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Research on the Impact of Artificial Intelligence on User Innovation Behavior in Online Communities

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Abstract. With the deep application of artificial intelligence (AI) technologies represented by generative and interactive AI, their impact on user innovation behavior in online communities has become increasingly profound. Taking the Xiaomi MIUI community, the Tesla owner community, and the LEGO IDEAS community as examples, this study analyzes the paths through which AI influences user innovation behavior in online communities and the chain changes it triggers, and discusses the practical problems and optimization directions in its application. The study finds that AI, through three paths—lowering the innovation threshold, optimizing the matching of innovation resources, and reconstructing the value distribution mechanism—promotes three core transformations of user innovation behavior in online communities: from "niche participation" to "mass co-creation," from "experience-driven" to "data-empowered," and from "scattered and disorderly" to "collaborative and efficient," while triggering chain changes at the levels of innovation subjects, costs, benefits, and industrial coordination. However, it also gives rise to problems such as ambiguous ownership of innovation outcomes, uneven benefit distribution, and risks to data security and privacy protection. Accordingly, this paper puts forward optimization suggestions in four aspects: clarifying the ownership rules of innovation outcomes, improving value distribution and incentive mechanisms, improving the data governance and privacy protection system, and upholding the principal position of users, so as to provide a reference for enterprises seeking to empower user innovation with AI.

Keywords: artificial intelligence, online community, user innovation behavior, influence path

1. Introduction

The report of the 20th National Congress of the Communist Party of China explicitly proposed to "build a number of new growth engines, such as next-generation information technology, artificial intelligence (AI), biotechnology, new energy, new materials, high-end equipment, and green environmental protection" [1]. In recent years, China has achieved remarkable results in AI development. According to the Report on the Development of Generative AI Applications (2024) released by the China Internet Network Information Center (CNNIC), by the end of 2024, China had more than 4,500 core AI-related enterprises, and the scale of the core industry was close to 600

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billion yuan [2]. These achievements are being transformed into real innovation momentum in specific application scenarios, and online communities are one of the important scenarios. In August 2025, the State Council issued the Opinions on Deeply Implementing the "AI Plus" Initiative, proposing to accelerate the formation of a new form of intelligent economy and intelligent society featuring "human-machine collaboration, cross-domain integration, and co-creation and sharing" [3]. As virtual spaces where users gather, interact, and create, online communities are a typical carrier for putting the concept of "co-creation and sharing" into practice. The user innovation behavior they carry has become a core driving force for enterprises' product iteration and service optimization, breaking the traditional single innovation paradigm dominated by producers. Against this background, this paper focuses on the impact of AI on user innovation behavior in online communities.

Research on the question of "how AI influences user innovation behavior in online communities" has both theoretical and practical significance. At the theoretical level, existing studies mostly focus on the direct impact of AI on innovation efficiency [4, 5], lacking results that combine enterprise practice to systematically examine the new changes in user innovation triggered by AI and their subsequent chain changes, and the integration of influencing factors such as user interaction and emotional bonding is also insufficient. At the practical level, the community practices of leading enterprises such as Xiaomi, Tesla, and LEGO, as well as the exploration of user-centered interaction in the HarmonyOS online community [6], provide rich observation samples for answering the above question. On this basis, this paper first draws on Schumpeter's innovation theory, transaction cost theory, network effect theory, and innovation economics to sort out the main mechanisms by which AI influences user innovation behavior in online communities, distills the influence paths, and proposes research hypotheses; it then examines whether these influences exist and how they work through the typical community cases of Xiaomi, Tesla, and LEGO; finally, it puts forward targeted optimization suggestions, with a view to providing theoretical reference and practical lessons for enterprises to empower user innovation with AI.

2. Concept definition and literature review

2.1. Definition of core concepts

Around the research object, this paper defines two core concepts: artificial intelligence and user innovation. First, the concept of AI was first proposed by McCarthy et al. in the Dartmouth Summer Research Project in 1955 [7]; the Artificial Intelligence Standardization White Paper (2018 Edition) defines it as the theory, methods, technologies, and application systems that simulate, extend, and expand human intelligence, perceive the environment, acquire knowledge, and use knowledge to obtain the best results [8]. Referring to the above definitions and combining the needs of this study, the AI referred to in this paper focuses on two types of technological forms that directly act on online communities: first, generative and interactive AI tools that can directly participate in knowledge creation; second, data intelligence technologies embedded in community operations, represented by semantic understanding, demand identification, and contribution measurement. Second, the concept of user innovation was first proposed by Von Hippel, referring to the process by which users independently develop or improve products and services to meet their own needs [9]; Yang and others extended it to the online community scenario [10]. Accordingly, this paper defines user innovation behavior in online communities as the activity process in which users, relying on online community platforms, based on their own needs and usage experience, and with the help of

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technological tools such as AI, participate in product and service innovation in the forms of idea submission, demand feedback, collaborative development, and so on.

2.2. Whether artificial intelligence influences user innovation behavior in online communities

Most studies confirm that AI has a significant positive impact on user innovation behavior in online communities: Belz and Baumbach proposed using the netnography method to identify lead users in online communities, providing a methodological basis for accurately screening users with innovation potential [11]; Salminen et al. demonstrated that machine learning can automatically detect pain points from user-generated content, improving the precision of innovation [4]; Xie et al. found that involving community users in innovation can significantly improve enterprise innovation performance [12]. At the same time, Murray et al. pointed out that there are multiple forms of relationship between humans and technology, ranging from "tool" to "actor," and that AI has both enhancing and substituting effects on user innovation [13].

2.3. Paths of artificial intelligence influencing user innovation behavior in online communities

Existing studies have mainly identified three types of mechanisms. The first is user identification and resource allocation optimization: Fu et al. showed that data-driven methods can accurately identify lead users with strong innovation willingness and high professional levels from massive user populations [14]. The second is demand mining and pain point identification: Von Hippel and Kaulartz found that machine learning can identify "need-solution" pairs in advance and capture users' implicit needs [15]; Salminen et al. also showed that AI can transform fragmented user expressions into structured pain point signals [4]. The third is idea matching and collaboration efficiency improvement: Timoshenko and Hauser demonstrated that machine learning can efficiently identify customer needs from user-generated content [5]; Qi et al., based on evidence from the LEGO IDEAS platform, showed that user social networks can significantly improve collaborative innovation output [16]. In terms of case studies, the Xiaomi MIUI community has formed a user innovation model of "demand mining—idea screening—rapid iteration" [17]; Hienerth et al. revealed the synergies among producer firms, lead users, and user communities in the LEGO ecosystem [18]; Zhang et al. found that user-centered interaction is the core mechanism for stimulating the innovation vitality of the HarmonyOS online community [6].

2.4. Key factors of artificial intelligence influencing user innovation behavior in online communities

The first is the depth and breadth of user interaction information: based on the latent Dirichlet allocation (LDA) topic model, Zhang et al. showed that the richer the interaction information, the more accurately enterprises can grasp user needs [19]. The second is community emotional bonding: Wang and Li pointed out that strong emotional bonding can significantly enhance users' community identity and innovation willingness [20]. The third is user heterogeneity: the community user classification model of Yang shows that accurate user stratification is a prerequisite for AI to optimize the allocation of innovation resources [10].

2.5. Literature commentary

Taken together, existing research still has the following deficiencies: first, the research perspectives are relatively scattered, and technical path research and case research lack integration; second, most

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studies focus on the direct impact of AI, paying insufficient attention to the new changes in user innovation and the chain changes it triggers; third, the integration of the synergistic effects of factors such as user interaction and emotional bonding with AI empowerment is insufficient. On this basis, combining relevant theories and enterprise practices, this paper systematically analyzes the influence paths of AI on user innovation behavior in online communities and the chain changes they trigger.

3. Analysis of the influence paths of artificial intelligence on user innovation behavior in online communities

On the basis of the above literature review, this paper combines Schumpeter's innovation theory, transaction cost theory, network effect theory, and innovation economics to distill three influence paths and propose research hypotheses accordingly.

3.1. Path 1: breaking resource constraints and lowering the innovation threshold—analysis based on Schumpeter's innovation theory

Schumpeter's innovation theory holds that innovation is the core driving force of economic development, and its essence is a process of "creative destruction"—new technologies break the existing combination of production factors and resource allocation patterns, promoting the diffusion of innovation from a few subjects to the majority [21]. From this perspective, the primary impact of AI on user innovation behavior is precisely to disintegrate the threshold structure of traditional innovation through "creative destruction": its "destruction" lies in breaking the monopoly of professional knowledge and skills over innovation activities—under the traditional model, idea expression, solution design, and prototype production highly depend on professional training, and ordinary users are shut out of the innovation process; its "creation" lies in the fact that AI recombines massive knowledge and intelligent tools, creating unprecedented innovation conditions for ordinary users—generative AI opens up massive knowledge for free or at extremely low cost, interactive AI can directly participate in knowledge creation, and the innovation links that originally required professional training are greatly simplified.

This mechanism has been confirmed by empirical research: the randomized experiment of Noy and Zhang showed that generative AI significantly improves users' content creation efficiency and quality, with more obvious improvement for users with weaker foundations [22]; the research of Brynjolfsson et al. based on real enterprise scenarios similarly found that generative AI brings the largest efficiency gains to low-skilled employees [23]. Corresponding to online communities, ordinary users are no longer limited by professional knowledge and skill reserves and can directly participate in idea submission and solution improvement with the help of AI, which is also consistent with existing evidence on identifying lead users and activating ordinary users' participation to expand the innovation base [11, 14, 19]. Accordingly, this paper proposes research hypothesis H1: by breaking resource constraints and lowering the innovation threshold, AI promotes user innovation behavior in online communities from "niche participation" to "mass co-creation" and from "experience-driven" to "data-empowered."

3.2. Path 2: reducing transaction costs and optimizing the matching of innovation resources—analysis based on transaction cost theory and network effect theory

Transaction cost theory holds that transaction costs are the core factor affecting the efficiency of resource allocation [24]; related research further shows that information asymmetry is an important

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source of transaction costs, and compressing the costs of information search, communication and negotiation, and supervision and execution is the basic way to improve the efficiency of resource allocation [25]. In traditional online communities, there is serious information asymmetry between users and between users and enterprises, and the costs of idea search, communication, and matching are high, which restricts innovation efficiency. AI optimizes the allocation of innovation resources precisely by reducing transaction costs: at the information level, it uses technologies such as semantic understanding and topic identification to transform fragmented user expressions into structured demand signals, alleviating the information gap between enterprises and users [5, 19]; at the matching level, it efficiently completes user screening, idea classification, and the precise docking of innovation resources, reducing ineffective communication [11, 14].

Network effect theory further reveals the amplification mechanism of the above effects: the value of a network increases with the number of users [26]. After the innovation threshold is lowered, the number of participating users continues to grow, and the interaction and collaboration among users further amplify the network value of the community, forming a virtuous circle of "increased participation—enhanced collaboration—improved innovation efficiency" [16]; the research of Zhang et al. also confirms that the user-centered interaction model significantly improves the collaborative innovation efficiency of the community [6]. Accordingly, this paper proposes research hypothesis H2: by reducing transaction costs and optimizing the matching of innovation resources, AI promotes user innovation behavior in online communities from "scattered and disorderly" to "collaborative and efficient."

3.3. Path 3: reconstructing the value distribution mechanism to promote sustained user innovation—analysis based on innovation economics

Innovation economics emphasizes that a reasonable incentive mechanism is the prerequisite for the continuous output of innovation [27]; from existing research, a reasonable incentive mechanism covers value distribution, reputation incentives, growth returns, and financial capital support, and their common foundation is that innovation contributions can be fairly evaluated and rewarded [28, 29]. From this perspective, under the traditional model, the value distribution of online communities faces a dual dilemma: on the one hand, users' innovation contributions are difficult to measure, and labor input, idea value, and communication value cannot be distinguished; on the other hand, the distribution rules are unilaterally dominated by enterprises, making it difficult for users to obtain returns matching their contributions, which restricts innovation enthusiasm.

The contribution measurement capability of AI provides conditions for solving the above dilemma: relying on data systems, users' contributions throughout the whole process from idea submission and interactive improvement to outcome transformation are accurately recorded, so that user innovation contributions become measurable, comparable, and traceable, and value distribution gains an objective basis. From the perspective of value composition, the reconstructed distribution mechanism covers multiple dimensions: at the material level, users can obtain monetary returns such as remuneration and royalty shares based on quantified contributions; at the reputation level, contribution records are transformed into community identity capital such as levels and certifications; at the growth level, users gain knowledge and skill improvement in collaboration and feedback. As a result, value distribution moves from "enterprise-dominated" to "multi-party sharing," and users' motivation for continuous innovation is enhanced accordingly. Accordingly, this paper proposes research hypothesis H3: by reconstructing the value distribution mechanism, AI promotes sustained user innovation and triggers chain changes at the levels of innovation subjects, costs, benefits, and industrial coordination.

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4. Case analysis of artificial intelligence empowering user innovation behavior in online communities

To test the above hypotheses, this paper selects three typical cases: the Xiaomi MIUI community, the Tesla owner community, and the LEGO IDEAS community. All three are classic samples repeatedly used in existing research and public reports—the participatory R&D model of the Xiaomi MIUI community has been widely cited [17], the LEGO IDEAS platform is a representative case for examining user collaborative innovation [16, 18], and the Tesla owner community is regarded as a benchmark of user co-creation because user suggestions such as "Dog Mode" were implemented through over-the-air (OTA) remote upgrades [30]; the three cases have different emphases and can provide complementary evidence for testing the three paths.

4.1. Xiaomi MIUI community: rapid iteration driven by the intelligent aggregation of user demand

The Xiaomi MIUI community has established a weekly iteration mechanism called "Orange Friday": a new version of the system is released every Friday, after which users submit "four-grid experience reports" summarizing their evaluations and expectations, with more than one hundred thousand users participating in the feedback of each period [17], and the release rhythm is publicly agreed upon through the community's official channels [31]; the community has also formed a layered co-creation structure progressing layer by layer from official engineers, to the thousand-member honorary beta testing group, to one hundred thousand development-version users, and to tens of millions of stable-version users [17]. Behind the scale expansion is the continuous lowering of the innovation threshold: when the first version of MIUI was released, it had only 100 users, and the number reached 500,000 one year later [32]—ordinary users can participate in innovation simply by submitting their usage experience, without programming skills.

In this process, the role of data intelligence technology is concentrated in the following aspects: the "four-grid experience report" provides formatted guidance for user expression, massive feedback is aggregated and ranked by popularity, and iteration priorities are intelligently identified based on feedback data. Fragmented user expressions are thus transformed into structured demand signals, the costs of idea search and matching are significantly reduced, and a closed loop of user innovation featuring "demand mining—idea screening—rapid iteration" is formed [17]—on the one hand, this confirms Path 1, in that the lowering of the innovation threshold enables ordinary users to participate in innovation; on the other hand, it confirms Path 2, in that the reduction of transaction costs greatly improves the matching efficiency between demand and innovation resources.

4.2. Tesla owner community: demand response and product evolution driven by data intelligence

The prominent feature of the Tesla owner community is the deep coupling of user ideas with vehicle-level data intelligence: owners can submit suggestions directly to the enterprise and even to the person in charge of the enterprise through the official community or social platforms, and the enterprise uses intelligent data analysis to identify high-frequency demands from massive feedback and fleet operation data, publicly responds to feasible suggestions, and incorporates them into the development schedule. A typical case is "Dog Mode": in October 2018, a Model 3 owner suggested to Musk on a social platform that a "dog mode" be added to keep pets left alone in the car cool, and

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Musk immediately replied "yes" [30]; in February 2019, the function was officially pushed through an OTA remote upgrade [33].

Product evolution driven by data intelligence is embodied in the continuous upgrading of vehicles throughout their entire life cycle: "Dog Mode" is not the installation of new hardware, but an intelligent extension of the "cabin overheat protection" function of firmware version 8.0 in 2016—relying on existing sensors and vehicle-level data capabilities, user ideas can be quickly transformed into mass-production functions through software iteration. This model centrally embodies Path 2: AI compresses the information and communication costs of "user expression—enterprise identification—function implementation," and user innovation moves from "scattered and disorderly" to "collaborative and efficient"; it also shows that owners do not need a professional engineering background, and a single public suggestion can promote the birth of a mass-production function, so Path 1 is also confirmed.

4.3. LEGO IDEAS community: value co-creation and sharing driven by intelligent contribution measurement

The LEGO IDEAS community is a benchmark platform for global user co-creation: users submit original works, and those that obtain the support of 10,000 users within the specified period can enter the official review; ideas that pass the review are mass-produced and marketed by LEGO, and the creators can receive a royalty share of 1% of the product's net sales [34]. Based on evidence from this platform, Qi et al. showed that user social networks can amplify interaction value and improve collaborative innovation output [16]; Hienerth et al. revealed the synergies among producer firms, lead users, and user communities in the LEGO ecosystem [18].

The core of this mechanism is the intelligent measurement of user contributions by the platform's data system. Previously, user ideas were scattered among massive discussions, and value distribution could only be dominated by the enterprise's subjective judgment; the data system accurately records the whole process of idea submission, user voting, and mass-production transformation, so that user contributions become measurable, comparable, and traceable, and value distribution gains an objective basis—the 1% royalty share is precisely a reconstruction of material value distribution based on quantified contributions. This centrally confirms Path 3: Franke et al. found that fair benefit expectations are an important guarantee for users' continuous participation in innovation [29]; Lakhani and Von Hippel also showed that multiple returns such as reputation, reciprocity, and learning are the key to users' continuous contribution [28]. When users' innovation contributions are "made explicit," value distribution can move from enterprise-dominated to multi-party sharing, and users' motivation for continuous innovation is enhanced accordingly.

4.4. Case comparison and hypothesis testing

The three cases provide supporting evidence for the research hypotheses from complementary perspectives: the practices of Xiaomi and Tesla show that ordinary users can participate in innovation with the help of intelligent tools without professional skills, so H1 is verified; Xiaomi's closed loop of "demand mining—idea screening—rapid iteration" and Tesla's chain of "user expression—enterprise identification—OTA implementation" jointly show that AI significantly compresses the costs of information search and idea matching, so H2 is verified; the intelligent contribution measurement and royalty sharing mechanism of LEGO IDEAS show that AI reconstructs the value distribution mechanism and stimulates users' motivation for continuous innovation, so H3 is verified. At the same time, the cases also expose common risks such as the

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definition of idea ownership, benefit distribution, and data protection, which constitute the basic direction of the optimization suggestions below.

5. Optimization suggestions

5.1. Clarifying the ownership rules of innovation outcomes

Enterprises should clarify the ownership arrangements of AI-assisted innovation outcomes in the community rules, distinguish situations such as "user originality," "human-machine collaboration," and "platform processing," and agree on the attribution of rights respectively; at the same time, they should use AI's contribution recording capability and means such as blockchain-based evidence storage to leave traces of the idea generation process, so that user innovation contributions are "supported by evidence," reducing ownership disputes from the source.

5.2. Improving value distribution and incentive mechanisms

Enterprises should use AI's contribution quantification capability to establish a contribution measurement system covering the links of idea submission, feedback improvement, and communication and diffusion, promoting the transformation of value distribution from "enterprise-dominated" to "multi-party sharing" [28]; in terms of incentive design, they can draw on the sharing mechanism of LEGO IDEAS, combining material, reputation, and growth incentives, taking into account both head users and ordinary participants, and avoiding excessive concentration of innovation benefits [29].

5.3. Improving the data governance and privacy protection system

Community platforms should follow the principle of "minimum necessity" in collecting user data, clearly inform users of the scope, purpose, and duration of collection and obtain their substantive consent; desensitize the data used for model training and manage it with hierarchical authorization, and establish a normalized data security audit mechanism, so as to exchange institutionalized data governance for users' continuous trust and innovation participation.

5.4. Upholding the principal position of users and preventing innovation homogenization

As Murray et al. reminded, AI has both enhancing and substituting effects on user innovation [13]. Enterprises should position AI as a tool to amplify users' creativity, guard against innovation homogenization caused by replacing user originality with algorithmic generation, and maintain the diversity and original vitality of user innovation by retaining manual review links and encouraging differentiated expression.

6. Conclusion and outlook

Focusing on the question of "how AI influences user innovation behavior in online communities," this paper combines Schumpeter's innovation theory, transaction cost theory, network effect theory, and innovation economics to distill three influence paths—lowering the innovation threshold, optimizing the matching of innovation resources, and reconstructing the value distribution mechanism—and tests them with the practices of the Xiaomi MIUI community, the Tesla owner community, and the LEGO IDEAS community. The study shows that AI has a significant impact on

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user innovation behavior in online communities and, through the three paths, promotes the core transformations from "niche participation" to "mass co-creation," from "experience-driven" to "data-empowered," and from "scattered and disorderly" to "collaborative and efficient," thereby triggering chain changes at the levels of innovation subjects, costs, benefits, and industrial coordination.

At the same time, it should be noted that, from a practical perspective, there is still room for improvement in the application of AI to user innovation in online communities: first, the ownership of innovation outcomes is ambiguous—ideas are proposed by users, processed by AI, and commercialized by enterprises, making the contributions of the three parties difficult to separate, and current intellectual property rules still lack clear norms on the ownership of "AI-assisted generated outcomes"; although the Beijing Internet Court has determined in a typical case that AI-generated images embodying human original intellectual input can constitute works whose copyright is enjoyed by the user, it also emphasized that the attribution of rights needs to be comprehensively determined in light of the degree of human intellectual input in each case, and the relevant rules are still under exploration [35]. Second, benefit distribution is uneven—value distribution is still dominated by enterprises, and the problems of missing contribution measurement standards and opaque distribution rules remain prominent. Third, there are risks to data security and privacy protection—platforms may collect user data beyond the scope of "minimum necessity," whereas Article 6 of the Personal Information Protection Law of China establishes that the processing of personal information shall have a clear and reasonable purpose, be directly related to the processing purpose, and adopt the method with the least impact on personal rights [36]; once trust is damaged, users' willingness to participate in innovation will be fundamentally shaken. Future research can be deepened in two aspects: first, conducting research on innovation governance mechanisms around the above problems, exploring institutional arrangements for ownership confirmation, distribution, and data protection; second, combining questionnaire surveys and econometric methods to conduct large-sample empirical tests on the action strength and boundary conditions of the influence paths.

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