles et al., 2014) which consists of four interconnected components that interact dynamically: (1) data collection; (2) data condensation, including election, centralization attention, simplification, abstraction, and transformation of raw data; (3) presentation of data (data display) in the form of text narrative, tables, and matrices; and (4) drawing a conclusion, drawing/verification. The analysis process is ongoing, occurring simultaneously with data collection and continuing until researchers achieve a comprehensive understanding.

For ensure data validity, research This use four triangulation strategies: (1) triangulation source, with compare data from different informants position and background back; (2) triangulation technique, with compare data from results interviews, observations, and documentation; (3) member checking, with return findings temporary

to informant key for verification; and (4) peer debriefing, with discuss findings and interpretations with colleague researchers and experts cooperative.

Results and Discussion

Condition of Latest Digitalization Cooperatives in Lampung

Findings of the study show that the determination of prices on digital platforms does not fully follow a cost-plus pricing model that places production costs and profit margins as the main basis. The perpetrator's business generally starts with the cost of the main product, operational costs, platform services, and the expected minimum margin. However, the price begins with the experience adjustment after considering digital market conditions. Informant mentions that the price of the product is often compared with competitor store prices that appear on the page search before being published to consumers.

Findings from the field show a diverse and layered picture of condition digitalization cooperatives in Lampung Province. In general, aggregate-level adoption of digital technology across the seven cooperatives under study can be grouped into six main aspects, as presented in Table 2.

Table 2. Level of Digital Adoption in the Cooperatives Studied

Digital Aspects	Present condition	Main Obstacles	Adoption Rate
System Digital Bookkeeping	Most (5/7) have been using accounting software-based	Cost-limited licenses and human resources	71%
Mobile Banking/ Save Application Borrow	3 of 7 cooperatives own an application, alone or affiliated	Internet infrastructure is not evenly	43%
Internal E-Commerce Platform	Only 2 cooperatives (KSU) are active in selling online	Lack of digital literacy among members	28%
System Management Digital Member	6 of 7 cooperatives have a digital member database	Data security and privacy	86%
Non- Cash Transactions / QRIS	4 of 7 cooperatives already accept QRIS	Network signals and trust member	57%

Report Online Finance (Digital RAT)	Only 2 cooperatives have implemented hybrid RATs	Regulation is not yet fully supported	28%

Source: Interview Results and Field Observations, 2025-2026

The data in Table 2 show that digital system management is the most widely adopted aspect (86%), whereas internal e-commerce and digital RAT remain very limited (28%). The average index of digitalization across six measured aspects is 51.8%, indicating that, in general, cooperatives in Lampung are still in a phase of transition, beginning to move toward becoming digital cooperatives.

Observation results from fieldwork conducted at KP-01, one of the largest cooperative savings and loans in Bandar Lampung, show that the practice is the most advanced in terms of digitalization among the cooperatives studied. Cooperatives: This has developed an Android-based mobile application that allows members to simulate loans, apply for credit online, check savings balances, and view payment installments via bank transfer or QRIS. However, the interview with the head of KP-01 revealed complexity that is not seen from the outside:

"*We have indeed already had the application for two years, but honestly, of our 3,400 members, who actively use the application, only around 800. The others are still more like coming directly to the office. Some don't have a smartphone; some have one but can't operate it; some have one and can, but don't believe in putting money into the app. So the challenge is not only to question the technology, but also to question the beliefs and customs of our members*." (KP-01, interview, November 15, 2025)

The above statement reflects a phenomenon observed in almost all cooperatives studied: gaps between available technological capacity and the level of utilization achieved by members. Phenomenon This can be explained through the concept of 'adoption gap', which refers to the distance between the technology adopted by the management and the technology truly used by users at the end user (in this case, the member cooperative).

A striking contrast is found in KP-05, a cooperative in Pesawaran whose majority of members are farmers aged 45 or older. Observation at the cooperative shows that almost all transactions are still done manually, although the cooperative administrator realizes the need for digitalization:

"We want to move forward, but we can't leave our members who have elders. They cannot use a sophisticated cellphone; they are already used to meeting in person, asking for help, and seeing book savings in person. If we force digital, they Can No believe and go out

of the cooperative without members. That's nothing." (KP-05, interview, December 3, 2025)

Expression: This contains wisdom on local matters: digitalization, cooperation. No one may sacrifice the principle of inclusivity and service to the most vulnerable members. Findings. This is in line with (Ali et al., 2023) perspective, which argues that digital transformation of cooperatives must start from the cooperative's core values, rather than merely chasing efficiency technologies.

Digital Transformation Patterns: Typology Cooperatives in the Field

Based on data analysis from all the cooperatives studied, researchers identify four patterns or typologies of digital transformation. Typology This is constructed based on two main dimensions: (1) level of adoption of digital technology (low vs. high) and (2) motivation for digitalization (reactive vs. proactive).

Type First is Digital Pioneers, characterized by technology adoption, height, motivation, and proactivity. KP-01 and KP-04 are included in this category. Cooperative digital pioneers not only adopt available technology but also, in a way, actively innovate by developing customized digital solutions that meet their members' needs. They have dedicated IT staff, a budget specifically for development technology, and leadership with a clear digital vision. KP-04, a cooperative employee company manufacturing, has even developed a module for planning a simple AI-based personal finance application.

Type two is a Selective Adopter, characterized by moderate, varying motivations for technology adoption, ranging from reactive to proactive. KP-02, KP-03, and KP-06 are included in this group. Cooperatives adopt technology selectively, based on pragmatic cost-benefit considerations. They use technology for back-office processes (bookkeeping, member database) but still maintain face-to-face interaction mainly for services. An interview with the Manager of Operational KP-02 revealed a distinctive perspective:

"We use a digital system for bookkeeping and member data management, which clearly helps our efficiency. But for service loans and savings, we still maintain face-to-face advances because our members need that personal touch. Cooperative, that is not a bank, personal relationships are superior to our competitiveness, which may be lost because of digitalization." (KP-02, interview, November 22, 2025)

Type three is a Forced Follower (Reluctant Follower), characterized by a low rate of technology adoption but strong motivation and reactive pressure from external forces. KP-07 represents type this. Cooperative. This new start adopts digital technology after

pressure from the Cooperatives and SMEs Service and sees a significant decline in the number of active members who switch to fintech. The adoption process is forced and lacks adequate internal readiness, so its implementation is often hampered.

Type four is Resistance Passive (Passive Resistant), which, although not explicitly rejecting digitalization, in practice means no one takes steps to make real changes. KP-05 tends to fall into this category, with characteristics such as awareness of the importance of digitalization. However, it is accompanied by various justifications. The current condition (status quo) cannot yet be changed due to factors such as demographic composition, limited capital, and limited human resources.

Driving Factors Digitalization

An analysis of cross-case studies identifies several factors driving the main digitalization cooperatives in Lampung. The first and most consistently mentioned factor by all informants is competitive pressure from fintech and digital banking. The phenomenon manifested in a decline in the number of active members and transaction volume in slow cooperatives. The data provided by KP-03 show that during 2020-2025, cooperatives lost around 340 active members, with 67% stating they switched to online loan applications in the exit survey conducted among cooperatives.

The second factor is to support government policies and programs. The 2026 Modern Cooperative Program is being implemented. The Ministry of Cooperatives and SMEs provides support through subsidies for device soft management cooperatives, HR training, and technical mentoring. Three of the seven cooperatives studied (KP-01, KP-03, KP-06) have taken advantage of this program and report significant benefits, particularly in reducing license and software costs, enhancing human resource capacity, and improving device software.

The third factor is visionary leadership in a cooperative. That alone. Findings of interest from the study: the level of digitalization inter-cooperative is not always correlated with cooperative size or financial condition, but is strongly influenced by orientation and leadership capacity. KP-04, although smaller than KP-05, successfully achieved a high level of digitalization and was taller because our chairman has a background in technology, extensive knowledge, and a network with the local startup community.

Inhibiting Factors of Digitalization

Study This identifies four main categories of obstacles to the digitalization of cooperatives. Obstacles: First, limitations in the source Power; digitally literate people. Almost all informants mention difficulty in getting and keeping power work that requires adequate digital competency. In general, remuneration in cooperatives is lower than in the private sector, making it difficult for cooperatives to compete in the labor market for digital work. Treasurer KP-06 illustrates the situation:

"*We have recruited a good young man, an IT graduate, who can develop our system well. But six months. Then he went out because the company offered double salary in Jakarta. We cannot compete with wages. So now we are more. Lots rely on internal training and outsourcing for development technology."* (KP-06, interview, December 10, 2025)

The second obstacle is the uneven distribution of digital infrastructure. Cooperatives operating in semi-urban and rural areas (KP-05, KP-07) face serious constraints, including instability and limited internet connectivity. Observations at KP-05 show that frequent digital transactions fail due to a weak internet connection, which in turn causes members to distrust digital systems overall.

The third obstacle is culture-resistant organizations to change. This phenomenon is most obvious in cooperatives that have long operated under senior management accustomed to conventional ways. Secretary KP-03 described complex internal dynamics:

"At the meeting, administrators, every time we propose digitalization, always a smooth rejection. Not openly refuse, but the question always is: 'What guarantee of security?' 'If the system is damaged, how?', 'Is it?' Member, are we ready? Finally, all end with ' we' need to study more. The study No Once finished Because of course No Once truly started." (KP-03, interview, November 28, 2025)

The fourth obstacle is the low digital literacy among cooperative members. Most of them, the cooperative being studied owns a profile dominated by members aged 40 and above, with diverse levels of education. A survey quickly done with 120 members from seven cooperatives found that only 31% said they feel comfortable using digital finance applications in general, independently.

Impact of Digital Transformation on Cooperative Performance

Cooperatives that have implemented digitalization more comprehensively (KP-01 and KP-04) report several measurable positive impacts. First, operational efficiency increased significantly: KP-01 reports a 23% decline in administrative operational costs over two years following the full digital system's implementation, while loan processing time decreased from an average of 5 days to 1.5 days. Second, the reach service is

expanding: KP-04 successfully added 240 new members in one year; 60% of them joined through online registration without coming to the office.

However, the field findings also identified unanticipated impacts. In KP-01, implementing mobile applications reduces the frequency of office visits, thereby increasing efficiency. Still, on the other hand, it reduces the intensity of social interaction, which has historically become the ' glue ' of the community cooperatives. Some senior members of KP-01 expressed concern about this:

" Before every month we gather here to pay installments, so all friends chat and share news. Now all via cell phone, no need to meet again. Cooperative, so it felt like a regular bank. Family spirit "(Senior Member of KP-01, interview, November 20, 2025)

Observation: This raises a critical question: how to get attention for critical needs? Serious in policy digitalization cooperative: how to transform the operational cooperative digitally without eroding values, kinship, and cooperation, which become the fundamental identity of the movement cooperative? Findings This is parallel with Birchall's warning (2022) that in chasing digital efficiency, cooperatives must be careful not to lose the' edge cooperative advantage which is sourced from social capital and relationships with the community.

Conclusion

Study This shows that the practice of determining prices on digital platforms has experienced a shift from a conventional pattern that relies on calculations of cost, production, and profit margins to more dynamic, adaptive, and responsive mechanisms to the digital platform structure. Prices in the marketplace are not solely formed by the internal considerations of the perpetrator's effort, but also influenced by the platform algorithm, intense competition between stores, promotional momentum, visibility of products, and consumer behavior. Thus, prices on digital platforms are the result of interactions between market logic, technology, and ongoing competitive strategies in real time.

Findings of the study show that changing prices is basically viewed by the perpetrator business as a rational strategy for maintaining power, competitiveness, and sustainability of the business. Within the framework of the digital market, flexibility of price is a form of adaptation to the dynamics of demand, pressure of competition, and mechanisms of platform promotion. However, research has also found that the main problem lies in the changes in price itself, but at the level of transparency of the formation process.

Structured digital pricing often involves platform discounts, vouchers, fee-for-service, promotions that are temporary, and algorithmic adjustments that are not at all understood by consumers. Conditions: This can cause room asymmetry, potentially influencing quality agreement awareness in transactions.

From the perspective of Islamic Business Ethics, the practice of determining prices on digital platforms in principle can be accepted, as long as it is ongoing in a way that is proportional, open, and does not contain elements of manipulation and exploitation. Principle *al -' adl, bayān, tarā ḍ in,* and amanah become of normative importance in evaluating the legitimacy of digital prices. Therefore, flexibility of price is not contradictory with the ethics of Islamic business; the change of price still reflects honest information, transparency mechanisms, and the benefit of the parties. On the other hand, when the pricing strategy is directed to form a perception mark in an artificial way without adequate information, then ethical problems appear that require attention.

Academically, research confirms that pricing on digital platforms must be understood as a construction mediated by socio - economic technology, and not solely as variable economic factors that influence the decision to purchase. Contribution of the main study. This lies in the effort to place the formation process of prices as a negotiation arena between digital market rationality, structural institutional platforms, and values, ethics, and transactions. Practical implications from findings. This shows the need to strengthen governance, improve price transparency, improve consumer literacy about the structure of digital prices, and develop more platform policies accountable for the ecosystem, so that digital trade can grow in an efficient way, at the same time fair, open, and oriented towards the welfare of the ecosystem.

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Author Contributions Statement

FSI conceptualized the qualitative case study design, conducted the in-depth field interviews with marketplace operators, and MH structured the dynamic pricing analytical framework, aligned the empirical findings with Islamic business ethics principles.

Conflict of Interest

The authors declare that there is no conflict of interest regarding this study. This research was conducted independently without any commercial involvement from digital platform institutions or any other external parties that could compromise the objectivity of the analysis and manuscript.

AI Usage Statement

In the process of drafting this manuscript, the authors used a generative artificial intelligence system based on Large Language Models to assist with exploring initial ideas, developing the writing structure, and linguistic editing. The entire conceptualization process, research data collection, empirical analysis, academic interpretation, reference verification, and scientific argumentation remain the full responsibility of the authors, who critically reviewed, verified, and edited the final content prior to submission.

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