Human-Computer Interaction Perspective on Investigating the Impact Mechanism of Psychological Contract Violation on Business Model Innovation with CAD Technology

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Abstract. To explore the impact mechanism of psychological contract violation on business model innovation, CAD and big data technology are combined to analyze the impact mechanism of psychological contract violation on business model innovation. Moreover, this paper uses the self-organization theory to discuss the evolution characteristics and mechanism of the platform-based business ecosystem. It introduces the big data algorithm to analyze the platform-based business ecosystem's evolution stages and each stage's evolution trend. In addition, the research is carried out from three perspectives: business data mining, psychological contract violation data analysis, and business model innovation analysis. Finally, this paper verifies the effectiveness of this method through model test research and analyzes the impact mechanism of psychological contract violation on business model innovation.

Keywords: CAD technology; psychological contract violation; business model; Human-Computer Interactioninnovation; influence mechanism
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1 INTRODUCTION

1.1 Related Work

Business model construction consists of two major types of projects: framework construction and implementation construction. The former solves the material of each plate, that is, the construction of plate rules and the connection and assembly between the plates; the latter solves the specific construction action plan. The two significant projects eventually form an ideal business model to play the problem function of the business model and generate an identity effect that is conducive to the company's sustainable development by improving predictability (Sigala et al. 2019).

The business model began to receive the attention of academic circles and developed rapidly. Literature (Flyverbom et al. 2019) believes that business model refers to the combination design of transaction activities involved in creating opportunities to realize value creation; literature (Morrissey et al. 2020) regards business model as integrating products, services, and information. From the perspective of technological innovation, literature(Peters et al. 2020) clarifies that a business model is a construction that connects technological potential with value creation. Although existing studies have analyzed the nature of business models from different theoretical perspectives, in recent years, the understanding of business models in the academic community has gradually become more consistent, basically agreeing that it includes "value proposition and customer segmentation," "value creation and The three basic dimensions of "transmission" and "value acquisition," as well as the complete system of these dimensional connection relationships(Yang et al. 2020) The understanding of business model adopts the viewpoints that are generally accepted by the current academic circles, and believes that it emphasizes transactions across organizational boundaries, opportunity-driven organizational design, and resource synergy and integration (Andronie et al. 2019). Business model adjustment research is derived from related research on business models(Alkhalil et al. 2021). Business model adjustment refers to the partial or complete update and reconstruction of the existing business model (CHOI et al. 2019) to cope with changes in the internal and external environment and achieve the growth of new ventures (Yang et al. 2018). Relevant research mainly cites business model adaptation and business model innovation in adjustment to describe this process (Wei et al. 2019). Among them, business model adaptation is an adaptive change made by entrepreneurs on the specific dimensions of the business model under the perception of changes in the internal and external environment(Zhenjian et al. 2021), while business model innovation is regarded as a destructive innovation behavior. However, "Innovation" may result from debugging the business model, but it is unnecessary (Jing et al. 2020).

From a cognitive perspective, the business model design expresses the process of constructing and designing a series of activity logic, including value creation, in decision-makers minds. Individuals with different cognitive characteristics have other ideas for business model design. Similarly, the explanatory logic of cognitive perspective research plays a particularly prominent role in the motivation and process of business model adjustment (Hou et al. 2021). The empirical research in Literature (Davies et al. 2020) shows that managers are more likely to adjust their business models when they perceive threats rather than opportunities in the face of changes in the external environment; Literature (Davide et al. 2018) examines the impact of managers' cognition on business model adjustment, and the research shows that Managers' perception of opportunity promotes exploratory business model adjustment, while the threat perception of performance decline promotes exploitative business model adjustment; Literature (Baur et al. 2020) proposes that entrepreneurs' cognitive habits and cognitive characteristics play an essential role in business model design; Literature (Wang et al. 2020)Through multiple case studies, it is found that certain cognitive factors of entrepreneurs (such as changes in expectations level, perception of the feasibility of business models, etc.) Under the background of knowledge theory, empirical research shows that the level of cognitive combination positively impacts the novelty of business models. In contrast, the overall cognitive tendency tends to promote and inhibit the novelty of business models.

1.2 Objectives

This paper integrates big data technology with Human-Computer Interaction (HCI) principles to analyze the impact mechanism of psychological contract violation on business model innovation within the e-commerce sector. By incorporating HCI, the user interface and experience of interacting with big data technology are optimized, ensuring that the analysis process is intuitive and user-friendly for e-commerce stakeholders. This analysis is a valuable reference for further developing and improving subsequent e-commerce business models. The integration of HCI enriches user engagement and facilitates informed decision-making, contributing to advancing innovative business strategies in the e-commerce landscape.

2 METHODOLOGY

2.1 Platform-Based Business Ecosystem Relationship Analysis

Platform-based business ecosystem structure

By combining the existing literature, it is found that scholars generally divide the population composition of the platform-type business ecosystem according to the ecological niche where the system's members are located. In addition, some scholars divide it according to the roles of enterprises in the value chain. The conceptual model diagram of the platform-based business ecosystem is shown in Figure 1.

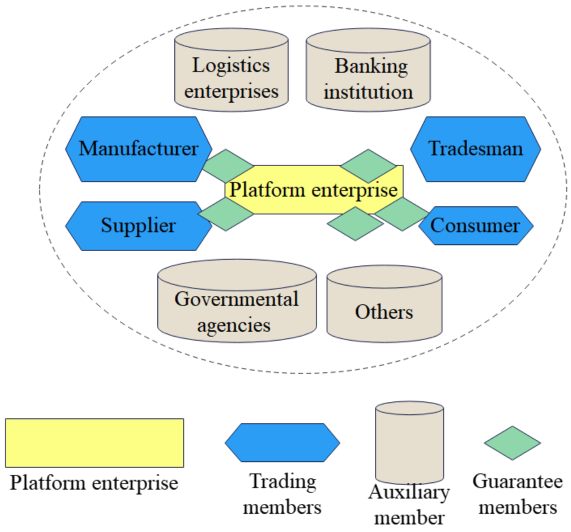

Figure 1: Conceptual model diagram of platform-based business ecosystem.

On the one hand, the external environment provides information, knowledge, material, and energy for the platform ecosystem, and the input of these elements contributes to the operation, innovation, and development of the platform ecosystem. On the other hand, the system will also export new services and products, technologies, and knowledge to the external environment. The output of these elements affects the evolution of the external technical environment, social environment, legal environment, etc., and helps to improve the market environment. Therefore, this exchange enhances the benign interaction inside and outside the system, promoting mutual co-evolution.

As shown in Figure 2, the above analysis shows a synergistic relationship between the platform-based business ecosystem and the external environment. On the one hand, the system and the external environment achieve coordinated development through the input and output of information, knowledge, matter, and energy. On the other hand, the constantly changing external environment brings new opportunities and challenges to the platform ecosystem, and the platform system must continue to innovate and actively adapt to changes in the external environment.

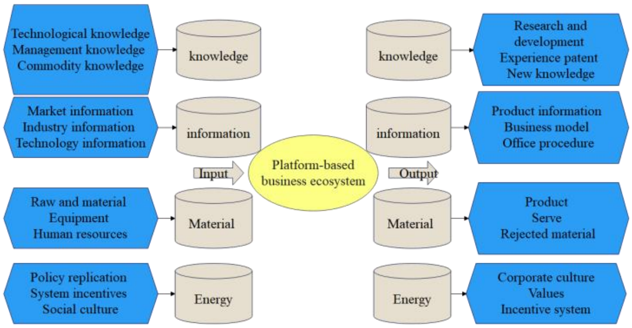

Figure 2: The exchange relationship between the platform-based business ecosystem and the external environment.

2.2 Analysis of the Symbiotic Relationship Among the Members of the Platform-Based Business Ecosystem

The bifurcation phenomenon is a concrete manifestation of the diversity and uncertainty of the platform business ecosystem's evolution path. As shown in the figure below, the bifurcation phenomenon in the evolution of the platform business ecosystem is like a tree, and t1 represents the bifurcation point, that is, the qualitative change point in the evolution process of the platform business ecosystem. As can be seen from the figure, each bifurcation point has a variety of evolution directions, just like tree weights.

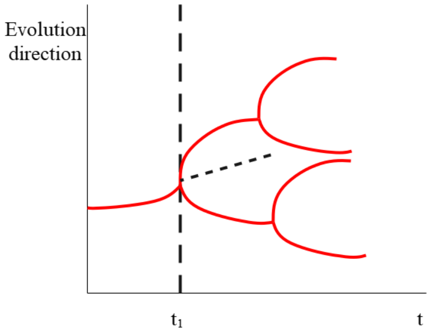

Figure 3: The evolutionary bifurcation phenomenon of the platform-based business ecosystem.

2.3 Logistic Equation Model Analysis

The logistic model of the platform-based business ecosystem is as follows:

$$\begin{cases} \frac{dN(t)}{dt} = \alpha N(t)\left[1 - \frac{N(t)}{M}\right] \\ N(t_0) = N_0 \end{cases} \tag{1}$$

In formula (1), N(t) represents the number of members of the platform business ecosystem at time t, α is the endogenous growth rate of the platform business ecosystem, which is affected by the scale of the system at time t, and $\alpha > 0$. M represents the maximum size of the system members under the constraints of current resources, environment, and other factors, and M>0. N0 represents the number of platform business ecosystem members at the initial time t and $0 < N_0 < M$. Affected by the current development level and limited resources, the development speed of the platform ecosystem is limited, where $\left(1-\frac{N(t)}{M}\right)$E represents the development barrier coefficient, also known as the logistic coefficient. Solving the separation variables of formula (1), we get:

$$N(t) = \frac{M}{1+\left(\frac{M}{N_0}-1\right)e^{-\alpha t}} \tag{2}$$

Calculating the limit value of formula (2), $\lim_{t\to+\infty} \frac{M}{1+\left(\frac{M}{N_0}-1\right)e^{-\alpha t}} = M$ Can be obtained. With time, the number of members of the platform ecosystem is infinitely close to the maximum scale M, which means that the evolution of the platform ecosystem gradually approaches the limit of resource and environmental carrying over time.

The image of the Logistic function is an S-shaped curve. To determine the inflection point of the Logistic function, by taking the second-order derivative of N(t), we get:

$$\frac{d^2N(t)}{dt^2} = \alpha^2 N(t)\left[1-\frac{N(t)}{M}\right]\left[1-\frac{2N(t)}{M}\right] \tag{3}$$

We set $\frac{d^2N(t)}{dt^2} = \alpha^2 N(t)\left[1-\frac{N(t)}{M}\right]\left[1-\frac{2N(t)}{M}\right] = 0$.By finding the inflection point,

we get:

$$\begin{cases} N(t') = M, t = +\infty \\ N(t'') = \frac{M}{2}, t^* = \frac{1}{\alpha} ln\left(\frac{M}{N_0}-1\right) \end{cases}$$

Therefore, the inflection pointt^* of the N(t) graph is $\left(\frac{ln\left(\frac{M}{N_0}-1\right)}{\alpha}, \frac{M}{2}\right)$, and the first-order teaching value at the inflection point is $\frac{d^2N(t^*)}{dt^*} = \frac{\alpha}{4}M$. Since the function changes the concavity and convexity at the inflection point, when $t \in \left(0, \frac{ln\left(\frac{M}{N_0}-1\right)}{\alpha}\right)$, $\frac{d^2N(t)}{dt^2} < 0$, The scale of the system members grows faster, and the original Logistic function is upwardly concave. When $t \in \left(0, \frac{ln\left(\frac{M}{N_0}-1\right)}{\alpha}, +\infty\right)$, The development speed of the scale of system members gradually slows down, and the original Logistic function is downward convex, as shown in Figure 4.

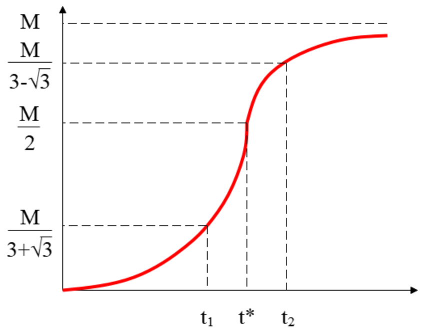

Figure 4: The evolution curve of the platform-based business ecosystem.

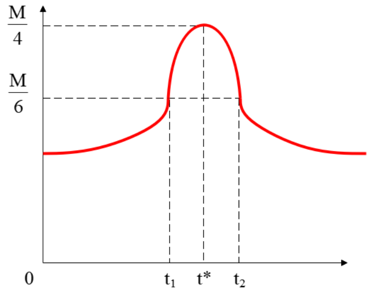

Figure 5: The evolution speed equation curve of the platform-type business ecosystem.

The logistic function's first-order derivative represents the platform ecosystem's evolution speed. To better describe the evolution speed trend of the system, we continue to derive the second-order derivative function of N(t) to obtain the third-order derivative function of N(t):

$$\frac{d^3N(t)}{dt^3} = \frac{\alpha^3}{M^2}N(t)\left[1-\frac{N(t)}{M}\right][M-(3+\sqrt{3})N(t)][M-(3-\sqrt{3})N(t)] \tag{4}$$

By solving the function

$\frac{d^3N(t)}{dt^3} = \frac{\alpha^3}{M^2}N(t)\left[1-\frac{N(t)}{M}\right][M-(3+\sqrt{3})N(t)][M-(3-\sqrt{3})N(t)] = 0$ We can get:

$$\begin{cases} N(t_1) = \frac{M}{3+\sqrt{3}}, t_1 = \frac{ln(2-\sqrt{3})\left(\frac{M}{N_0}-1\right)}{\alpha} \\ N(t_2) = \frac{M}{3-\sqrt{3}}, t_2 = \frac{ln(2+\sqrt{3})\left(\frac{M}{N_0}-1\right)}{\alpha} \end{cases}$$

The function $\frac{dN(t)}{dt} = \alpha N(t)\left[1-\frac{N(t)}{M}\right]$ has the above two inflexion points, and when $t \in \left(0, \frac{ln(2-\sqrt{3})\left(\frac{M}{N_0}-1\right)}{\alpha}\right)$ and $\left(\frac{ln(2-\sqrt{3})\left(\frac{M}{N_0}-1\right)}{\alpha}, +\infty\right)$, $\frac{d^3N(t)}{dt^3} > 0$, That is, the acceleration of evolution accelerates with time. When $t \in \left(\frac{ln(2-\sqrt{3})\left(\frac{M}{N_0}-1\right)}{\alpha}, \frac{ln(2+\sqrt{3})\left(\frac{M}{N_0}-1\right)}{\alpha}\right)$, $\frac{d^3N(t)}{dt^3} < 0$, The evolution acceleration decreases continuously with time. Meanwhile, at $t_1 = \frac{ln(2-\sqrt{3})\left(\frac{M}{N_0}-1\right)}{\alpha}$, The evolution acceleration takes a maximum value at $t_2 = \frac{ln(2+\sqrt{3})\left(\frac{M}{N_0}-1\right)}{\alpha}$, j acceleration takes a minimum value; and at t1, t2, the evolution speed is $\frac{dN(t_1)}{dt_1} = \frac{dN(t_2)}{dt_2} = \frac{\alpha}{6}M$. The evolution speed function curve of the platform ecosystem is shown in Figure 5 above.

This paper combines the output value evolution curve, the evolution speed of the platform business ecosystem, and the logistic function's theoretical characteristics to divide the platform ecosystem's evolution into three stages: construction, development, and evolution (decline).

2.4 Phase Analysis of Platform Business Ecosystem Evolution

The evolution of a platform-based business ecosystem can be divided into construction, development, and evolution (decline) stages. Each stage's number of members, system boundaries, competition degree, and control rights show different characteristics. The following sections will analyze the platform-based business ecosystem's evolution stages and characteristics.

2.5 Build Phase

When $t \in (0, t_1)$, The platform-type business ecosystem is in the initial stage; the number of system members is $N(t) \in \left(0, \frac{M}{3+\sqrt{3}}\right)$, The system evolution speed is $\frac{dN(t)}{dt} \in \left(0, \frac{\alpha}{6}M\right)$, The evolution acceleration is $\frac{d^2N(t)}{dt^2} > 0$, and $\frac{d^3N(t)}{dt^3} > 0$. The initial stage is the construction stage of the platform-based business ecosystem. The above mathematical analysis shows that the system evolution speed and acceleration in the construction stage constantly increase, and the platform ecosystem has grown from nothing. Moreover, it relies on resource conditions, technical conditions, production factors, and government policy support to continuously attract members who need to join the system and accumulate user scale. Although the number of system members gradually increases, the platform business ecosystem is still in its infancy. There are few types of populations in the system, the density of populations is low, and the functions and structures within the system are not perfect. Therefore, there is less competition and cooperation among members. Currently, the system aims to attract members and accumulate user scale.

In the construction stage, platform enterprises build a basic system structure to provide high-value-added products and services for target groups, attract enterprises needing to participate in the platform system, and gradually form a business ecosystem with platform enterprises as the core. Therefore, the number of members in the system grows smoothly and steadily, the business scope of the platform enterprise is simple, and the system boundary is clear. Moreover, the population structure in the system is simple, the degree of competition is low, and the platform enterprises have absolute leadership in the system.

2.6 Development Stage

According to the evolution speed of the platform system, this paper divides the development stage into the expansion and stable development stages.

Expansion development stage

When $t \in (t_1, t^*)$, The platform-type business ecosystem evolves into an expansion and development stage. In this stage, the number of system members is $N(t) \in \left(\frac{M}{3+\sqrt{3}}, \right)$ M2, the system evolution speed is $\frac{dN(t)}{dt} \in \left(\frac{\alpha}{6}M, \frac{\alpha}{4}M\right)$, And the evolution acceleration is $\frac{d^2N(t)}{dt^2} > 0$.

To develop its competitiveness and monopolize the ecological niche, the system members tend to specialize in the division of labour and establish synergistic and cooperative relations among the members. It can be seen from the analysis of the above formula that the evolution and development speed of the system at this stage still keeps increasing. Still, the acceleration gradually decreases and tends to 0. When the number of members in the system develops to 1/2 of the upper limit M of the platform business ecosystem members under the current resource conditions, the system evolution acceleration is 0, and the evolution and development speed reaches the maximum value.

Stable development stage

When $t \in (t^*, t_2)$, The platform-type business ecosystem evolves into a stable development stage, and the system output value is $N(t) \in \left(\frac{M}{2}, \frac{M}{3-\sqrt{3}}\right)$, The system evolution speed is $\frac{dN(t)}{dt} \in \left(\frac{\alpha}{6}M, \frac{\alpha}{4}M\right)$, And the evolution acceleration is $\frac{d^2N(t)}{dt^2} < 0$. After the rapid expansion of the previous stage, the system has entered a stable development stage, and some scholars believe it is mature. However, due to the large number of accumulations, the competition within the system is more intense. On the one hand, adding new members increases the business scope of the system. It expands the ecosystem's boundaries so that the scale of the system continues to grow, and the boundaries also expand and tend to be blurred.

On the other hand, ecological niche overlap is becoming increasingly evident, the exciting relationship among members is complex, and the competition inside and outside the system is more intense. At the same time, due to the limitations of resources, environment, policies, regulations, etc., the development of the platform ecosystem has entered a bottleneck period. In this stage, the evolution speed and acceleration of the system gradually decrease the denominator, three minus the square root of the three end denominator, and the evolution acceleration of the system reaches a minimum value. Then, the system starts to enter the next stage.

2.7 Evolution (Decline) Stage

When the system enters the evolution stage, that is $t \in (t_2, +\infty)$, The output value of the system in this stage is $N(t) \in \left(\frac{M}{3-\sqrt{3}}, M\right)$, The evolution speed of the system is $\frac{dN(t)}{dt} \in \left(0, \frac{\alpha}{6}M\right)$, and the evolution acceleration is $\frac{d^2N(t)}{dt^2} < 0$. From the above mathematical derivation results, the evolution speed of the system at this stage decreases and tends to zero. The system has developed to the limit that the current external resource environment can carry and is fully mature. At the same time, the external environment is threatened by new technologies, the Industrial Revolution, and other factors, so many scholars call this stage the recession stage. As the evolved platform business ecosystem seeks new business structures and business models, the ecological niches of population members are also redefined. In a brand-new external environment, the developed platform business ecosystem will again experience expansion to mature development to the final evolution (decline) stage based on the original population size.

2.8 Simulation Model

This research combines knowledge management theory, organizational search theory, and enterprise capability theory to integrate cross-border search, extensive data capabilities, knowledge creation, environmental uncertainty, and business model innovation into a framework to explore how platform companies can achieve business model innovation in an uncertain environment. Figure 6 shows the mechanism of action between the variables in this study.

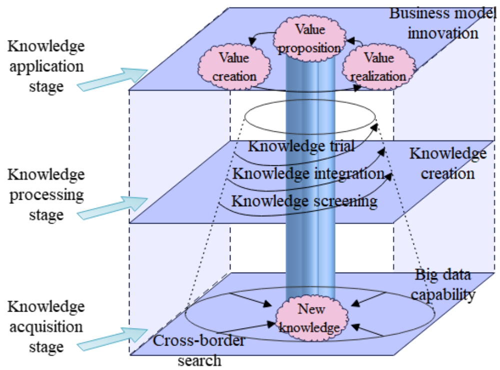

Figure 6: Mechanism of action between variables.

The influence mechanism of extensive data capability on knowledge creation is shown in Figure 7.

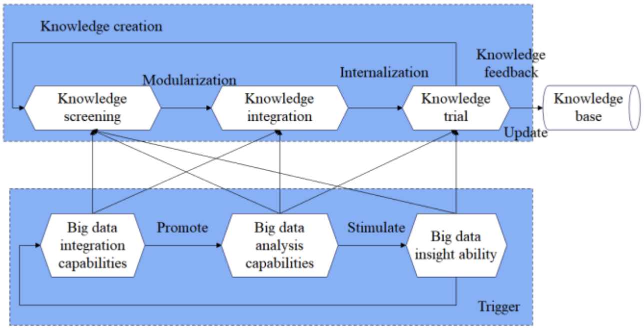

Figure 7: Influence mechanism of extensive data capability on knowledge creation.

Extensive data capabilities can analyze and predict competitors, helping platform companies establish barriers to competition and maintain value. Figure 8 shows the mechanism of influence of extensive data capability on the innovation of the platform enterprise business model.

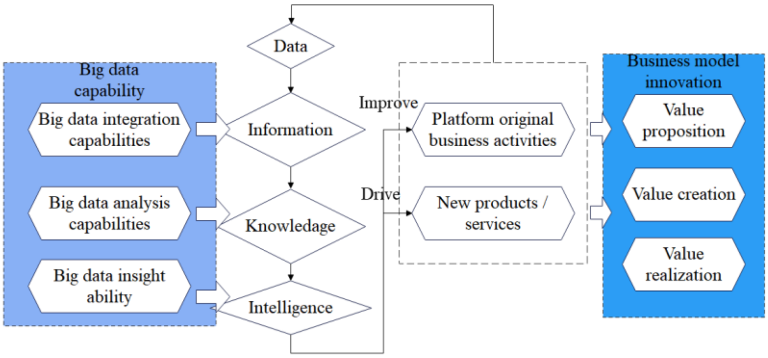

Figure 8: Influence mechanism of extensive data capabilities on platform enterprise business model innovation.

This paper uses a big data model to analyze how psychological contract violations influence business model innovation in e-commerce. It investigates this relationship through business data mining, psychological contract violation data analysis, and business model innovation analysis. Integrating Human-Computer Interaction (HCI) principles makes the analysis process more intuitive and user-friendly. This research contributes valuable insights for enhancing e-commerce strategies and addressing psychological contract issues in business model innovation.

3 RESULTS

This paper conducts data statistics from three perspectives: business data mining, psychological contract violation data analysis, and business model innovation analysis. The research results are shown in Tables 1, 2, and 3.

Num	Business data mining	Num	Business data mining	Num	Business data mining
1	85.98	10	91.78	19	87.54
2	90.07	11	87.08	20	84.25
3	91.37	12	89.07	21	87.21
4	84.36	13	88.98	22	88.53
5	91.61	14	87.84	23	91.36
6	91.84	15	89.96	24	89.69
7	85.05	16	86.28	25	84.16
8	86.54	17	90.58	26	85.30
9	86.42	18	91.26	27	91.29

Table 1: Evaluation of commercial data mining effect.

Num	Psychological contract violation	Num	Psychological contract violation	Num	Psychological contract violation
1	75.66	10	80.20	19	70.62
2	78.57	11	75.72	20	74.02
3	74.14	12	75.63	21	78.08
4	75.60	13	74.52	22	80.74
5	71.54	14	80.78	23	75.69
6	75.14	15	71.35	24	71.08
7	73.92	16	70.71	25	76.37
8	71.81	17	72.54	26	73.85
9	80.20	18	70.26	27	73.28

Table 2: Evaluation of psychological contract violation data analysis effect.

Num	Business model innovation	Num	Business model innovation	Num	Business model innovation
1	67.24	10	73.55	19	72.39
2	72.92	11	68.29	20	74.52
3	69.39	12	73.48	21	70.54
4	67.55	13	70.14	22	71.42
5	68.38	14	65.67	23	71.54
6	70.83	15	66.14	24	72.17
7	66.05	16	72.99	25	66.90
8	68.72	17	66.38	26	68.87
9	73.10	18	67.85	27	67.48

Table 3: Evaluation of the effect of the business model innovation.

4 DISCUSSION

The data in Tables 1 and 2 show that the impact mechanism analysis of psychological contract violation based on big data technology on business model innovation is valid from the perspectives of business data mining, psychological contract violation data analysis, and business model innovation analysis. Hence, the method proposed in this paper has specific effects.

5 CONCLUSIONS

This paper studies the impact mechanism of psychological contract violation based on big data technology on business model innovation through intelligent algorithms. It points out that the internal and external synergistic relationships and the symbiotic relationship of internal members in the platform business ecosystem drive the evolution of the platform business ecosystem. Moreover, this paper studies the evolution mechanism of the platform-based business ecosystem by introducing the self-organizing evolution system. It analyzes and clarifies the platform-based business ecosystem's evolution conditions, incentives, and paths. Through experimental research, studying the impact mechanism of psychological contract violation based on big data technology on business model innovation is very effective. This is true from the perspectives of business data mining, psychological contract violation data analysis, and business model innovation analysis, so the method proposed in this paper has specific effects. Our study investigates the influence of psychological contract violations on business model innovation in e-commerce, particularly in the context of extensive data technology adoption. Through a mixed-methods approach, we validate hypotheses and uncover critical mechanisms. We highlight how perceptions of the employment relationship impact innovation and the role of big data technology. We ensure user-friendly interactions with data technology by integrating Human-Computer Interaction (HCI) principles. Our findings offer managerial insights and guide future research to enhance e-commerce strategies for innovation and competitive sustainability.

6 RECOMMENDATIONS

This paper adopts the method of empirical research to reveal the internal mechanism of cross-border search and considerable data ability affecting the business model innovation of platform enterprises. Moreover, this paper clarifies the mediating role of knowledge creation in cross-border search, extensive data capabilities and business model innovation, and the moderating role of environmental uncertainty. Therefore, the innovation of the follow-up business model can further improve its analysis effect by promoting big data technology.

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