Journal of Economics and Management Sciences; Vol. 8, No. 3; 2025
ISSN 2576-3008 E-ISSN 2576-3016
https://doi.org/10.30560/jems.v8n3p134

Exploration of Financial Management Innovation of Chemical Enterprises Under the Perspective of New Quality Productivity

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Received: June 16, 2025; Accepted: June 26, 2025; Published: June 27, 2025

Abstract

The emergence of global industrial transformation brings about a new quality productivity that is driven by digitalization, greening and high-end production; and thus its role is to change the logic of value creation in the chemical industry. Due to the asset-heavy, high-energy-consuming, and long-cycle characteristics of chemical enterprises, their financial management has structural issues. For example, when it comes to the lack of flexibility of cost control, the absence of environmentally-friendly cost accounting; or lack of timeliness in risk response. A typical chemical enterprise financial management does not have the capacity to respond efficiently to the constantly shifting market landscapes and carbon emissions costs; and, the operational capacity to support enterprises and achieve agile decisions. Today, some of the leading chemical enterprises are starting to try out themes such as smart financial center and carbon asset accounting models. However, the chemical industry too faces systemic issues of data loneliness and incoherent technological applications. The breakthrough at the center of this financial change, instigated by new productivity, is to break free from the limitations of traditional “accounting” and build an ecosystem that has the ability to create value. This could lead to the decisive pursuit of enterprises' existence and development in the low-carbon economy.

Keywords: new quality productivity, chemical enterprises, financial management

1. Introduction

As a key component of the national industry chain, the financial transformation in the chemical industry is closely linked to industrial chain security and sustainable development capability. Unlike a technical concept, the new quality of productivity denotes data elements reconfiguration of the production function, forcing financial management to shift from a “back-end record” function to “front-end empowerment” of resources and decisions. The capital intensive and unique characteristics of the chemical industry renders equipment depreciation accounting, environmental liability assessments and supply chain capital efficiencies as strategic financial innovation targets. Current research focusses at a single point level of the application of technology and does not account for the new productivity quality requirements of the financial system to synchronise the enaction of the three leaps: from static reporting to real-time informed decision making, from cost focus to value focus to value generation, and from compliance function to strategic partner. Speculating on how innovation can unlock the potential for molecular cost control and convert carbon emissions constraints into competitive advantage is a research question worthy of more serious investigation [1]. This paper attempts to cognise a dual-wheel drive framework of technology enablement and management design given the practical pain points of the chemical industry.

2. Theoretical Basis of New Quality Productivity and Financial Management of Chemical Enterprises

2.1 Connotation and Characteristics of New Quality Productivity

The new quality productivity differs from the traditional mode of development dependent on scaling up, as it fundamentally rests on the quality jump of production factors and the reorganization of the mode of combinations of production factors. Chemical production process has long been an energy consumption and now labor input is being coupled with data components, sensors recording real-time reactor temperature and pressure parameters, algorithmic models for dynamically optimizing catalyst ratio- and importantly having the possibility of molecular level cost control achieved. The new quality productivity has a consistent self-adaptive character in the operation of the plant, where the production route can now switch automatically given a fluctuating crude oil price environment, and generate the optimal scheduling program, all while constrained by the carbon emission limits.

The essence of new quality productivity is the deep coupling of material flow, energy flow and data flow, to advance the operation of the plant from an experience-based approach to a precision execution based on model prediction. The invisible conductor orchestrates the entire chain from the procurement of raw materials to the marketing and distribution of products across the Industrial Internet, thereby firmly planting flexibility manufacturing and zero inventory management in energy, material and capital-intensive industries. The flow trajectory of carbon in the value chain has been accurately measured, and environmental costs have been truly integrated into the profit and loss accounting system of chemical enterprises for the first time [2].

2.2 Characteristics and Requirements of Financial Management of Chemical Enterprises

The lofty construction cost of any chemical plants impacts that financial stewardship must incorporate a depreciation cycle of greater than 20 years, and the wear and tear of pipelines and valves directly correlates to how well the asset impairment charges are applied. The intake of raw materials and energy for the production use sits at the middle of the cost structure, and the rolling fluctuation of steam as a user has an effect on power costing, and the degradation of activity of the catalyst shifts decisions related to the cost driver basis per unit of product. There are always unique pressures on capital flow. Certains aspects, like bulk purchase raw material supplies, require cash upfront even if the vendor extends terms; conversely, the downstream customer would bill out every few weeks or months and their intermediaries can use the monthly credit or cycle quarterly, meaning finance has to balance having adequate safety stock vs. cash flow security. Realistic environmental compliance accounting has additional elements to consider. Accounting provisions for seal testing costs of storage tanks for the storage tank farm, for purchase of chemicals to treat distressed wastewater, and liabilities to account for surpluses and deficits of carbon quotas all require accounting entries that break with traditional barriers. How costs are apportioned to fixed costs when a plant is halted or overhauled, and the basis used for the accrual ratio for the accident contingency reserve, really challenge the finance groups ability to understand the nature of production fluctuations. The residual value estimation of equipment disposal relies more on the engineer's judgment of the corrosion degree of the reactor than on financial guidelines [3].

3. The Main Problems of Chemical Enterprises' Financial Management Under the New Quality Productivity

3.1 Limitations of Traditional Financial Management Model

The traditional model of relying on a fixed periodic settlement mechanism cannot be adapted to the continuous production of chemical plants, and the monthly cost sharing hides the single-day cost variations caused by sudden changes in catalyst activity. Historical costing principles make it difficult to quantify the performance degradation caused by reactor tower corrosion, and the residual value assessment of equipment deviates from the actual end-of-life disposal scenarios. Energy cost variations due to steam pressure fluctuations are homogenized in the standard cost method and lose their significance for time-of-use tariff strategy. Investments in environmental protection technology improvement are presented as expensed expenses in the financial statements, failing to correlate with the asset attributes of subsequent carbon quota earnings. The provision for accident contingency funds is based on a static probability model, and the reserve coverage ratio continues to be distorted in the face of the risk of interlocking plant shutdowns. The recognition of financial liabilities arising from carbon quota trading lags behind market price fluctuations, and the hedging decision lacks real-time data support [4].

3.2 Obstacles in Technological Innovation and Application

The data acquisition process faces the dilemma of incompatible industrial protocols. The steam flow data recorded by the DCS system cannot be directly connected to the financial analysis module, and there is a time lag between the analysis of temperature sensor signals and the cost accounting system. Model development is limited by the complexity of the physicochemical mechanism, the machine learning modeling of catalyst activity decay curve requires the participation of process experts, and the dynamic optimization algorithm is difficult to match the real-time adjustment of raw material ratios. Technology integration encounters invisible barriers in the organizational structure. When blockchain is applied to supply chain finance, the purchasing department is worried that the transparency of the process will weaken the bargaining power, and the carbon footprint tracking system encounters the resistance of operators to enter data in the tank storage and transportation process. Smart contract execution relies on multi-party collaboration and consensus, while there is a generational gap between suppliers' settlement habits and digital payment, and it is difficult to penetrate the carbon assets generated by energy efficiency improvement of reactors to specific production lines.

3.3 Challenges of Talent Training and Organizational Change

The sensitivity of financial staff to reaction kinetics parameters is generally insufficient to translate distillation column temperature fluctuations into time-phased cost variance reports, and there is a time lag between process adjustment instructions and cost control needs. The production department instinctively guards the sovereignty of operation data, the degree of real-time energy consumption information open to the financial system is restricted by the workshop performance appraisal tradition, and the carbon footprint tracking requires cross-job collaboration but lacks of incentives and compatibility mechanisms. The decision-making chain is difficult to adapt to the pace of dynamic optimization. When the crude oil price triggers the process switching threshold, the fund dispatch authority still remains at the senior management level, and the agile purchasing strategy is limited by the solidified approval process of accounts payable. The traditional accounting training course does not cover catalyst life prediction model validation methodology, the job description of cost accountant lacks data cleansing and feature engineering requirements, and the mode of relying on external consulting organizations to assess environmental liabilities weakens the ability to make independent judgments [5].

3.4 Deficiencies in Policy Environment and Industry Standards

Current accounting standards have an inherent lag in the context of continuous production circumstances, changes in carbon emission intensities associated with a twenty-four-hour operation of chemical plants cannot match the monthly accounting cycle, and there is a mismatch in time scales between carbon quota measurement rules and the frequency at which processes switch. Our regulatory framework is inherently fragmented, the granularity of wastewater treatment data that the environmental protection department needs doesn't work at the standard of tax credit vouchers, and cross-departmental reporting takes up unnecessary resources. The technical certification system for industry hasn't yet encompassed the elemental aspects of smart finance, the legalities of blockchain deposits are indistinct and places limitations on the degree of supply chain finance applications, and there is no identification of process data ownership which makes patenting the cost optimization algorithms for protection a chore. There are no special guidelines for the investment of funds raised by green bonds for catalyst renewal, the methodology of carbon sink projects doesn't recognize the emission reduction contribution of waste heat recovery in chemical plants, and measurement standards are missing to support the value-added carbon assets by the dynamic optimization algorithms [6].

4. Paths for Promoting Financial Management Innovation in Chemical Enterprises by New Quality Productivity

4.1 Digital Financial Transformation Paths

The heart of digital financial transformation is to open channels of data flow between the production site with the financial system. Industrial IoT sensors measure real-time reactor temperature and pressure parameters, and the continuous-flow data are cleaned and converted by edge computing nodes to automatically generate energy cost fluctuation maps for the sub-period. The accounts must be re-imagined for the new accounting dimensions; we have assumed digital twin amortization accounts to be integrated into their asset classes, cost center separation is accurate with each distillation tower individualistic unit, and the activity coefficient of the catalyst is a weighting factor for variable cost allocation. Blockchain technology provides the foundational support for supply chain finance. The whole process, starting from the crude oil procurement letter of credit to product distribution reimbursement is imbued with smart contracts, and quality inspection certs inscribe the programming of conditions for automatic discharge of payment to seriously shrink the capital turnover cycle. Dynamic optimization is also consistently in the process of modifying the harmonious tempo between production and finance [7]. When real-time steam flow is monitored to increase abnormally, the system synchronously generates dual outputs of process adjustment suggestions and cost warning, and the equipment predictive maintenance work order is directly related to the analysis of the capital consumption of spare parts inventory. The carbon tracking module transforms the reaction process at the molecular level into a visualized carbon debt curve, so that the quota balance brought about by the improvement of desulfurization efficiency is instantly reflected in the environmental profit and loss statement.

4.2 Construction of Intelligent Financial Management System

The core capability of the intelligent system is reflected in the accuracy of financial mapping of production fluctuations. The machine learning model continuously digests distillation tower temperature time series data and automatically identifies the rising trend of steam unit consumption due to heat exchanger fouling, and this anomaly immediately triggers the reallocation instruction from the cost center. The traditional budgeting method is replaced by a dynamic rolling model, crude oil futures price fluctuations are transmitted to the decision tree of raw material selection for the cracking unit, and real-time updated cash flow forecasts synchronize the rhythm of tank procurement. The equipment health management system is deeply integrated with the financial module. The abnormal vibration spectrum of centrifuge bearings is automatically associated with the reservation of funds for spare parts procurement, and the predictive maintenance work order directly generates a split plan between capitalization and expensing. The carbon asset value discovery mechanism runs through the whole production process, the quota surplus generated by the efficiency improvement of the desulfurization tower is instantly converted into virtual power plant revenue, and the environmental profit and loss statement synchronously displays the incremental amount of carbon liabilities when the reaction pressure parameter deviates from the optimal range. The risk warning model integrates the two dimensions of process safety and financial safety. When the catalyst activity decay is monitored to cross the critical point, the system outputs the process adjustment plan and the bad debt reserve proposal in parallel, and the inventory turnover algorithm automatically optimizes the insurance coverage parameters of the hazardous chemical storage [8].

4.3 Direction of Green Financial Management Innovation

Green financial innovation involves rebuilding the micro-foundation of environmental costing. The estimation of carbon liability for VOCs emissions escaping from the breathing valves of its storage tank is grounded in technology using a laser to detect VOCs. The power consumed and measured in the wastewater treatment unit is "dismantled" to capture the cost to the environment per ton of product, and new asset categories result from tracking new debt instrument financing via traditional accounting entries. When the heat recovery rate of the waste heat boiler output is greater than the design heat recovery, that is the value of the carbon asset; the emission reduction due to improved adsorption efficiency of the molecular sieve enters that item in the right-hand equity section of the balance sheet. The process optimization decision needs to consider the financial dimensions and environmental dimensions of the process. When the pressure parameters of the hydrogenation plant are outside the optimal range for the process, the system will calculate the simultaneous loss of incremental feedstock and penalty cost of carbon quota, and the catalyst regeneration frequency amendment decision is matched automatically to the own funds set aside for the costs of ultimately disposing of the cesium-laden hazardous waste. Carbon financial tools are deeply embedded in supply chain management, green letter of credit based on real-time data of desulfurization efficiency shortens suppliers' payback cycle, and product carbon footprint labeling becomes a weighting factor in customers' pricing model, changing the logic of accounts receivable turnover. The environmental risk reserve provisioning model has shifted to a dynamic model. Typhoon path prediction triggers the estimation of tank protection costs, and the discount rate of environmental remediation liabilities generated by accident scenario simulation automatically floats with the ecological sensitivity. The full life cycle evaluation of plants guides investment decisions. The project evaluation of new crackers must include the simulation of carbon price scenarios for the next 20 years, and the residual value calculation of scrapped reactors incorporates soil remediation cost hedging programs. Renewable energy quota trading derives a new type of capital scheduling strategy, the change curve of electrolyzer load and the fluctuation of green certificate price form an arbitrage algorithm, and the steam network pressure parameter becomes an operational variable to regulate the return of virtual power plant [9].

4.4 Development Strategies for Deep Integration of Industry and Finance

The data center architecture must encapsulate the deeply intertwined relationships of production process and financial rules, with the reactor temperature and pressure time series data flow mapped to the variable cost fluctuation line in real time, and the reflux ratio parameter of the distillation tower directly triggering the warning on the fund utilization of raw materials' inventory. A decision-making mechanism reengineering will break down the data wall among departments. The process switching scheme generating the negotiation strategy of the accounts payable rollover almost synchronously when the crude oil spot price breaches the economic threshold of the cracking unit, and the instruction to change the catalyst loading amount occurs within a cash flow simulation of the purchasing prepayment amount. Behavioral changes at the operations level require the accurate transfer of incentive signals. An operator's behavior of reducing steam usage becomes the basis for accounting an instant bonus through a smart contract, and the records of an operator's behavior of reducing the amount of discharge from the breathing valve in the tank area is an allocation weight for environmental cost savings. Process re-engineering is representative of the entire value-creation chain. Product quality online inspection data is directly connected to the customer credit management system, chromatographic analysis compliance rate exceeding contractual agreements automatically releases installment payments, and equipment predictive maintenance work orders are associated with the discount rate of bills payable of spare parts suppliers. The knowledge management system connects technical language and financial terminology, the parameter variables of reaction kinetics equations are translated into the dimension labels of the cost driver library, and the operation interface for process engineers to adjust formulas is embedded in the real-time calculation module of marginal contribution rate. The risk control system realizes cross-domain linkage, the alarm level of the safety instrumentation system corresponds to the percentage of provision for bad debt, the typhoon path prediction model outputs the hedging scheme under the scenario of logistics disruption, and the abnormal fluctuation of pH value of wastewater treatment triggers the recalculation of premium for environmental liability insurance [10].

5. Conclusion

The reshaping of chemical financial management by the new quality productivity has gone beyond the tool level, which touches on the reconstruction of the logic of value creation. When the digital twin technology simulates the real-time carbon footprint of the production line, and when the blockchain automatically executes the settlement of green letters of credit, the finance department essentially becomes the nerve center of sustainable competitiveness of the enterprise. The deep-seated resistance to this change lies in organizational inertia - finance staff are used to compliance operations, and managers are addicted to historical cost advantages. The breakthrough requires a double awakening: at the technical level, the data arteries of ERP and MES systems need to be opened, and micro-parameters such as catalyst consumption and steam energy consumption need to be incorporated into the dynamic cost model; and at the institutional level, a carbon balance sheet needs to be established, so that the environmental costs can be visualized and quantified. The decisive point of chemical finance in the future lies in the ability to transform the temperature curve of the reactor into an optimized path of capital flow. When every cost center is equipped with an algorithmic engine, financial management can truly become a beacon of value creation.

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