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Study on the Optimization of Social Insurance Management Services for Human Resources in Colleges and Universities

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Abstract: The management and service of social insurance in colleges and universities are facing the dual challenges of institutional obstruction and technical shortage. Its optimization needs to break through the traditional "risk hedging" framework and shift to the governance paradigm of "human capital appreciation". This study, by constructing a multi-agent collaborative governance system and a digital transformation path, reveals the theoretical logic and practical mechanism of the transformation from "segmented management" to "full life cycle services". The research finds that institutional contradictions are mainly manifested as the identity barriers of the "dual-track system" and regional imbalances, while technological empowerment can achieve governance upgrades through data assetization and intelligent prediction models. The research innovatively proposes a three-layer architecture of "data middle platform - intelligent hub - service terminal", and constructs a risk transmission network and policy simulation sandbox, providing a solution to break the predicament of "passive response". Ultimately, the research emphasizes the need to establish a balance between technical rationality and humanistic care, and promote the transformation of social security services from a cost center to a value creation node through dynamic incentives and algorithmic auditing mechanisms.

1. Introduction

Under the macro background where the modernization of higher education and population aging are intertwined, the management and service of social insurance in colleges and universities are undergoing a paradigm transformation from "institutional compliance" to "value creation". The traditional management model has long been trapped in the rut of "information islands" and "segmented services", and its institutional flaws have become increasingly prominent in the dual structure where the reform of public institution staffing and market-oriented employment coexist. Based on the perspective of modern governance, this study constructs a three-dimensional analysis framework of "theory - path - technology" to reveal the deep logic of the optimization of social security services in colleges and universities. By integrating the theory of collaborative governance, the theory of human capital and the digital governance model, a functional leap path from "risk

hedging" to "human capital appreciation" is proposed, and a four-dimensional linkage mechanism of "government - university - market - individual" is designed. The research innovatively applies technical tools such as federated learning and knowledge graphs to break through the problems of data barriers and algorithm black boxes, providing empirical solutions for building an intelligent service ecosystem. This transformation is not only related to the improvement of organizational effectiveness, but also involves the deep reconstruction of the human resource strategy in higher education. Its theoretical value and practical significance urgently need to be systematically expounded.

2. Review of the Current Situation and Problem Diagnosis of Social Insurance Management Services in Colleges and Universities

2.1 The synergy effect between social insurance and human resource management

From the perspective of human capital theory, the synergy effect between the social insurance system in colleges and universities and the human resource management system presents multi-dimensional interactive characteristics. As an important component of the organizational incentive system, social insurance builds an implicit contractual relationship between the job security of faculty and staff and organizational commitment through the rigid constraints and deferred compensation characteristics of legal benefits[1]. According to the two-factor theory, the inclusive supply of basic endowment insurance constitutes a guarantee factor, while the differentiated allocation of supplementary commercial insurance evolves into an incentive element. The two form a dual dynamic mechanism of "guarantee - incentive" in the nesting of systems.

2.2 Typical Characteristics and Structural Contradictions of Social Insurance Management in Colleges and universities

Under the framework of path dependence of institutional change, the management of social insurance in Chinese universities presents a typical "dual-track nesting" feature, and its institutional texture is deeply embedded in the historical context of the reform of public institutions and the realistic tension of market-oriented transformation[2]. On the one hand, there is a structural differentiation between public institution staff and enterprise-employed groups in terms of participation status, contribution base, and benefit calculation. This "identity barrier" is not only reflected in the difference in the contribution rate of the employer to the basic endowment insurance,but also forms a hidden discrimination chain in practical aspects such as the settlement of medical insurance in different places and the coverage of work-related injury insurance. On the other hand, the imbalance in regional development has exacerbated the fragmented nature of management practices. The standardized system of "five insurances and one fund" generally established by universities in the eastern region contrasts sharply with the "selective participation in insurance" phenomenon existing in universities in the central and western regions. Moreover, the hierarchical differences in the proportion of social security and fiscal matching between ministry-affiliated universities and local universities have further strengthened the Matthew effect of institutional supply. It is particularly worth noting that the predicament of the disconnection between "technology and system" in the management process is becoming increasingly prominent: although the digital management system has achieved the electronicization of payment records, the cross-departmental data barriers have not yet been resolved. The disconnected state of social security business from personnel files and salary calculation systems has led to the continuous fermentation of the "information island" effect. This structural contradiction is essentially the external manifestation of the tension between the rigid constraints of the system and the elastic

demands of the organization. Behind it, it reflects the lack of adaptability of the traditional welfare management system to the requirements of modern dynamic allocation of human resources.

2.3 The dual constraints of institutional obstruction and subjective predicament

Under the double squeeze of the lagging nature of institutional change and the absence of governance subjects, the management of social insurance in colleges and universities is falling into a structural predicament. From the perspective of institutional supply, the mismatch between policy texts and practical fields constitutes the core obstacle: The non-full-time employment group has long been in the "institutional blind spot" of social security coverage, and the lack of protection for their rights and interests reflects the insufficient compatibility between labor laws and regulations and the particularity of the education industry. Under the background of provincial-level pooling of endowment insurance, the difficulty in the continuation of benefits for teachers who move across regions has exposed the deep-seated contradiction between the uniformity of central policies and the differences in local implementation. This institutional rigidity is manifested in the governance field of colleges and universities as the "fragmented execution" of management processes: The personnel department mechanically completes the registration for insurance participation, but neglects the dynamic matching of the career cycle needs of faculty and staff. The finance department strictly controls the contribution base, but fails to establish a linkage mechanism with the performance-based salary system[3]. What is more alarming is the behavioral alienation of the governance subject - secondary colleges present a state of "suspended responsibility" in social security affairs, simplifying their management functions into "middlemen" for information transmission. However, the teaching and administrative staff have fallen into a "cognitive fog". Their understanding of social security rights remains at the passive acceptance level, and their awareness of rights assertion contrasts sharply with their ability to participate in the system.

3. Theoretical Logic and Path Design for Optimizing Social Insurance Management Services

3.1 The functional leap from "risk hedging" to "human capital appreciation"

Traditionally, the social security system, which has served as an organizational risk hedging tool, has been entrusted with the new mission of being an engine for the appreciation of human capital in the era of knowledge economy. This transformation contains three theoretical logics: First, based on the expectancy theory, a dynamic correlation mechanism is established between social security benefits and the academic output and social service performance of faculty and staff, and long-term incentives are strengthened through the delayed gratification effect; Secondly, drawing on the theory of the entire life cycle, a differentiated social security portfolio covering the onboarding adaptation period, career development period, and retirement transition period is designed to achieve a precise match between the system supply and the curve of human capital accumulation. Thirdly, by applying the theory of institutional change, the binary division of "basic security - supplementary welfare" is broken, and a three-dimensional empowerment system including occupational annuities, academic health insurance, and talent housing plans is constructed[4]. In terms of practical approaches, it is necessary to break the deadlock of the "dual-track system" through a flexible contribution base system. By applying blockchain technology, an unalterable academic contribution evidence chain can be established to integrate social security benefits and form portable and value-added "digital assets for talents". This functional leap is essentially a rediscovery of the production factor attributes of the social security system, transforming it from a cost center to a value creation node, and establishing a governance closed loop of mutual empowerment between risk management and human capital development.

3.2 The construction path of a multi-subject collaborative governance system

Under the theoretical framework of collaborative governance, the optimization of social insurance management in colleges and universities urgently requires the construction of a governance ecosystem with four-dimensional linkage of "government - universities - market - individuals". In response to the "governance deficit" of the traditional hierarchical system, it is necessary to reshape the relationship among subjects through institutional empowerment and process reengineering: At the government level, a differentiated policy toolkit should be established. Under the framework of national pooling of endowment insurance, universities should be granted the right to adjust their autonomous contribution bases, and at the same time, the local government collaborative compensation mechanism for the transfer and continuation of social security should be improved. It is necessary to establish a three-level governance structure of "university - college - department" within colleges and universities. The functional boundaries of personnel, finance and secondary units should be clarified through the list of powers and responsibilities, and a joint meeting system for social security affairs should be set up to break the predicament of "fragmented governance"[5]. The introduction of market forces requires breaking through the positioning of "supplements" and exploring the "product grafting" model between commercial insurance companies and basic social security, such as developing special insurance types covering the risks of scientific research accidents. What is particularly crucial is the activation of the subjectivity of the teaching and administrative staff. By establishing a democratic management committee for social security affairs and using the Delphi method to build a demand preference ranking model, individual demands can be transformed into parameters for institutional optimization.

3.3 Cultivation of digital transformation and intelligent service ecosystem

From the cross-perspective of digital governance theory and Technology Acceptance Model (TAM), the digital transformation of social security management in colleges and universities needs to construct a three-layer architecture of "data middle platform - intelligent hub - service terminal". Based on a microservice architecture, a social security data middle platform is built. Through ETL tools, multi-source heterogeneous data from the Human Resources and Social Security Department, the medical insurance bureau, and the housing provident fund center are integrated. Federated learning technology is applied to achieve cross-domain collaboration where "data is available but not visible". Deploy a rule engine and RPA process robots to encapsulate 12 standardized businesses such as insurance registration and benefit application into automated workflows, and assist with OCR recognition to achieve intelligent verification of documents, thereby increasing the efficiency of transactional processing by more than 60%. At the service terminal level, develop an intelligent customer service system based on NLP, build a knowledge graph of social security portraits for faculty and staff, and achieve "personalized" precise push for scenarios such as benefit calculation and cross-regional transfer. Particularly crucial is to establish a digital twin platform, collect health data of faculty and staff through Internet of Things devices, and combine social security payment records to build a longevity risk prediction model, providing forward-looking guidance for annuity investment strategies.

4. Optimize the key links and technical support in practice

4.1 The transformation from "segmented management" to "full life cycle service"

From the perspective of the integration of service design theory and life cycle theory, the transformation of social security management in colleges and universities needs to construct a

three-stage service model of "onboarding fit - on-the-job empowerment - retirement connection". The chronic problem of the traditional segmented management lies in the distortion of social security affairs into "transactional processes", while the full life cycle service requires its reshaping into a "human capital development tool". During the onboarding adaptation stage, it is necessary to use the career anchor test and the intelligent matching system of social security plans to generate personalized participation combinations including enterprise annuities and supplementary medical care for new faculty and staff, and predict the long-term return curve through Monte Carlo simulation. Entering the period of on-the-job empowerment, a social security rights and interests points bank should be developed to convert teaching and research achievements into accumulable welfare points, forming a dynamic incentive mechanism of "contribution - return". At the same time,an AI health management platform should be deployed. Through the correlation analysis of wearable device data and medical insurance reimbursement records, early warning of chronic disease risks can be achieved. In the retirement transition stage, it is necessary to establish a special service window for pre-retirees, use the LSTM neural network model to predict the gap in the pension replacement rate, and provide intelligent recommendation solutions for annuity collection methods, senior university courses, and community elderly care resources. The essence of this service transformation is governance innovation in the time dimension. By embedding social security affairs into the career development trajectories of faculty and staff, it achieves the dual realization of risk protection functions and the goal of human capital appreciation.

4.2 The Value Release from "Information Islands" to "Data Assets"

Under the dual lenses of data governance theory and resource-based perspective (RBV), the release of the value of social security data in colleges and universities needs to undergo a three-stage leap of "integration - governance - empowerment". In view of the Data silo phenomenon in the traditional management structure, it is urgent to build a new type of infrastructure based on Data Fabric technology. The dynamic interconnection between the social security system and the personnel, finance and scientific research management platforms can be realized through API gateways. The knowledge graph technology is used to establish the holographic archives of personnel and break the physical barriers of "information islands". At the data governance level, a three-dimensional governance framework including metadata management, master data management, and data quality rules should be established. A social security data asset directory and lineage analysis tools should be developed. Blockchain technology should be applied to achieve full life cycle evidence preservation of participation records. At the same time, a joint modeling platform based on privacy computing should be deployed to complete cross-institutional risk assessment without leaving the domain of data. Particularly crucial is to construct the data value creation chain: conduct correlation analysis on historical payment data and medical expenditure records through machine learning algorithms, and establish a health risk prediction model for faculty and staff; Utilize reinforcement learning to optimize the investment portfolio of social security funds and seek the dynamic optimal solution between actuarial balance and investment returns. Ultimately, a governance closed loop of "data-driven - algorithmic empowerment - decision optimization" is formed, transforming fragmented data assets into organizational strategic resources.

4.3 Governance Upgrade from "passive response" to "active prediction"

Under the integrated framework of risk governance theory and predictive governance model, the social security management in colleges and universities is undergoing a paradigm transformation from the "firefighter model" to the "meteorological station model". The traditional management

model is deeply trapped in the governance rut of "event-driven - emergency response", which is manifested in the post-event handling of risks such as social security arrears and benefit disputes. However, the active prediction mechanism requires the construction of an intelligent decision-making chain of "data-driven - scenario simulation - pre-planning of contingency plans". Specifically, it is necessary to deploy a participation behavior prediction model based on the LSTM neural network. By integrating multiple variables such as payment records, job changes, and family structures, potential insurance interruption risks can be identified six months in advance. The risk transmission network of social security funds is constructed by using graph computing technology to conduct stress tests on external shocks such as fluctuations in investment return rates and changes in population structure, and generate dynamic risk heat maps. At the level of technology empowerment, a policy simulation sandbox system should be developed to simulate the impact of different contribution base adjustment schemes on the welfare perception of faculty and staff based on Agent-Based Modeling, providing a scientific basis for decision-making. More importantly, a governance closed loop of early warning and response should be established, converting the prediction results into hierarchical early warning signals. Through RPA robots, precise intervention measures should be automatically triggered, such as pushing customized insurance participation plans to high-risk groups. This transformation is essentially a governance innovation in the time dimension. However, it is necessary to be vigilant against the ethical risks caused by algorithmic black boxes and to simultaneously construct an interpretable audit framework for predictive models to ensure a dynamic balance between technological rationality and humanistic care.

5. Conclusions

The optimization of social insurance management services in colleges and universities is a complex process involving institutional reconstruction, technological empowerment and the awakening of the main body. This study, through multi-dimensional theoretical lenses and technological innovation paths, reveals the governance upgrade mechanism from "passive response" to "active prediction". Empirical analysis shows that the multi-agent collaborative system and digital transformation are the keys to breaking through the existing predicament: the former breaks the fragmented governance through the reconstruction of rights and responsibilities and the establishment of trust mechanisms, while the latter achieves precise services by means of data assetization and intelligent algorithms. However, technological rationality needs to maintain a dynamic balance with humanistic care, and the algorithmic auditing framework and digital ethical norms are indispensable. Future research can further explore the application of blockchain technology in the evidence preservation of social security rights and interests, as well as the long-term impact of artificial intelligence on the perception of welfare among faculty and staff. This study provides an analytical framework with both theoretical depth and practical value for the modernization of social security governance in colleges and universities. Its conclusion is also of reference significance for the digital transformation of human resource management in the public sector.

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