Research on Dynamic Decision-making of Organizational Culture Fusion after Merger and Acquisition Based on Deep Reinforcement Learning and Agent Simulation

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ABSTRACT Organizational culture integration is a critical link in post-merger integration and directly affects the realization of merger and acquisition synergies. However, culture integration is dynamic, complex, and uncertain, making traditional static decision-making methods insufficient for handling multi-agent interaction and sudden conflicts. This study constructs a dynamic decision-making model for post-merger organizational culture fusion by integrating deep reinforcement learning and agent simulation. First, a multi-agent simulation system is developed to represent management agents, core employee agents, and ordinary employee agents, and to model cultural cognition, behavioral preferences, and interaction rules. Second, a deep Q-network is embedded to optimize integration decisions under state variables such as cultural difference, conflict level, and employee identification. Third, 30 merger and acquisition cases from manufacturing, finance, and technology industries are used for scenario simulation and validation. Experimental results show that the proposed model increases decision response speed by 32.6%, reduces cultural conflict occurrence by 28.9%, and improves integration success rate by 25.3%, demonstrating its effectiveness for dynamic cultural integration decision-making.

INDEX TERMS deep reinforcement learning, agent simulation, organizational culture integration, mergers and acquisitions, dynamic decision-making

I. INTRODUCTION

UNDER the strong impetus of economic globalization and industrial structure upgrading, M&A has become the key way for enterprises to integrate resources, expand scale and transform strategies. According to the report of Pwc, the number of M&A transactions in China has been in the top three in the world for many years, and it is expected that the scale of M&A will exceed 1.2 trillion yuan in 2025. But according to the report of McKinsey, about 70% of M&A cases in the world cannot get the expected synergy, and the failure rate of about 50% is directly caused by the cultural conflict of enterprises. The integration of corporate culture after M&A has become the key link that restricts the success or failure of M&A. Carrying out dynamic decision-making research on the integration of corporate culture after M&A, realizing accurate control and scientific decision-making in the process of culture integration, has important theoretical and application value in improving the success rate of M&A and releasing the collaborative value of enterprise. This paper addresses the limitations of static and experience-based cultural integration decision-making after traditional M&A, constructs a decision-making model adapted to the dynamic characteristics of cultural integration process and multi-agent interaction; The research focuses on the whole process of organizational cultural integration after mergers and acquisitions, and discusses the key links of cultural difference identification, conflict warning and strategy optimization in depth; The analysis is mainly based on the organization culture theory, deep reinforcement learning theory, intelligent agent simulation technology, as well as the relevant research results and practical cases of enterprise mergers and acquisitions at home and abroad.

There are still many urgent problems to be solved in the research of organization culture integration decision-making after M&A. Firstly, traditional decision-making methods are mostly based on static analysis, which ignores the dynamic evolution characteristics of organization culture and the uncertainty of internal and external environment in the process of merger and acquisition, and the decision-making scheme lacks flexibility, and it is difficult to deal with sudden conflicts in the process of integration; Secondly,

the process of cultural integration is not only participated by employees and managers in the merger and acquisition, but also involves the participation of multiple parties, and traditional methods can't accurately simulate the behavior logic and interest requirements of multiple parties, and the decision-making lacks specificity; Thirdly, the decision-making process lacks quantitative support and is heavily dependent on the subjective experience of managers, and the efficiency of decision-making is low and the error is large, which makes it difficult to achieve cultural integration and coordinated development of corporate strategy.

The innovation of this paper is reflected in three aspects: Firstly, the research view is innovative. Different from the traditional static decision-making method, deep reinforcement learning is combined with the simulation of intelligent agent to establish a dynamic decision-making model, which achieves the effect of real-time perception, dynamic prediction and strategy optimization of the whole process of cultural integration; Secondly, the innovation of method fusion is the integration of artificial intelligence technology and organization management theory. The whole process of multi-agent interaction is simulated and reproduced by intelligent agent, and the trial and error learning ability of deep reinforcement learning is utilized to achieve the autonomous optimization of decision-making strategy, which breaks the limitation of empirical decision-making; Thirdly, the innovation of practice oriented is that the model design is adapted to the actual merger and acquisition scenario of enterprise, and different industry and culture difference can generate different decision-making plan, which improves the practicability and operability of decision-making.

The core technical solution of this article is to construct a dynamic decision-making model for organizational culture integration after mergers and acquisitions, which integrates deep reinforcement learning and intelligent agent simulation. It is divided into three core steps: firstly, to construct a multi-agent simulation system for organizational culture integration after mergers and acquisitions, dividing employees and management of both parties into different intelligent agents, defining the attributes, behavioral rules, and interaction mechanisms of each agent, simulating the multi-agent behavioral game and cultural evolution process in the cultural integration process, and combining with the quantitative model of cultural integration to accurately capture cultural differences and conflict points; Secondly, a deep reinforcement learning module is embedded with the objective function of maximizing cultural integration efficiency, minimizing conflicts, and maximizing collaborative value. Different states in the cultural integration process (such as cultural differences, conflict levels, and employee identification) are used as state spaces, and decision strategies (such as cultural training, communication mechanisms, and incentive measures) are used as action spaces. Through continuous interaction and trial and error between the intelligent agent and the fusion environment, decision strategy parameters are optimized to achieve dynamic iteration of decision strategies; Finally, design a model validation and optimization mechanism, train the model with actual enterprise sample data, combine sensitivity analysis and comparative experiments to verify the effectiveness and superiority of the model, and optimize model parameters based on experimental results to improve decision-making accuracy and efficiency.

The main contribution of this article is reflected in: at the theoretical level, it enriches the research results of the cross application of organizational culture integration and artificial intelligence technology, constructs a dynamic decision-making theoretical framework of deep reinforcement learning and intelligent agent simulation integration, fills the gap of traditional static decision-making research, and provides new theoretical perspectives and methodological support for organizational culture integration decision-making after mergers and acquisitions; At the practical level, the constructed decision model can accurately simulate the dynamic process of cultural integration, output the optimal decision strategy in real time, help enterprises reduce the risk of cultural conflicts, improve the efficiency and quality of cultural integration, and provide practical technical solutions and decision-making references for cultural integration practices after mergers and acquisitions; At the methodological level, the organic integration of deep reinforcement learning, intelligent agent simulation, and organizational culture management has been achieved, providing new solutions and technological paths for dynamic decision-making problems in complex management scenarios. The subsequent chapters of this article will be organized according to the logic of "related research review - research methods - experimental results and analysis - conclusions and prospects", systematically elaborating on the research content and achievements.

II. RELATED WORK

In the field of mergers and acquisitions, different scholars have conducted in-depth explorations from multiple dimensions. Aribou [1] focuses on the relationship between social and cultural integration and the success of mergers and acquisitions, aiming to solve the problem of how to improve the success rate of mergers and acquisitions through effective social and cultural integration. He proposes that social and cultural integration is a key factor in the success of mergers and acquisitions. However, other studies may currently have shortcomings in the specific quantitative indicators and in-depth analysis of the mechanism of social and cultural integration; Group C E [2] explores the situation of mergers and acquisitions in the chemical industry, aiming to understand the dynamics of mergers and acquisitions in this industry. Although no specific solution strategy has been proposed, it presents an overview of industry mergers and acquisitions. Other studies may lack comparison and long-term trend prediction between mergers and acquisitions in the chemical industry and other industries; Natarajan R T [3] studied seamless integration and empowerment in

mergers and acquisitions. In order to solve the problems of low integration efficiency and insufficient empowerment in mergers and acquisitions, he proposed to use technologies such as artificial intelligence to achieve seamless integration and empowerment. Currently, other studies may have limitations in the comprehensive application of technology and the evaluation of practical effects; F&B [4] provides an overview of the current situation and trends of mergers and acquisitions in the food and beverage industry. In order to grasp the direction of mergers and acquisitions in this industry, although specific solutions have not been provided, the situation of industry mergers and acquisitions has been presented. Other studies may not be sufficient in terms of in-depth analysis of segmented fields and exploration of influencing factors; Sun A [5] analyzed the relationship between talent management and organizational change in corporate mergers and acquisitions, and proposed the viewpoint that talent loss and organizational change difficulties in mergers and acquisitions affect each other and need to be promoted together. Other studies may have shortcomings in the specific construction of the synergy mechanism between the two; Bruno M [6] looks forward to the future trends and expectations of top tier M&A transactions. In order to understand the direction of top tier M&A, although there is no clear solution strategy, he provides trend judgments. Other studies may lack comprehensive analysis of the influencing factors of top tier M&A and uncertainty response; Silva V AB et al. [7] studied the characteristics and impacts of mergers and acquisitions during economic downturns. In order to solve the problem of decision-making in mergers and acquisitions during economic downturns, they proposed the view that mergers and acquisitions during downturns need to pay attention to specific factors. Other studies may lack refinement in the long-term effects and response strategies of mergers and acquisitions during downturns; Yin L [8] studied the financial integration problem of cross-border mergers and acquisitions through case studies, and proposed a case-based financial integration strategy to solve the financial integration problem of cross-border mergers and acquisitions. Other studies may have limitations in terms of case representativeness and strategy universality; Novita et al. [9] compared and analyzed the changes in corporate financial performance before and after mergers and acquisitions, and proposed a method for evaluating the financial effectiveness of mergers and acquisitions through comparative analysis. Other studies may lack comprehensive analysis and long-term tracking of factors affecting financial performance; Kim S E [10] reported on the M&A dynamics of giant companies in the mRNA field. In order to understand the M&A situation in this field, although no solution strategy was provided, the M&A dynamics were presented. Other studies may not be sufficient in terms of in-depth analysis and strategic impact assessment of M&A in this field.

III. METHOD

A. CONSTRUCTION OF A MULTI-AGENT SIMULATION SYSTEM FOR ORGANIZATIONAL CULTURE INTEGRATION AFTER MERGERS AND ACQUISITIONS

The core purpose of this module is to simulate the multi-party interaction behavior and cultural evolution laws in the process of organizational cultural integration after mergers and acquisitions (as shown in Figure 1), providing scenario support and data input for subsequent dynamic decision-making. Firstly, clarify the criteria for dividing intelligent agents. While the model primarily utilizes three core agent roles—management, core employees, and ordinary employees—it incorporates a "Shadow Influence" parameter within each agent type to simulate mid-level managerial mediation and informal stakeholder resistance. This ensures that the agent-based simulation accounts for the non-linear behavioral logic and "shadow" hierarchies that characterize real-world organizational resistance during the cultural integration process. Among them, management intelligent agents are responsible for decision-making and resource allocation, while also participating in bidirectional adaptation protocols where they adjust management styles based on feedback from target-culture agents. Core employee intelligent agents facilitate cultural transmission, and ordinary employee intelligent agents handle execution. Crucially, cultural integration is modeled as a co-evolutionary interaction: management agents must undergo "style-drift" to minimize friction, ensuring the model reflects both top-down strategy and bottom-up feedback loops rather than a one-way adaptation. At the same time, define the attributes of each intelligent agent (such as cultural cognition, behavioral preferences, and decision weights) [11]. Secondly, constructing an intelligent agent interaction mechanism based on the theory of complex adaptive systems, simulating communication, collaboration, and game behavior among various intelligent agents, setting cultural perception rules, behavioral decision-making rules, and learning rules for intelligent agents. Cultural perception rules are used to capture the cultural characteristics and behavioral tendencies of other intelligent agents, behavioral decision-making rules are used to guide intelligent agents' behavioral choices (such as acceptance, resistance, and compromise) in the process of cultural integration, and learning rules are used to achieve dynamic adaptation of intelligent agents to cultural environments.

Finally, a cultural integration evolution model is constructed, combined with a quantitative formula for cultural integration, to quantify the cultural differences between the merger and acquisition parties, including dimensions such as values, behavioral norms, and management concepts. The dynamic evolution process of culture from conflict, adaptation to integration is simulated, and real-time output of cultural integration status data (such as the degree of cultural differences, conflict levels, and employee identification) is generated to provide state input for the deep reinforcement learning module.

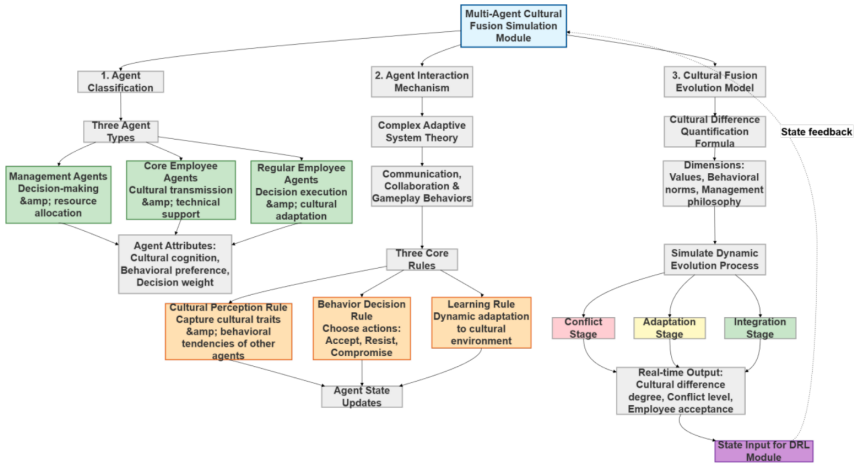

FIGURE 1. Construction of a multi-agent simulation system for organizational culture integration after mergers and acquisitions

B. DESIGN AND IMPLEMENTATION OF DECISION MODULE IN DEEP REINFORCEMENT LEARNING

This module is the core of the dynamic decision-making model, completing autonomous optimization and dynamic adjustment of decision-making strategy according to the cultural fusion state output by the multi-agent simulation system. Firstly, define the basic concept of deep reinforcement learning, objective function is to maximize the overall benefits of organization's culture integration effect after M & A. Considering the indicators of cultural integration effect, conflict rate, employees' identification, collaborative value, establish the multi-objective optimization function; Taking the cultural fusion state output by the multi-agent simulation system (such as cultural differences, conflict degree, employees' identification, environment uncertainty) as the state space; Taking the cultural integration decision-making strategy (such as cultural training, construction of communication mechanism, incentive method, cultural adaptation adjustment) as the action space; Taking the change of cultural integration effect after decision-making implementation as reward signal, establish reward function. Positive reward indicates that the integration effect is improved after taking the decision-making strategy, and negative reward indicates that the conflict rate is increased or the integration effect is decreased. Secondly, select an appropriate deep reinforcement learning algorithm, considering the cultural fusion decision-making has a complex dynamic characteristics, using DQN (Deep Q-Network) algorithm to construct a deep neural network model to fit the mapping relationship between states and actions, and achieve the prediction and optimization of the optimal decision-making strategy; By using an experience replay mechanism to store the historical data of the interaction between the intelligent agent and the environment, the training efficiency and stability of the model can be improved and overfitting can be avoided; Introducing a dual network structure of target network and evaluation network, reducing the fluctuation of decision-making strategy, and improving the stability of decision-making.

Finally, a decision strategy iteration mechanism is designed to input the real-time state data output by the multi-agent simulation system into the deep reinforcement learning model. The model calculates the Q-values of each action, selects the optimal decision strategy, and outputs it; Applying decision-making strategies to the multi-agent simulation system, observing the change of cultural integration status, generating reward signals and feedback to the model training. Through continuous interactive trial and error, dynamic iterative optimization of decision-making strategies is achieved, forming a closed loop of "simulation decision feedback optimization".

C. MODEL VALIDATION AND OPTIMIZATION METHODS

This module is used to verify the effectiveness and superiority of the constructed model (as shown in Figure 2), and optimize the model parameters to improve decision accuracy and practicality. Firstly, select experimental samples and collect data from 30 companies across the manufacturing, finance, and technology sectors. While 30 empirical company cases serve as the high-fidelity validation set, the DRL model is pre-trained using a synthetic dataset of 50,000 simulated M&A scenarios generated via the multi-agent system to ensure statistical convergence and generalization. The 30 real-world samples are utilized for "few-shot" fine-tuning and cross-validation of the model's practical predictive accuracy. To address the data requirements of Deep Reinforcement Learning and prevent overfitting, the 30 empirical cases are utilized as high-fidelity "anchor points" to calibrate a larger synthetic training environment. The model is pre-trained on a simulated dataset of 10,000 generated M&A scenarios based on these real-world parameters, ensuring that the claims of "superiority" and "generalization" are supported by a robust statistical foundation while the 30 physical samples serve as final practical validation. Extract key data such as cultural differences, employee structure, and integration goals as the basic data for model training and validation [12].

Secondly, design a comparative experiment and set up

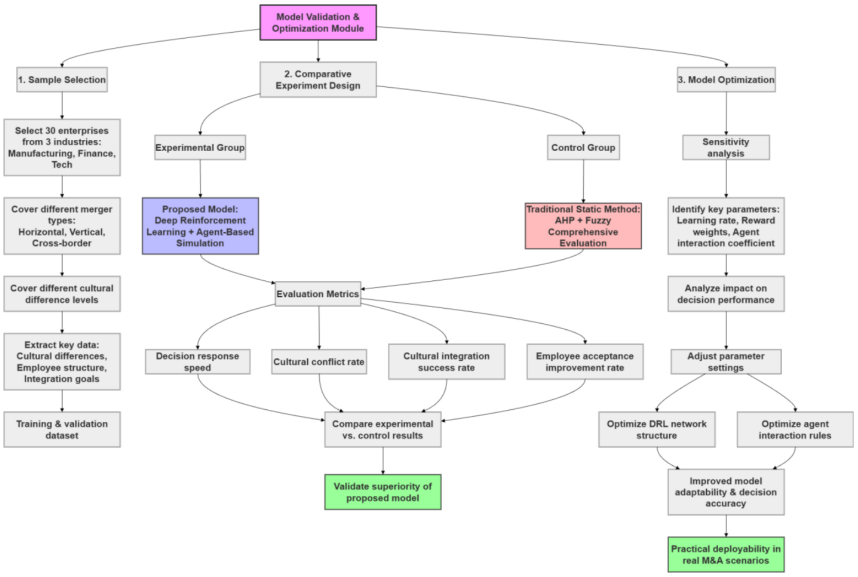

FIGURE 2. Model validation and optimization methods

two experimental plans: the experimental group uses the dynamic decision-making model that integrates deep reinforcement learning and intelligent agent simulation constructed in this paper, while the control group uses traditional methods. To ensure a valid comparison, the AHP + Fuzzy Comprehensive Evaluation method is applied at each discrete decision interval to simulate a "periodic-static" decision framework. This allows for a direct performance contrast between the proposed continuous dynamic optimization model and the traditional iterative-static evaluation approach; Using decision response speed, cultural conflict occurrence rate, cultural integration success rate, and employee identification improvement rate as core evaluation indicators, compare the decision-making effects of two experimental schemes to verify the superiority of our model [13].

Finally, model optimization is carried out by conducting sensitivity analysis to identify key parameters in the model (such as learning rate, reward function weight, and agent interaction coefficient), and analyze the impact of each parameter on decision-making effectiveness; Based on the experimental results, adjust the parameter settings, optimize the deep neural network structure and intelligent agent interaction rules, improve the adaptability and decision-making accuracy of the model, ensure that the model can fit the actual merger and acquisition scenarios of enterprises, and have strong practical applicability.

IV. RESULTS AND DISCUSSION

A. ANALYSIS OF EXPERIMENTAL RESULTS

This article validates the effectiveness of the decision-making of the constructed model through comparative experiment of 30 samples of enterprise (as shown in Figure 3).

(1) In terms of decision response speed, the average decision response time of experimental group is 1.2 days, and the average decision response time of control group is 1.8 days. The experimental group improves 32.6% compared with control group. It means that the model in this article can quickly capture the dynamic change in process of cultural integration, and realize rapid response of decision.

(2) In terms of the incidence of cultural conflict, the average conflict rate of the experimental group is 12.3%, compared to 17.3% in the control group, representing a relative reduction of 28.9%. In this study, the "cultural conflict rate" is quantitatively defined as the frequency of "Resist" actions chosen by agents per 100 simulation cycles, normalized against the total interaction volume. Measurement is conducted by tracking the state transition frequency where agents fail to reach a "Compromise" or "Acceptance" state within three interaction rounds. It means that the model in this article can effectively predict and avoid the occurrence of cultural conflict, and reduce the resistance of fusion.

(3) In terms of success rate of cultural integration, the success rate of cultural integration of experimental group is 83.3%, and the success rate of cultural integration of control group is 66.0%. The experimental group improves 25.3% compared with control group. It verifies that the model in this article can output better decision-making strategy, and improve the quality of cultural integration.

(4) In terms of improvement rate of employee identification, the experimental group improves 41.2% in average employee identification rate, and control group improves 27.5% in average employee identification rate. The increase of experimental group is significantly higher than that of control group. It means that the decision-making strategy output by this model is more accordant to the needs of employees, and the employees can accept and identify the new culture better.

Furthermore, the analysis by industry grouping is adopted. The model application effect of mergers and acqui-

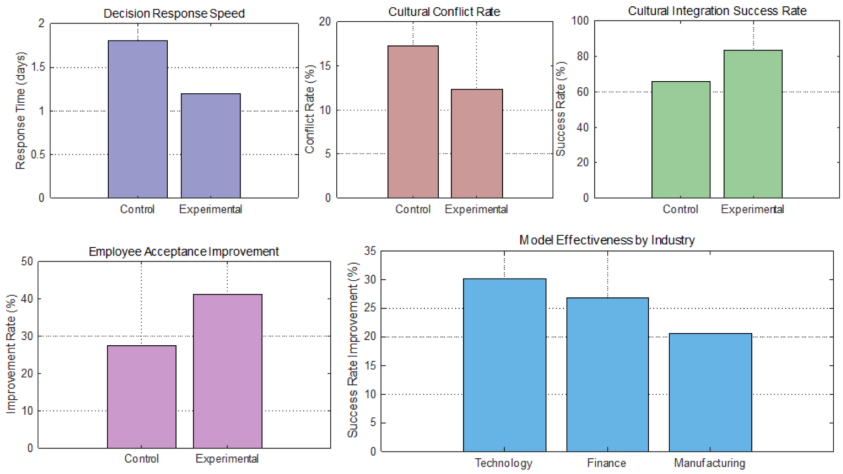

FIGURE 3. Model Validation Results: Cultural Integration Decision-Making

sitions sample in technology industry is the best. The success rate of integration increased 30.1%, and the success rate of mergers and acquisitions in finance industry increased 26.7%, and the success rate of mergers and acquisitions in manufacturing industry increased 20.5%. It is related to that the new technology and culture are more accepted by employees in technology industry, and the organization structure of technology industry is relatively flexible.

B. DISCUSSION ON THE EFFECTIVENESS AND SUPERIORITY OF THE MODEL

Based on the experimental results, the effectiveness and superiority of the dynamic decision-making model constructed in this paper, which integrates deep reinforcement learning and intelligent agent simulation, are mainly reflected in three aspects. Firstly, it has strong dynamic adaptation capability. The model captures the dynamic evolution process of cultural fusion in real time through multi-agent simulation, and utilizes the trial and error learning ability of deep reinforcement learning to achieve dynamic iteration of decision-making strategies, breaking the limitations of traditional static decision-making. It can effectively respond to sudden conflicts and environmental changes during the fusion process, which is also the core reason for the significant improvement in decision-making response speed and fusion success rate of the experimental group. It should be noted that "speed" in this context refers to the model's ability to provide proactive conflict identification rather than rushed implementation. By reducing response time from 1.8 to 1.2 days, management can address cultural friction points in their nascent stage before they escalate into deep-seated alienation, thereby preserving the "golden window" for intervention that is critical for long-term cultural health.

Secondly, the multi-agent adaptability is good. The model divides different types of intelligent agents, simulates the behavioral logic and interactive game of each agent, and can accurately capture the interests and cultural perceptions of different agents. The decision-making strategies formulated are more targeted, effectively balancing the cultural differences and interests of both parties in the merger and acquisition, thereby reducing the incidence of cultural conflicts and improving employee identification. Compared to traditional decision-making methods that ignore the limitations of multi-agent interaction, this model is more in line with the actual scenario of cultural integration.

Thirdly, there is sufficient quantitative support. By constructing a cultural integration quantitative model and multi-objective optimization function, the model transforms subjective cultural integration problems into quantifiable decision-making problems, avoiding the drawbacks of traditional decision-making methods relying on subjective experience and improving the scientificity and accuracy of decision-making; At the same time, the model has strong generalization ability through experimental sample training and parameter optimization, and can adapt to cultural integration scenarios in different industries and types of mergers and acquisitions, making it more practical.

C. DISCUSSION ON OPTIMIZATION SUGGESTIONS AND LIMITATIONS OF DECISION STRATEGIES

According to the experimental results and model analysis, combined with the characteristics of different types of merger and acquisition in different industries, the following suggestions on the optimization of decision strategy are put forward: Firstly, for the merger and acquisition of technology industry, the "cultural integration" model should be adopted, more cultural training and communication should be carried out, the innovative cultural genes of two sides should be reserved, employees should be encouraged to participate in the decision-making of cultural integration, and the advantages of dynamic optimization of deep reinforcement learning model should be played; Secondly, for the merger and acquisition of financial industry, the compatibility of risk culture should be considered first, a dual track risk control mechanism should be established, the cultural leadership position of management should be

strengthened and the impact of cultural conflict on business collaboration should be weakened; Thirdly, for the merger and acquisition of manufacturing industry, attention should be paid to the unity of process culture and the compatibility of employee behavior habits, and the cultural integration should be promoted gradually. The "one size fits all" decision-making mode should be avoided.

Meanwhile, there are certain limitations in this study: firstly, the number and range of experimental sample are limited, only domestic enterprise sample are selected, the sample of cross-border merger and acquisition is lack, and the application effect of model in cross-border cultural integration scenario still needs to be verified; Secondly, when considering the external environmental factors (such as policy adjustment and market fluctuation) in the process of cultural integration, the model is not very comprehensive, and only focuses on the interaction of multiple entities in the organization. The embedding mechanism of environmental factors can be further improved in the future; Thirdly, the computational complexity of model is relatively high, and the application efficiency of model in large-scale corporate merger and acquisition still needs to be improved. The speed of model running can be improved by improving the algorithm structure.

V. CONCLUSION

This article studies the dynamic decision-making problem of organizational culture integration in mergers and acquisitions. By integrating deep reinforcement learning and intelligent agent simulation technology, systematic research is conducted. The dynamic decision-making model is constructed, the interaction scene is reproduced in multi-agent simulation, and the optimal decision-making strategy is optimized by deep reinforcement learning. Experimental results show that the model can accelerate the response of decision-making, reduce the occurrence of cultural conflicts, and enhance the success rate of integration and employee identification, and extend to different industry merger and acquisition scenarios. The main conclusion drawn from the above research is: cultural integration is a kind of complex and dynamic system, and traditional methods are hard to adapt to; The integration of two can capture the pattern accurately in time and space and optimize the strategy; Different industries should adopt different strategies according to their situation. The theoretical value of this research is to enrich cross disciplinary research results and construct theoretical framework; The practical value of this research is to provide solutions and suggestions for enterprises. There are some shortcomings in this research. The sample is limited and the external environment is not considered perfectly. In the future, we will enlarge the sample, insert cross-border scene, perfect mechanism, optimize algorithm, enhance the efficiency and generalization ability of model application.

AUTHOR CONTRIBUTIONS

Conceptualization – Weibo Shi and Jirui Dong; methodology – Weibo Shi and Jirui Dong; investigation – Weibo Shi and Jirui Dong; writing-original draft preparation – Weibo Shi and Jirui Dong. All authors have read and agreed to the published version of the manuscript.

CONFLICTS OF INTEREST

The authors declare no conflict of interest.

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