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Original Paper

Research on an Integrated Multi-Objective Decision-Making Model for Fixed Assets Based on State Awareness

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Abstract

The objectives, methods, and timing of fixed asset disposal have a profound impact on corporate profitability and operational efficiency. With the advent of the digital era, simulating a variety of disposal combinations has become a practical reality, enabling enterprises to generate greater value from asset disposals. This study takes Liangshan Tobacco as the research object and constructs a multi-objective decision-making model for fixed assets based on dynamic state awareness. The model aims to minimize economic cost, maximize health score, and minimize disposal loss risk as decision objectives. Through the integration of dynamic depreciation simulation, asset health and efficiency scoring, and disposal early-warning modules, it effectively addresses the disposal issues faced by Liangshan Tobacco, enhances both safety and efficiency, and provides a theoretical modeling reference for asset disposal in other prefectures and cities.

Keywords

fixed assets, multi-objective decision-making, health score

1. Introduction

1.1 Research Background and Significance

Fixed asset disposal has an impact on corporate profits, tax liabilities, and cash flows, which means that it not only affects the current operational objectives of the enterprise but also has far-reaching implications for the future. Therefore, when disposing of fixed assets, how to ensure disposal returns, reduce operating costs, and simultaneously achieve lower disposal risk has become an important research topic in the field of fixed asset disposal.

1.2 Literature Review

Current academic research has made significant progress in asset condition monitoring, maintenance optimization, and multi-objective decision support systems, which can be summarized along three dimensions: state awareness and predictive maintenance, multi-objective optimization algorithms, and specific industry scenarios decision.

State awareness and predictive maintenance. Zhang et al. (2021) addressed uncertainty in state awareness through probabilistic models, providing logically rigorous decision support for long-term maintenance planning. Zhang et al. (2022) realized real-time perception and intelligent regulation of asset states via virtual mapping. Lv et al. (2023) emphasized that condition-based maintenance decisions need to consider cost differences to maximize economic benefits. Sheng et al. (2023) achieved real-time asset state perception and intelligent control through virtual mapping. Liu (2024) demonstrated that AI-driven data analytics can deeply mine asset portfolios, thereby optimizing asset utilization and minimizing risks. Mirshekali et al. (2024) took asset state reliability as a core constraint and balanced maintenance costs against service interruption risks.

Multi-objective optimization and decision algorithms. Petchrompo et al. (2020) quantified the relationship between asset value and system reliability, enabling multi-objective trade-offs in maintenance strategies. Rivera-Niquepa et al. (2020) combined fuzzy decision methods to handle uncertainty and multiple conflicting objectives in energy supply. Shehadeh et al. (2024) built an expert system to solve complex decision problems in equipment scheduling and maintenance.

Industry-specific scenarios and depreciation strategies. Dias et al. (2021) provided a theoretical framework for managing asset portfolios with different aging rates. Hong et al. (2022) highlighted the multi-objective trade-offs in asset allocation under resource constraints. Ma et al. (2022) proposed an intelligent decision model for building project retrofits that considers tacit knowledge and multiple objectives. Qiao et al. (2023) used dynamic programming to reveal the relationship between accounting depreciation strategies and the actual physical state of assets, as well as their effect on replacement timing decisions. La et al. (2024) comprehensively considered asset age, value, and condition to achieve objective-based disposal decisions.

Although existing research has achieved fruitful results in state awareness, multi-objective optimization, and scenario-specific applications, greatly promoting the digital development of fixed asset disposal, a comparative review of relevant studies reveals that there remains a lack of a multi-objective decision-making framework that bridges asset status and financial decision-making, and that such frameworks cannot adapt to changing scenarios, leading to poor empirical performance of theoretical research. To address these research gaps, this study proposes a state-awareness-based multi-objective decision-making model for fixed assets, which covers multiple scenarios including disposal benefits and health status perception, thereby enabling adaptive decision-making across scenarios.

2. Mathematical Modeling of Dynamic Decision-Making for Fixed Assets

This chapter constructs a state-awareness-based multi-objective decision-making model for fixed assets, defining three optimization objectives: minimizing the total economic cost over the decision window, maximizing the asset health score at the end of the window, and minimizing the maximum potential disposal loss risk within the window. According to scenario requirements, the weight of each objective is set, and the weights are adjusted for different scenarios, with the sum of the three weights equaling 1. Two types of constraints are established: (1) state-transition constraints, requiring that candidate management actions comply with legitimate transfer rules from the current usage state; and (2) accounting compliance constraints, specifying that assets which have been fully depreciated or selected for immediate disposal shall cease depreciation accrual in subsequent months. Through the dynamic depreciation simulation sub-model, the health scoring sub-model, and the risk quantification sub-model, the corresponding objective values are computed, and the weighted score of all actions is calculated. The optimal management action is then determined by maximizing the composite score.

2.1 Research Assumptions

In actual asset decision management, within a fixed time window, the finance or asset management department often faces disposal decisions for dozens or even hundreds of fixed assets. The complexity of disposal decisions is positively correlated with asset scale—i.e., the larger the asset scale, the more complex the decision-related issues, such as which equipment to continue depreciating, which to lease out, which to idle, and which to scrap. Accordingly, the following research assumptions are proposed: In the absence of monthly disposal-quantity constraints, each asset independently selects the action that maximizes its composite score, thereby achieving local optimality at the individual level, and the decisions across assets are mutually independent. When global constraints such as a disposal quantity ceiling exist, the candidate actions of all assets must be incorporated into a unified optimization, and an integer programming model is used to solve for the action combination that maximizes the sum of composite scores across all assets; this combination's overall score is significantly better than a heuristic approach that simply truncates individual optima and then randomly removes over-limit items.

2.2 Multi-Objective Optimization Model

2.2.1 Multi-Objective Evaluation Function

The comprehensive decision evaluation function integrates three normalized objective indicators with fixed weight coefficients, and the core calculation formula is shown in Eq. (1):

$$S_{i,a}=\omega_1\bar{J}_{1,i,a}+\omega_2\bar{J}_{2,i,a}-\omega_3\bar{J}_{3,i,a}$$

where: $S_{i,a}$ is the final evaluation score of asset i under candidate action a; a higher score indicates a better management plan, and the action corresponding to the highest score is output as the asset management decision. $\omega_1,\omega_2,\omega_3$ denote the weight of economic cost, asset health, disposal loss risk respectively; $\bar{J}_{1,i,a},\bar{J}_{2,i,a},\bar{J}_{3,i,a}$ represent min-max normalized values of three original objectives.

For each fixed asset i, given its current state and future window parameters, one action is selected from the candidate management action set $A=\{a_1,a_2,a_3,a_4,a_5\}$ to maximize the asset's comprehensive evaluation score$S_{i,a}$. The single-asset optimal decision criterion is:

$$a_i^*=\arg\max_{a\in A} S_{i,a}$$

For the multi-asset batch expansion integer programming model, a monthly disposal quantity ceiling constraint is added to achieve the globally optimal combination decision, the global objective and constraint are shown in Eq. (3):

$$\begin{aligned} max \quad & \sum_{i=1}^{N} S_{i,a_i} \\ \text{s.t.} \quad & \sum_{i=1}^{N} x_{i,a} \leq Q_{\max} \\ & x_{i,a} \in \{0,1\} \end{aligned}$$

where: N is total number of decision-making assets;$x_{i,a}$ is 0-1 decision variable, $x_{i,a}=1$ means asset i executes action a; $Q_{\max}$ is enterprise monthly maximum disposal asset quota.

2.2.2 Minimization of Total Comprehensive Holding Economic Cost over the Window

State-transition constraint: The predicted state sequence must follow business transition rules; reverse transitions are prohibited, and assets marked as pending disposal cannot return to in-use, leased-out, or idle states. State transition domain constraint formulas:

$$s_{i,t}\in S=\{1\text{:in use},2\text{:leased out},3\text{:idle},4\text{:pending disposal}\}$$

$$\text{If} s_{i,t}=4,\forall\tau>t,s_{i,\tau}\equiv 4$$

(1) Dynamic depreciation simulation

Standard straight-line theoretical monthly depreciation formula compliant with accounting standards:

$$D_i^*=\frac{C_i\cdot(1\text{-}r_i)}{L_i\times 12}$$

(2) State-linked depreciation accrual determination formula

Combining asset operational status and accounting compliance rules, the actual monthly depreciation accrual amount is constrained by disposal status, depreciation completion status and usage state:

$$d_{i,t}=\mathrm{I}\{y_{i,t}=0\}\cdot\mathrm{I}\{T_{i,t}<T_i^{\text{full}}\}\cdot D_i^*$$

where: $\mathrm{I}\{\cdot\}$ is an indicator function that takes the value 1 if the internal condition holds and 0 otherwise; The four usage states are all allowed to accrue depreciation by default—no state-based depreciation restriction exists. Simultaneously, the following conditions must be met: the asset has not been disposed of ($y_{i,t}=0$), depreciation has not been fully accrued ($T_{i,t}<T_i^{\text{full}}$), and the state allows depreciation, before depreciation can be accrued in that month.

(3) Monthly closed-loop recursive update equations

At the end of each month, all parameters in the asset depreciation ledger are updated iteratively, including cumulative depreciation, net book value and depreciation months:

$$\begin{cases} T_{i,t+1}=T_{i,t}+\mathrm{I}\{d_{i,t}>0\} \\ AD_{i,t+1}=AD_{i,t}+d_{i,t} \\ V_{i,t+1}=V_{i,t}-d_{i,t}-O_i(s_{i,t}) \end{cases}$$

where: $O_i(s_{i,t})$ denotes monthly holding operation and maintenance cost function determined by real-time usage state.

(4) Future window depreciation prediction rules

Given the current decision month t_0 and the selected control action, the future state sequence is derived through simulation; substituting into the above recursive equations yields the future net value sequence. The first optimization objective minimizes the sum of depreciation cost and operational holding cost within decision window H:

$$J_{1,i,a}=\sum_{t=t_0}^{t_0+H-1}(d_{i,t}+O_i(s_{i,t}))$$

Min-max normalization for economic cost objective (reverse normalization, lower cost corresponds to higher score):

$$\bar{J}_{1,i,a}=1-\frac{J_{1,i,a}-min(J_{1,i})}{max(J_{1,i})-min(J_{1,i})}$$

2.2.3 Maximization of Asset Health Score

The health score is based on a 100-point scale, incorporating both book-value depreciation loss and usage-state degradation, coupling asset residual value ratio and state efficiency coefficient:

$$H_{i,t}=100\cdot\frac{V_{i,t}}{C_i}\cdot\eta(s_{i,t})$$

The state-efficiency coefficient$\eta(s_{i,t})$ is assigned piecewise according to tobacco fixed asset operation specification:

$$\eta(s)=\begin{cases} 1.00, & s=1\text{(in use)} \\ 0.80, & s=2\text{(leased out)} \\ 0.40, & s=3\text{(idle)} \\ 0.10, & s=4\text{(pending disposal)} \end{cases}$$

Objective 2: End-of-period asset health score, take terminal moment of evaluation window as evaluation benchmark:

$$J_{2,i,a}=H_{i,t_0+H}$$

Positive min-max normalization for health score:

$$\bar{J}_{2,i,a}=\frac{J_{2,i,a}-min(J_{2,i})}{max(J_{2,i})-min(J_{2,i})}$$

2.2.4 Minimization of Maximum Disposal Loss Risk

(1) Net realizable value estimation formula for assets

Combining second-hand tobacco equipment transaction big data, introduce fixed recovery rate parameter to quantify realizable value:

$$R_{i,t}=\beta_i \cdot V_{i,t}$$

(2) Single-disposal book loss formula

Disposal book loss equals the difference between current book net value and second-hand realizable value:

$$L_{i,t}=V_{i,t}-R_{i,t}$$

Objective 3: Maximum disposal loss risk over the window (optimization direction: minimization), take peak loss within whole prediction window as risk measurement index:

$$J_{3,i,a}=\max_{t\in[t_0,t_0+H-1]} L_{i,t}$$

Positive min-max normalization for disposal loss risk:

$$\bar{J}_{3,i,a}=\frac{J_{3,i,a}-min(J_{3,i})}{max(J_{3,i})-min(J_{3,i})}$$

2.3 Model Parameter Description

Table 1. Variable Definitions (supplemented with complete mathematical symbol specification)

Mathematical symbol	Variable description
i	Asset index number
C_i	Asset book original cost (in local currency)
r_i	Asset net residual value rate
L_i	Statutory useful life under accounting standards (years)
T_i^{full}	Total depreciation months for full depreciation (months)
$V_{i,\text{end}}$	Asset end-of-period book net residual value
t_s	Month index when depreciation starts
t	Global absolute monthly index
t_0	Current asset decision base month
H	Future decision evaluation window length (months)
$s_{i,t}$	Asset monthly usage state, value set $\{1,2,3,4\}$
$y_{i,t}$	Asset monthly disposal status: 0 = not disposed, 1 = disposed

$T_{i,t}$	Cumulative depreciation months accrued up to the current month
$AD_{i,t}$	Cumulative depreciation 总额 up to the current month
$V_{i,t}$	Real-time book net value of the asset in the current month
D_i^*	Constant theoretical monthly depreciation amount
$d_{i,t}$	Monthly depreciation accrual flag: 0 = not accrued, 1 = accrued
$O_i(s_{i,t})$	Monthly holding operation and maintenance cost function determined by usage state
$\eta(s_{i,t})$	Asset usage state efficiency degradation coefficient
β_i	Second-hand market disposal value recovery rate, $\beta_i \in (0,1)$
$R_{i,t}$	Estimated net realizable value from second-hand market in the current month
$L_{i,t}$	Immediate disposal book loss amount in the current month
a	Single candidate control action
$Q_{\max}$	Maximum number of assets that can be disposed of by the enterprise in a month
$\omega_1,\omega_2,\omega_3$	Decision weight coefficients for the three optimization objectives, $\omega_1+\omega_2+\omega_3=1$

3. Model Solution

3.1 Weight Setting for Objective Functions

For cost-oriented enterprises, the weight of total economic cost is set highest, as the primary task is to compress operating expenditures and control depreciation losses and holding costs; thus actions with low total depreciation and low holding expenses are preferred, and weights are set as $\omega_1=0.6,\omega_2=0.2,\omega_3=0.2$.

Efficiency-oriented enterprises typically rely on high-value equipment to generate revenue and are willing to bear slightly higher holding costs or small disposal risks in order to keep assets in use or leased out, thereby maximizing the product of book net value rate and state-efficiency coefficient; therefore, weights are set as $\omega_1=0.2$, $\omega_2=0.6$, $\omega_3=0.2$.

Risk-averse enterprises usually operate in highly regulated sectors or environments with large asset value fluctuations; they tend to choose immediate disposal or early transfer to pending-disposal status to lock in losses and avoid future risk expansion, and hence set weights as $\omega_1=0.2$, $\omega_2=0.2$, $\omega_3=0.6$.

3.2 Single Fixed Asset

3.2.1 Data for a Single Fixed Asset

Taking a single fixed asset (1080P video conference terminal A) from Liangshan Prefecture as the research object, its usage and depreciation status are as follows:

- Current usage state: in use (s=1)
- Disposal status: normal (y=0)
- Depreciation status: normal accrual
- Useful life: 3 years
- Depreciation period: 36 months
- Months already accrued: 7 months
- Net residual value rate: 5%.

3.2.2 Calculation of Objective Values for Each Action

Model parameters are set as: decision window H = 12 months, monthly holding cost = 0.1% of original cost, disposal recovery rate β = 0.7, and weights are set to efficiency-oriented configuration ω_1=0.2, ω_2=0.6, ω_3=0.2.

Basic data: Original cost C = 41,118.58 yuan; current net value = 33,523.09 yuan; monthly depreciation = 1,085.07 yuan; 7 months already accrued, remaining useful life 29 months; net residual value rate 5%; decision window H = 12 months; monthly holding cost = 41.12 yuan; disposal recovery rate β = 0.7. Substituting the data into formulas (9), (13), and (16), the calculation results are shown in Table 2.

Table 2. Calculation Results (supplement objective correspondence: Column6=J_1, Column7=J_2, Column8=J_3)

Action	Total depreciation over window (yuan)	Holding cost over window (yuan)	Immediate disposal loss (yuan)	End net value (yuan)	J_1	J_2	J_3
Keep current status	13,020.84	493.44	0	20,502.25	13,514.28	49.87	10,056.93
Transfer to leased out	13,020.84	493.44	0	20,502.25	13,514.28	39.90	10,056.93
Transfer	13,020.8	493.44	0	20,502.2	13,514.2	19.95	10,056.9

to idle	4			5	8		3
Transfer to pending disposal	0	0	0	33,523.09	0	8.15	10,056.93
Immediate disposal	0	0	10,056.93	—	10,056.93	0	0

After calculating the three values J_1,J_2,J_3, min-max normalization is applied, normalized indicators $\bar{J}_1$,$\bar{J}_2$,$\bar{J}_3$ as shown in Table 3.

Table 3. Min-max Normalization

Action	$\bar{J}_1$	$\bar{J}_2$	$\bar{J}_3$
Keep current status	1.000	1.000	1.000
Transfer to leased out	1.000	0.800	1.000
Transfer to idle	1.000	0.400	1.000
Transfer to pending disposal	0.000	0.163	1.000
Immediate disposal	0.744	0.000	0.000

Composite score calculation formula executes Eq.(1): $S=0.2\bar{J}_1+0.6\bar{J}_2-0.2\bar{J}_3$.

- Keep current status: S=0.2×1+0.6×1-0.2×1=**0.600**
- Transfer to leased out: S=0.2×1+0.6×0.8-0.2×1=**0.280**
- Transfer to idle: S=0.2×1+0.6×0.4-0.2×1=**0.040**
- Transfer to pending disposal: S=0.2×0+0.6×0.163-0.2×1=**-0.102**
- Immediate disposal: S=0.2×0.744+0.6×0-0.2×0=**0.149**

3.2.3 Optimal Decision

The action with the highest composite score is keep current status. Therefore, under efficiency-oriented weight configuration, the model recommends maintaining in-use status to balance operational efficiency and asset revenue, which matches daily management logic of tobacco informatization equipment.

3.3 Multiple Assets

The tobacco carton conveyor system, empty carton conveyor system, and case conveyor equipment on the sorting line are selected as the research objects. All three assets were put into use on June 30, 2021, and have the same depreciation period of 5 years, with 58 months already accrued, leaving only 2 months of depreciation remaining. The net residual value rate is about 5%, and the book net values are already close to residual values. Their current usage state is "in use," disposal status is normal, and depreciation status is normal accrual.

From the perspective of multi-asset batch decision-making, these three pieces of equipment belong to the same workshop and the same functional module and are strongly correlated—if one of them is disposed of early, it may affect the collaborative work of the entire sorting line. Therefore, it is recommended to treat them as a whole: either continue using all of them until depreciation is completed, or simultaneously transfer them to pending disposal and arrange batch disposal at an appropriate time. Furthermore, since at most two assets can be disposed of per month, all three cannot be disposed of immediately in the same month and must be scheduled in batches.

Based on the provided financial data and model parameters for the three assets (window H = 12 months; monthly holding cost depends on state: in use/leased out = 0.1% of original cost; idle = 0.05% of original cost; pending disposal = 0; remaining depreciation months = 2, so depreciation is accrued in the first 2 months and no depreciation in the following 10 months; disposal recovery rate β=0.3), details are shown in Table 4.

Table 4. Basic Parameters for Sorting Line No. 1

Asset	Original cost C	Net residual value	Current net value	Monthly depreciation	Monthly holding cost	Remaining depreciation months
Sorting line No. 1 cigarette carton conveyor system	208,000.00	10,400.00	16,800.00	3,407.66	215.22	2
Sorting line No. 1 empty carton conveyor system	80,000.00	4,000.00	6,500.00	1,242.84	78.50	2
Sorting line No. 1 case conveyor equipment	115,000.00	5,750.00	9,500.00	1,803.31	113.89	2

3.3.1 Calculation of Objective Values for Each Asset under Each Action

Substituting the data into formulas (6)–(16), the state-efficiency scores differ. The results for the sorting line No. 1 cigarette carton conveyor system are shown in Table 5: J_1 range [5040, 9311.32]; J_2 range [0, 4.80]; J_3 range [0, 5040]. The results for the empty carton conveyor system are in Table 6: J_1 range [1950, 3445.68]; J_2 range [0, 5.02]; J_3 range [0, 1950]. The results for the case conveyor equipment are in Table 7: J_1 range [2850, 4986.62]; J_2 range [0, 5.12]; J_3 range [0, 2850].

Table 5. Asset 1 (cigarette carton conveyor system)

Action	J_1	J_2	J_3
Keep current status	9,311.32	4.80	5,040
Transfer to leased out	9,311.32	3.84	5,040
Transfer to idle	8,063.32	1.92	5,040
Transfer to pending disposal	6,815.32	0.48	5,040
Immediate disposal	5,040	0	0

Table 6. Asset 2 (empty carton conveyor system)

Action	J_1	J_2	J_3
Keep current status	3,445.68	5.02	1,950
Transfer to leased out	3,445.68	4.02	1,950
Transfer to idle	2,965.68	2.01	1,950

Table 7. Asset 2 (empty carton conveyor system) (Continued)

Action	J_1	J_2	J_3
Transfer to pending disposal	2,485.68	0.50	1,950
Immediate disposal	1,950	0	0

Table 8. Asset 3 (case conveyor equipment)

Action	J_1	J_2	J_3
Keep current status	4,986.62	5.12	2,850
Transfer to leased out	4,986.62	4.10	2,850
Transfer to idle	4,318.62	2.05	2,850
Transfer to pending disposal	3,650.62	0.51	2,850
Immediate disposal	2,850	0	0

3.3.2 Normalization and Single-Asset Composite Score

Consistent with the single-asset case, this multi-asset experiment adopts the efficiency-oriented weight scheme $omega_1$=0.2, $omega_2$=0.6, $omega_3$=0.2. All objective indicators are standardized via Eq. (10) and Eq. (60)-(71), and the single-asset composite scores of three conveyor devices are calculated separately, as listed in Table 8.

Table 9. Normalized Indicators and Single-asset Composite Scores of Sorting Line Assets

Asset No.	Action	$barJ_1$	$barJ_2$	$barJ_3$	Composite Score S
Asset 1	Keep current status	0.000	1.000	1.000	0.400
Asset 1	Transfer to leased out	0.000	0.800	1.000	0.280
Asset 1	Transfer to idle	0.252	0.400	1.000	0.100
Asset 1	Transfer to pending disposal	0.505	0.100	1.000	-0.079
Asset 1	Immediate disposal	1.000	0.000	0.000	0.200
Asset 2	Keep current	0.000	1.000	1.000	0.400

	status				
Asset 3	Keep current status	0.000	1.000	1.000	0.400

3.3.3 Global Optimal Decision under Disposal Quantity Constraint

According to the enterprise asset management regulation proposed in Section 2.1, the monthly maximum disposal asset quota $Q_{textmax}=2$. Two alternative decision schemes are compared to verify the effectiveness of the proposed integer programming optimization framework:

Scheme 1: Heuristic greedy decision. Screen individual optimal actions of each asset separately, select assets marked for immediate disposal with top scores, and truncate redundant disposal items to meet the monthly quota constraint. Under single-asset optimal rules, the immediate disposal score of three assets is 0.200, 0.196 and 0.203 respectively. The heuristic rule selects Asset 1 and Asset 3 for batch disposal, with total global composite score $sumS=0.403$. This scheme ignores linkage constraints of production line equipment, which will cause shutdown of the sorting line and interrupt daily tobacco packaging operation.

Scheme 2: Proposed integrated integer programming decision. Bring cross-asset linkage constraint into Eq. (3): the three sorting line conveyor assets are bundled as associated equipment, prohibiting separated disposal. Solve the global optimization model, the optimal feasible solution is retaining in-use status for all three assets, global total composite score $sumS=1.200$. Compared with the heuristic greedy scheme, the global score increases by 197.8%, which simultaneously satisfies business linkage constraints, monthly disposal quota constraints and accounting depreciation compliance constraints.

3.3.4 Multi-Asset Decision Conclusion

For coupled functional fixed assets in tobacco production workshops, decentralized single-asset optimal decision will trigger industrial linkage risk and produce suboptimal global solutions. The proposed batch decision integer programming model can embed business domain constraints of tobacco asset operation, balance financial cost, equipment health and disposal risk multidimensional objectives. For the sorting line conveyor assets with nearly expired depreciation cycle, the model suggests continuing daily operation until full depreciation, avoiding unnecessary production halt and excessive disposal loss; if subsequent monthly disposal quota is relaxed, the enterprise can uniformly transfer the whole equipment group to pending-disposal status for centralized batch scrapping.

4. Discussion

4.1 Result Interpretation and Industry Adaptability

From the single-asset perspective, informatization office equipment with long remaining depreciation period gains the highest comprehensive benefit by maintaining in-use status; idle and pending-disposal actions will sharply reduce asset health score, resulting in deteriorated decision indicators, which matches the cost-control and operational efficiency requirements of grassroots tobacco branch companies. From the multi-asset perspective, production linkage assets cannot adopt isolated disposal decisions; the embedded business constraint correction mechanism remedies the defect of traditional mathematical models that only focus on financial indicators while ignoring industrial operation logic.

Compared with classic depreciation and asset decision models, this study has two core improvements: first, it breaks the static straight-line depreciation assumption, maps four practical asset usage states to depreciation rules and operation cost functions, realizing fusion of accounting compliance and state dynamic iteration; second, it unifies financial cost, equipment health and disposal risk into a closed-form multi-objective function, avoiding subjective empirical judgment relied by traditional tobacco asset management.

4.2 Sensitivity Analysis of Objective Weight

To explore model robustness, this study conducts weight perturbation sensitivity analysis based on the single video conference terminal case, retaining all asset inherent parameters unchanged, traversing three enterprise orientation weight groups: cost-oriented ($omega_1$=0.6,$omega_2$=0.2,$omega_3$=0.2), risk-averse ($omega_1$=0.2,$omega_2$=0.2,$omega_3$=0.6), and efficiency-oriented benchmark group. The decision deviation results are shown as follows:

Under cost-oriented configuration, the composite score of keeping current status drops to 0.320, and immediate disposal score rises to 0.345; the model tends to recommend early disposal to cut long-term holding and depreciation expenditure, which fits the operation logic of cost-squeezed grassroots departments. Under risk-averse configuration, pending-disposal action obtains the optimal score, the model prefers locking asset value loss in advance to avoid future market fluctuation risk. The sensitivity test proves that the weight coefficient has clear physical interpretability, and the model output decision is monotonic and stable without abnormal mutation.

5. Conclusion

This study establishes state-transition rules that comply with tobacco business specifications and accounting standards, and constructs coupled dynamic depreciation recursion equations, an asset health evaluation function, and a disposal risk assessment model. The proposed framework can effectively address the diverse scenarios of fixed asset disposal in the tobacco industry, demonstrating strong adaptability. It achieves a dynamic trade-off among economic cost, equipment health, and disposal loss risk, thereby avoiding empirical and subjective management decisions. Furthermore, the integrated decision framework, which combines a batch decision-making module with industry business linkage constraints, effectively eliminates suboptimal solutions generated by isolated single-asset decisions, fitting the characteristics of integrated tobacco production and informatized assets. This provides refined, traceable, and standardized quantitative decision support for the life-cycle management of fixed assets at the provincial and municipal tobacco levels.

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