

Retraction

Retracted: Application of Computer Simulation Optimization Algorithm in Waste Treatment of Drilling Engineering

Complexity

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

- (1) Discrepancies in scope
- (2) Discrepancies in the description of the research reported
- (3) Discrepancies between the availability of data and the research described
- (4) Inappropriate citations
- (5) Incoherent, meaningless and/or irrelevant content included in the article
- (6) Manipulated or compromised peer review

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

References

- [1] C. Shu and J. Zhang, "Application of Computer Simulation Optimization Algorithm in Waste Treatment of Drilling Engineering," *Complexity*, vol. 2021, Article ID 9927438, 10 pages, 2021.

Research Article

Application of Computer Simulation Optimization Algorithm in Waste Treatment of Drilling Engineering

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The existing computer technology is used to conduct an in-depth study and analysis of drilling waste treatment, and the results are analyzed by computer simulation optimization algorithms. Based on the system theory, we define the research system, combine the unique characteristics of the technological innovation mechanism of drilling waste treatment, and use the internal and external factors affecting the technological innovation dynamics of drilling waste treatment, such as drilling waste treatment capacity, from the current actual situation. On this basis, factor analysis is used to analyze the factors affecting technological innovation dynamics from both internal and external aspects of the system, establish a system model of technological innovation dynamics of drilling waste disposal, and give the initial values of the simulation model. This will reduce the pollution of the environment and enhance the competitiveness of enterprises. Drilling waste treatment technology is getting increased attention, but at this stage, there is no suitable technology innovation mechanism for drilling waste treatment. Through the simulation trend chart obtained by sensitivity analysis, the key factors in the system are found, and the innovation power mechanism of drilling waste treatment technology is constructed, which provides a basis for the formulation of enterprise technological innovation strategies and the development of technological innovation activities. Research on the dynamic mechanism of drilling waste treatment technology innovation explores a waste treatment mechanism suitable for the drilling industry, so as to promote the steady development of the drilling industry and at the same time provide theoretical support for the treatment of drilling engineering waste.

1. Introduction

Along with the rapid development of the national economy, the demand for energy by self-production has long been unable to meet, and domestic oil and gas enterprises have gone abroad for overseas oil and gas exploration, development, and production to obtain the oil and gas resources of resource countries [1]. Oil drilling production has the characteristics of field-independent operation, mobility, and complex environment. Drilling fluid (or drilling flushing fluid), commonly known as mud, is a medium consisting of the liquid phase, solid phase, and chemical treatment agent used for circulating and flushing in the borehole, which is continuously circulated through the surface and downhole and has the functions of carrying rock chips to the surface,

cleaning the bottom of the well, cooling and lubricating the drill bit, and balancing the formation pressure to ensure the safety of the well so as not to cause downhole accidents and to ensure that it can be operated continuously downhole [2]. Many foreign research departments have conducted a lot of research work on drilling fluids and achieved fruitful results, confirming that the chromium, lead, benzene, and arsenic contained in them can cause damage to people and the environment. The following are a few foreign drilling waste fluid treatment technologies.

According to the current actual situation of drilling waste treatment, considering the obstacles of technological innovation in drilling waste treatment, system dynamics theory is selected and combined with incentive and constraint theory, to analyze the factors affecting technological

innovation dynamics from both internal and external aspects of the system, establish a model of technological innovation dynamics system of drilling waste treatment, and give the initial value of the simulation model. Based on this model, we establish the technological innovation dynamics mechanism of drilling waste treatment and provide a theoretical basis and suggestions for technological innovation of drilling waste treatment, to reduce the pollution of drilling waste to the environment and enhance the competitiveness of enterprises [3]. Comparing the characteristics of drilling waste treatment technology, it is recognized that drilling waste treatment technology needs innovative breakthroughs to create good economic and social benefits for enterprises and society under the premise of meeting the requirements of reduction, harmlessness, and resourcefulness [4]. This study has certain theoretical exploration and practical application, based on incentive constraint theory and system dynamics theory, and is closely integrated with the characteristics of current drilling waste treatment technology to build a dynamic mechanism for technological innovation in drilling waste treatment, which is of profound practical significance.

It can be seen from the comprehensive research on drilling waste treatment technology at home and abroad that scholars at home and abroad have a lot of research on the technology and principles of drilling waste treatment, but at this stage, the treatment of waste has not been completely harmless and resourceful. Secondary pollution will occur during and after the treatment, so the drilling waste treatment technology urgently needs innovation. The first section of this paper introduces the research background and significance of computer simulation optimization algorithm in drilling engineering waste treatment, and at the same time, it describes the research route of this paper. The second section tells the status quo of domestic and foreign-related research, and the key direction of this paper is obtained through analysis. The third section builds an optimization model of drilling waste treatment based on computer simulation optimization algorithm and designs a drilling waste treatment system at the same time. We used the system dynamics modeling method to analyze the causal relationship between the abovementioned dynamic factors and their derived factors, establish a technological innovation system dynamics model, and draw a stock-flow diagram. The fourth section builds a technological innovation power mechanism based on related theories and the reality of drilling waste treatment, analyzes the interlayer and interlayer relationships of each structural layer that constitutes the power mechanism, and finally analyzes the operation mechanism of the power mechanism and conducts drilling waste treatment simulation of the technological innovation power system. The last section is the summary and outlook. On the basis of summarizing the work of the paper, the problems of the model proposed in the paper are analyzed in depth, and the future research and development of drilling engineering waste treatment models based on computer simulation optimization algorithms are prospected. This article establishes a dynamic mechanism for drilling waste treatment technology innovation to provide theoretical basis and

suggestions for drilling waste treatment technology innovation, so as to reduce the pollution of drilling waste to the environment and enhance the competitiveness of enterprises.

2. Related Research Work

The in-pit sealing method proposed by Gao is to seal the waste drill cuttings and drilling fluids in a fixed area, which is essentially the current hazardous waste landfill method [5]. The toxicity of toxic and hazardous substances and heavy metals in the treated waste drill cuttings and waste drilling fluids is not changed, but there is only a transfer of hazards, which cannot achieve the effect of harmless treatment. The key to this technology is to ensure tight sealing, no leakage, and prevention of rain and formation water immersion, and at present, water-based rock chip treatment is not used in China because of the high treatment cost [6]. Drill chip reinjection technology is to inject waste drilling fluid and waste drill chips into the annular space or safety stratum after slurring, which is a new technology that has been paid much attention to in recent years [7]. In a typical drill cuttings injection operation into a safe formation, waste drill cuttings are mixed with seawater and made into a stable viscous slurry by grinding treatment or other mechanical action, after which they are pumped downhole through a special treatment well or pumped downhole through the annular space between casing columns in production well and then pressurized to enter the formation [8]. This treatment method requires that a hydraulically fractured fracture be pressed into the formation to effectively contain the drilling fluid. At the end of the injection, the well or annulus is sealed with cement. This technique is more demanding and expensive to treat, and the drill cuttings reinjection technique may cause contamination to groundwater or the formation; for example, during drill cuttings reinjection, the reinjected slurry may leak through natural fractures, hydraulically fractured fractures, and poorly cemented parts of the well, thus causing contamination to groundwater and the formation [9].

The centralized treatment method is a common treatment method used in developed countries such as the United States. By professional solid waste treatment companies, the generated waste drilling chips and waste drilling fluids are transported away from the drilling site to a centralized treatment plant. This method can eliminate the drilling fluid sinkhole, oil-based drilling waste management is mostly used in this method, and the treatment cost of this method is determined according to the degree of the environmental impact of pollutants and the size of the hazard [10]. The cost of this method varies according to the degree of environmental impact and hazard, and it has a greater economic advantage and industrial value for blocks with more concentrated drilling operations. Drilling waste treatment methods include in situ discharge, in-pit sealing, backfill treatment, curing treatment, biodegradation, MTC conversion, injection into the wellbore annulus or safe strata, and land cultivation [11]. Among them, curing treatment is the most researched and widely used, and the process is

characterized by strong water absorption, short cycle time, easy construction, and low cost [12]. Stabilization/solidification treatment can immobilize heavy metals, petroleum, and other contaminants in them, eliminating or reducing their diffusion, migration, and percolation, thus making them more environmentally compatible. Cao et al. developed a technique for enhanced cement stabilization of high-salt wastes that can increase the amount of waste treated and reduce the leaching level of cured material [13]. Pirbhulal et al. developed a microencapsulation technique of high-salt wastes where the material reacts at room temperature to form Si-O-Si bonds with organic compounds [14]. Paul et al. used cement mortar stabilization to treat Na Cl⁻ containing drill cuttings from offshore drilling and found that mixing low doses of phosphate in the cement mortar reduced the salt leaching rate [15].

Glass curing technology is based on glass materials as the curing substrate and the use of high-temperature calcination of waste into oxide. We add glass materials and melt the two and sintered into a glass body at a temperature of more than 1000°C to achieve the curing of waste. Glass curing technology has converted the waste components into glass components, which is the best curing of waste treatment, and the treatment of curing body pollutant leaching rate is the lowest, which is the best waste reduction effect [16]. However, the disadvantages of glass curing technology are as follows: the process is complex, high equipment material is required, in the treatment process, there is a high-temperature operation, there is a waste of energy while generating a variety of pollutant gases, there is a pollutant transfer problem, the comprehensive treatment costs are high, and it is difficult to carry out the large-scale hazardous waste treatment. Composite curing technology uses a variety of inorganic compounds to form a curing agent for the treatment of drilling waste; compared to the single-component curing agent, it has a good curing effect. Compound curing technology is used to treat the waste solid phase in three stages: coalescence, development, and aging. The first compound curing agent is added to the waste after mixing; curing agent particles absorb water (hydrolysis, dehydration, and agglomeration of clay); then, the other components continue to absorb water, and there is a hydration reaction to generate insoluble crystals and gradually develop; finally, curing system stability gradually increased, the strength continues to grow until the curing agent exhaustion, and the reaction is over.

3. Computer Simulation Optimization Algorithm Engineering Waste Treatment Analysis

3.1. Computer Simulation Optimization Algorithm Design. The main goal of factor analysis is to reduce the dimensionality of many variables and find common factors. The basic principle is to investigate the internal dependencies among variables by statistically analyzing observable variables and attribute variables with high correlation to several potentially unobservable composite variables. Factor analysis

methods mainly include exploratory factor analysis (EFA) and confirmatory factor analysis (CFA). Both methods are based on the factor analysis model, and the purpose of representing observable variables with a few variables is achieved by examining numerous variables [17]. The exploratory factor analysis is a process in which the number of influential factors is not known before the analysis, statistical software is used to analyze the factors based on the obtained sample data (observable variables), and the factors are finally derived from the factor loadings, usually using SPSS software. The confirmatory factor analysis is a process in which the number of common factors is determined in advance, and each factor is assumed to correspond to a specific number of observable variables. The factor structure is checked for consistency with the observed data, usually using AMOS software. In doing a study on the dynamics of technological innovation in drilling waste disposal, exploratory factor analysis (EFA) is used because the number of influencing factors cannot be determined in advance.

Each variable in the factor analysis model is a linear combination of a set of factors. N samples are selected from the overall sample, each with P being observed variables that can be standardized, and X_1, X_2, \dots, X_P denoted F_1, F_2, \dots, F_m ($m < P$) where F_m is an unobservable variable.

The special factors $\delta = (\delta_1, \delta_2, \delta_3, \dots, \delta_m)^P$ and vector F are independent of each other, and $\delta_m = 0$. The covariance array $\text{cov}(\delta)$ is a diagonal array; i.e.,

$$\text{cov}(\delta) = \sum \begin{bmatrix} \beta_{11}^2 & 0 & 0 \\ 1 & \beta_{11}^2 & 1 \\ 1 & 1 & \beta_{11}^2 \end{bmatrix}. \quad (1)$$

The observed variables can be expressed as linear combinations of the factors.

$$G = \begin{cases} a_{11}F_1 + a_{12}F_2 + \dots + a_{1m}F_m + \delta_1 \\ a_{21}F_1 + a_{22}F_2 + \dots + a_{2m}F_m + \delta_2 \\ a_{p1}F_1 + a_{p2}F_2 + \dots + a_{pm}F_m + \delta_p \end{cases} \quad (2)$$

The data are collected according to the actual situation, and to make the data available for statistical analysis under equal conditions and the results of the analysis reasonable and valid, the collected data are standardized before the statistical analysis is performed [18]. A prerequisite for factor analysis is the requirement of correlation between many original variables, so it is necessary to calculate the correlation coefficient matrix for correlation analysis of observed variables before factor analysis. A sample of n is selected, with P being observed variables in each sample, and the original data matrix is

$$X = \begin{cases} a_{11}F_1^2 + a_{12}F_2^2 + \dots + a_{1m}F_m^2 + \delta_1^2 \\ a_{21}F_1^3 + a_{22}F_2^3 + \dots + a_{2m}F_m^3 + \delta_2^3 \\ a_{p1}F_1 + a_{p2}F_2 + \dots + a_{pm}F_m + \delta_p \end{cases} \quad (3)$$

Let the correlation matrix be

$$R = \begin{cases} a_{11}^2 F_1^2 + a_{12} F_2^2 + \dots + a_{1m} F_m^2 + \delta_1^2 \\ a_{21}^2 F_1^3 + a_{22} F_2^3 + \dots + a_{2m} F_m^3 + \delta_2^3 \\ a_{p1}^2 F_1 + a_{p2} F_2 + \dots + a_{pm} F_m + \delta_p \end{cases} \quad (4)$$

Correlation coefficients in the matrix are

$$r_{ij} = \frac{\sum_{i,j} (P_{ij} - R)(P_{ij} + R)^2}{\sum_{i,j} (P_{ij} + R)^3 (P_{ij} - R)^2}. \quad (5)$$

The oil industry is currently in a period of rapid development, with total oil and gas production increasing year by year and sales and profits reaching record levels. However, the process of oil exploration and development will produce a large amount of waste that will pollute the environment, and environmental damage will affect the development of the oil industry.

With the general increase in environmental awareness and the increasing improvement of national laws and regulations, legislation concerning environmental protection in the exploration and development of the petroleum industry has gradually increased. The introduction of national and local environmental protection laws can improve the environment to a certain extent, but it will subsequently increase the cost of oil and gas extraction companies in the waste disposal and the cost of good construction. The old drilling waste treatment technology can no longer meet the oil and gas extraction companies' pursuit of maximizing economic, social, and environmental benefits, and how to obtain applicable treatment technology is a difficult problem currently plaguing the oil industry.

This paper focuses on the research and development of drilling waste treatment technology for oil and gas exploration companies, as well as government, research institutes, and universities. All parties involved working together to promote further breakthroughs in treatment technology, reduce the impact of drilling waste treatment on the development of oil and gas exploration companies, fundamentally solve the environmental hazards of drilling waste and reduce the resulting economic losses, and promote the stable development of the entire oil industry, as shown in Figure 1.

As an important part of the oil industry, drilling waste treatment plays an important role in accelerating the improvement of environmental quality and promoting the rapid development of the oil industry. The technological innovation of drilling waste treatment is based on the premise of harmless and resourceful treatment under the premise of meeting the existing environmental protection laws and regulations and focuses on technology application due to the large number of parties involved. The external driving force mainly includes government support, improvement of environmental protection laws and regulations, and promotion of environmental benefits. The proposed mechanism of technological innovation in drilling waste treatment is because the existing treatment technology cannot meet the requirements of harmless and resourceful waste treatment, and enterprises pursue benefits while

drilling waste treatment will consume a lot of human, material, and financial resources and may not necessarily obtain good returns.

The high-pass acceleration channel simulates the platform instantaneous overload acceleration. In the filter selection, considering the low-frequency signal in the simulation process will make the electric cylinder produce larger travel, so the simulation process high-pass acceleration channel, using third-order high-pass filter, filters out other frequency signals. Leaving only the high-frequency acceleration signal, the transfer function expression is

$$H_{ah} = \frac{s^3}{(s + w_m)(s^2 + 2w_{ak}s)}. \quad (6)$$

The technological innovation of drilling waste treatment is an application innovation, which focuses on solving the problem of environmental pollution by waste encountered in the process of oil industry exploration and development to ensure the sustainable development of the oil industry. Depending on the location of the well site, geological conditions, climatic conditions, and ecological environment, the process, equipment, and materials required for oil industry exploration and development are different, resulting in certain differences in waste treatment technologies, such as different base fluids and treatment agents in drilling fluids used in different geological conditions, and different treatment technologies required for the used waste drilling fluids. This makes the drilling waste treatment technology poorly versatile.

The proportional limit is usually adjusted using the linear method of limiting and the nonlinear method of bringing in a polynomial of the cubic function, and the linear limit is controlled by the two gain parameters k_1 and k_2 .

$$f_{AA} = k_1 k_2 f_A. \quad (7)$$

The contribution of the i -th composite factor is

$$d_i = \chi * \sum \chi_i. \quad (8)$$

The cumulative variance contribution of the first m common factors is

$$\partial(k) = \sum \chi_i * \sum \zeta_i. \quad (9)$$

Factor rotation is required when the derived factors are not representative and difficult to express realistic meanings, generally using rotational orthogonal and oblique rotations. Through factor rotation, the expert factors are finally identified and renamed and reinterpreted based on the combined significance of several variables with larger weights in the linear combination. After determining the principal factors, the position of each factor in the overall model has to be evaluated. This entails calculating the factor scores of the sample by the variables.

$$F_m = \sum d_i \sum \zeta_i \chi_i. \quad (10)$$

F_m is the score of the m -th sample at the i -th common factor.

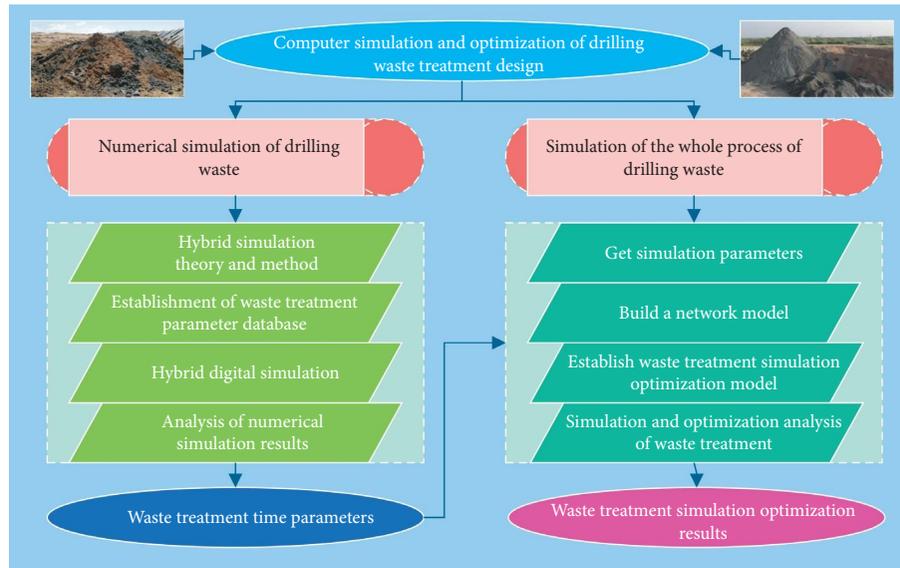


FIGURE 1: Computer simulation to optimize the design.

It provides an important theoretical basis and research methods for exploring the study of the dynamics of technological innovation out of drilling abandonment; again, it introduces the incentive constraint theory, including the basic concepts of incentive constraint theory and the incentive constraint theory in management and economics, which provides a certain theoretical basis for the study.

3.2. Experimental Design of Drilling Engineering Waste Treatment. The uniqueness of technological innovation in drilling waste treatment itself is that it is not primarily aimed at maximizing profit, is predicated on meeting environmental regulations to protect the environment, is predicated on a large number of high-technology personnel, and requires significant investment in research and development, leading to increasing difficulty in technological innovation in treatment. Studying the literature of domestic and foreign scholars on technological innovation can show that internal factors of technological innovation also play an important role. In this paper, we propose the following internal factors that influence technological innovation, taking into account the characteristics of drilling waste treatment technology itself.

Talent is a high-quality worker who has certain professional knowledge and skills and a good personality, who can achieve results through creative work and contribute to the development of society in a certain field. The survival and development of the enterprise cannot be separated from the enterprise's reliance on talents. With the rapid development of today's society and the changing market situation, the competition among enterprises is evolving into the competition of talents, as talents are the source of sustainable development of the enterprise. Research and development talents have an important role in the process of technological innovation and influence the whole process of technological innovation.

As one of the most important concerns of the employees, the remuneration package is a basic guarantee for the employees to devote themselves to their work. To improve the innovation ability of drilling waste treatment technology, we need to start from the research and development ability of employees, and to retain the employees with high research and development ability, we need to have the corresponding remuneration package. Remuneration is the most direct motivation for employees to carry out technological innovation, which can enhance the enthusiasm of employees for technological innovation. Improving the treatment of employees is the core issue of the company, not just talking about corporate culture, team building, etc. China's oil and gas extraction enterprises, to carry out technological innovation in drilling waste treatment, need to establish a team of employees with high R&D capabilities. And to retain high-quality talent, remove redundancy, and enhance the team's innovation ability, it is necessary to improve employee compensation, from enhancing the enthusiasm of employee technological innovation, to enhance the enterprise's technological innovation ability. This has led to a shortage of high-quality technical innovation talents, a lack of R&D personnel who can independently undertake innovation projects, and a lack of technical leaders who can solve key problems of technical innovation. In the area of drilling waste treatment technology, the same problem of insufficient training of technical innovation talents exists. Therefore, oil and gas extraction enterprises should strengthen the learning and training of employees and establish a mechanism that can effectively disseminate, share, and acquire knowledge, so that employees can easily and quickly access information and develop an innovative culture of self-learning to promote technological innovation, shorten innovation time, and improve innovation efficiency. The specific simulation flow of the evolution of waste recycling is shown in Figure 2.

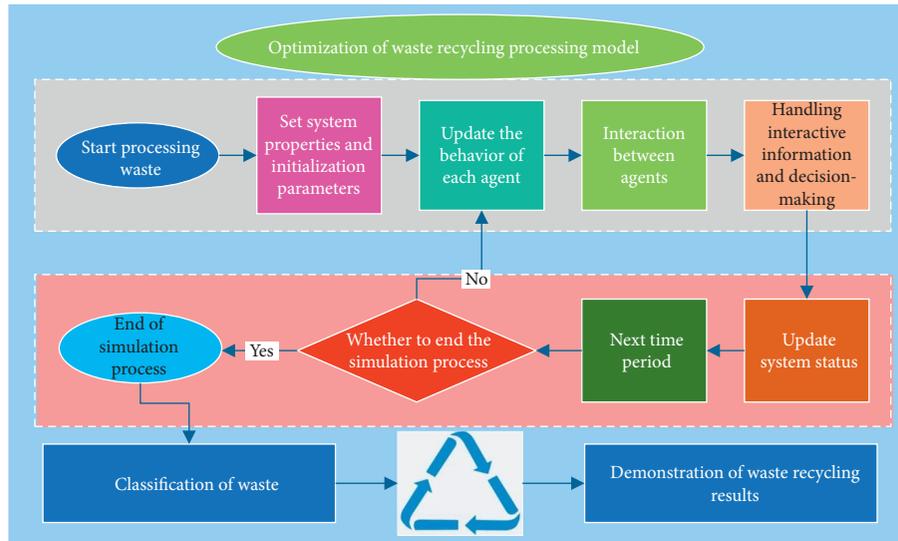


FIGURE 2: Simulation flow of the evolution model of waste recycling and treatment channels.

The output results of the simulation model depend on the input parameters, and different initial values of the simulation input parameters may lead to completely different simulation output results [19]. To make the simulation results more consistent with reality, the initial values of simulation parameters in this study are mainly obtained through actual surveys and then simplified in equal proportions according to the survey data. Some parameters are also determined through scenario assumptions, or based on other simulation parameters, the approximate range of input parameters is determined through the equilibrium state of the simulation model.

The active learning ability, adaptive capacity, and interactive activities with the external environment of microscopic individuals in the model are the direct drivers that eventually shape the dynamic evolution of the system. It is an innovation for us to apply the research method of computational experiments in exploring the evolution of recycling and disposal channels of e-waste. The influence of multiple factors and different parameter value settings will eventually produce different experimental results, and we need to conduct several repetitive experiments to dissect the laws of the dynamic evolution of the simulation model. In the following, according to the discussion of the initial values of parameters, we set different parameter values to observe the evolution of e-waste recycling and disposal channels, respectively. In several experiments, we set the same ratio of parameters with an increasing number of parameters to observe the system evolution. Further studies can consider different parameter ratios, a larger number of subjects, etc., to observe different experimental results.

The distribution of each subject in the two-dimensional world at the beginning of the model, during the run, and at the end of the run is shown in Figure 3, respectively. The number and location of formal recycling companies are randomly scattered in the model at the beginning and

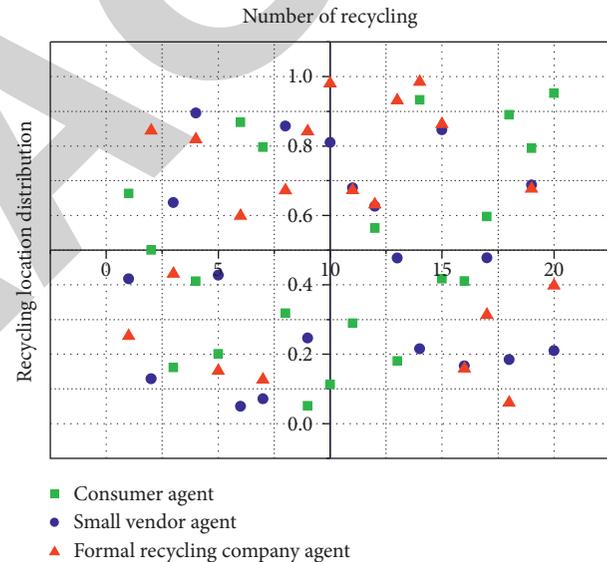


FIGURE 3: Distribution of subjects in the model.

remain constant during the run. The number and location of vendors change continuously as they travel around the model, and as they exit and enter recycling.

Formal recycling enterprises are in different cycles of operation. When the model first started to run, due to the dominance of small vendors in e-waste recycling, the number of e-waste recovered by formal enterprises is small. But to dismantle and process it, or to start large processing equipment and high-end processing technology, the cost is huge, the income does not cover the expenses, and it is difficult to make a profit. Therefore, the formal recycling enterprises will start by reducing costs, part of the profits as research and development investment, and the development of more advanced processing equipment and processing technology.

Reliability refers to the degree of consistency of the results obtained when the same method is used to measure the same object repeatedly, in this case, the reliability of the scale data. When the measurement object is repeatedly measured, the systematic error does not affect the measured results, but mainly the influence of random error causes the reliability to decrease [20–24]. Only when the measurement results are consistent with the true value or very small difference, the reliability of the measured results is high, to ensure the authenticity and reliability of the scale and avoid the impact on the analysis results, so the scale needs to be tested for reliability. The main methods of reliability testing are replicate reliability, retest reliability, and internal consistency reliability. Parallel-form reliability is to use two questionnaires with similar content and difficulty for the same group of respondents to conduct two surveys successively and get the correlation degree of the two survey results [25]. The higher the degree of correlation, the higher the reliability and the more reliable the measurement results. Although there are advantages of higher accuracy of replicate reliability, because it is difficult to design two highly similar scales, and two surveys will reduce the motivation of the respondents, replicate reliability also has some limitations, mainly for follow-up studies [26].

4. Analysis of Results

4.1. Analysis of Simulation Optimization Algorithm Results. Validity refers to the degree to which a measurement instrument can accurately measure what is to be measured and is expressed as the degree of validity of the measurement results, mainly divided into content-related validity, construct-related validity, and criterion-related validity. Content validity refers to the applicability of the test questions to the content or behavioral sample in question, thus determining whether the test is a representative sample of the behavioral domain to be measured. Correlation analyses were first conducted on the measured variables, which are not listed here for reasons of space. The 6 measurement factors were further analyzed, and the results are shown in Figure 4.

From Figure 4, the common degree among the influencing factors is basically above 0.6, which is a high common degree, indicating a close relationship and a good factor extraction effect. Then, the eigenvalue and cumulative contribution rate of each factor were calculated, the number of common factors was selected based on the factor loading matrix, and the common factors with eigenvalue (Eigenvalue) >1 and cumulative contribution rate (Cumulative %) >70% were chosen.

The first column of the factor contribution table is the factor number, followed by a group of three columns: the first group is the initial eigenvalue, the second group is the extracted square loading, and the third group is the rotated square and loading. Each group has the total, variance contribution, and cumulative variance contribution. It can be seen from the table that the eigenvalue and eigenfactor root of the first factor are greater than the extracted factors, and the cumulative contribution rate meets the

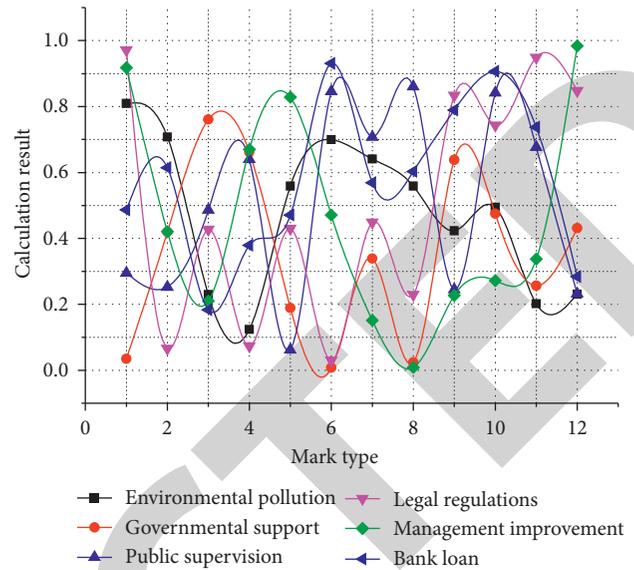


FIGURE 4: Calculation results of common factor variance.

requirements, and a factor is extracted from 6 variables as a common factor that can explain the scale and contribute a lot to explain the original measured variables, as shown in Figure 5.

The calculation result of the EROI method is different from that of DCF, the evaluation result of EROI is almost not affected by oil price, and its decreasing trend indicates that the net energy output of oilfield is decreasing year by year, which truly reflects the actual situation of decreasing net energy, as shown in Figure 6, and its contribution to social and economic development is decreasing. The future production planning of Daqing oilfield is arranged according to the calculation results of the DCF method. Through the example study, it is further argued that the value is multi-dimensional, and the value of energy and material dimensions has the same important role as the value of economic dimensions and should not only focus on the evaluation of economic value dimensions but also evaluate the energy resource development from multiple dimensions.

To construct the metabolic theory of energy resource development, this section firstly explores the essence of energy resource development, the energy resource development system is the intermediary between the socioeconomic system and the natural system, which is a dissipative structure, and the essence of energy resources is the potential entropy increase capacity, which is a low entropy resource; secondly, it analyzes the essence of metabolism, which is essentially the process of generating entropy increase, absorbing low entropy resources, and excluding entropy increase. In this way, the feasibility of constructing a metabolic theory of energy resource development is argued from the development of metabolic theory, and the definition, connotation, main research content, and conceptual model of energy resource development metabolism are given. Based on the metabolic theory of energy resource development, the value is recognized, the value is multidimensional, and the methodological system of energy resource development and metabolism is

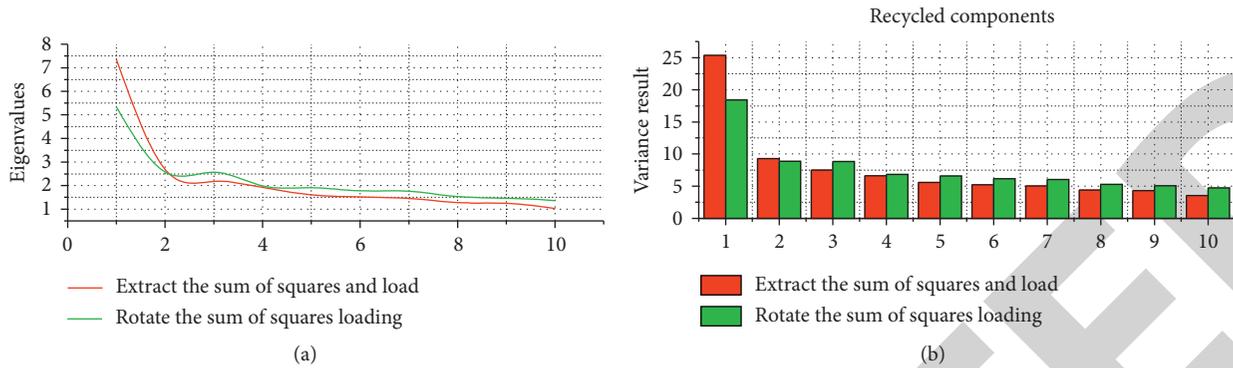


FIGURE 5: Eigenvalues and variance contribution rate.

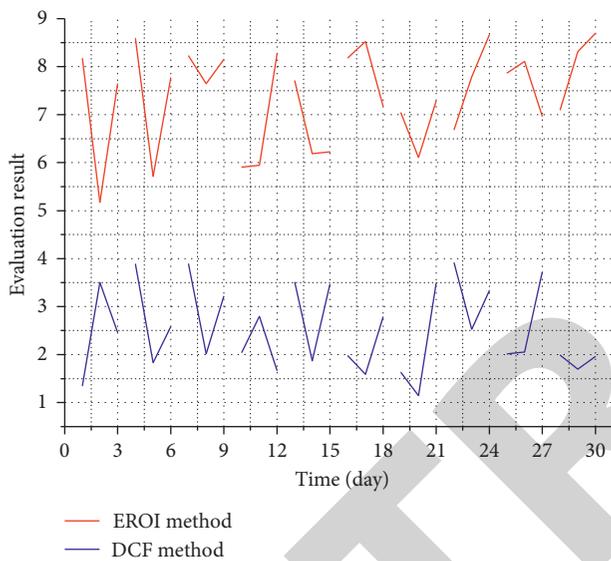


FIGURE 6: Calculated optimization results.

depicted. It is proposed that at the early stage of the development of the metabolic theory of energy resources development, the research should focus on the basic contents to lay the foundation for further development in the future.

4.2. Analysis of Experimental Results. The formulation of a high-strength curing system has a good effect on the treatment of tight oil and gas drilling waste. The 28 d unconfined compressive strength of the system is close to 40 MPa, and the waste treatment rate is about 70%, which meets the dual requirements of high strength and high treatment efficiency. However, the strength of the cured waste will change with the change of curing age, forming pressure and soaking conditions during the curing process. Meanwhile, the downhole conditions of tight oil and gas drilling are complex and changeable, and the change of reservoir lithology and drilling fluid composition will lead to a significant change of solid-phase composition of the cured waste, which will affect the final strength of the cured system.

Therefore, studying the influencing factors of drilling waste curing can not only guide the implementation of the high-strength curing process but also study the influencing rules of curing strength of drilling waste formed under different reservoir lithology and different drilling fluid systems and improve the adaptability of the high-strength curing process.

The curing system molding pressure has a large impact on the compressive strength of the specimen, which is related to the density of the cured specimen and the compactness between the solid particles. The optimized curing system formulation was used in the experiments, and the specimens were pressed at 1 MPa, 4 MPa, 6 MPa, 8 MPa, and 10 MPa for 3 min and cured for 14 d under natural conditions to test the compressive strength of the specimens. The results are shown in Figure 7. When the molding pressure was increased within a certain range, the compressive strength of the cured specimens increased significantly. When the molding pressure was 1 MPa, the specimen structure was loose and the solid particles were not in close contact with each other, and the hydration reaction was not sufficient, resulting in a 14 d compressive strength of 31.18 MPa. When the molding pressure was 3 and 6 MPa, the specimen strength increased significantly, and the 14 d strength increased to 37 at 6 MPa, which was 19.02% higher than that at 2 MPa. However, the difference between the two is not large, indicating that the molding pressure of 3–5 MPa particle spacing is appropriate, the hydration reaction is more adequate, while the pressing has not caused the formation of a certain mechanical strength between the solid particles. When the molding pressure is increased to 7 and 10 MPa, the strength of cured specimens further increased. At the early stage, high mechanical strength is formed, a hydration reaction is complete, the molding pressure is 10 MPa, and the specimens are about to reach high strength at 5 d. At 10 MPa, the specimens reached a very high strength at about 5 d, and at the later stage, the compressive strength reached 43.04 MPa at 14 d. The increase in molding pressure from 1 MPa to 10 MPa increased the strength by 38.04%. The increase in molding pressure can effectively increase the elastic-plastic deformation of the solid particles, make the solid particles move closer to each other, increase the contact

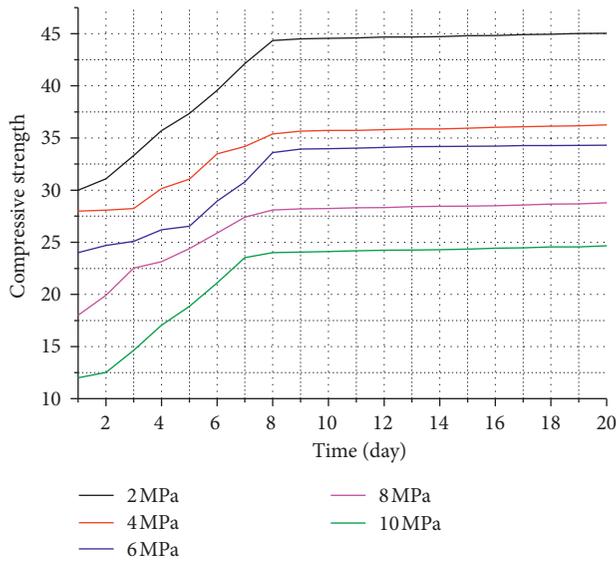


FIGURE 7: Variation of the strength of cured specimen with molding pressure.

surface of the hydration reaction, reduce the porosity of the specimen and the density of the structure, improve its mechanical strength, and effectively improve the overall compressive strength of the cured specimen, as shown in Figure 7.

The main magnesium chloride material used in the high-strength curing system for drilling waste has poor water resistance, and its water resistance needs to be evaluated after modification to analyze the effect of immersion on strength. In the experiments, the specimens were immersed in pH = 7 water, pH = 10 NaOH solution, pH = 4 HCl, and H₂SO₄ solution to simulate a neutral water environment and weak acid and weak alkali environment after 7 d of system maintenance, and the results of strength change after 7 d of immersion are shown in Figure 8.

Using IOT technology, SQL-Server database, and C# language, we developed an overseas drilling site HSE risk grading management system to realize online risk list filling and risk list sharing by overseas drilling site personnel and promote good risk grading prevention and control work. The strength of the cured specimens decreased significantly after soaking and decreased with the extension of soaking time, but the decrease was small. The strength of the specimens decreased most slowly in the HCl solution, and Cl inhibited the hydrolysis of the hydration products to a certain extent, while OH⁻ and SO₄²⁻ in the NaOH and H₂SO₄ solutions promoted the precipitation of Mg²⁺ and the hydrolysis of the hydration products. Soaking had a large negative impact on the compressive strength of the cured system, promoting the decomposition of the hydration products in the system and destroying a part of the strength structure in the specimen, which still retained a certain strength after soaking.

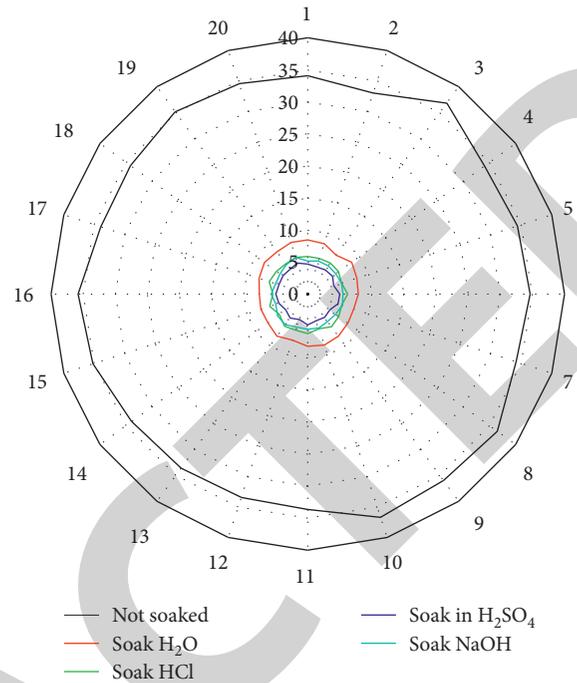


FIGURE 8: Variation of the strength of cured specimens with soaking time.

5. Conclusion

In this paper, we apply the system thinking to explore the dynamic factors affecting technological innovation, extract the key factors affecting technological innovation dynamics, draw the causal loop diagram and a stock-flow diagram for technological innovation dynamics combined with system dynamics, conduct simulation, and finally construct the technological innovation dynamics mechanism. Starting from the feedback loop and cause and effect tree analysis, the interrelationships among the dynamic factors are analyzed and the stock-flow diagram is drawn. After determining the state variables, rate variables, auxiliary variables, and constants, the structural equations are written based on the relationships among the variables, and simulations are performed. Finally, the simulation trend diagram derived from the sensitivity analysis is used to find the key factors in the system. Based on the theoretical basis of system theory, factor analysis method, and system dynamics combined with the realistic basis of insufficient technological innovation of drilling waste treatment in oil and gas extraction enterprises, the mechanism of technological innovation dynamics of drilling waste treatment in oil and gas extraction enterprises is constructed and its operation mechanism is analyzed in detail. If it can be combined with specific enterprises or projects, it can better refine the technology innovation power mechanism, can verify the scientificity and reliability of the research results, and provide reference and reference for drilling waste treatment technology innovation activities.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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References

- [1] R. Bambura, E. Sujová, and H. Čierna, "Utilization of computer simulation for optimization of furniture production system," *BioResources*, vol. 15, no. 3, pp. 6752–6765, 2020.
- [2] Y. Yang, J. Wu, J. Lin, J. Wang, Z. Zhou, and J. Wu, "An efficient simulation-optimization approach for controlling seawater intrusion," *Journal of Coastal Research*, vol. 84, pp. 10–18, 2018.
- [3] W. Qian, J. Chai, Y. Qin, and Z. Xu, "Simulation-optimization model for estimating hydraulic conductivity: a numerical case study of the Lu Dila hydropower station in China," *Hydrogeology Journal*, vol. 27, no. 7, pp. 2595–2616, 2019.
- [4] P. Cao, Z. Chen, M. Liu, H. Cao, and B. Chen, "Numerical and experimental study of a novel aerodynamic foam breaker for foam drilling fluid," *Energy Science & Engineering*, vol. 7, no. 6, pp. 2410–2420, 2019.
- [5] D. Marini and J. R. Corney, "Process selection methodology for near net shape manufacturing," *The International Journal of Advanced Manufacturing Technology*, vol. 106, no. 5–6, pp. 1967–1987, 2020.
- [6] R. A. Laghari, J. Li, A. A. Laghari, and S.-Q. Wang, "A review on application of soft computing techniques in machining of particle reinforcement metal matrix composites," *Archives of Computational Methods in Engineering*, vol. 27, no. 5, pp. 1363–1377, 2020.
- [7] Z. Deng, L. Lv, W. Huang, and Y. Shi, "A high efficiency and low carbon oriented machining process route optimization model and its application," *International Journal of Precision Engineering and Manufacturing-Green Technology*, vol. 6, no. 1, pp. 23–41, 2019.
- [8] S. Jia, C. Wen, and B. Wu, "A nonlinear elasto-viscoplastic model for clayed rock and its application to stability analysis of nuclear waste repository," *Energy Science & Engineering*, vol. 8, no. 1, pp. 150–165, 2020.
- [9] L. G. Hernández-Pérez, L. F. Lira-Barragán, and J. M. Ponce-Ortega, "Hybrid multiobjective optimization using deterministic and metaheuristic techniques for flowback water reusing in hydraulic fracturing processes," *Industrial & Engineering Chemistry Research*, vol. 59, no. 34, pp. 15298–15308, 2020.
- [10] M. Ramezanzpour and M. Siavashi, "Application of SiO₂-water nanofluid to enhance oil recovery," *Journal of Thermal Analysis and Calorimetry*, vol. 135, no. 1, pp. 565–580, 2019.
- [11] M. S. Tavallali, F. Bakhtazma, A. Meymandpour, and I. A. Karimi, "Optimal drilling planning by considering the subsurface dynamics-combining the flexibilities of modeling and a reservoir simulator," *Industrial & Engineering Chemistry Research*, vol. 57, no. 48, pp. 16367–16378, 2018.
- [12] H. Bakhshandeh Amnieh, M. Hakimiyan Bidgoli, H. Mokhtari, and A. Aghajani Bazzazi, "Application of simulated annealing for optimization of blasting costs due to air overpressure constraints in open-pit mines," *Journal of Mining and Environment*, vol. 10, no. 4, pp. 903–916, 2019.
- [13] K. Cao, P. Siddhamshetty, Y. Ahn, R. Mukherjee, and J. S.-I. Kwon, "Economic model-based controller design framework for hydraulic fracturing to optimize shale gas production and water usage," *Industrial & Engineering Chemistry Research*, vol. 58, no. 27, pp. 12097–12115, 2019.
- [14] S. Pirbhulal, W. Wu, K. Muhammad, I. Mehmood, G. Li, and V. H. C. de Albuquerque, "Mobility enabled security for optimizing IoT based intelligent applications," *IEEE Network*, vol. 34, no. 2, pp. 72–77, 2020.
- [15] U. Paul, C. Karpf, and T. Schalk, "Hydraulic simulation of perforated pipe systems feeding vertical flow constructed wetlands," *Water Science and Technology*, vol. 77, no. 5, pp. 1431–1440, 2018.
- [16] F. Cui, J. Ni, Y. Du, Y. Zhao, and Y. Zhou, "Soil water content estimation using ground penetrating radar data via group intelligence optimization algorithms: an application in the Northern Shaanxi coal mining area," *Energy Exploration & Exploitation*, vol. 39, no. 1, pp. 318–335, 2021.
- [17] A. R. Dormishi, M. Ataei, R. Khaloo Kakaie, R. Mikaeil, and S. Shaffiee Haghshenas, "Performance evaluation of gang saw using hybrid ANFIS-DE and hybrid ANFIS-PSO algorithms," *Journal of Mining and Environment*, vol. 10, no. 2, pp. 543–557, 2019.
- [18] B. H. Husain and S. Askar, "Science and business," *International Journal*, vol. 5, no. 3, pp. 52–60, 2021.
- [19] X. Yao and G. Li, "Big spatial vector data management: a review," *Big Earth Data*, vol. 2, no. 1, pp. 108–129, 2018.
- [20] S. F. F. Mojtahedi, I. Ebtehaj, M. Hasanipanah, H. Bonakdari, and H. B. Amnieh, "Proposing a novel hybrid intelligent model for the simulation of particle size distribution resulting from blasting," *Engineering with Computers*, vol. 35, no. 1, pp. 47–56, 2019.
- [21] A. Seyfollahi and A. Ghaffari, "Reliable data dissemination for the internet of things using harris hawks optimization," *Peer-to-Peer Networking and Applications*, vol. 13, no. 6, pp. 1886–1902, 2020.
- [22] Q. Shi, B. Dong, T. He et al., "Progress in wearable electronics/ photonics-moving toward the era of artificial intelligence and internet of things," *InfoMat*, vol. 2, no. 6, pp. 1131–1162, 2020.
- [23] A. B. Kanase-Patil, A. P. Kaldate, S. D. Lokhande, H. Panchal, M. Suresh, and V. Priya, "A review of artificial intelligence-based optimization techniques for the sizing of integrated renewable energy systems in smart cities," *Environmental Technology Reviews*, vol. 9, no. 1, pp. 111–136, 2020.
- [24] B. Muthu, C. B. Sivaparthipan, G. Manogaran et al., "IOT based wearable sensor for diseases prediction and symptom analysis in healthcare sector," *Peer-to-Peer Networking and Applications*, vol. 13, no. 6, pp. 2123–2134, 2020.
- [25] X.-N. Bui, H. Nguyen, H.-A. Le, H.-B. Bui, and N.-H. Do, "Prediction of blast-induced air over-pressure in open-pit mine: assessment of different artificial intelligence techniques," *Natural Resources Research*, vol. 29, no. 2, pp. 571–591, 2020.
- [26] J. Huang, L. Wang, and Z. Jiang, "A method combining rules with genetic algorithm for minimizing makespan on a batch processing machine with preventive maintenance," *International Journal of Production Research*, vol. 58, no. 13, pp. 4086–4102, 2020.