International Journal for Housing Science and Its Applications
Publish August 4, 2025. Volume 46, Issue 3 Pages 9080-9091

https://doi.org/10.70517/ijhsa463180

Enhancing Real-Time Decision-Making in Corporate Accounting and Costing through Computational Methods in the Digital Era

Wei Su[1,*]
[1] School of Taiyuan Tourism Vocational College, Taiyuan, Shanxi, 030006, China
Corresponding authors: (e-mail: 13613485479@163.com).

Abstract In the context of the digital era, the real-time and accuracy of enterprise accounting costing has become the key to improve the efficiency of decision-making. This paper proposes a comprehensive method system integrating rough set theory and attribute approximation algorithm, aiming at reconstructing the framework of enterprise cost accounting through technological innovation and process optimization. Aiming at the problems of low efficiency and redundant accounts in the existing computerized accounting system, the paper proposes the development of customized accounting software and the strategy of setting up cost items scientifically to optimize the classification and aggregation of direct materials, labor and auxiliary expenses. It also introduces the attribute simplification algorithm of rough set theory, reduces data redundancy through knowledge granularization and dimensionality reduction technology, and combines with the heuristic greedy algorithm to realize dynamic cost tracking and refined management. The empirical part takes Building Construction Enterprise A as a case study, and the relative error of the data mining-based procurement cost accounting system is reduced to 0.175%, which is significantly better than the traditional method (1.135%). Meanwhile, the attribute approximation algorithm is outstanding in memory performance, compared with Genmax, MAFIA and other algorithms, the memory consumption is reduced to 263.59 in a huge scale dataset (700,000 records) with 20% support, which verifies its high efficiency and applicability in complex data scenarios.

Index Terms business accounting, cost accounting, rough set, attribute approximation, greedy algorithm

I. Introduction

In today's competitive business environment, effective cost control is crucial for enterprises to maintain profitability and competitiveness [1], [2]. And cost accounting as the core link of cost management, its efficiency directly affects the decision making, resource allocation and economic benefits of enterprises [3]-[5]. Based on this, how to improve the real-time decision-making ability of cost accounting has become the focus of attention of enterprises [6].

In the digital era, various emerging information technologies have begun to develop rapidly, and the accounting costing work of enterprises has more technical support [7], [8]. In order to better solve the problems of various enterprise accounting management, digital technology should be introduced in accounting cost accounting and control work in a timely manner [9], [10]. As a whole, the cost accounting work of enterprise accounting is mainly aimed at the entire process of economic activity cost occurrence, and in the whole stage process, the economic activities occurring in the enterprise will produce corresponding economic information [11]-[13]. Digital technology can collect the specific information of each economic activity of the enterprise, integrate and conduct professional information analysis [14], [15]. By strengthening the relevant analysis of digital technology, it helps enterprises to better grasp the user information, especially in the supervision of digital technology behavior [16], [17]. In the work to find their own shortcomings, and timely standardization and optimization of their own work behavior, to improve the efficiency of enterprise accounting cost accounting, strengthen the convenience of the enterprise system work, so that accounting cost accounting work more in line with the development needs of the enterprise [18]-[21].

This paper proposes a set of comprehensive methodology system integrating technological innovation and process optimization, aiming at reconstructing the framework of enterprise cost accounting and strengthening the real-time decision-making ability through the application of computational methods. Starting from the practical pain points of enterprise accounting computerized cost accounting, it proposes the specific strategies of developing customized accounting software and setting cost items scientifically to solve the problems of low efficiency and confusing accounts in the existing system. On this basis, the attribute simplification algorithm of rough set theory is introduced to reduce data redundancy and optimize the extraction of decision-making attributes through knowledge granularization and attribute simplification technology, providing mathematical support for the accurate analysis of complex cost data. The development of accounting software provides a technical carrier for enterprise cost accounting, and the maximization of the utility of the software depends on the scientific setting of cost items. Through the reasonable division of direct materials, labor and auxiliary costs and other subjects, the complexity of accounting can be further simplified to ensure that the output data of the software has practical significance. Combined with the activity-based cost accounting application process, the standardized operation chain from parameter setting to data aggregation is constructed, and the heuristic greedy algorithm is proposed to realize the engineering landing of attribute simplification through suboptimal solution approximation to realize the dynamic tracking and fine management of cost accounting.

II. Optimization of enterprise accounting and costing systems based on computational methods and real-time decision support

II. A. Methods of strengthening computerized cost accounting in enterprise accounting

II. A. 1) Development of accounting software

Some enterprises have loopholes in the development of computerized cost accounting work, resulting in low accounting effectiveness, and therefore need to develop accounting software to lay the foundation for the development of cost accounting work. But in the development of new cost accounting software, will inevitably encounter a variety of difficulties, resulting in software development constraints, so it is still necessary for enterprises to strengthen the importance of software development, enterprises can work with UFIDA, Kingdee and other large financial software companies to develop accounting software, according to the enterprise's own characteristics of the design of costing software suitable for the enterprise, for the development of financial management work to provide protection.

II. A. 2) Rationalization of cost items

Because different enterprises produce different products, in the process of carrying out computerized accounting, it is necessary to rationally set up the cost items, so that the direct materials, direct labor and manufacturing costs incurred by each product can be subdivided according to the name of the product. This way to simplify the complexity of the cost of accounts, in the computerized cost accounting more intuitive understanding of the cost of each product. Enterprises in the production process in the production of utilities and maintenance costs and other auxiliary production costs, also requires the setting of auxiliary production cost accounts to ensure the accuracy of cost accounting. Reasonable set of cost accounting accounts can reduce the workload of cost accounting personnel to avoid the phenomenon of subject confusion.

II. B. Rough set based attribute approximation algorithm

Although the optimization of computerized accounting tools significantly improves the data processing efficiency, the challenges of information redundancy and feature extraction still need to be further solved in the face of massive and multi-dimensional cost data. To this end, this section introduces rough set theory to granularize and downsize the knowledge of cost data through attribute approximation algorithms, which lays the foundation for subsequent refinement analysis.

II. B. 1) Knowledge and indistinguishable relationships

In RS theory, "knowledge" is considered to be the ability to classify real or abstract objects. Suppose we have some kind of knowledge about the domain, and use attributes and their values to describe the objects in the domain. For example, the space object set U has two attributes: "color" and "shape", the attribute value of "color" is red, yellow, and green, and the attribute value of "shape" is taken as square, circle, triangle. From the point of view of discrete mathematics, "color" and "shape" constitute a family equivalence relationship on U. The objects in U can be divided into sets such as "red objects", "yellow objects", "green objects" according to the equivalence relationship of "color"; According to the equivalence relationship of "shape", it can be divided into "square objects", "round objects", "triangular objects" and so on. According to the synthetic equivalence relationship of "color and shape", it can be divided into "red round objects", "yellow square objects", "green triangle objects" and so on. If two objects belong to the same set of "red round objects", they have an indistinguishable relationship between them, because the properties that describe them are both "red" and "circle". The notion of indistinguishable relations is the cornerstone of RS theory, which reveals the granular structure of domain knowledge.

II. B. 2) Lower Approximation, Upper Approximation, and Boundary Regions of Rough Sets

Given a finite nonempty set U called an argument domain, R is a family of equivalence relations on U. R divides U into fundamental equivalence classes that do not intersect each other, and the binary pair $K=(U,R)$ forms an approximation space. Let X be a subset of U, x an object in U, and $[x]_R$ denote the set consisting of all objects indistinguishable from x, i.e., the equivalence classes determined by x. A set X is said to be precisely definable when it can be represented as a concatenation consisting of elementary equivalence classes; otherwise, the set X can only be inscribed by approximation. The set X is defined with respect to the lower approximation of R as:

$$R\_(X) = \{x \in U : [x]_R \subseteq X\} \tag{1}$$

$R\_(X)$ is in fact the largest set consisting of those objects which, judged on the basis of prior knowledge, definitely belong to X, also known as the R positive domain of X, denoted as $POS_R(X)$.

The upper approximation of the set X with respect to R is defined as:

$$R^-(X) = \{x \in U : [x]_R \cap X \neq \varnothing\} \tag{2}$$

$R^-(X)$ is the concatenation of all the equivalence classes $[x]_R$ that intersect X in a non-empty way, and is the smallest set of those objects that may belong to X. The set consisting of objects that, judged on the basis of prior knowledge, certainly do not belong to X is called the R-negative domain of X, and is notated as $NEG_R(X) = U - R^-(X)$. The R boundary region of the set X is defined as:

$$BN_R(X) = R^-(X) - R\_(X) \tag{3}$$

$BN_R(X)$ is the difference between the upper and lower approximations of the set X. The set X is said to be clear with respect to R if $BN_R(X)$ is the empty set; conversely the set X is said to be a rough set with respect to R if $BN_R(X)$ is not the empty set. Figure 1 illustrates the concept of rough sets. The concepts of lower approximation, upper approximation and boundary region portray the approximation properties of a set that cannot be defined precisely. The approximation accuracy is defined as

$$d_R(X) = |R\_(X)| / |R^-(X)| \tag{4}$$

where $|X|$ denotes the cardinality or potential of the set X, and for finite sets denotes the number of elements contained in the set. Clearly, $0 \le d_R(X) \le 1$. A set X is said to be clear with respect to R if $d_R(X) = 1$; $d_R(X) < 1$, then the set X is said to be rough with respect to R. $d_R(X)$ can be thought of as approximating the accuracy of the set X under the equivalence relation R.

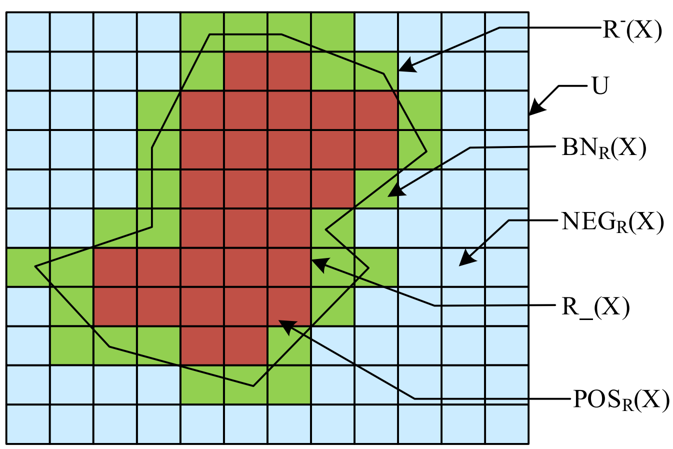

Figure 1: Conceptual illustration of Rough sets

II. B. 3) Knowledge Base, Minimization and Nucleation

A knowledge base is defined as a system of relationships

$$K = (U, R) \tag{5}$$

where U is a non-empty finite set of objects, called an argument domain, and R is a family set of equivalence relations on U.

Let R be a family set of equivalence relations and $R \in \mathrm{R}$, the relation R is said to be omissible among the family sets R if $IND(R) = IND\left(R - \{R\}\right)$, otherwise it is not. A family set R is said to be independent if every relation R in the family set R is irreducible, otherwise it is dependent or non-independent.

If $Q \subseteq P$ is independent and $IND(Q) = IND(P)$, then Q is said to be an approximation of the relational family set P. The set of all irreducible relations in the family set P is called the core of P and is denoted by $CORE(P)$.

In applications, the relation of one classification with respect to another is important, so the concepts of relative approximation of knowledge and relative kernel are introduced, and it is first necessary to define the positive region of one classification with respect to another.

Let P and Q be equivalence relations on the full domain U, the so-called $P-$ positive region of Q, denoted as $POS_P(Q)$, is defined as

$$POS_P(Q) = \underset{X \in U/Q}{Y} \underline{P}X \tag{6}$$

The $P-$ positive region of Q is the set of all those objects of the full domain U that can be correctly categorized among the equivalence classes of U/Q using the knowledge expressed by the categorical U/P.

Let P and Q be the family sets of equivalence relations on the full domain U, $R \in \mathrm{P}$. If

$$POS_{IND(P)}\left(IND(Q)\right) = POS_{IND(P-\{R\})}\left(IND(Q)\right) \tag{7}$$

Then the relation R is said to be $Q-$provable in the family set P, otherwise it is said to be $Q-$non-provable; and if every relation R in the family set P is $Q-$non-provable, then it is said to be independent with respect to Q, otherwise it is said to be dependent.

For simplicity, $POS_P(Q)$ is generally used instead of $POS_{IND(P)}\left(IND(Q)\right)$.

II. B. 4) Attribute Simplicity

Attribute approximation is the essence of RS methods, which removes attributes that are irrelevant for deriving decision attributes and is an essential step in the preprocessing of classification problems. Since the complexity of computing the approximation grows exponentially with the increase of the decision table, it is a typical NP-complete problem, and in practice heuristics are often applied to greedily compute the suboptimal approximation.

II. C.Activity-based costing application process

The attribute approximation algorithm provides theoretical support for the structured processing of cost data, but how to embed it into the actual business process still requires systematic design. Based on this, this section proposes an activity-based cost accounting application process, which realizes the efficient transformation of algorithmic results into practice through standardized parameter setting and dynamic data aggregation.

II. C. 1) Establishment of a cost-accounting base

Initial parameter settings: enable process routing, determine whether there is auxiliary production and the method of allocating auxiliary production costs, whether there are joint by-products, whether to calculate scrap costs, select the costing system as actual and planned costing system, and count production by cost center. Create product and material files: Define attributes such as type of material, whether it is a cost object, how it is valued, whether it is not accounted for on an order basis, and whether it is carried forward on an itemized basis. As well as the next definition of cost centers, definition of process routes, definition of the production bill of materials, etc. In addition, the standard cost can be calculated based on the material's fixed consumption in the bill of materials.

Define Cost Elements: Define various types of cost elements (cost items) and specify the data source and the way to get the data to be assigned to each cost center. Define cost drivers: Default drivers and customized drivers. Definition of cost carry forward method: Define the carry forward method for completed, in-process and scrap costs. Entry of products in process at the beginning of the period: enter the cost of products in process at the beginning of the period according to “Cost Center + Product + Cost Factor”.

II. C. 2) Cost information aggregation

Including material cost summarization: Get the data of raw materials and semi-finished products consumed in the current period from the inventory accounting system and the account system, including direct material cost and indirect material cost. Material Cost Adjustment: Adjust the direct material of one product to another product. Cost and Expense Sheet: In addition to material costs and auxiliary costs, other costs and expenses incurred by the enterprise are usually first grouped by cost centers and then allocated to be charged to cost objects. The data can be entered manually, or you can get the cost and expense from the general ledger, payroll, welfare, reporting, fixed asset system, as well as the consumption of purchased auxiliary services, consumption of self-made auxiliary services, transfer orders of self-made semi-finished products, statistics of completed production, statistics of scrap loss and scrap recovery, statistics of work-in-process, and approximate coefficient entry.

III. Empirical analysis and validation of performance optimization based on rough set algorithms

The rough set attribute-based approximation algorithm and cost accounting system optimization strategy proposed in Chapter 2 lays a methodological foundation for application in real enterprise scenarios. In order to verify its effectiveness and engineering potential, this chapter takes A building construction enterprise as the research object, and verifies the feasibility and superiority of the theoretical methodology from a practical perspective through the analysis of operational data, testing of the accounting system and evaluation of the algorithm performance.

Table 1: Cost and profit sub-division of Company A in 2024

Item		The amount in 2024 (10,000 yuan)			The amount in 2023 (10,000 yuan)		
		Income	Cost	Gross profit margin (%)	Income	Cost	Gross profit margin (%)
Ⅰ: Engineering Contracting	Ⅰ1. Metallurgical engineering and operation services	349,608.40	306,781.30	13.96%	374,348.40	328,393.60	13.99%
	Ⅰ2. Housing construction engineering	1,705,921.40	1,506,158.00	13.26%	2,034,771.00	1,739,293.00	16.99%
	Ⅰ3. Municipal and infrastructure engineering	999,178.40	888,169.60	12.50%	1,028,376.50	837,293.30	22.82%
	Ⅰ4. Other projects	8,720.00	4,650.90	87.49%	3,742.00	2,028.30	84.49%
	Total	3,063,428.20	2,705,759.80	13.22%	3,441,237.90	2,907,008.20	18.38%
Ⅱ: Resource Development	Ⅱ1. Polysilicon processing	0	0	0	0	0	0
	Ⅱ2. Mineral resource development	1,506,651.30	1,318,283.00	14.29%	1,728,910.30	1,527,360.50	13.20%
	Total	1,506,651.30	1,318,283.00	14.29%	1,728,910.30	1,527,360.50	13.20%
Ⅲ: Specialized Businesses	Ⅲ1. Core equipment and steel structure	457,927.90	428,378.00	6.89%	483,762.00	456,208.90	6.04%
	Ⅲ2. Ecological environmental protection and operation	0	0	0	0	0	0
	Ⅲ3. Engineering consulting and technical services	48,148.50	28,739.20	67.54%	62,830.90	47,289.00	32.87%
	Total	506,076.40	457,117.20	10.71%	546,592.90	503,497.90	8.56%
IV: Comprehensive Real Estate	IV1. Commercial real estate	0	0	0	0	0	0
	IV2. Residence	0	0	0	0	0	0
	IV3. Affordable housing	0	0	0	0	0	0
	IV4. Property operation	0	0	0	0	0	0
	IV5. Others	0	0	0	0	0	0
	Total	0	0	0	0	0	0
TOTAL		5,076,155.90	4,481,160.00	13.28%	5,716,741.10	4,937,866.60	15.78%

Table 2: A Company's 2024 and 2023 Cost Operating Division

	The amount in 2024 (10,000 yuan)					The amount in 2023 (10,000 yuan)				
	I1	I2	I3	I4	Total	I1	I2	I3	I4	Total
Income	349,608.40	1,705,921.40	999,178.40	8720.00	3,063,428.20	374,348.40	2,034,771.00	1,028,376.50	3,742.00	3,441,237.90
Income from external transactions	349,608.40	1,705,921.40	999,178.40	8,720.00	3,063,428.20	374,348.40	2,034,771.00	1,028,376.50	3,742.00	3,441,237.90
Main operating income	349,608.40	1,705,921.40	999,178.40	0	3,054,708.20	374,348.40	2,034,771.00	1,028,376.50	0	3,437,495.90
Other business income	0	0	0	8,720.00	8,720.00	0	0	0	3,742.00	3,742.00
Revenue from inter-segment transactions	0	0	0	0	0	0	0	0	0	0
Cost	306,781.30	1,506,158.00	888,169.69	4,650.90	2,705,759.80	328,393.60	1,739,293.00	837,293.30	2,028.30	2,907,008.20
External transaction costs	306,781.30	1,506,158.00	888,169.69	4650.90	2,705,759.80	328,393.60	1,739,293.00	837,293.30	2,028.30	2,907,008.20
Main business operation cost	306,781.30	1,506,158.00	888,169.69	0	2,701,108.90	328,393.60	1,739,293.00	837,293.30	0	2,904,979.90
Other business costs	0	0	0	4,650.90	4,650.90	0	0	0	2,028.30	2,028.30
Transaction costs between segments	0	0	0	0	0	0	0	0	0	0
Taxes and surcharges	1,461.36	7,130.75	4,176.57	36.45	12,805.13	1,564.78	8,505.34	4,298.61	15.64	14,384.37
Sales expenses	1,128.00	9,029.00	0	0	10,157.00	1,003.30	8,874.40	0	0	9,877.70
Research and development expenses	22,393.70	93,872.00	19,244.00	2,302.30	137,812.00	20,372.70	62,394.90	100,282.00	3,642.70	186,692.30
Administrative expenses	30,384.10	107,293.00	537.00	207.80	138,421.90	28,390.00	100,384.30	603.6	183.9	129,561.80
Financial expenses	2,182.00	21,983.50	0	78.30	24,243.80	2,030.80	21,038.00	0	60.4	23,129.20
Cost management expense	51,796.80	192,691.60	100,885.60	3,887.00	349,261.00	56,087.80	232,177.50	19,781.00	2,588.40	310,634.70

Table 3: Company A 2024 and 2023 Cost Income Settlement Statistics

			2024				2023			
		The number of ongoing projects in 2024	Income	Cost	Gross profit margin (%)	Profit	Income	Cost	Gross profit margin (%)	Profit
Total		317	5,076,155.90	4,481,160.00	13.28%	594,995.90	5,716,741.10	4,937,866.60	15.78%	778,874.50
Ⅰ Total of Internal Projects/Contracts		129	1,673,642.80	1,228,323.30	36.25%	445,319.50	1,836,453.00	1,327,593.50	38.33%	508,859.50
(1) Revenue recognized on a timely basis		92	662,838.40	584,394.20	13.42%	78,444.20	745,693.00	590,586.30	26.26%	155,106.70
(2) Income by time period		37	1,010,804.40	643,929.10	56.97%	366,875.30	1,090,760.00	737,007.20	48.00%	353,752.80
Ⅱ Total of External Projects/Contracts		188	3,402,513.10	3,252,836.70	4.60%	149,676.40	3,880,288.10	3,610,273.10	7.48%	270,015.00
(1) Revenue recognized on a timely basis	1. Survey, design, consultation and other projects/contracts	20	178,239.40	168,355.60	5.87%	9,883.80	452,445.40	405,569.60	11.56%	46,875.80
	2. Equipment supply and other projects/contracts	26	263,485.60	223,405.90	17.94%	40,079.70	174,598.20	105,453.30	65.57%	69,144.90
	3. Real estate sales contract	37	84,536.50	64,459.80	31.15%	20,076.70	106,238.90	72,385.40	46.77%	33,853.50
	4. Other projects/contracts that recognize revenue on a timely basis	29	136,576.90	128,172.90	6.56%	8,404.00	12,410.50	7,178.00	72.90%	5,232.50
(2) Income by time period	1. Engineering construction projects	27	458,394.40	324,459.60	41.28%	133,934.80	429,459.40	375,495.10	14.37%	53,964.30
	Completed and concluded projects	19	273,388.20	203,343.40	34.45%	70,044.80	183,449.40	162,345.20	13.00%	21,104.20
	(2) Completed but unfinished projects	6	108,496.20	74,348.20	45.93%	34,148.00	202,493.70	188,349.70	7.51%	14,144.00
	(3) Unfinished projects	2	76,510.00	46,768.00	63.59%	29,742.00	43,516.30	24,800.20	75.47%	18,716.10
	2. Surveying, design, consultation and other projects	7	458,394.40	324,459.60	41.28%	133,934.80	429,459.40	375,495.10	14.37%	53,964.30
	(1) Completed and concluded projects	5	118,239.80	78,440.30	50.74%	39,799.50	294,459.50	193,456.30	52.21%	101,003.20

	(2) Completed but unfinished projects	1	143,495.60	70,049.30	104.85%	73,446.30	183,493.50	104,495.40	75.60%	78,998.10
	(3) Unfinished projects	1	121,599.40	53,967.10	125.32%	67,632.30	26,899.50	18,996.70	41.60%	7,902.80
	3. Large-scale equipment and steel component supply projects	2	76,556.70	49,550.80	54.50%	27,005.90	53,486.70	28,349.20	88.67%	25,137.50
	4. Other non-engineering projects confirmed by time periods	1	92,518.50	67,462.00	37.14%	25,056.50	102,961.40	16,214.50	535.00%	86,746.90

III. A. Company A's business situation

A building construction enterprise, founded in September 1988. There are 663 employees and 385 professional and technical personnel of all kinds, and it is one of the top 100 units of comprehensive strength of national survey and design, the advanced unit of national engineering survey, and the unit of national surveying and mapping quality commendation.

III. A. 1) Cost profit sub-segment

Building Construction Company A can be categorized by business segments as Metallurgical Engineering and Operations Services, Building Construction, Municipal and Infrastructure Engineering, Specialty Business, and Other Engineering. Table 1 shows the cost and profit sub-segments of Company A in 2024.

As can be seen from the table, the revenue for the year 2024 decreased compared to the revenue for the year 2023, with the revenue decreasing by 9.25%, which is mainly due to the external factors of the general environment and the lack of internal cost accounting system. In the general contracting of construction, the largest proportion of revenue from building construction is 33.61%, for this part of the cost accounting system, Company A has not started to establish.

III. A. 2) Cost operating segments

This table shows the cost operating segments of Company A's period expenses explicitly to specific subsections, because only mineral resources have projects in the resource development segment, and only core equipment and steel structure projects in the specialty business segment, therefore, analyzing on the engineering contracting subsegment, the development of various types of costs and expenses are reflected in accordance with the proportion of the business of each subsegment.Company A's cost operating segments for the years 2024 and 2023 are shown in Table 2.

As can be seen from the table, the revenue of the engineering contracting segment decreased in FY2023 compared to FY2022, with a drop of 10.98%, mainly due to external environmental factors and internal cost management expenses accounted for a higher percentage of the result. The cost management expenses of the engineering contracting segment rose 12.43% compared with the year 2022, which shows that Company A needs to reduce this part of the expenses, and after analyzing the reasons for the expenses, it is proposed to build a cost accounting system of the financial sharing center, which can be used to reduce the management expenses of the cost accounting of the project.

III. A. 3) Cost-income settlement statistics

Company A's cost and revenue settlement statistics for the years 2024 and 2023 are shown in Table 3. This statement will be the total profit according to the actual occupancy of the business will be the headquarters of the management costs and other reasonable share of the income statement of the provision of the impairment is reduced to specific items, can be visualized to reflect the proportion of cost and profit of the project cost of income recognized in accordance with the time period.

As can be seen from the table, the profit margin of the projects with revenues recognized on time in FY2024 compared to FY2023 decreased, with the profit margin decreasing by 12.84%. In addition to the external environment, the lack of internal accounting system also focuses on the inaccurate costing of the projects under construction, which in turn affects the profitability of the enterprise.

III. B. Cost-accounting system testing

Through an in-depth analysis of Company A's cost and profit structure and operating segments, it is found that its cost accounting system has problems such as redundancy and excessive overhead. To solve these problems, an efficient cost accounting system needs to be constructed. In this section, based on the method proposed in the previous section, we design and test the procurement cost accounting system to verify its practical application.

III. B. 1) Test preparation

Build a procurement cost accounting system according to the proposed design process. Select 6 groups of building facilities equipment of Company A, B, C, D, E and F. Obtain the procurement cost of 6 groups of full building facilities in order of 321.32 million yuan, 283.48 million yuan, 284.36 million yuan, 638.09 million yuan, 172.83 million yuan and 464.81 million yuan. Utilizing the proposed cost accounting system, the six groups of procurement costs are accounted for, the accounting results are obtained and compared with the actual costs, and the designed system is verified to be feasible through the deviation of the procurement cost accounting results.

III. B. 2) Test design

In order to make the results of the system test have a certain degree of comparability, the proposed charging and switching facilities procurement cost accounting system based on data mining technology is set as an experimental group, and the use of the traditional cost accounting system is set as a control group, in order to compare the form of experiments, to determine whether the proposed cost accounting system is feasible or not.

The two costing systems are used to account for all aspects of the procurement costs of six groups of building facilities, and the MATLAB simulation and analysis software is used to simulate the whole process of the two systems. The results of the system procurement costing are compared with the actual facility procurement costs. Calculate the relative error Q of the system procurement cost accounting, the formula is

$$Q = \frac{R - R_A}{R} \times 100\% \tag{8}$$

Where: R is the actual procurement cost of building facilities; RA is the result of the system procurement costing.

III. B. 3) Test results

The results of the comparison of the relative errors in the system's procurement costing are shown in Figure 2.

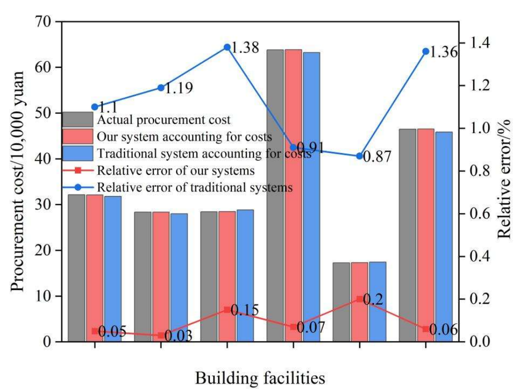

Figure 2: Comparison results of relative errors in system procurement cost accounting

As seen in Figure 2, the two procurement costing systems show different performance results. After the application of the proposed cost accounting system, the relative error of the procurement cost accounting of 6 groups of charging and switching facilities is significantly smaller than that of the traditional method, with the maximum relative error not exceeding 0.2%, while the average relative error of the traditional cost accounting method is 1.135% (0.175% for this paper's method), and the proposed procurement costing system has a higher feasibility, and the deviation of the costing results from the actual results is small, and the system operation has significant advantages. The effect of the advantages of the system is significant.

III. C. In-memory performance evaluation of rough set-based attribute approximation algorithm

The test results of the cost accounting system show that the accounting method based on data mining significantly reduces the error. In order to further improve the operational efficiency of the system, the memory performance of the algorithm needs to be optimized. In this section, the memory consumption of the attribute approximation algorithm is analyzed in a multi-dimensional comparison with the rough set theory to verify its applicability in complex datasets.

In order to evaluate the performance of rough set-based attribute approximation algorithms, this paper compares and analyzes them with the existing better-known maximal frequent itemset mining algorithms, such as Genmax, MAFIA, MFIM-P, and FPmax. all the experiments are run on PCs with a CPU of P4-3GHz and 1GB of RAM, and all the algorithms are run for ten times, and the performance of the mining algorithms is expressed by calculating their average memory consumption to express the performance of the mining algorithms.

III. C. 1) Data sets

In this paper, three real datasets are selected, namely, Company A's product production tracking dataset for the year 2024, Congressional Coting Records sparse dataset and Adult Dataset dense dataset in the standard database of UC Irvine Learning Dataset Repository. For the standard dataset there are some missing data and thus an interferential approach is required to deal with these missing data before mining algorithms are performed, e.g., universal or random values are used to fill in the missing attribute values, respectively. In addition, corresponding discretization methods are also implemented.

The Congressional Coting Records dataset has a total of 502 records and the Adult Dataset data record count is 52843. The Product Production Tracking Dataset is provided by the enterprise and records the tracking data when producing the product, including the operation process, operation time, processing weight, etc. Here, this paper only mines and applies the data of all the operation processes (i.e., the actual production process route) experienced in the production of products. Since the size of the selected data has reached more than 700,000 records, it belongs to the category of large-scale datasets.

III. C. 2) Analysis of evaluation results

The memory performance analysis of the five algorithms running on three datasets is shown in Table 4. It can be summarized that the attribute approximation algorithms proposed in this paper have less memory usage requirements than other mining algorithms, both in small and sparse datasets, as well as in huge and dense datasets.

Table 4: The memory consumption of different algorithms in different datasets

Minimum support degree		1%	5%	10%	15%	20%
Congressional Coting Records	Genmax	2.78	2.56	2.33	2.16	2.03
	MAFIA	2.50	2.26	1.98	1.74	1.52
	MFIM-P	3.61	3.32	3.08	2.90	2.74
	FPmax	3.45	3.21	1.99	2.76	2.50
	Ours	1.94	1.73	1.48	1.19	0.91
Adult Dataset	Genmax	52.31	50.04	47.32	44.09	42.38
	MAFIA	53.42	51.23	49.39	48.02	47.08
	MFIM-P	43.28	40.73	39.29	37.66	36.92
	FPmax	31.20	28.39	25.70	22.51	19.35
	Ours	23.10	20.83	17.39	26.57	14.29
Product production tracking dataset	Genmax	900.45	850.84	775.39	720.58	687.43
	MAFIA	928.39	862.10	804.28	756.32	702.44
	MFIM-P	750.31	679.92	593.48	529.23	488.30
	FPmax	695.34	629.40	573.29	510.24	453.49
	Ours	604.47	517.39	448.26	316.30	263.59

Table 4 compares the memory consumption performance of Genmax, MAFIA, MFIM-P, FPmax and the rough set-based attribute approximation algorithm proposed in this paper for the three datasets. The results show that the algorithm in this paper significantly outperforms the other methods in terms of memory efficiency. For the sparse dataset Congressional Coting Records (502 records), the memory consumption of this paper's algorithm is consistently the lowest (1.94 to 0.91) for the minimum support ranging from 1% to 20%, while the highest memory consumption of Genmax and MAFIA are 2.78 and 2.50, respectively.MAFIA outperforms the memory performance of the Genmax, MFIM-P and FPmax.This is because in small sparse datasets, fewer candidate maximal frequent itemsets and maximal frequent itemsets will be generated, so it will not occupy too much memory resources. But MAFIA still needs some memory resources to store the bit vectors, while Genmax needs to store the difference sets.FPmax also needs extra memory resources to store the arrays during the construction of FP trees. In contrast, the rough set based attribute approximation algorithm proposed in this paper performs knowledge granularization and dimensionality reduction of cost data through attribute approximation algorithm, thus saving the memory consumption and thus improving the storage efficiency.

In the dense dataset Adult Dataset (52,843 records), the memory consumption of this paper's algorithm is 23.10 at 1% support, which is much lower than that of FPmax's 31.20 and Genmax's 52.31; and its memory consumption is further reduced to 14.29 when the support level rises to 20%, which exhibits excellent adaptability. For a large-scale production tracking dataset (more than 700,000 records), the memory consumption of this paper's algorithm at 1% support is 604.47, which is significantly lower than that of Genmax's 900.45 and MAFIA's 928.39. As the support threshold is lowered, other algorithms increase their memory consumption significantly, while this paper's algorithm effectively suppresses the redundancy of data through attribute approximation and the increase in memory demand is is flat (e.g., the memory consumption is only 263.59 at 20% support). In dense and large-scale datasets, MFIM-P and Genmax must store a large number of candidate maximal frequent itemsets and intermediate over-sets, and thus take up much memory resources.MFIM-P needs to construct and store pruned trees, and FPmax needs to store arrays and mutated trees (i.e., MFI trees). However, the use of attribute approximation algorithm is more efficient and compact, saving memory consumption. As the minimum support threshold gets lower, the number of frequent sets of items does not produce a significant change, and therefore the size of the directed itemset graph based on the rough set-based storage structure does not produce a significant change.

IV. Conclusion

In this study, an optimization system for enterprise accounting cost accounting is constructed by integrating rough set theory and computational methods, which significantly improves the real-time decision-making ability and data processing efficiency. The rough set-based attribute approximation algorithm effectively reduces data redundancy, and the combination of heuristic greedy algorithm realizes dynamic cost tracking, which solves the pain points of low efficiency and confusing subjects in traditional accounting systems. In the case of Company A, the purchasing cost accounting system developed controls the relative error within 0.2% (1.135% in the traditional method), which verifies the accuracy of the method; the attribute approximation algorithm excels in memory performance, with a memory consumption of only 263.59 in 700,000 pieces of production data (a reduction of 63% compared with Genmax), which is suitable for large-scale complex datasets.

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